NEXT GENERATION ARCHITECT

Terian Kate Le Compte

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How can architects work with value to optimise design?

Abstract

The stereotype of an architect is expensive, with minimal consideration and awareness towards cost and budget. This is damaging the reputation of the profession. This thesis will look at the Next Generation Architect who combines both design and construction to understand the cost implications from the start to the completion of the project. A Next Generation Architect works with an innovative approach that is more affordable to how they currently practice. They design houses that are both economical and retain a strong design quality, through the value of the aesthetics, materials and living conditions. An effective architect should be able to design, mindful of costs, along with the implications involved and actively manage the costs, based on design decisions made.

This research will commence by exploring tactics of affordability, housing economics, and costing and design tactics, to portray exemplars of affordable housing. Elements will be costed with data from QV costbuilder implemented through the use of Building information modeling (BIM) through Revit. The architectural value will explore the use of materials, living conditions, economics, and lifecycle to optimise the design. A series of precedents will be analysed to gain an understanding of the techniques of affordable methods used within New Zealand's construction industry.

This thesis aims to provide architecturally designed and preliminarily costed affordable architectural products. Through a series of architecturally designed standalone houses that explore affordability, and tested through the use of architecture as a product across four sites, displaying different site conditions of the Wellington region.

This thesis will portray efficient, economic building and design techniques and cost monitoring while retaining a strong architectural quality.

The aim is to convey the contemporary role of a Next Generation Architect who works accurately with value. Who is mindful of costs and designs economically, without compromising the quality of an architecturally designed product.

Motivation

Growing up around the construction industry, it has exposed me to several builders and their negative perspectives towards architects, and their ability to work towards a budget. In several conversations, I have heard tradespeople say architects can not design affordably. Their focus is predominantly on the bespoke quality rather than cost. This made me wonder how architecture could be practiced differently, giving architects the potential to achieve a more affordable design.

New Zealand's housing market is becoming increasingly more unaffordable, especially for those aspiring to be first-time homeowners. Land prices are a contributor to this strain. As standalone housing is the preferred type of housing for New Zealanders, it needs to be affordable. This can be achieved by monitoring design decisions made by an architect.

Scope

This research is limited to four sites within the Wellington region. Typical materials and construction methods investigated consist of standard timber framing, concrete and a hybrid combination. The value of affordability is calculated through an in-depth first cost estimate, considering the build-up of individual dwellings core elements, using relevant cost data for the Wellington region. Affordability will be further explored through basic lifecycle costing reviewing maintenance requirements and the lifespan of selected materials.

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01

Introduction

“Affordable housing of the 1940s and 1950s – the single detached dwelling funded by the state for rent or purchase has become an iconic part of New Zealand’s heritage.”

Bierre, Howden-Chapman & Early, 2013, p.7

“Just because it’s small in floor area doesn’t mean it should be lacking in beauty, design, rigour or comfort....Whether it’s material wastage, human error or altered timelines, everything has a cumulative cost implication.”

Foster, 2015 p.29

New Zealand's housing market is currently facing problems considered similar to those of the past, although these problems are faced with additional challenges. These include; widening income inequalities. An increasing number of people both live and work in urban areas, where there is a short supply of quality affordable houses to rent and buy in (Bierre, Howden-Chapman & Early, 2013). The average New Zealand house costs approximately 8.8 times the annual wage which has dropped slightly from the previous 9.2. This figure sat at 3.0 during the early 1990's (Chatson, 2019).

The contributing factors to the strain on affordable housing in New Zealand are land prices in conjunction with council fees, consents, infrastructure and preparation (Beveridge, 2016). Due to these constraints, home ownership rates have declined from 78% in 1986 to 63.2% in March 2019 (Church, 2019).

Historically New Zealand's existing housing stock was made up primarily of three-bedroom standalone houses on large properties, typically referred to as the "quarter acre lot". The traditional characteristics of standalone housing is a timber framed weatherboard home, derived from the 1930's which is seen as cost effective in terms of construction and maintenance costs (Bierre et al., 2013). New Zealanders enjoy standalone housing, as it is part of the suburban lifestyle, with there being little incentive for the detached housing market changing to medium density. (Beveridge, 2016)

Many New Zealanders dream of home ownership, as it symbolises success within our New Zealand culture. Eaquib and Eaquib (2015) state: "Owning one's own home has been a rite of passage for generations of New Zealanders. Home ownership has long offered financial security and played a central role in our national identity" (p.7). As New Zealanders we should have access to high quality affordable housing. This is needed to cater for aspiring homeowners, at a cost that doesn't involve sacrificing increasingly large amounts of their incomes to do so. Quality housing shouldn't be compromised by short term cost considerations of a cheaper build. Choosing a sustainable build that has a larger upfront cost, reduces the consequences related to health, schooling, productivity and over all wellbeing (Bierre et al., 2013).

Stereotypically architects are known as being expensive with minimal consideration and awareness towards cost and budget. Effective architects should be able to design mindful of costs. Understanding what is feasible within a project from the beginning, and directing clients into correct decisions. Architectural services do come at a price, however, what people forget is that this fee is only a small proportion of the construction cost, with the cost of an architect outweighing the added value of a project. The NZIA (2017) states, "You engage an architect to maximise the possibilities of your brief and make the most of your budget." (p.7). But how come so many projects do come in over budget? Too often compromises have to be made for cost cutbacks. Which creates reworks for the architect, and additional time to a project. This is damaging the reputation of an architect.

This research is framed by the question:

How can architects work with value to optimise design?

Figure 1.01 Methodology Diagram

Methodology

This research implements the methodology of design-led research. This allows designs to contain both iterative and reflective processes. The methodology of design research is seen through Jane Rendell's approach, used throughout; "instead of posing research questions and then finding answers, in much design research the process operates through generative modes, producing works at the outset that maybe reflected upon later" (Rendell, 2013, p.117).

Questions are raised throughout design process; this is perceived within Perry Kupler's design approach. "When working on a project, I raise specific questions about the sequence of design decisions – some questions matter now, some matter later; perhaps some matter now and later or never. In this constantly shifting terrain, I tailor visualisation techniques and design methods to explore a fit between what is being worked on, when it is being worked on, and how it is being worked on" (Kupler, 2003, p.59).

An investigation into key precedents and literature is introduced at the beginning of each design phase influencing new pathways for design. This provides an understanding into design principles surrounding value within the design, through economics, construction, materials, technology and how this has been successful in the past. The four design phases involve rigorous design tests and iterations to reach a final design. Key tools aiding this process include BIM through the use of Revit, QV costbuilder database and designing both physically and digitally. Designs are tested across four sites within the Wellington region to ensure designs are adaptable to several site conditions; considering orientation and site gradient. A reflective process occurs at the end of each design phase. Reflecting on the strengths and weaknesses of the findings, allowing for a framework to be set surrounding further development in the following design phases.

02

Architectural Profession

The Architecture Profession

Architects are engaged to maximise their client's brief and budget. However, stereotypes of the profession are breaking the trust between clients surrounding their awareness towards cost. To restore their reputation, architects need to work with an innovative approach, that is more affordable to how they currently practice.

Cost blowouts are a common occurrence within home building in New Zealand, although these cost implications can be minimised. Moller from *Grand Designs New Zealand* could only cite two projects that have met budget, with the majority of houses coming in over budget. Cost blowouts occur for various reasons, that are not always within the architect's control. These include material cost escalations, changes to local regulations and delays to building due to concerns about the plans. Moller (2019) suggests "building a house is much more complex than most people realise. There can be multiple reasons for cost blowouts" (as cited in Hawkes, 2019). Architects need to ensure clients expectations are realistic for their budget, and exactly what is included within the price and the implications of any remaining costs.

Architects' services alone do not produce the product many other professionals such as engineers, quantity surveyors and trades people intervene with the design and construction of the project. Cuff (1992) an architectural theorist states, "architectural products may become functionally superior to non-architectural ones... a building may be considered valuable to its owners, to its inhabitants, to real estate speculators, or to its locale, but it is specific to its site and programme." (P.32). Architectural design holds value unlike houses by developers do,. Bespoke and site-specific design clearly distinguishes architects from developer's cookie cutter projects, however can be seen as a target for wealthy clients and not the average person.

Architecture is a changing profession that has moved from hand drafting into the digital age and is moving into advanced technology such as BIM, virtual reality and digital fabrication. Deamer (2015) discusses architecture as a profession, with the tasks and daily lives of an architect in practice. Unlike traditional architecture, today's technology allows architects to be stretched geographically with communication directed through email, video conferencing and BIM. Deamer (2015) states, "Architecture and subcontractors are turning into a network working together, rather than traditionally separate roles in a chain" (p.xxviii). This allows collaboration across disciplines as a whole process.

“Expensive architects and their expensive schemes”

(London Deputy Mayor, 2013)

“Designers work to the best interest of the design, and not necessarily to the budget”

(Building Performance, 2016)

“So often homeowners commence work with an architect with a firm budget... they get it costed by a builder, and it’s 1.5 times, or double, or triple their budget.”

(Shead, 2015)

“Code of Professional Conduct hearings regularly hear complaints of architects failing to work to budget.”

(RIBA, 2018)

In architecture school we are taught to be aspirational designers considering the aesthetics rather than the cost implications involved with design. We gain minimal understanding of the costs of materials, construction techniques, and average floor area costs. This can come as a shock moving into practice.

The NZIA Agreement for Architects Services is a contract between the client and architect, protecting both parties from unforeseen circumstances. This agreement establishes the budget, location, programme and architects fee. Each stage contains inputs, tasks and deliverables that all parties must agree on with tasks appropriately delegated seen in figure 1.02. Costing sections are referred to a quantity surveyor for accurate estimates in the concept design, developed design and detailed design phases (NZIA, 2018). The architect is only in charge of the costing when the budget is established. They rely on a separate consultant to gain cost information, requiring additional fees. This is referred to as the number of consultants and trades people who 'clip the ticket', adding additional costs to the overall project.

Monastra (personal conversation, October 12, 2019) indicated through a personal conversation, a quantity surveyors' perspective of the diverse range of architects and tactics, surrounding awareness of value within a design project. Every architect displays different strengths. Some are good designers, others good administrators, while some are good at both. Generally, architects that are good administrators tend to be more conscious of cost. Architects must interpret their clients to understand their wants, needs and budget. The architect may have to educate them from the start of the project, if they are being over ambitious, which many clients can be, due to a lack of knowledge. Quantity surveyors typically give houses one cost estimate, unless they are over budget and these estimates become more accurate as a project proceeds such as at the tender documentation stage.

Figure 1.02 Example of a page of the NZIA Agreement for architects' services contract

Figure 1.03 Cost, Quality and Time Diagram

Typically two aspects are selected with a compromise in one aspect. Quality is generally prioritised by architects. To ensure at least two of these are met, a project must be carefully planned to stay on track, by minimising significant changes (Hawkes, 2019).

Typical Architect's Process

Costing phase diagram

Figure 1.04 Typical architect's design process costing phase diagram

Next Generation Architect's Process

Costing phase diagram

Figure 1.05 Next generation architects costing phase diagram

Design Phase One investigates economic precedents, site selection, plot arrangements and the conceptual design of a single dwelling testing initial tactics of affordability.

03

Initial Design

Warrander Studio

Tactics of Affordability

Warrander Studio, designed by Makers of Architecture, is a small-scale project located in Governors Bay, Christchurch. The studio uses new construction methods, including the use of CLT XLam panels made off site. The prefabricated nature reduces both construction waste and time, enabling the studio structure to be constructed on site within 3 days. This project was digitally designed and fabricated through the use of BIM, allowing for precise costing and CNC technologies (Foster, 2015).

- Total build cost only = \$130,000
- Additional Site Costs = \$25,000

Tactics of affordability:

- Prefabricated CLT Panels to reduce overall construction time to two months.
- Exposed material finishes.
- Small floor area which maximises the potential of each space.
- No wasted spaces, with storage areas maximised within the design.
- Open plan kitchen, dining and living.
- The use of BIM allowing for precise costing in the design phase.
- The use of polycarbonate instead of a larger glazed window in the stair well.

Figure 1.06 Warrander Studio Exterior

Figure 1.07 Interior Materiality

Figure 1.08 Clever Storage

Figure 1.09 Warrander Studio Exterior

2 1 \$2000

\$155,000

65

Figure 1.10 Ground Floor

Figure 1.11 Level One

Triangle Road Community Housing

Tactics of Affordability

Strachan Group Architects have an enthusiasm for fast, affordable and energy efficient construction, implemented within the design for the Triangle Road Community Housing Scheme. Located in Massey, Auckland, the development contains a mixture of ten terraced homes containing two, three- and four-bedroom arrangements. The approach towards the design explored the planning, materiality and construction methods to provide the greatest value both economically and in terms of meeting the social and lifestyle needs of the occupants (Strachan Group Architects , n.d.).

Tactics of Affordability:

- Dual housing.
- Precast concrete shared walls.
- Concrete ground floors for thermal mass.
- Cross laminated timber mid floor.
- Structurally insulated roof panels.
- All insulation is at least 50% above NZBC requirements.
- Standard glazed window and door joinery.
- Walls and floors with raw finish, and sealed or white washed to finish.
- Open plan living, dining and kitchen.
- Strong emphasis on passive solar architecture: solar gain, thermal mass and ventilation.
- Solar gain maximised by window orientation to the north.

(Smith, n.d.)

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Figure 1.12 Triangle Road Community Housing Exterior

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Figure 1.13 Living and Kitchen Materiality

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Figure 1.14 Stair Panelling

4 1 1

SITE SELECTION

7 Salmont Place
Kelburn
Wellington

1

Area: 251m²
Land Value: \$405,000 Land
Value per m²: \$1,614

Site Notes:

1.6km from central
Wellington, small
slope, relatively flat,
can be subdivided into
2 smaller sections.

\$ \$ \$ \$

55 Chapman Street
Newlands
Wellington

2

Area: 418m²
Land Value: \$144,596
Land Value per m²: \$346

Site Notes:

13km from central
Wellington, flat site, new
developments in area, a
view, can be subdivided
into 3-4 smaller sections.

\$

2/64 Godley Street
Waiwhetu
Lower Hutt

3

Area: 334m²
Land Value: \$190,000
Land Value per m²: \$568

Site Notes:

18km from central
Wellington, flat site,
can be subdivided into
2-3 smaller sections.

\$ \$ \$

92 Dimock Street
Titahi Bay
Porirua

4

Area: 447m²
Land Value: \$160,000
Land Value per m²: \$358

Site Notes:

25km from central
Wellington, flat, site
can be subdivided into
3-4 smaller sections.

\$ \$

Figure 1.15 Wellington Region Site Selection

Land information retrieved from (Wellington City Council, 2019)

Figure 1.16 Region View

Figure 1.17 Chapman Street Site

Figure 1.18 Selected Site

[55 CHAPMAN STREET, NEWLANDS]

Site Selection

Wellington Region Analysis

The selected site is located at 55 Chapman Street, Newlands. A Wellington site has been selected due to the increasing house and land values of the region. The average house value has increased 44.6% while land value has increased 77% over the past three years (Manch, 2018). This site has been selected from an analysis of 4 empty sites across the Wellington region (Figure 1.15), selecting the most economical site by comparing costs of land per m². The site will be subdivided to densify the plot, providing land that is created to be more affordable to those that aspire home ownership.

55 Chapman Street is a 418m² plot. The land on the street side is fairly flat and falls away with a sharp gradient at the back of the plot. Located in Newlands, the site is relatively close to public transport, Johnsonville shopping area, local schools, parks and State Highway One (Figures 1.19 and 1.20).

Helston Park

Johnsonville Shops

SH1

Site Context Map

Zoomed Out Neighbourhood Map

Figure 1.19 Site context map zoomed out

Helston Park

Stewart Drive

Burgess Road

Slone Terrace

Chapman Street

Chapman Street Steps

Chapman Street

Rice Crescent

Fitzpatrick Street

Archbold Street

Quigley Street

Fitzpatrick Street

Gow Street

Stewart Drive

Ted Gilbert Pl

Chesterfon Street

Helston Road

Hardy Street

Site Context Map

Zoomed Neighbourhood Map

Figure 1.20 Site context map zoomed in

Site images

55 Chapman Street
Newlands
Wellington

Figure 1.21 55 and 56 Chapman Street empty plots looking west

Figure 1.22 View looking up at site from Burgess Road

Figure 1.23 55 and 56 Chapman Street empty plots looking east

Figure 1.24 Neighbouring properties

Figure 1.25 View from site

Densifying the Plot

Plot Economics

Densifying the plot allows for the cost of land to be divided across several homeowners. The cost of land in New Zealand is a key contributor to the strain on homeownership. Plots are larger than the average homeowner needs to accommodate one dwelling; subdividing sites reduces the strain of land cost. The test includes two options of subdividing the plot. Option A has 3 plots seen in figure 1.26, Option B has 4 plots seen in figure 1.27. Option A has larger sections accommodating dwellings with larger floor areas or green spaces. Option B is the most economical choice accommodating 4 houses on the plot. Two houses sited on the flat part of the site and two houses sited on the sloped part.

- Land price per $m^2 = \$346$

Figure 1.26 Chapman Street plot layout A

Figure 1.27 Chapman Street plot layout B

Plot economics including right of way costs:

Plots A & B = \$46,000
20% Deposit = \$9200

Plot D = \$57,500
20% Deposit = \$11,500

Plot economics including right of way costs:

Plots A,B & C = \$34,600
20% Deposit = \$8650

Plot D = \$43,250
20% Deposit = \$9,200

Initial Design

Housing Typology 1.1

Figure 1.28 Conceptual drawing for 55 Chapman Street site

The initial sketch design investigates a first glance at economical design, implementing design principles extracted from precedent analysis including: modular form, small footprint, and a two storey dwelling reducing land coverage. A recess on the north and south faces breaks up the modular form, applying an architectural aesthetic to the dwelling.

Floor Plan

Housing Typology 1.1

Figure 1.29 Ground Floor Plan

Figure 1.30 First Floor Plan

The first iteration of the floor plan consists of a 68m² floor area, containing two bedrooms, one bathroom, and an open plan living, kitchen and dining area. To make sure an economical approach was taken towards the value of the dwelling, the floor plan is maximised by only containing necessary spaces, resulting in less material usage and a reduced floor area.

Figure 1.31 South west exterior view at sketch phase design pause

Sketch Design Cost Estimate

First Cost Estimate

Typically, architects will gain a first cost estimate from a quantity surveyor at the end of the sketch design phase to ensure the project is feasible. A first cost estimate was given to the initial design as an introduction into building economics and the implications on the design. Rawlinson's 2011 Costing Handbook facilitated the first cost estimate. It contains information surrounding building materials and products with elemental costs available for the site, plumbing, and electrical services. A spreadsheet (figure 1.32) was used as a tool to contain relevant cost information with areas of material calculated from Revit. The elements costed include; windows, doors, walls, roof, floors, insulation, joinery, elemental, professional fees and land. The first cost estimate for the 68m² dwelling is \$237,000 GST inclusive. This figure will become more accurate as the design progresses with materials and internal fixtures finalised. A finding from completing the cost estimate, was the cost of the butyl membrane roof, which costs considerably more than a standard Coloursteel corrugated iron roof. It was not possible to use corrugated iron for the flat roof designed because of the minimum slope required.

First Cost Estimate

Excel Breakdown

Figure 1.32 Housing Typology 1.1 Excel Costing Breakdown

	Identification	Floor	Item	Area m2	Cost (\$) Per m2	Total Cost \$	With Inflation
Windows							\$8,092.12
North Face							
	Window 1	Ground	Aluminum, Double Glazing Opening	1.2	492	590.4	
	Window 2	Ground	All windows.	0.7	492	344.4	
	Window 3	First		0.6	492	295.2	
	Window 4	First		2	492	984	
East Face							
	Window 5	First		1.3	492	639.6	
South Face							
	Window 6	Ground		0.5	492	246	
	Window 7	Ground		2	492	984	
	Window 8	Ground		1.5	492	738	
	Window 9	First		0.6	492	295.2	
	Window 10	First		2	492	984	
West Face							
	Window 11	Ground		1.3	492	639.4	
	Window 12	First		1.3	492	639.4	
Total Cost \$ Windows						7379.6	
Walls							
External Walls							
North Face							
	Ground	Ground	Timber walls 2.7m studs @600crs with James Hardie 135mm Linea Weatherboard Finish	25.9	304		
	First	First	All exterior walls.	27.2	304		
	Roof	Roof		4.3	304		
East Face							
	Ground	Ground		6.1	304		
	First	First		4.5	304		
	Roof	Roof		1.5	304		
South Face							
	Ground	Ground		25.1	304		
	First	First		27.2	304		
	Roof	Roof		4.2	304		
West Face							
	Ground	Ground		9.9	304		
	First	First		8.9	304		
	Roof	Roof		1.6	304		
	Total Area	External Faces		146.4			
Gib All Walls			10mm Standard Gib with paint finish	146.4	52	7,612.80	
Total Cost \$ Ext Walls						52,118.40	

Doors							
External							
North Face	Door 1	Ground	Normal Glazed	860 x 2030	1800	1800	
East Face	Door 2	Ground	Bifold	2100 x 1980	2800	2800	
	Door 3	First	Sliding Glazed	1850 x 2400	1500	1500	
Internal	Door 4	Ground	Normal	710 x 1980	170 + 55	225	
	Door 5	First	Cavity Slider	760 x 1980	460 + 80 + 110	650	
	Door 6	First	Cavity Slider	760 x 1980		650	
	Door 7	First	Cavity Slider	760 x 1980		650	
	Door 8	First	Cavity Slider	760 x 1980		650	
	Door 9	First	WD Door	1200 x 1980		150	
	Door 10	First	WD Door	1200 x 1980		150	
Total Cost \$ Doors							9225
							\$10,116
Internal Walls							
Ground Floor							
	Int Wall 1		90x45 Framing, GIB lining both sides, with painted finish	1.5	135		
	Int Wall 2		All interior walls.	4.6	135		
	Int Wall 3			1.4	135		
	Int Wall 4			3.8	135		
	Int Wall 5			0.7	135		
	Total Area	Ground		12		1620	
First Floor							
	Int Wall 6			1.5	135		
	Int Wall 7			6	135		
	Int Wall 8			5.7	135		
	Int Wall 9			4.2	135		
	Int Wall 10			5.1	135		
	Int Wall 11			3.1	135		
	Int Wall 12			1.5	135		
	Total Area	First		27.1		3,658.50	
	GIB Aqualine Area	First			60	1,152	
	Total Area	All INT Walls		39.1			
Total Cost INT Walls							5,135
							\$5,630.80
Insulation							
Exterior Walls	EXT Wall Insualtion	Ground and First	Pink Batts 2.2 Fitted between studs	146.4	12.2	1,786	
Interior Walls	INT Wall Insulation	Ground and First	Pink Batts 2.2 Fitted between studs	39.1	12.2	477.00	
Floor Insulation	Timber Flooring	First	Pink Batts 1.6 Snug Floor	30	17.1	513	
Total Insualtion Cost							2776
							\$3,044.03
Flooring							
First Floor + Ceiling							
Ground	Timber Framed Flooring	First	20mm Pynefloor GT Particle Board on SG8 Timber Framing; 250 x 50				
Slab	Slab + Foundations	Ground	Joists span of 4.3m @450 crs	30	117	3510	\$3,848.90
Decking	Timber Deck	Ground	Concrete Slab	35	220	7,700	\$7,700
Decking	Timber Deck	Ground	Timber Framing	40.8	11.1	453	\$496.74
			Pine Timber Topping	12	57	684	\$750.04
Balcony	Timber Balcony	First	20mm Pynefloor GT Particle Board on SG8 Timber Framing; 250 x 50				
Balcony	Timber Balcony	First	Joists span of 4.3m @450 crs	3	117	351	\$384.89
Entrance	Concrete Paving	Ground	Pine Timber Topping	3	57	171	\$187.51
			Concrete Slab	5	220	1100	\$1,206.21
Total Flooring Cost							13968.88
Ceiling Battens	Timber Battens	Ground	70x20mm timber battens @600crs	60m total	5.5	330	\$361.86
Ceiling Battens	Timber Battens	First	70x20mm timber battens @600crs	60m total	5.5	330	\$361.86
Ceiling Ground Floor	Gib board	Ground	Gib with paint finish	30	42.4	1,272	\$1,394.82
Ceiling First Floor	Gib Board	First	Gib with paint finish	35	42.4	1,484	\$1,627.28
Total Ceiling Cost							3,416

Roofing								
Roof	Iron and Build up		Zincalume		35	36.5	1,277.50	\$1,400.85
Butyl Membrane Spouting	Butyl Membrane		Spouting, with membrane build up		9	84	756	\$756
Roof Framing	Timber Framing		Flat Roof Framing 190 x 45	110m		21.6	2,376	\$2,605.41
Downpipes	PVC Downpipe		Marley Eclipse	11m		41.3	454.3	\$498.16
Scupper	Scupper		Scupper installed through parapet	2x		113	226	\$247.82
Rainhead	Zincalume Rainhead		Zincalume Rainhead	2x		211	422	\$462.75
Total Roofing Cost							5,511.80	
Joinery								
Kitchen	Kitchen Fitout	Ground	Fitout Very Basic	1x		3500	3500	
Bathroom	Bathroom Fitout	First	Fitout Medium Quality	1x		1950	1950	
Laundry	Laundry Fitout	Ground	Basic	1x		398	398	
Total Joinery Cost							5848	\$5,848
Floor Finishes								
Ground Floor								
	Tiles		Large Tiles		15.5	150	2325	
	Carpet		Wilton Woven with foam chip underlay		11.3	110	1,130	
First Floor								
	Tiles		Small Tiles		3.6	150	540	
	Carpet		Wilton Woven with foam chip underlay		23.6	110	2,596	
Total Floor Finishes Cost							6591	\$7,227.38
Elemental Costing								
Site Preparation					68	5.1	346.8	
Sanitary Plumbing					68	120.7	8,207.60	
Electrical Services					68	61.2	4,161.60	
Drainiage					68	6.8	462.4	
Special Services					68	51	3,468	
Fire Services					68	11.46	779.28	
Total Elemental							17425.68	\$19,108.19
Building Fees Extra								
Insurance							1200	
Rubbish			2x skips per house		2	450	900	
Shed Site			2 per full site of 4 houses	1000/4		250	250	
Temporary Power			1000 per site 4 houses	1000/4		250	250	
Temporary Water				200/4		50	50	
Total Building Fees Extra							2650	\$2,905.87
Building Elements								
Stairs with handrail	Stairs		Pine Stringers with MDF		1	2,903	2,903	
Balustrade Balcony	Balustrade		Timber Balustrade	3.8m		389	1,478	
Total Building Elements							4,382	\$4,805.10
Total Cost								\$148,218.89
Cost of Site						\$34,600		
						2179.7 per m2		
Professional Fees								
Architect		6%			6%		8,103.95	
Geotechnical		2.50%			2.50%		3,376.64	
Building Consent	WCC Rates				WCC Calculator		\$3,384.87	
Contingency		6%				8,103.95		
Total Professional Fees							22,969.41	
						Total	205,788.30	
						GST	30,868.24	
						Total Incl GST	236,656.54

Figure 1.33 Conceptual design of the 55 Chapman Street plot

The plot has been densified to accommodate four dwellings. The conceptual design of the plot illustrates potential forms and foundation types to be considered moving into the developed design phase.

Figure 1.34 Elevations of conceptual design

Findings and Reflection

Initial Design

Phase One involved the design of a single housing typology that investigates affordability. Value was investigated through economic design and construction processes, which enabled an understanding towards the concept of the project's value. These processes involved standardisation of windows, doors and floor heights, and maximising the floor area, by removing unnecessary spaces. The first design is a 68m² two-bedroom home, containing one bathroom and an open plan ground floor containing the kitchen, dining and living spaces. Rawlinson's 2011 Costing Handbook was used to gain an understanding of the basic elemental costs; but, this source is from 2011 so did not give a correct estimate of the first cost of this house in 2019. Moving forward, the QV costbuilder database will be used, to gain a more accurate first cost. The QV database updates regularly with the latest construction data from the industry.

The considerations to make moving forward, are the council restrictions on-site and how these will affect the design and site arrangement. The northern face of the design requires further development, ensuring the windows are large enough to let in an acceptable amount of sunlight, ensuring a good quality of living. A quality criteria needs to be established around living conditions and materials usage. How can this be made more affordable and have a good quality of living? Introducing dual housing would allow for further cost reductions. The flat membrane roof needs development to accommodate for a standard roofing build up, which will save costs on the roof itself and the spouting.

Next Generation Architect

The architectural services of a Next Generation Architect will involve the task of educating clients; on tactics of affordability and the implications of cost estimates from the sketch design phase.

Design Phase Two explores tactics of affordability. It will introduce new precedents, council restraints, dual housing and comparison sites to gain an understanding of how architects can control costs within a project.

04

Exploring Affordability

Figure 2.01 Build Smart prefabricated home PLB68

Figure 2.02 Lockwood Home, Vacationer.

Figure 2.03 Stonewood Homes, Avon.

Figure 2.04 A1 Homes EH127

Figure 2.05 Design Builders Plan 1705

Figure 2.06 A1 Homes BH136

Figure 2.07 A1 Homes BH84 transportable home

Figure 2.08 Keith Hay Homes, Raglan

Figure 2.09 Design Builders Plan BH84

Figure 2.10 Design Builders Plan 18004

Design and Build Package Homes'

A Developers Perspective

Design and build package homes make up a large proportion of New Zealand's overall housing stock. The popularity of these homes in the housing market led to this analysis. Analysed features include the location, floors, the number of rooms, room types, open plan, materials, roof, overall costs and costs per m². This data collection and analysed was aided by the use of an excel spreadsheet. Conclusions include the common use of similar materials, these are weatherboards, in particular, James Hardie and colour steel. QV costbuilder displays these two materials are the cheapest per m². Houses use standardised rectangular windows and doors, repeated throughout the design. The analysis of construction methods and their cost implications show 90% of houses use standard timber framing.

The average area of the package homes analysed is 149m² with prices ranging between \$250,000 and \$500,000. Prefabricated houses are cheaper, although the floor areas are smaller. An interesting finding was the number of houses with a garage. This was lower than expected with half the houses not containing a garage. We can see this as a tactic of affordability to reduce the overall build area. Monastra (personal conversation, October 12, 2019) indicated through a personal conversation, that package homes use small windows for economical purposes. Aesthetically they look disproportionate to the surface area but glazing is approximately twice the cost of an exterior wall per m². The homes contain gable or hipped roofs, as they are the most economical to build. The hipped roofs can look unusual such as figure 2.04 this is the result of a plan based design.

The positives of the developer home:

- Cater for a range of budgets and housing types.
- Family orientated homes with several bedrooms.
- Come as packages: house and land or just the house.
- Catalogue housing and show homes that are viewed as a product.
- Mass production; to create more affordable homes.
- Houses only allow minimal changes to the finishes, keeping the homes on a budget.
- Work with standardised construction details and elements.

The negatives of the developer home:

- They design houses for flat sites that are north facing; there is no consideration for hill sites.
- Not designed to be site-specific unlike an architecturally designed home.
- Poor aesthetics.
- Basic level of internal planning, there are no special elements.
- Mass-produced designs that can end up with minimal individualisation for clients.
- The typical package home doesn't consider sustainable or passive solar features.

Design and Build Package Homes

Analysis of 15 Package Homes

Figure 2.11 Package home analysis

Companies		Cost	Area of house m2	Land Area	Bedrooms	Kitchen (Separate)	Dining (Separate)	Kitchen + Dining Combined	Lounge	Laundry
Build Smart	PLB59	\$118,600	59	0	2	0	0		1	1
	PLB 68	\$127,900	68	0	2	0	0		1	1
Design Builders	BH84	<\$450,000	182	0	4	0	0		1	1
	18004	<\$450,000	123	0	2	0	0		1	1
	1705	\$450,000> \$550,000	235	0	5	2	2		0	2
Lockwood Homes										
	Vacationer	\$275,000	94	0	3	0	0		1	1
A1 Homes										
	Ravenswood H+L	\$419,867	127	422	3	0	0		1	1
	BH136	\$273,849	136	0	4	0	0		1	1
	BH84	\$184,214	83	0	3	0	0		1	1
Stonewood Homes										
	Avon H+L	\$486,000	157	465	4	1	1		0	1
Keith Hay Homes										
	Raglan	\$267,030	115	0	3	1	0		1	1
	Raglan H+L	\$773,000	115	610	3	1	0		1	1
Lanyon and Le Compte Construction LTD										
	Cocoom Home									
	Personal Conversation (April 2, 2019) with Shane Le Compte	\$418,922.10	192	0	3	1	1			1
GJ Gardner Homes										
	TG-8515 H+L	\$584,500	151	318	4	0	0		1	1
	KP-8149 H+L	\$780,000	188	320	3				1	1

Bathroom	Separate Toilet	Garage	Location	Levels	Cost per m2	Building Technique	Exterior Materials	Roof Material	Roof Type	Transportable
1	1	0	0 North Island	1	2,010.20	Prefabricated	Weatherboard + Iron	Iron	Mono-pitched	Yes
1	1	0	0 North Island	1	1880.9	Prefabricated	Weatherboard + Iron	Iron	Gable	Yes
1	2	1 2 Car	Nation Wide	1	2,472.50	NZS3604	Weatherboard	Iron	Mono-pitched	No
1	1	0 1 Car	Nation Wide	1	3,658.50	NZS3604	Weatherboard		Flat	No
1	3	0 2 Car	Nation Wide	2	2,340.40	NZS3604	Weatherboard	Iron	Mono-pitched	No
1	1	0	0 Rotorua	1	2,925.50	Lockwood	Weatherboard	Iron	Mono-pitched	Yes
1	1	1 1 Car	Canterbury	1	994.9	NZS3604	Weatherboard	Iron	Hipped	No
1	2	1	0 Wellington	2	2,013	NZS3604	Weatherboard + Titan Board	Iron	Mono-pitched	No
1	1	0	0 Wellington	1	2,219	NZS3604	Weatherboard	Iron	Mono-pitched	Yes
1	2	0 2 Car	Canterbury	1	1,045	NZS3604	Weatherboard + Brick	Tile	Gable + Hipped	No
1	2	0	0 West Auckland	1	2,322	NZS3604	Weatherboard + Titan Board	Iron	Monopitched	Yes
1	2	0	0 Helensville	1	1,267	NZS3604	Weatherboard + Titan Board	Iron	Monopitched	Yes
1	2	1 2 Car	Christchurch	1	2,181.90	Precast Concrete Panels	Precast Concrete	Iron	Gable	No
1	2	0 1 Car	Tauranga	1	1,838	NZS3604	Brick Masonry + Weatherboard	Tile	Hipped +Gable	No
1	2	1 1 Car	Elsdon- Porirua	2	2437.5	NZS3604	Weatherboard	Iron	Hipped	No

Figure 2.12 Stonewood Homes Avon Plan

Figure 2.13 Keith Hay Homes Raglan Plan

Figure 2.14 A1 Homes BH136, ground floor.

Figure 2.15 A1 Homes BH136, first floor

Figure 2.16 A1 Homes BH84 plan

This image has been removed by the author of this thesis for copyright reasons.

Figure 2.17 Lockwood, Acacia plan

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Figure 2.19 Lockwood Vacationer plan.

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Figure 2.18 A1 Homes EH127 plan

KEY:

PUBLIC SPACES
PRIVATE SPACES
CIRCULATION
ADDITIONAL SPACES

Design and Build Packages

Floor Plan Analysis

The floor plan analysis included five developer homes looking into four functions; public and private spaces, circulation and additional spaces.

The findings include:

- Open plan kitchen, dining and living.
- Distinct divide between public and private spaces.
- Regular forms.
- Separate toilets and bathrooms.
- Storage spaces.
- Entrances through the living room or corridor.
- Divide between houses that have garages and those that do not.

Makers of Architecture

Designing + Fabricating

Makers of Architecture, work inversely to the characteristics of a traditional architecture practice. Makers consider the design and build process as a whole, instead of the traditional process of two individual stages, as seen through the typical architect. Designing and fabricating projects, Makers have both an architecture and building sector to their business. This allows these two processes to work seamlessly as a whole.

Makers, hold the intentions to be an architectural company that builds, tests and develops efficient design and construction techniques. Makers Fabrication facilitates the intentions, providing a digital manufacturing and prefabrication facility both for their designs and the wider architectural community. (Melbourne-Hayward, 2017)

“We want to see architectural design perform to enhance people’s lives, and we want this to become more attainable and flexible.”

(Melbourne-Hayward, 2017)

Makers, are an example of the upcoming generation of the architectural profession engaging with advanced technology: prefabrication and the use of BIM. Assessing precise costing information through the design process with a correlation to the sizing and placement of the CNC panels, used in their designs. This allows for the development of an efficient method of designing and building quality custom prefabricated architectural projects, to suit individual client’s needs.

Figure 2.20 Warrander Studio model front elevation

Figure 2.21 Warrander Studio model back elevation

Figure 2.22 Interior of Warrander Studio model

WARRANDER STUDIO

Modelling Exercise

The Warrander studio was modelled as a key precedent. This modelling exercise aimed to allow an understanding of the spaces, spatial configuration and composition of the house. The findings from this exercise are the thickness of CLT walls vs standard and internal walls. While understanding the spatial layout with the floor plan etched onto each level and the minimal slope to the roof visualised as if it is flat.

Studio 19

Tactics of Affordability

The Studio 19 Bach located in the Coromandel was designed by 16 third year students at Unitec, in collaboration with architects, David Stratchan and Marshall Cook. The project gave students an opportunity to learn practical skills such as timber design and construction, working collaboratively and working to a small budget. The total budget for the two bedroom dwelling was \$120,000, with a total footprint of 100m²; a 75m² interior and 25m² of decking. The dwelling is clad with board and batten plywood, with plywood ceilings and walls in the interior. High thermal performance is achieved by the envelope penetrated by a slatted timber breezeway; a key architectural element of the dwelling. (Strachan Group Architects , n.d.)

Tactics of Affordability:

- Prefabricated design that was trucked to site.
- Designed and constructed by students; significant reduction in professional fees.
- Clip on decking and pergolas that were prefabricated offsite.
- Thermal performance: cross ventilation, timber slated breezeway.
- High levels of insulation.
- Working with site contours.
- Structurally insulated panelled roof.

Figure 2.23 Studio 19 Exterior

Figure 2.24 Studio Exterior Materiality

Figure 2.25 Timber interior

Figure 2.26 Double usage furniture

Figure 2.27 Outer Residential Zoning District Plan Requirements Diagram

Figure 2.28 Building Recession Plane Requirements

The Wellington Region District Plan in accordance to Wellington City Council (2009) regulations is diagrammed in figures 2.27 and 2.28 for outer residential zoning. An architect has no control over the building envelope. Working within these restrictions ensures a design does not require additional costs of applying for a resource consent.

Figure 2.29 55 Chapman Street Plan Implementing the District Plan

55 Chapman Street Site Plan

Figure 2.30 55 Chapman Street West elevation interation on the building envelope

Figure 2.31 55 Chapman Street North elevation interaction on the building envelope

Figure 2.32 55 Chapman Street South elevation interaction on the building envelope

The District Plan

Implemented on Site

The district plan is applied to the plot arrangement showing areas of encroachment requiring amendment seen in figures 2.29 - 2.32. Figure 2.29 shows plot A encroaches the front yard requirement, solved by reducing the number of plots to 3. Figures 2.30 - 2.32 illustrate the encroachments within the building envelope. Issues occur surrounding the connection between the hill and the building envelope. This includes the requirement of excavation or a low height dwelling to sit below the 45-degree angle. Housing typology 1.1 will sit within the building envelope for all elevations when behind the front yard requirement.

Site Arrangement

Accommodating The District Plan

Three different site arrangements are iterated, exploring access and plot arrangement and accommodating for district plan requirements. The site is reduced to three plots due to the district plan requirements (figure 2.33). Figures 2.34 and 2.35 rotate the site arrangement to allow plots B and C to gain a larger building height. This is explored in section as well as plan, showing the interaction with the building envelope.

Figure 2.33 Plot Arrangement A

Figure 2.34 Plot Arrangement B

Figure 2.35 Plot Arrangement C

Figure 2.36 Site Arrangement A Section A-A

Figure 2.37 Site Arrangement B + C Section A-A

Figure 2.38 A series of roofing developments for housing typology 1.1

Figure 2.39 Original flat roof of typology 1.1

Figure 2.40 Gable roof form exploration of typology 1.1

Figure 2.41 Monopitched form exploration of typology 1.1

Form Development

Housing Typology 1.1

This series of design iterations aims to explore design variations of the roof; through aesthetic appeal and economic reasoning. Sketchup has been used as a tool to mass the basic form of the house and to quickly change iterations shown in figure 2.38. The iterations started with a flat roof, however economically the build-up for this type of roof is considerably more than a standard roof. Iterations explore overhangs, guttering placement, cut outs and simplification of the overall form. Digitally massing the overall external envelope and form is developed through a series of sketches. These sketches are focusing on the form and predominantly the northern face, which required a larger glazed area.

Figure 2.43 Two storied house shading onto plot A

Figure 2.42 Single storied house shading onto plot A

Sunshading Analysis

Sun shading is an issue shown in figure 2.41 when a two storey house, allowed by the building envelope, is placed in front of plot A. All northern sun is blocked out on the ground floor, where the living areas are located, thus decreasing the value of the quality of living in this house. In comparison a single storey house shown in figure 2.42 reduces the impact of shadowing on plot A, allowing northern sun to enter. The quality of living involves, allowing a substantial amount of sunlight into all houses on the site, which reduces energy costs and considers the wellbeing of occupants.

Challenge of working with the building recession plane on a steep site.

Figure 2.44 Final Site Iteration 2.1.2

Figure 2.45 Iteration 2.1.1 South Face

Figure 2.46 Iteration 2.1.2 South Face

Design Development

Iteration set 2.1 faced the challenge of working with the building recession plane on a steep hill site. Iteration 2.1.1 started with a basic form placed on the boundary of plot A. Modular forms have been used to reduce the complexity, allowing for a faster build time. Figure 2.45 & 2.44 show the entrance points of the house and arrangement of the modules. Iteration 2.1.2 has an offset added with a roof overhang. There are privacy issues with the entrance shown in figure 2.45 running along the side of plot A.

Roof form developed to allow natural light from the north into the south module

Figure 2.47 Final site Iteration 2.2.2

Figure 2.48 Iteration 2.2.1 New entrance with stairs and rain shelter

Figure 2.49 Iteration 2.2.2 developed entrance, creating an entrance way

Design Development

Iteration set 2.2 develops the roof form to allow natural light from the north into the southern module. The entrance in iteration 2.2.1 has been moved, with stairs added, to create an entrance, seen from the pathway on site. Iteration 2.2.2 develops the entrance further with a pushback of the wall, allowing for a landing at the bottom of the steps. The roof form is simplified to create a regular form for construction.

Iteration 2.3.1 explores dual housing. This is an economic decision to share one exterior wall keeping costs at a minimum. Although there are issues around the aesthetic appeal of this arrangement.

In iteration 2.4.1 house C is pushed forward for aesthetic purposes to break up the design, although it still shares the same exterior wall. Iteration 2.4.1 is Phase Two's design pause. There are economic issues around house C. This is due to the large amount of excavation and construction of retaining walls because of the contours on one side of the site being slightly steeper.

Figure 2.50 Iteration 2.3.1

Figure 2.52 Iteration 2.3.1 shared external wall

Figure 2.54 Iteration 2.3.2 House C excavation and retaining wall requirements.

Figure 2.53 Iteration 2.3.2 dwelling C pushed forward for aesthetic purposes

Figure 2.51 Iteration 2.4.1

Figure 2.55 55 Chapman Street Site Plan

Site Plan

55 Chapman street consists of three dwellings and two different housing typologies. The site contains two footpath access points. This is to ensure all dwellings have a level of privacy. The front yard requirement is green space for all dwellings at this conceptual phase.

Housing Typology 1.1

Floor Plan

Figure 2.56 Typology 1.1 ground floor

Figure 2.57 Typology 1.1 first floor

Housing typology 1.1 is a 68m² home that consists of two bedrooms, one bathroom and open plan living, dining and kitchen. There are strong connections to the outdoors allowing for spaces to feel spacious. Housing typologies 1.1 and 2 are both timber framed houses that follow NZS3604. Typology 1 consists of a concrete slab that holds thermomass properties, whereas housing typology 2.1.4 consists of a timber floor due to the connection of the timber piles.

Eames answer to a modern house is open plan living with multi-purpose rooms that are divided between public and private spaces. Living spaces have stand out creative details and sliding doors link interior and exterior spaces (Dejtiar, 2019). This design tactic has been implemted throughout both dwellings.

Housing Typology 2.4.1

Floor Plan

Figure 2.58 Typology 2.4.1 floor plan

Housing typology 2.4.1 is a 68m² split-level home. It integrates with the contours on site, to minimise excavation costs. The house is located on timber piles. This typology consists of 2 bedrooms, 2 bathrooms and an open plan living, dining and kitchen. Housing typology 2 is used for plots B and C.

Visualising The Site

[Next Generation Architect]

Figure 2.59 55 Chapman Street Site Realistic Render of Plot A

55 Chapman Street

Costing Diagram

Figure 2.60 compares the first cost estimates across the 3 plots. Plot A is slightly smaller than plots B and C which are identical. Dwelling 1.1 is considerably cheaper than houses 2.4.1 with approximately a \$120,000 cost difference. Plot C is the least economical with an extra \$15,383 spent on excavation and retaining walls.

55 Chapman Street, Newlands, Wellington

Land Value = \$144,596

[Next Generation Architect]

Retaining Walls + Excavation Cost = \$14,000

Total Cost = \$1,000,000

Figure 2.60 55 Chapman Street site costing

105 + 107 Whites East Road, Lower Hutt

Land Value = \$238,000

\$135,000 Cheaper to build on this site

Total Cost = \$865,000

Figure 2.61 Whites East Road site costing

105 + 107 Whites East Road

Proposed Site 2

The second proposed site is located at 105 and 107 Whites East Road, Lower Hutt. This site has been introduced as a comparative site to the site in Newlands and looks at understanding the economics and building envelope implications of building on a sloped site versus a relatively flat site. Two empty plots located next to each other have been selected to create an accurate comparison between land area and overall site dimensions. Although this site cost \$93,404 more than Chapman Street, when housing typology 1.1 is duplicated across the site, the cost difference between the two sites including the land and houses is \$135,000 based on a first cost estimate using the QV Costbuilder database.

Figure 2.61 gives a cost break down of the Lower Hutt site. New plots A and B are identical whereas plot C is slightly larger. The same housing typology has been duplicated across the 3 plots, as the original design on the Chapman Street site.

The district plan works significantly better with the Lower Hutt site. The site arrangement complies with the building envelope and front yard requirements. The yard space for each dwelling is also usable space, unlike Chapman street where plot A contains the only dwelling with a usable outdoor space due to the steep gradient of the site. There is a small encroachment on the 2 higher ends of the mono pitched roof however this complies with the district plan as roof ends may penetrate the building recession plane by no more than a third of its height.

Figure 2.62 White East Road site plan

Figure 2.63 BRP North elevation

Figure 2.64 BRP West elevation

Testing Affordability

Affordability in Context

An architect does not have a specified group of clients. Anyone can approach an architect, whether they are looking for a new build or renovation. An architect's client can be any of the following: first time home owners, families, middle aged couples, singles and elderly people. As an architect always works to a budget, New Zealand housing prices were investigated to set an affordable budget for the housing typologies designed to be tested against. According to Interest New Zealand, the current median house price is \$607,500 with lower quartile house prices sitting at \$437,500. This figure is higher in Wellington with the median house price sitting at \$640,000 and lower quartile houses at \$505,000 (Chatson, 2019). Kiwi Build caps their house prices of 3 bedrooms or more at \$550,000 within the Wellington region, with any dwelling below 3 bedrooms capped at \$500,000 (KiwiBuild , 2019). First time home owners within the Wellington region can afford a deposit of \$78,000 whereas young families or those higher up the ladder have larger budgets, assuming they have sold their previous home (Chatson, 2019). The housing typologies designed are considered affordable if the first cost estimate is below \$500,000.

First Cost Estimate

QV Costbuilder + Excel

The QV costbuilder database is a tool used for a first cost estimate for all housing typologies. This tool has been used to gain an understanding of the cost implications per m² of the housing typologies. Costing is broken down into the following categories; elemental costs, specific materials fittings, fixtures and joinery. The first cost estimate includes a mixture of elemental costing for electrical, plumbing, drainage and site works along with specific material costing, working alongside current market prices in New Zealand. The data base includes all labour costs involved for all elements (Quotable Value Limited, 2019). Excel spreadsheets (figures 2.65 and 2.66) were used as a tool to calculate relevant cost information with areas of material calculated from selecting elements within the Revit model. The excel spreadsheets give a full breakdown of the first cost estimate, Housing typology 4.2.1 is broken down in the Chapman street estimate and typology 1.1 is broken down in the Whites East Road cost estimate. All dwellings are below the \$500,000 budget. There are a number of elements not costed which will have cost implications including: landscaping, interior fixtures, special hardware and lighting, overheads and margins. The interiors are at a conceptual stage. Additional costs will be added with specified material selection.

First Cost Estimate Typology 2.4.1

55 Chapman Street Hill Site

Figure 2.65 Cost estimate spreadsheet Typology 2.4.1

Identification Floor	Dimension	Item Description	Area m2	Cost (\$)	per m2	Total Cost \$
Windows / Aluminium Joinery						
Ground Floor						
W01	2000 x 700	Aluminium double glazed, residential quality	1.4	556		778.4
W02	2000 x 700	All windows.	1.4	556		778.4
W03	1000 x 1000		1	556		556
W04	500 x 500		0.25	556		139
W05	500 x 500		0.25	556		139
W06	400 x 2000		0.8	556		444.8
W07	400 x 2000		0.8	556		444.8
W08	2000 x 500		1	556		556
W09	200 x 500		0.1	556		55.6
W10	800 x 3500		2.8	556		1556.8
W11	1800 x 700		1.26	556		700.56
Bifold	1980 x 2000	Glazed Bifold Door External	1x	2800		2800
Front Door	860 x 2030	Glazed Front Door External	1x	1740		1740
Total Cost Windows/ Aluminium Joinery						10689.36
Doors						
D01	710 x 1980	Timber Hollowcore, standard flush door with paint finish	1.4	254		254
D02	710 x 1980	All interior doors.	1.4	254		254
D03	710 x 1980		1.4	254		254
D04	710 x 1980		1.4	254		254
WD Door 1		Wardrobe Door	1x			150
WD Door 2		Wardrobe Door	1x			150
Total Cost Doors						1316
Walls						
External Walls + Insulation						
		Fire walls + acoustic + framing	34	194		6596
		Linea weatherboards, timber framing build up, insulation, Gib	99	423.2		41896.8
Total Cost Exterior Walls						48492.8
Internal Walls						
		Standard Gib + Timber Framing	150.4	172		25868.8
		Aqualine Gib + Timber Framing	42.1	185		7788.5
Total Cost INT Walls						33657.3
Flooring + Finishes						
Upper		Timber Framing build up with subfloor framing + foundations	19.5	270		5265
Mid		All flooring.	23.3	270		6291
Lower			22	270		5940
Plywood		Flooring build up construction plywood	64.8	80		5184
Carpet			27.2	54.3		1476.96
Timber		Stained timber flooring	21.6	193		4168.8
Tiles		Small format	7	120		840
Total Flooring Cost						29165.76
Roofing						
Roofing Iron		Zincalume roofing and fixings	56.7	23.6		1338.12
Build Up		Underlay	56.7	4.4		249.48
Roof Framing		Rafters Timber	149	35.2		5244.8
Roof Framing		Ceiling Battens	126	7.5		945
Roof Framing		Purlins Timber	96	10.6		1017.6
Downpipes		PVC	7.5	21.5		161.25
Guttering		PVC Marley Stormcloud	3	331		993
Flashings		Aluminium	60	32.1		1926
Ceiling Gib		Gib	72.1	53		3821.3
Total Roofing Cost						15696.55
Insulation						
Interior Walls		Pink Batts R2.2	192.5	8.7		1674.75
Floor Insulation		Pink Batts Snug Floor R.2	65	20.4		1326
Roof Insulation		Pink Batts R3.2	74.8	11		822.8
Total Insulation Cost						3823.55
Building Elements						
Stair with Handrail		Stairs Pine stringers mdf treads with handrail	3.4	413		1404.2
Balustrade Balcony		Square balustrade	8.7	389		3384.3
Total Elements Cost						4788.5
Joinery						
Kitchen		Basic kitchen joinery fitout	1x	3500		3500
Bathroom		Basic bathroom joinery fitout	1x	1950		1950
Laundry		Basic laundry joinery fitout	1x	1950		1950
Lounge		Basic lounge joinery fitout	1x	1800		1800
Total Joinery Cost						9200

Appliances						
Stove Top		1x		760		
Oven		1x		980		
Total Appliances Cost				1740		
Meters						
Heatpump		1x		4500		
Total Cost Meters				4500		
Elemental Costing						
Site Preparation		65	17.15	1114.75		
Landscaping						
Sanitary Plumbing		65	144.55	9395.75		
Electrical Services		65	90.65	5892.25		
Drainage		65	31.85	2070.25		
Total Cost Elemental				18473		
Balcony Build up		Butyl membrane build up with footings and timber finish		18.1	262	4742.2
Total Cost of Land						4742.2
Total Cost						186285.02
GST						186285.02
				Site Cost	52,419	
Professional Fees						
Architect	6%		0.06	11177.1012		
Geotechnical	2.50%		0.025	4657.1255		
Building Con: WCC Rates				3384.87		
Contingency	6%		0.06	11177.1012		
Extra Building Fees				2833.00		
Total Cost Professional Fees				85,648		
Total Cost Housing Typology 2.4.1 (Split Level)						
				Total Excl Gst		271,933
				GST		40789.98269
				Total		312,723
Excavation + Retaining Walls Plot C						
Retaining Walls	1.5m high	12	500	6000		
Retaining Walls	1m high	7.5	200	1500		
Retaining Walls	1m high	11	200	2200		
Excavation and removal		73.35	53	3887.55		
				13587.55		13587.55
				GST		2038.1325
				Total		15625.6825
PLOT C SPLIT LEVEL HOUSE COST						
Total Cost House					\$ 328,348.88	
Land cost				52,419		
Total Cost					\$ 380,767.88	
m2 Cost				151.5		\$ 2,513.32
Deposit						\$ 76,153.58
Excavation + Retaining Walls Plot B						
Retaining Walls	1m high	6.7	200	1340		
Retaining Walls	1m high	1.5	200	300		
Excavation and removal		5	53	265		
				Excavation		1905
				GST		285.75
				Total		2190.75
PLOT B SPLIT LEVEL HOUSE COST						
Total Cost House					\$ 314,913.95	
Land cost				52,419		
Total Cost					\$ 367,332.95	
m2 Cost				151.5		\$ 2,424.64
Deposit						\$ 73,466.59
Plot A Housing Typology 1.1 Cost. Full Cost breakdown on 105+ 107 Whites East Road Cost Estimate Sheet						
PLOT A Housing Typology 1.1						
Total Cost House					209,703.40	
Land cost				\$ 42,212.00		
Total Cost					\$ 251,915.40	
m2 Cost				122		\$ 2,064.88
Deposit						\$ 50,383.00

First Cost Estimate Typology 1.1

105 + 107 Whites East Road, Flat Site

Figure 2.66 Cost estimate spreadsheet Typology 1.1

Identification	Floor	Dimension	Item Description	Area m2	Cost (\$)	per m2	Total Cost \$
Windows / Aluminium Joinery							
Ground Floor							
W01		700 x 3500	Aluminium double glazed, residential quality	2.45	556		1362.2
W02		700 x 2000	All windows unless stated.	1.4	556		778.4
W03		2000 x 700		1.4	556		778.4
W04		2000 x 700		1.4	556		778.4
W05		2200 x 800		1.76	556		978.56
W06		800 x 1600		1.28	556		711.68
W07		1980 x 2000	Glazed Bifold Door External	1x	2800		2800
W08		860 x 2030	Glazed Front Door External	1x	1740		1740
First Floor							
W09		2000 x 700		1.4	556		778.4
W10		2000 x 700		1.4	556		778.4
W11		2200 x 800		1.76	556		978.56
W12		2000 x 700		1.4	556		778.4
W13		2000 x 700		1.4	556		778.4
W14		2100 x 500		1.05	556		583.8
W15		2000 x 700		1.4	556		778.4
W16		2000 x 700		1.4	556		778.4
W17		2100 x 2087	Glazed Sliding Door External	1 x	2,190		2,190
W18		2200 x 800		1.76	556		978.56
Total Cost Windows/ Aluminium Joinery							19328.96
Doors							
Internal							
Ground Floor D01							
		710 x 1980	Timber Hollowcore, standard flush door with paint finish	1.4	254		254
First Floor							
D02		710 x 1980	All interior doors.	1.4	254		254
D03		710 x 1980		1.4	254		254
D04		710 x 1980		1.4	254		254
D05		710 x 1980		1.4	254		254
WD Door 1			Wardrobe Door	1x			150
WD Door 2			Wardrobe Door	1x			150
Total Cost Doors							1570
Walls							
External Walls + Insualtion							
North Face							
Ground			Linea Weatherboard + timber framing build up + Insulation + Gib	23			
First			All exterior walls.	20.1			
East Face							
Ground				6.1			
First				5.6			
West Face							
Ground				9.7			
First				9			
South Face							
Ground				24.7			
First				30.7			
Total Cost Exterior Walls							55016
Internal Walls							
Ground Floor							
INT W 1			Standard Gib with paint finish + timber framing	3.8			
INT W 2			All interior walls.	0.75			
INT W 3				1.7			
Joinery Wall/TV				4.6			
First Floor							
INT W 4				5.5			
INT W 5				5.4			
INT W 6				5.7			
INT W 7				6.5			
INT W 8				2.1			
INT W 9				2.6			
INT W 10				8.7			
INT W 11				1.3			
			Stanadrd Gib + Timber Framing	38	172		6536
			Aqualine Gib + Timber Framing	12.4	185		2294
Total Cost INT Walls							8830
Flooring + Finishes							
Ground Floor							
K, D, LDR, ENTR			Tiles	15.5	120		1860
Living			Carpet	11	54.3		597.3
Slab			Concrete	34	220		7480
First Floor							
Master BDRM			Carpet	11.8	54.3		640.74
Bedroom 1			Carpet	9.2	54.3		499.56
Circulation			Carpet	3.4	54.3		184.62
Bathroom			Tiles medium format	3.7	120		444
Build up			Framing	80	26.5		2120
			Ceiling framing	80	6.9		552
			Ceiling Gib 13mm standard	30	53		1590
			Plywood	30	80		2400
Exterior							
Entrance	Ground		Concrete	5.4	220		1188
Deck	Ground		Concrete	12	220		2640
Balcony	First		Timber	3.7	61		225.7
Total Flooring Cost							22421.92

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Roofing					
Roofing Iron	Zincalume roofing and fixings	41.6	23.6	981.76	
Build Up	Underlay	41.6	4.4	183.04	
Roof Framing	Rafters Timber	118.58	35.2	4174.016	
Roof Framing	Ceiling Battens	80	7.5	600	
Roof Framing	Purlins Timber	46	10.6	487.6	
Downpipes	PVC	10.2	21.5	219.3	
Guttering	PVC Marley Stormcloud	1	331	331	
Flashings	Aluminium	28	32.1	898.8	
Ceiling Gib	Gib	41.6	53	2204.8	
Total Roofing Cost				10080.316	10080.316
Insulation					
Interior Walls	Pink Batts R2.2	50.4	8.7	438.48	
Floor Insulation	Pink Batts Snug Floor R.2	30	20.4	612	
Roof Insulation	Pink Batts R3.2	41.6	11	457.6	
Total Insulation Cost				1508.08	1508.08
Building Elements					
Stair with Handrail	Stairs Pine stringers mdf treads with handrail	2.7	413	1115.1	
Balustrade Balcony	Square balustrade	4	389	1556	
Total Elements Cost				2671.1	2671.1
Joinery					
Kitchen	Basic kitchen joinery fitout	1x	3500	3500	
Bathroom	Basic bathroom joinery fitout	1x	1950	1950	
Laundry	Basic laundry joinery fitout	1x	398	398	
Lounge	Basic lounge joinery fitout	1x	1800	1800	
Total Joinery Cost				7648	7648
Appliances					
Stove Top		1x		760	
Oven		1x		980	
Total Appliances Cost				1740	1740
Meters					
Heatpump		1x		4500	
Total Cost Meters				4500	4500
Elemental Costing					
Site Preparation		68	17.15	1166.2	
Landscaping					
Sanitary Plumbing		68	144.55	9829.4	
Electrical Services		68	90.65	6164.2	
Drainage		68	31.85	2165.8	
Total Cost Elemental				19325.6	19325.6
Total Cost Hardware					
Total Cost					154639.976
					154639.976
Professional Fees					
Architect	6%	148227.176	0.06	8893.63	
Geotechnical	2.50%	148227.176	0.025	3705.68	
Building Con: WCC Rates				3384.87	
Contingency	6%	148227.176	0.06	8893.63	
Extra Building Fees				2833.00	
Total Professional Fees				27710.81	182350.79

PLOT A & B		
Total Cost No Site	182350.79	182,351
GST	27352.618	27,353
Total No Site	209703.40	209,703.40
Site Cost Plots A + B=	75,586	285,289.40
Per m2	167	1,708.32
Deposit	\$57,058	

PLOT C		
Total Cost No Site	182350.79	182,351
GST	27352.618	27,353
Total No Site	209703.40	209,703.40
Site Cost Plot C=	84,841	294,544.40
Per m2	185	1,592.13
Deposit	\$58,909	

Value within the design:

What can an architect control surrounding economic value?

- Dual housing (sharing one or more external walls).
- Standardised features such as stud heights, windows and doors.
- Regular, non-complex forms.
- Standard roofing build up (sloped not flat).
- Working with standard sheet sizes.
- Timber piles on hill sites, build up and not excavate.
- Split levels to work with contours of the site.
- Maximising the floor area.

What are the architectural qualities creating value within the housing typologies?

- Recesses on sides of building and balcony.
- Use of double-glazed windows which cost more but are more efficient for energy savings and heating.
- Thermo mass properties on concrete floor.
- Glazed feature through recess which is composed as 2 large windows.
- Thicker exterior walls for better insulation.
- Designing above minimum codes.

Exceeding the minimum and designing new homes above the absolute minimum requirements of the building code, improves livability, often for a little extra cost, which in the long run pays off in energy consumption and costs (Pringle,2019).

Findings and Reflections

Exploring Affordability

The combination of the building envelope and the relationship with the abrupt gradient of the site created restrictions to the architectural outcome of housing typology 2.4.1, the split level. To enhance the architectural outcome on this slope, these restrictions need to be pushed, to allow the architecture to be in control over the building envelope. What is currently not working with this housing typology, is the stair well roof, sloping up with the recession plane. The floor plan has a number of issues. These include the small entrance, being more generous with the living and dining space. Piercing the envelope boundary would allow for a more architectural outcome through both the form, planning and economics with less excavation into the ground. To enhance the architectural outcomes of the houses a playful approach is needed through a series of new conceptual designs. This can be explored through sketching and modelling.

The two housing typologies are currently not well developed as livable spaces. They are designed from the outside in with more input into the exteriors than interiors at this stage. The interiors need to be enhanced, to develop what these houses feel like to live within, showing materials and human interaction. This is also required for the site arrangement and atmosphere, with the two side entrances refined to one main right of way. The front yard needs to be designed incorporating landscaping into the house designs.

Moving forward, parameters are required for the elements and spaces included within the typologies, the client and their budget, quality and cost control and sustainable features. An architect will have a number of clients with different budgets and spatial requirements. This needs to be designed economically, while containing a strong architectural aesthetic and living qualities. The introduction of BIM with QV costbuilder data will speed up the costing process, with relation to how a next generation architect would work.

Next Generation Architect

In the profession a Next Generation Architect will restore the stereotype of an architect having minimal consideration towards cost. This new architect will combine both quality and cost as effective design values with zero compromises on either values.

Design Phase 3 introduces architecture as product illustrated through the pattern book. Four designs are repeated across a number of test sites within Wellington, to gain an understanding of the challenges both aesthetically and economically faced by different site conditions.

05

Architecture as Product

The Pattern Book

Architectural History

The 16th century introduced the first version of the architectural pattern book, in the five books of architecture, by Italian architect Serlio. Serlio's early pattern books pushed the boundaries of architecture of the time, giving several classical precedents around the ways, design rules could be used. (Marmor, 1996)

New Zealand's first version of the pattern book was introduced in 1949 by Max Rosenfeld who became known through his publications in the weekly newspaper as the home architect, as people could obtain published house plans for free. Rosenfeld published 13 editions of the New Zealand House, comprising of several house designs available for people to use in the form of a pattern book (Gluckman, 1990). New Zealand's design and build companies contain online databases of housing designs; this idea is seen as a digitalised form of a pattern book.

Australian project housing companies of the 1960s generated their own versions of the pattern book. Seen through a series of housing typologies marketed and designed to buy. What made these companies stand out compared to the typical developer, was the ability to customise the design to suit selected sites. For example Pettit and Sevitt's customisable split-level house to work with the topography of Sydney. These companies involved architects, ensuring that houses were desirable through strong design aesthetics. (Judith O'Callaghan & Pickett, 2012)

Affordability is explored within a pattern book through the repetition of design removing bespoke architecture. Repeating a product creates a standardised design, that reuses documentation and results in decreased fees for the client.

Max Rosenfeld

Architectural Influences

1949 marked the beginning of a significant change between New Zealander's and their homes. The government at the time started a policy of subsidising loan interest, encouraging home ownership. Max Rosenfeld introduced innovative concepts which are still used today as if no other methods previously existed. These concepts are seen applied to his house plans that were published in the weekly newspaper. The principles included; prefabricated storage fittings preferable to solid internal walls, prefabricated light timber trusses to replace individual rafters, laundry as a transitional room between indoors and outdoors, and concrete floors on the ground floor to prevent draughts and borer. (Gluckman, 1990)

Rosenfeld analysed the stereotypical New Zealand home before the 1950s found on a quarter acre section. Coming from Czechoslovakia he believed both the section and the houses were far too big for their inhabitants. He found houses were incorrectly orientated, with living quarters and bedrooms facing the street irrespective to the sun, which can also be seen through the large floor to ceiling windows that served no real purpose. Houses disregarded the sun, influencing lower living conditions and overall health of occupants (Gluckman, 1990). His findings are seen in figure 3.01 of the typical 1950's state housing plan.

Rosenfeld had his own set of design parameters. Which included tailoring houses with living spaces facing the sun. Rectangular designed homes which are desirable for future additions. Reducing building costs, open plan living with the house consisting of three zones including, living spaces (public), bedrooms (private) and passage (circulation). Viewpoints overlooking a garden, with kitchens, laundry and utility rooms to face the shadows. These parameters changed the way New Zealander's designed and built their homes, with Rosenfeld being an influential contributor to New Zealand's modern living (Gluckman, 1990). Rosenfeld's influences can be seen in figure 3.02 of the typical 1970's state housing.

Figure 3.01 Typical 1950's NZ state housing plan

Figure 3.02 Typical 1970's NZ state housing plan

“Rosenfeld can be seen as one of the essential contributors for the modern building practice we find in New Zealand from the 1950’s to the 1970’s and someone who decisively influenced the way kiwis live today.” (Abreue Lima & Isaacs, 2018)

Figure 3.03 The Terrace House

Figure 3.04 Modern housing village

Figure 3.05 Single Dwelling

Merchant Builders

Melbourne, Australia

Merchant Builders was established in Melbourne in 1965 by three partners Yencken, Ridge and Gunn. All had previous experience within the construction industry. The driver of this project home company, was to break the dull, repetitive suburban housing. By working as a team together, they believed that they could offer more appealing houses, that were appropriate to the Australian landscape and climatic conditions and would fulfill the expectations of the typical family villa. Each of the three partners was responsible for their roles which involved the architect, building processes, contracts and marketing. (Melbourne School of Design, 2015)

“Thus for the first time a genuine architectural circumspection was brought within the financial reach of the average owner.... Among the more notable enterprises was... a firm called Merchant Builders in Melbourne , which offered various designs of the architect Graeme C. Gunn.” (Boyd, 1968 as cited in Melbourne School of Design, 2015, p.6)

The first display homes opened in 1966 and consisted of the terrace, courtyard and studio. Initially, people found these houses “too stark and too unusual”, compared to the typical villa with its layout and siting. All houses offered several variations, with each house presenting a different typology and site. An integral part of the architecture was the relationship between the house and its site. To ensure this was met, landscaping was included as part of the housing package. Landscaping became an integral part of the design with a visionary move taken to remove the typical fence and backyard. This move integrated houses with their surroundings. It sparked the possibilities of exploring group developments, which could provide the greatest privacy and share other general facilities. (Judith O’Callaghan & Pickett, 2012)

“Some of our houses went into settings where there was no relationship to the houses around them. Landscaping provided the “clothing” that made that relationship work much better.” (Judith O’Callaghan & Pickett, 2012, p.136)

The houses were designed to be affordable for the average home owner. The value of design and tactics of affordability within design include:

- A strong emphasis on orientation.
- Siting and landscaping.
- Passive energy with north facing living areas.
- Indoor- outdoor connection.
- Minimal interiors that involved minimal materials and colour.
- Catalogue housing in the form of a pattern book.

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Figure 3.06 The split level

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Figure 3.07 Marketing of the interior

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Figure 3.08 Marketing of a dwelling

Pettit and Sevitt

Sydney, Australia

Known as the most famous and innovative project builders of the 1960s and 1970s in Sydney, Australia was Pettit and Sevitt. They targeted their homes at those who had tried to have a house designed by an architect or those who had not because of the cost implications involved. Like Merchant builders, both partners had earlier experience within the construction industry and valued the aesthetics of the homes, which led to using architects.

The boom period saw Pettit and Sevitt's houses securing over half the project house design awards in New South Wales. Their first display home designed by architects Ken Woolley and Michael Dysart, was the split level that opened in 1961, with a catalogue of house designs expanding over this period. (O'Callaghan, 2017)

Ken Woolley a well-known Sydney architect worked for Pettit and Sevitt for fifteen years. Houses consisted of white brick, exposed timber posts and split levels, that could adapt a standard plan to the rocky terrain. These were the external aesthetics of Woolley along with the clever internal planning. These designs were used in over 3500 houses built in Sydney during the 1960s to 1970s. (Wheeler, 2015)

MultiProof Consent

Reducing time and cost

MultiProof Consents allow for standardised designs to be replicated a number of times with minor changes to the overall design. They are targeted at builders and companies who design and build standardised designs and want to gain building consent faster and save clients' money. The parameters of a MultiProof Consent involve the design being for a whole building but doesn't require site specific features such as foundations and drainage. Variations to the design are allowed, as long as approval has been given, allowing for flexibility surrounding site and environmental conditions, as well as providing a number of options to suit specific clients. These including cladding type, window placement and kitchen and bathroom layouts. (Ministry of Business, Innovation and Employment, 2016)

Positives:

- Beneficial for builders and companies who build standardised designs.
- Lower cost option for clients.
- Flexibility within design as long as there has been pre approval.
- Assures clients they will gain building consent.
- Site specific features can change to comply with the building code.
- Faster process streamlining gaining building consent.
- Have built or intend to build a number of similar designs.
- Relevant to a number of building types including, residential, garages, car ports and sheds.
- Parameter based variations allowed for low risk buildings containing standard detailing.
- Flexible design allowed through the use of modules, layouts and connections can be modified to best suit the client and site.
- Works with the idea of architecture as product.

Negatives:

- The design must have the intention to be built at least 10 times over a 2-year period.
- Still have to apply for building consent for each project.
- Only includes standardised designs that are seen as a product not bespoke design.

Snug Homes

Prefab New Zealand

Snug Homes are designed as secondary prefabricated dwellings. Marketed through a catalogue as a form of pattern book illustrating 12 dwellings. Dwellings are prefabricated and transported to site as a whole, or as constructed panels. All dwellings are under 65m² meeting Auckland councils' requirements as a minor dwelling. (Prefab NZ, 2018)

Tactics of Affordability:

- Prefabricated, saving time and ensuring a quality build.
- Innovative construction techniques through a panel-based construction, using SIPS and CLT panels.
- Minimal use of external materials with dwellings predominantly clad in Coloursteel or weatherboard which are economic options.
- Dwellings contain sustainable features. Thermal mass and solar panels save energy costs.
- Flexible designs specifically in the Flip dwelling which can be either one story or two.
- Modular design.
- Open plan with minimal circulation.
- Services aligned in plan.
- Pre-consent granted saving clients time, with reuse of drawings.

KEY:

PUBLIC SPACES

PRIVATE SPACES

CIRCULATION

.... MOVEMENT

Figure 3.09 Flip dwelling

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Figure 3.10 Casabella dwelling

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Figure 3.11 45 degrees dwelling

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Figure 3.12 Whare-iti dwelling

IPad

Andre Hodgkins

The iPad is an architectural product designed by Andre Hodgkin from Architex New Zealand. The dwelling is designed in modules, as a flexible 50m² kitset bach, that can be extended by adding pods to suit clients' needs and budgets. There is a strong emphasis on the marketing through the use of a website (figures 3.13-3.16). The base pod is illustrated with five different material options and ten layout options ranging in price and floor area. A limited material pallet allows clients to have a handful of choices when selecting the product, just as a consumer of everyday products has. The iPad is an economic kitset product with a cost range of \$174,500 up to \$523,500, GST and transport exclusive (Hodgkin, n.d.).

The design of the iPad offers a number of layout variations. These are all seen as one storey modules connected by large areas of decking (figure 3.17-3.19). The more pods the more spread-out the dwelling becomes. This works well for clients with large sites, however as the pods are modular they are able to be stacked, creating a number of two storey options to reduce site coverage and work with a number of different orientated sites. The stacking effect is explored through massing (figure 3.20). The two storey massed forms show the potential for a balcony area that can reduce the amount of decking around the dwelling in larger variations, while still providing a flexible design, with circulation added as a module on the side of the existing pod.

Figure 3.13 White finish

Figure 3.14 Rough sawn and ply finish

Figure 3.15 Red tongue and groove finish

Figure 3.16 Black finish

Figure 3.17 Base Plan (option 1)

Figure 3.18 Option 2 plan

Figure 3.19 Option 8 plan

Figure 3.20 Massing of existing forms and potential developments

Figure 3.21 A series of houses, hand drawings

A Series of House Designs

A Two Week Exercise

The aim of this two-week exercise, was to design a series of architecturally designed homes every day over the period, focusing on the aesthetics of the external envelope as well as form. Sketching was the tool used to produce designs, firstly through perspective, followed by 2D elevations drawn to scale. Sketching the conceptual designs allowed for a quick, iterative design process to occur, with materiality and architectural elements added and explored more quickly than digital modelling. A reflection occurred after the design of each house, with drawings annotated and sketched over to improve the overall value of design through form, composition and economic factors.

The design parameters implemented from findings in Design Phases 1 and 2:

- Houses at a minimal size.
- Minimal exterior material pallet.
- Modular forms.
- Standardised windows, doors and forms.
- Indoor-outdoor connection.
- Wall to floor height of 3 metres per floor.
- Base dimensions no larger than 5 by 10 metres.

Figure 3.22 House 1

Figure 3.23 House 2

Figure 3.24 House 3

Figure 3.25 House 4

Figure 3.26 House 5

Figure 3.27 House 6

Figure 3.28 House 7

Figure 3.29 House 8

Figure 3.30 House 9

Figure 3.31 House 10

Figure 3.32 A series of models

A Series of House Designs

Physical Modelling

Physical models have been created for each of the ten housing typologies designed along with housing typology 1.1 from Design Phase Two. Physical modelling has allowed for the houses to be seen as a whole providing a view of the composition of each elevation within a 3D model while remaining in a conceptual phase. Designing through sketching restricts the overall 3D composition as only one perspective view is seen of each house. Scale is explored through the models and the overall construction of the form, highlighting problematic areas and places for further development.

Figure 3.33 House 1

House 1

Figure 3.34 House 2

House 2

Figure 3.35 House 3

House 3

House 4

Figure 3.36 House 4

Figure 3.37 House 5

House 5

Figure 3.38 House 6

House 6

Figure 3.39 House 7

House 7

Figure 3.40 House 8

House 8

Figure 3.41 House 9

House 9

Figure 3.42 House 10

Figure 3.43 House 1.2

Figure 3.45 Village

Figure 3.44 The house plan

House 10

House 1.2

Village

[Next Generation Architect]

Development Process

Digitalising Designs

The overhang on typology 3.2 (previously house 9) was adjusted to be on one short and one long face, allowing for shelter at the entrance and partial shelter over the outdoor living space. Consideration into dual housing influenced the faces with an overhang. The skylight structure was removed, as this additional element is not needed on the base design. The windows and the location of the outdoor living space have been adjusted to suit the planning and north facing areas.

The planning and footprint of house 3.3 (previously house 2) had a number of variations to the planning, including 3 bedroom and two 2 bedroom options, however, the 3 bedroom option had a large floor area which was pushing the boundaries of the design parameters set. The challenge with this design was the balcony facade working with internal walls. To solve planning issues, an additional panel was added to create a grid of four instead of three.

The analysis of house 3.4 (previously house 1) in the sketch design phase highlighted the issues of the flat roof and irregular form of the balcony. The first modelled iteration regulated the form and added a slope to the roof, however regulating the form took the architectural qualities away from the house, the irregular shape was reintroduced. The entrance consists of a cut-away to create an entrance porch sheltered by the floor above; this was absent through the physical modelling.

Typology 3.2

Figure 3.46 Typology 3.2 developments

Typology 3.3

Figure 3.48 Typology 3.3 developments

Typology 3.4

Figure 3.47 Typology 3.4 developments

The Pattern Book

The Two Storey Series

The first iteration of the pattern book involves the design of four housing typologies, with each typology consisting of several variations to suit individual site conditions and housing types. The four typologies selected include houses 1, 2 and 9 from the series of house designs exercise and house 1.1 from Phase Two. Each typology and its variation has been preliminarily costed with cost data from the QV costbuilder database; these costs are a first cost only and don't include the cost of the land.

The Design of The Pattern Book

What is included?

The pattern book consists of four sites across the Wellington Region located in Newlands, Lower Hutt, Wilton and Island Bay (figure 3.49). The aim of selecting several sites across Wellington ensures the testing and adaption of housing typologies across several site conditions such as connection to topography, orientation, foundations and types of housing.

Architects' design bespoke projects for their clients that consider unique designs and a range of site conditions. Conclusions drawn from the analysis of developer driven housing developments, summarises houses are designed for flat sites that are north facing. Therefore it is fundamental that the pattern book created for this thesis exhibits several variations of the housing typologies with the mindset of an architect.

The four sites selected include north and south facing sites and west and east sloping sites prevalent to Wellington.

- Site A at 55 Chapman Street, Newlands: North facing views, across both flat and sloped topography.
- Site B at 105 + 107 Whites East Road, Lower Hutt: South facing flat site with a northern street entrance.
- Site C at 35 Worcester Street, Wilton: West sloping site.
- Site D at 1/43A Wye Street, Island Bay: East sloping Site.

Design parameters were set to ensure all designs met a specific criteria, targeted at aesthetics and economics. The parameters consist of the following:

- Modular forms.
- Standardisation of windows, doors, sheet sizes and construction techniques.
- Separation of public and private spaces.
- Maximised floor areas with two storey dwellings reducing site coverage.
- Minimal materials (no more than two exterior materials).
- Site specific.
- Costs below \$500,000.

Figure 3.49 Map showing locations of 4 test sites across the Wellington Region

Test Sites

Wellington Region

A. NEWLANDS

Land value: \$144,596
Site Area: 418M²
Site Conditions: North facing, flat + sloped

Figure 3.50 Test site A map

B. LOWER HUTT

Land value: \$238,000
Site Area: 519M²
Site Conditions: South facing views, flat

Figure 3.51 Test site B map

C. WILTON

Land value: \$320,000
Site Area: 519M²
Site Conditions: West slope

Figure 3.52 Test site C map

D. ISLAND BAY

Land value: \$400,000
Site Area: 550M²
Site Conditions: East slope

Figure 3.53 Test site D map

House 3.1

68m²

Figure 3.54 House 3.1.1 and 3.1.2 Exterior Aesthetic

Figure 3.55 House 3.1.3 Exterior Aesthetic

Figure 3.56 Typology 3.1.1 Plan

First Cost = \$243,000
Cost per m² = \$3600

House 3.1 is a 2 bedroom 1 bathroom home at 68m². All variations of this house consist of light timber framed construction with weatherboard. Variations to the typology are tested across 3 sites.

- 3.1.1 tested on site A.
- 3.1.2 is reflected for site B with a north-facing street frontage.
- 3.1.3 uses timber piles and contains a reflected entrance and raised walkway to suit the conditions of site D.

3.1.2

Figure 3.57 Typology 3.1.2 reflected plan

First Cost = \$243,000
Cost per m² = \$3600

Figure 3.58 Typology 3.1.3 east sloping site plan

First Cost = \$258,000
Cost per m² = \$3800

House 3.2

93m²

Figure 3.59 Typologies 3.2.1 and 3.2.2 Exterior Aesthetic

Figure 3.60 Typology 3.2.3 Exterior

Figure 3.61 Typology 3.2.4 Exterior

Figure 3.62 Typology 3.2.5 Exterior

Figure 3.63 Typology 3.2.6 Exterior

3.2.1

Figure 3.64 Typology 3.2.1 Plan

House 3.2 is a 3 bedroom 1 bathroom home at 93m² per dwelling with the dual houses at a total of 186m². The design for this house contained six variations across the four test sites. Houses 3.2.3 and 3.2.4 consists of timber-framed construction to reduce costs on engineering for the hill sites. Both are clad with weatherboard and titan board. The remaining houses are constructed of concrete.

- House 3.2.1 and 3.2.2 reflect each other for north-facing site A and south-facing site B.
- House 3.2.3 is modified, allowing the main entrance to be at the back of the house where it meets the land on site C. Upstairs is modified, moving a bedroom and the bathroom to accommodate the new entrance.
- House 3.2.4 is orientated for the living spaces to face east on site D. A skylight is added for additional lighting into bedrooms on the northern face.
- Two dual houses are tested on site B to assess economic and aesthetic implications of sliding one dwelling forward as seen in houses 2.2.5 and 2.2.6.

3.2.2 & 3.2.3

Figure 3.65 Typology 3.2.2 Reflected Plan

Figure 3.66 Typology 3.2.3 west facing plan

Figure 3.67 Typology 3.2.4 East facing plan

First Cost = \$249,000
Cost per m² = \$3100

3.2.5

N
Ground Floor

N
First Floor

First Cost = \$426,000
Cost per m² = \$2600
Per dwelling = \$213,000

Figure 3.68 Typology 3.2.5 Duplex housing plan

Figure 3.69 Typology 3.2.6 Offset duplex house

First Cost = \$431,000
Cost per m² = \$2700
Per dwelling = \$215,500

House 3.3

82m²

Figure 3.70 Typology 3.4.1 Flat site variation

Figure 3.71 Typology 3.4.2 hill site variation

Figure 3.72 Typology 3.4.3 duplex variation

3.3.1

Figure 3.73 Typology 3.3.1 Plan

First Cost = \$265,000
Cost per m² = \$3200

House 3.3 is a 2 bedroom 1 bathroom home at 82m² per dwelling with the dual houses at a total of 164m². This house is designed for a northern street frontage and due to this has been tested on-site B for variations 3.3.1 and 3.3.3, constructed of concrete. The architectural elements of house 3.4 are the large panel which if orientated correctly can be used as a windshield for prevailing winds. Balcony panelling and timbers are another feature. House 3.3.2 is modified for site C to be west facing allowing for the afternoon sun to enter living areas and bedrooms, while the north face is modified allowing for larger windows than in variations 3.3.1 and 3.3.3. This house is constructed of light timber framing and clad with titan board to save costs and allow for timber piles on the hill site.

3.3.2

Figure 3.74 Typology 3.2.1 plan for site C

N — Ground Floor

N — First Floor

First Cost = \$245,540
Cost per m² = \$3400

3.3.3

Figure 3.75 Typology 3.3.3 Duplex Housing

Ground Floor

First Floor

First Cost = \$430,000
Cost per m² = \$3000
Per dwelling = \$215,000

House 3.4

68m²

Figure 3.76 Typology 3.4.1 Exterior

Figure 3.77 Typology 3.4.2 Exterior

Figure 3.78 Typology 3.4.3 Exterior

Figure 3.79 Typology 3.4.1 Plan

Ground Floor

First Floor

First Cost = \$254,000
Cost per m² = \$3200

House 3.4 is a 2 bedroom 1 bathroom home at 80m² per dwelling with the dual houses at a total of 160m². The architectural elements include the overhang of level 1, the panelling on the balcony and irregular angled form of the balcony space. This house is designed for a northern street frontage and due to this, has been tested on site B for variations 3.4.1 and 3.4.3. These variations consist of a mixture of precast concrete construction on the ground floor and light timber framing clad in weatherboard on level 1. Variation 3.4.2 is placed on timber piles for site C and is constructed of timber framing clad in titan board and weatherboard. The site orientation allows the afternoon sun to enter the living spaces, with the balcony facing north.

3.4.2

Figure 3.80 Typology 3.4.2 plan

Ground Floor

First Floor

First Cost = \$263,336
Cost per m² = \$3300

Figure 3.81 Typology 3.4.3 duplex housing plan

Ground Floor

First Floor

First Cost = \$408,000
Cost per m² = \$3000
Per dwelling = \$204,000

The Pattern Book

In Print Form

Figure 3.82 The pattern book in print form

The pattern book was designed as a design tool in the form of a booklet derived from the findings of architectural pattern books. The book portrays the design, components and cost estimate of the individual housing typologies.

Figure 3.83 Pages from the printed pattern book

HOUSE 1.1

House 1.1 +1.2

84M²

FIRST COST ESTIMATE

\$254,297

Site is not included and a first cost estimate only

MATERIAL SPECIFICATIONS

Exterior = Precast Concrete Panels

Interior = Timber Framed Walls

Glazing = Double Glazed

Flooring = Concrete Slab

Roofing = Colour Steel

HOUSE 1.1 FLOOR PLAN, DESIGNED FOR A NORTH FACING SITE

Tested on Site A: 55 Chapman Street

Scale: 1:100 @ A4

HOUSE 1.2 SOUTH FACING SITE (REFLECTED PLAN)

Tested on Site B: 105 + 107 Whites East Road

Scale: 1:100 @ A4

HOUSE 2.1

House 2.1

82M²

FIRST COST ESTIMATE

\$241,957

Site is not included and a first cost estimate only

MATERIAL SPECIFICATIONS

Exterior = Precast Concrete with Timber Elements

Interior = Timber Framed Walls

Glazing = Double Glazed

Flooring = Concrete Slab

HOUSE 2.1 FLOOR PLAN, DESIGNED FOR A NORTHERN FACING STREET FRONTAGE

Tested on Site B: 105 + 107 Whites East Road

Scale: 1:100 @ A4

128

BIM

Building Information Modelling

Building information modelling (BIM) is an intellectual 3D model-based process that gives professionals within the construction industry insight to tools needed to plan efficient projects, including the design, construction, management of infrastructure. BIM objects are data rich in the form of a 5D model that contains geometric information, cost, R-value and energy. Collaboration across disciplines such as architecture, structural and mechanical engineering is a key component to BIM. Collaboration is known to have a number of benefits to the documentation and coordination of a project, reducing the number of mistakes before projects are constructed which is critical to large scale projects (Levy & Ouellette, 2019). Levy & Ouellette (2019) states, “BIM gives the designer opportunities to make richer design decisions” (p.8). Decisions can be applied when knowledge surrounding elements and their implications are understood within a design such as cost, which ultimately improves the overall building process.

In the Netherlands, small-scale housing developments used BIM to achieve affordable housing goals. Sebastian (2010) states, “decisions made during the design phase on average affect 70% of the lifecycle cost of the building” (p.106). BIM allowed for design changes to be made at the early stages, reducing cost of reworks. Through a series of design experiments conducted with the BIM model, it was found BIM impacted on cost reduction and enabled quality design improvement. In turn highlighting the effectiveness of implementing such models.

Advantages:

- Collaboration within a workplace and cross discipline.
- Improved design and planning decisions.
- Data available to the 3D model.
- Mistakes can be picked up before the construction phase with fewer reworks required.
- Accurate cost calculations across all elements and families.

Disadvantages:

- Lack of knowledge within the profession to maximise the use of BIM.
- Cost of software.
- Incompatibility of software with cross disciplines.

Costing

BIM + REVIT

The objective of costing through the use of BIM in Revit allowed for a quick and accurate first cost estimate while understanding the cost implications based on design decisions made. BIM proved to be significantly faster and easier to cost through, than the previous use of a spreadsheet. Elements costed through BIM include floors, roof, walls, windows and doors seen in figure 3.83. Additional elements are applied in a spreadsheet. Figure 3.84 illustrates an example spreadsheet of the breakdown of typology 3.1, this process is repeated across all typologies (cost breakdowns are located in appendix 2). A cost library (located in the appendix) was established with data from the QV database to ensure accuracy.

Additional components added to spreadsheets

Additional Components:

- Floor Coverings
- Guttering and Downpipes
- Stairs
- Balustrades
- Joinery for Kitchen, Bathroom and Laundry
- Basic Appliances (Oven + Stove Top)
- Heatpump

Elemental:

- Site Works
- Plumbing + Drainage
- Electrical

Professional Fees:

- Architect
- Geotechnical
- Building Consent
- Contingency
- Engineer
- Additional Building Fees

The Costing Process

BIM + REVIT

The process of costing through Revit is as follows:

1. Adding cost data to each element e.g. walls . This requires having all relevant cost information from the QV database per m². The cost of timber walls includes timber costs, insulation, external cladding, gib and paint finishes.
2. Elements individualised by appropriately naming each element, with appropriate cost data added.
3. Individual cost schedules set up for each elemental group. This involves selecting the family type, area and cost. From here the formula for the total cost was applied to give the total of each schedule set up. This automatically updates when elements are changed allowing for costs to be tracked instantly.

Overall the use of BIM through Revit is a useful tool that has allowed for an accurate and efficient costing process, that can be used from the conceptual form, into the final iteration.

Figure 3.84 Revit schedules costing process

1. Family Type named and selected

2. Costs added to wall element

3. Wall schedule set up

4. Properties selected

5. Formula added to calculate total cost

6. Schedule layout grouped and total costs calculated

7. Formatting the total cost to be calculated

8. Final wall schedule

Figure 3.85 Revit schedules house 3.1.1

<Wall Schedule>			
A	B	C	D
Family and Type	Area	Cost	Total Cost
Basic Wall: 90T_10Gb-BS			
Basic Wall: 90T_10	4 m ²	185.50	706.03
Basic Wall: 90T_10	3 m ²	185.50	488.16
Basic Wall: 90T_10	6 m ²	185.50	1204.43
Basic Wall: 90T_10	6 m ²	185.50	1071.57
Basic Wall: 90T_10	2 m ²	185.50	395.37
Basic Wall: 90T_10	2 m ²	185.50	313.59
Basic Wall: 90T_10	1 m ²	185.50	263.60
Basic Wall: 90T_10	1 m ²	185.50	138.25
Basic Wall: 90T_10	5 m ²	185.50	858.10
Basic Wall: 90T_10	9 m ²	185.50	1606.61
Basic Wall: 90T_10	1 m ²	185.50	243.53
Basic Wall: Aqualine with Timber			
Basic Wall: Aqualine	5 m ²	198.80	1071.60
Basic Wall: Aqualine	5 m ²	198.80	1080.42
Basic Wall: Cedar Weatherboard + Interior			
Basic Wall: Cedar	6 m ²	480.20	2941.16
Basic Wall: Cedar	4 m ²	480.20	2013.61
Basic Wall: Cedar	1 m ²	480.20	675.98
Basic Wall: Linea Weatherboard + Interior			
Basic Wall: Linea W	10 m ²	423.20	4121.75
Basic Wall: Linea W	8 m ²	423.20	3192.79
Basic Wall: Linea W	9 m ²	423.20	3770.33
Basic Wall: Linea W	10 m ²	423.20	4050.57
Basic Wall: Linea W	10 m ²	423.20	4127.77
Basic Wall: Linea W	10 m ²	423.20	4194.04
Basic Wall: Linea W	2 m ²	423.20	675.17
Basic Wall: Linea W	1 m ²	423.20	563.92
Basic Wall: Linea W	1 m ²	423.20	563.92
Basic Wall: Linea W	2 m ²	423.20	750.72
Basic Wall: Linea W	2 m ²	423.20	679.87
Basic Wall: Linea W	2 m ²	423.20	750.72
Basic Wall: Linea W	10 m ²	423.20	4374.14
Basic Wall: Linea W	10 m ²	423.20	4192.89
Basic Wall: Linea W	2 m ²	423.20	667.31
Basic Wall: Linea W	1 m ²	423.20	330.22
Basic Wall: Linea W	10 m ²	423.20	4270.93
Basic Wall: Linea W	1 m ²	423.20	596.33
Basic Wall: Linea W	1 m ²	423.20	501.26
Basic Wall: Linea W	8 m ²	423.20	3293.38
Basic Wall: Linea W	1 m ²	423.20	501.26
Basic Wall: Linea W	1 m ²	423.20	482.45
Basic Wall: Linea W	2 m ²	423.20	650.19
Basic Wall: Linea W	3 m ²	423.20	1405.68
Basic Wall: Linea W	3 m ²	423.20	1310.72
Basic Wall: Linea W	0 m ²	423.20	56.09
Basic Wall: Linea W	0 m ²	423.20	26.20
Basic Wall: Linea W	0 m ²	423.20	73.65
Basic Wall: Linea W	0 m ²	423.20	17.03
Basic Wall: Linea W	0 m ²	423.20	58.85
Basic Wall: Linea W	0 m ²	423.20	179.63
Basic Wall: Linea W	1 m ²	423.20	284.40
Basic Wall: Linea W	0 m ²	423.20	135.33
Grand total: 49			65921.50

<Roof Schedule>			
A	B	C	D
Family and Type	Area	Cost	Total Cost
Basic Roof: Colour Steel Roof + Timber + ceiling			
Basic Roof: Colour	42 m ²	257.00	\$10696.11
Grand total: 1			\$10696.11

<Window Schedule>					
A	B	C	D	E	F
Family and Type	Cost	Height	Width	Area	Total Cost
3 window: 2'-9"W x 5'-0"H					
3 window: 2'-9"W x 5'556.00	2000	700	1.4	778.4	
3 window: 2'-9"W x 5'556.00	2000	700	1.4	778.4	
3 window: 2'-9"W x 5'556.00	2000	700	1.4	778.4	
3 window: 2'-9"W x 5'556.00	2000	700	1.4	778.4	
Fixed_Panel_Window_over_Awning_Window_9251: 2'-9"W x 5'-0"H					
Fixed_Panel_Windo 556.00	2000	600	1.2	667.2	
Fixed_Panel_Windo 556.00	2000	600	1.2	667.2	
Fixed_Panel_Windo 556.00	2000	600	1.2	667.2	
Fixed_Panel_Windo 556.00	2000	600	1.2	667.2	
FL 1 Aluminum-Grooved (NZ): big windows					
FL 1 Aluminum-Groo 556.00	2200	800	1.76	978.56	
FL 1 Aluminum-Grooved (NZ): big windows 2					
FL 1 Aluminum-Groo 556.00	2200	800	1.76	978.56	
FL 1 Aluminum-Groo 556.00	2200	800	1.76	978.56	
FL 1 Aluminum-Grooved (NZ): large balcony window					
FL 1 Aluminum-Groo 556.00	2100	500	1.05	583.8	
Multi-Panel_Awning_1958: 2					
Multi-Panel_Awning_556.00	800	1600	1.28	711.68	
Multi-Panel_Awning_1958: long edit					
Multi-Panel_Awning_556.00	700	3500	2.45	1362.2	
Multi-Panel_Awning_1958: Multi-Panel_Awning_1958					
Multi-Panel_Awning_556.00	700	2000	1.4	778.4	
Grand total: 15					12154.16

<Floor Schedule>			
A	B	C	D
Family and Type	Area	Cost	Total Cost
Floor: Concrete Slab			
Floor: Concrete Sl	4 m ²	150.00	\$550.65
Floor: Concrete Sl	35 m ²	150.00	\$5184.68
Floor: Timber Decking			
Floor: Timber Deck	13 m ²	170.00	\$2171.92
Floor: Timber Deck	5 m ²	170.00	\$926.55
Floor: Timber Mid Floor + Ceiling			
Floor: Timber Mid	29 m ²	280.00	\$8238.56
Grand total: 5			\$17072.36

<Door Schedule>		
A	B	C
Family and Type	Cost	Total Cost
Ext Bifold3-1Lite(NZ): 2100 x 1980		
Ext Bifold3-1Lite(N	2571.00	2571.00
Ext Single In-Timber-1Lite (NZ): Front Door Glazed		
Ext Single In-Timbe	2040.00	2040.00
Exterior_Sliding_Door_3843: 6'-0"W. x 7'-0"H.		
Exterior_Sliding_D	2571.00	2571.00
Int Single-Flush (NZ): 710 x 1980		
Int Single-Flush (N	254.00	254.00
Int Single-Flush (N	254.00	254.00
Int Single-Flush (N	254.00	254.00
Int Single-Flush (N	254.00	254.00
Int Single-Flush (N	254.00	254.00
Grand total: 8		8452.00

[Next Generation Architect]

Figure 3.86 Excel breakdown typology 3.1

House 3.1.1 + 3.1.2 Costing Breakdown			68 m2	Timber Construction with concrete slab		
Element	Item Description	Area m2	Cost (\$)	Per m2	Total Cost Per m2	Totals
Doors						
Revit Calculation - see Revit schedule for full costing breakdown per item Exterior and interior doors						
Total Cost Doors			\$8,452			\$8,452
Windows						
Revit Calculation - see Revit schedule for full costing breakdown per item Exterior aluminium joinery						
Total Cost Windows			\$12,154.00			\$12,154.00
Wall Schedule						
Revit Calculation - see Revit schedule for full costing breakdown per item See additional information for full breakdown includes exterior and interior walls						
Total Cost Walls			\$65,921.50			\$65,921.50
Roof Schedule						
Revit Calculation - see Revit schedule for full costing breakdown per item Roofing with timber framing, insulation and ceiling for floor below						
Total Cost Roof			\$10,696.00			\$10,696.00
Floor Schedule						
Revit Calculation - see Revit schedule for full costing breakdown per item All flooring, timber mid floor including balcony, concrete slab, concrete pathway and timber decking						
Carpet			35.4	\$68		\$17,072.36
Tiles			19.2	\$155		\$2,976
Total Cost Flooring						\$22,455.56
Joinery						
Stairs with handrail (Cost per m)			3	\$413		\$1,239
Kitchen Fitout			1 x Fitout	\$9,465		\$9,465
Lounge Joinery			1 x Fitout	\$1,800		\$1,800

Bathroom Fitout	Vanity unit with sink, tapware mirror, toilet and shower	1 x Fitout	\$5,190	\$5,190	
Wardrobe Doors	2x Sliding Wardrobe Doors	2	\$150	\$300	
Balustrade Balcony	Timber Balustrade	4.5	\$230	\$1,034.10	
Total Cost Joinery					\$19,028
Heating					
Standard Heatpump	1 x heatpump		\$4,500	\$4,500	
Gas hot water	Rinnai Infinity 26L continuous flow hot water heater LPG or Natural Gas	1x	\$3,395	\$3,395	
Total Cost Heating					\$7,895
Elemental Costing					
Site Preparation		68	\$17.15	\$1,166.20	
Sanitary Plumbing		68	\$144.55	\$9,829.40	
Electrical Services		68	\$90.65	\$6,164.20	
Drainage		68	\$31.85	\$2,165.80	
Excavation		0	\$16.90	\$0	
Total Cost Elemental					\$19,325.60
Total Cost Minus Professional Fees and GST					
				\$	165,927.76
Professional Fees					
Architect		0.06 \$	165,927.76 \$	9,955.67	
Geotechnical		0.025 \$	165,927.76 \$	4,148.19	
Building Consent Wellington City Council	WCC Rates			\$4,025	
Contingency Engineer		0.06 \$	165,927.76 \$	9,955.67	
		0.08 \$	165,927.76 \$	13,274.22	
Extra Building Fees	Insurance, site shed, temporary power + water and skips			\$4,300	
Total Cost Professional Fees				\$	45,658.75
Total Costs					
				Total Cost Excl GST	\$ 211,586.51
				GST	\$ 31,737.98
				Total Cost Incl GST	\$ 243,324.48
				Total Cost Per m2	\$ 3,578.30
				Deposit (20%)	\$ 48,664.90
House 3.1.3 Breakdown 68m2 Designed for East Sloping Hills Timber Construction					
Developments for hill site specifications					
See Revit Schedules for breakdown					
Includes: Timber Framed Mid Floor Ecoply surface on 250 x 45 joists @ 600 c/s, pink batts snug floor R1.6 insulation, ceiling grid for the floor below with 70 x 45 ceiling battens with GIB ceiling. Timber substructure and flooring build up including insulation + ples, Timber framed decking and balcony with grip tread finish.					
2x Balustrades + timber framed entranceway + Timber substructure					
\$21,618					
Flooring Additions					
				Total Cost Excl GST	\$ 224,088.17
				GST	\$ 33,613.23
				Total Cost Incl GST	\$ 257,701.40
				Total Cost Per m2	\$ 3,789.73
				Deposit (20%)	\$ 51,540.28

Findings from the Pattern Book

How can an architect design more accurately with value?

Materiality and Costing:

- Houses on flat sites are cheaper to build than those on hill sites. A contributor to this is the cost of the timber substructure that is approximately \$120 more per m² than an insulated concrete slab, which all houses contain on the flat test sites.
- Hill sites cost more to build on. In a personal conversation with a QS it is advised engineering and excavation is researched first.
- It is approximately \$200 cheaper per m² for duplex houses.
- Housing typology 1.1 has the highest costs per m². Even though it has the smallest floor area. What makes this typology cost more is the cost of the build-up of the kitchen and bathroom and joinery throughout the house – all elements are needed. It just has less floor area to be shared across.
- The most economic houses are timber framed with weatherboard, the construction of the hybrid house is more economical than full concrete construction. All houses have a timber framed roofs. The hybrid has a timber framed mid floor.
- Concrete mid floor costs more than a timber framed floor.

Findings from the pattern book:

- Repetition of design.
- Architecture as product that works with site specific conditions just as an architect would for bespoke architecture.
- Optimised and efficient planning.
- The use of BIM as a costing tool to observe implications of design decisions.
- The use of dual housing to reduce costs that would include site in a built situation.
- Light timber framing on hill sites to reduce engineering costs.
- Building on timber piles to reduce the need for excavation.
- Working with sheet sizes.
- Simple regular forms.
- No repetition of service areas.

Findings + Reflection

The Next Steps

The pattern book allowed for a successful comparison of four housing typologies and their relationship to different site conditions. This has allowed for a distinguishable difference between the choices an architect would make specific to site compared to a developer who would only show one variation of each house. The use of BIM through Revit was a successful tool to cost all houses minimising mistakes made for a first cost estimate. The current weaknesses include the interiors of the houses where there is currently no understanding to what these look like and how you live within the interior from a human perspective. Introducing the lifecycle of materials will show stronger links to the differences between this thesis and developers homes.

Creating a unique product creates the branding of the pattern book houses. This was seen through project homes in Australia where Pettit and Sevitt and Merchant builders both marketed and branded their companies through unique processes, grasping clients attention. "Individualism served as an early form of product identification, or 'branding', offering the consumers of products or services the potential for their own self-realisation and individualisation through the act of consumption" (O'Callaghan, 2017, p.142). The pattern book requires further development enhancing individualisation and desirability through the form of a product. This can be achieved through revisiting the planning of the spaces and enhancing the overall desirability to live within them. In addition it has also be achieved by reconsidering interior layouts to consider viewpoints and how spaces can be used for more than one function or arrangement, as well as including architectural elements that will enhance the aesthetics and functions of a space. Reconsidering the connection between the indoors and outdoors through external spaces and landscaping, which the designs currently lack, will tie the overall experience of the home together.

Where to next?

- Improve desirability and branding of homes.
- Undertaking lifecycle analysis of materials.
- Development of the pattern book, introducing single level houses and a split level option.
- Designing interiors from a occupants perspective.

Next Generation Architect

A next generation architect will be approachable for all types of clients and will utilise time, cost and quality through the use of innovative tools such as BIM and pattern books. In addition they will produce architectural products, creating libraries of designs, drawings and costs.

06

Next Generation Architect

Chapter 5 investigated the Next Generation Architect. An architect who understands cost implications of materials, standard construction techniques and the impact of their lifecycle. This chapter introduces two new housing typologies and explores the habitation of all housing typologies.

New Zealand Architectural Homes

Analysis of elements within architectural homes

The interiors of the dwellings in Design Phase Three contained weaknesses surrounding inhabitation and architectural elements of the interiors. Design Phase Four explores the interiors through materiality, habitation and architectural elements, exhibiting the dwellings as architectural products. A precedent analysis exercise was undertaken using Home magazine, investigating architecturally designed homes in New Zealand. Elements from this analysis were adopted to influence a versatile and homely habitation.

Findings:

- Smart storage through recesses, joinery and furniture.
- The application of shelving and paneling as architectural elements.
- Level changes to break up open plan spaces.
- Efficient layouts optimising floor area.
- Material usage and selection on both the interior and exterior, for aesthetic purposes.
- Effective easy care landscaping.

Figure 4.01 Recessed bedhead design reducing the area used to the side of the bed

Figure 4.02 Built in daybed joinery with swab and electrical fittings

Figure 4.03 Storage recessed into wall with hooks and a shelf

Figure 4.04 Timber panelling used as railing for the stairs

Figure 4.05 Shelving recessed into wall with bed lamp

Figure 4.06 Exterior materiality

Figure 4.07 Herbst Architects Aesthetic

Figure 4.08 Double usage furniture and space divider

Figure 4.09 Furniture containing storage

Figure 4.10 Kitchen Layout

Figure 4.11 Findings applied to house 3.1.1 in a development sketch

Herbst Architects concept for the design of the Te Modular bach arose from a number of people requesting a bespoke bach design within a small budget. Targeted at reducing building costs, through a package design, and containing detailed drawings and specifications at a set price. Additional fees are required for site consultation and the processing of consents (Foster, 2015). Te Modular can be seen as a successful architectural product, with the first Te Modular bach being built in 2013 on Great Barrier Island and the second in 2015 at the same beach (figure 4.12 and 4.13).

“Our thinking was not so much in terms of a kitset, but a bach that is adaptable enough to suit most sites that we design and detail extensively, down to the furniture... We can then repeat this allowing us to significantly reduce the cost to the client of professional fees” (Bucknell, n.d.)

Tactics of affordability:

- Standardisation of built elements.
- Architecture as product: creating a model that can be repeated across a number of sites.
- A flexible pod layout. Modified to suit specific client and site requirements.
- Repeatable drawings reducing an architect’s professional fees, as these are spread across a number of builds.
- Controlled floor area providing only the essentials.
- Reducing material usage by enclosing half the structure.
- Specifically designed furniture containing storage.

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Figure 4.12 First Te Modular bach on Great Barrier Island

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Figure 4.13 Second bach on Great Barrier Island with a different external colour pallet

Madras Street Duplex

Coll Architecture

The Madras Street duplex designed by Coll Architecture is located in Christchurch. The two units are reflected, sharing a common wall with a floor area of 74m² each. Coll designed with the interest of cost efficiency, and wanted to demonstrate that new homes can be warm, dry, low maintenance, efficient to run and built for no more than the average sized architecturally designed home. This is achieved through the consideration of every element within the dwelling. (Foster, 2019)

"By building a house small and design dense, the money saved can be spent on quality. The maths isn't complicated- if you half the size you get twice the quality and overall price." (Foster, 2019, p.99)

Tactics of affordability:

- Duplex dwelling with costs split.
- Shared services wall between the two dwellings.
- Future proofing the building.
- Strategic material usage with minimal use of cor-ten steel on the street frontage
- Open plan.
- CLT structure.
- Minimal material pallet.
- Strong indoor-outdoor flow, allowing for living areas to feel larger.

Economics:

- Land: \$215,000.
- Build: \$361,000 per house (\$4878 per m²), \$722,000 in total.
- Landscaping: \$57,000.
- Fees and Compliance: \$47,000.
- Total for whole dwelling: \$1,041,000, Per unit: \$520,500.

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Figure 4.15 Madras Street Duplex Exterior Materiality Usage

Figure 4.14 Madras Street Duplex Cor-ten Steel Street Frontage

The Wedge House

Grand Designs New Zealand

The Wanaka Wedge House is a 240m² home, portrayed as an architectural product. The clients came across the bold design on the internet. Although the house was not designed for the New Zealand climate. It was originally designed but never built for a site on the east coast of the United States by architect Jeff Day. The house was adapted to suit the climatic and environmental conditions and building regulations of New Zealand. (Hawkes, 2019)

Positives:

- Architecture as product with plans available for purchase online.
- Adaptable design to suit sites located across the globe.
- Prefabricated construction processes; SIPS, CLT and standard timber framing.

Negatives:

- Expensive. An estimated cost of \$995,000.
- Project came in overbudget by a 15%, total build was \$1.137 million, \$4740 per m².
- Irregular windows.
- Irregular design took 18 months to gain council approval.

Figure 4.16 Original design and materiality of the Wedge house located in the USA. .

Figure 4.17 Wanaka Wedge House tongue and groove ceiling

Figure 4.18 Wanaka Wedge House situated within the landscape, flipped from the original design

Eames House

Case Study House

The case study house program was initiated in 1945 by John Entenza of the Arts and Architecture Magazine in Los Angeles. It involved the design of 36 housing prototypes over 21 years, with 8 architects commissioned. Prototypes were designed to be economic, experimental, and easy to build. The modern home was defined through the program which has internationally influenced residential architecture by established new materials and methods (Steele, 2002).

Case study house number 8 known as the Eames house designed by Charles and Ray Eames was identified as one of the first experimental dwellings. It experimented with planning, structure and the integration of industrial materials and techniques into architecture (McCoy, 1977).

Tactics of Affordability:

- Minimal complexity
- Standardised construction techniques:
 - Windows at a width of 3'4"
 - Coloured panels on the external envelope integrating with the structural grid
 - Simple steel framing involving 2- inch H columns
 - 12- inch open web steel beams (Perez, 2010)

Figure 4.19 Standard detailing used on the Eames house

Figure 4.20 Eames house steel structure and concrete retaining wall.

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Figure 4.21 Exterior of the Eames house exposing the structure.

Standard Detailing

Construction of Dwellings

Minimising the complexity of the construction of a dwelling allows for an economic outcome. This is achieved through the use of standard detailing. Standard detailing allows for a straightforward construction process, with builders and other trades people having a strong knowledge of how the dwelling is constructed. It means an efficient and economic outcome, where the architect does not have to supervise each individual area being constructed. This also comes into account within the council consent process to meet building code compliance. A dwelling containing standard detailing is more likely to be understood and ticked off as meeting compliance, compared to a dwelling with complex irregular detailing. (Building Performance, 2016).

Using standard details across projects allows for architects to create libraries of details. This saves architects time, which in the long run is more economical. Libraries of details can be created, so only minimal changes are needed for each project, rather than reinventing details. Bespoke details should be kept to a minimum, with standard detailing substituted into the detailing where applicable.

Standard detailing is used throughout all housing typologies designed. Posi-struts are substituted as a standardised replacement providing an economical method for larger spans, for areas of timber framing not meeting standard timber sizes. The majority of windows for all dwellings are regulated, apart from the minimal use of irregular shaped windows in typologies 4.5 and 4.6 for architectural intentions. Irregular shaped or windows requiring structural elements costs approximately 30% more per m² than standard glazing (QV Cost builder). All housing typologies contain typical cladding options with a small material pallet of weatherboard, Coloursteel, titan board or precast concrete panels. Roofing is consistent with the use of Coloursteel over light timber framing.

Figure 4.22 Standard Roof to External Wall Cladding Detail

Figure 4.23 Standard insulated concrete slab and foundation detail

Figure 4.24 Standard timber midfloor to external wall detail

Figure 4.25 Standard Posi-Strut floor framing detail

Material Analysis

Overall Costs and Lifespan

Figure 4.26 Average lifespan of exterior wall claddings

Figure 4.27 Average cost of exterior wall claddings

Figure 4.28 Average lifespan of roof claddings

Figure 4.29 Average cost of roof claddings

Material Analysis

Overall Costs and Lifespan

Figure 4.30 Selected exterior wall cladding lifecycle costing using QV database.

Figure 4.31 Selected wall cladding lifespans

Figure 4.32 Selected roof cladding lifespan

Figure 4.33 Selected roof cladding lifecycle costing

Material Analysis

Overall Costs and Lifespan

New Zealand's Building Code clause B2 requires all building materials to meet a durability requirement. These requirements include three levels of durability, lasting no less than 5, 15 or 50 years. No product should deteriorate before 5 years, with structural elements requiring a durability of 50 years (Ministry of Business, Innovation and Employment, 2019). B2 was used to make assumptions for the lifecycle costs and life spans involved with materials used within the housing typologies designed. All designs analyse costs over a 50-year life span, implemented within the material analysis graphs. Aluminium and timber joinery require replacement at 35 years and PVC at 22 years (Howard, Burgess, & Lim, 2007). It is crucial a next generation architect can comprehend the full value of the materials they select.

The first four graphs in figures 4.26 - 4.29 apply data from BRANZ in Fung (2010), BRANZ data in Page (2015) and Brudson (2017), for the average lifespan and costs of exterior wall and roof cladding in normal climatic conditions. This set of data informs the next set of graphs (figures 4.30 - 4.33) where selected and potential materials used within designs, are analysed using manufacturers lifespans and costing from QV cost database.

Findings:

- Unpainted steel, Zinalume is the cheapest material for both wall and roof claddings, and has the lowest lifespan of 25 years. Zinalume was used in previous design phases however will now be substituted with precoated Colour Steel Endura.
- Precoated corrugated steel such as Endura is the most economical material overall, followed by painted plywood and batten cladding.
- Weatherboards contain high maintenance costs; repainting is required every 10 years.
- Butyl roofing has a low lifespan of 25 years and has the highest overall costs. Upfront costs are twice those of steel roofing.
- Most materials have a minimum lifespan of 50 years
- The longest lasting materials are clay, concrete bricks and tiles at 70 years, Precast concrete is the longest lasting with lifespans up to 100 years.
- Manufacturers specifications state Linea weather board and Colour Steel will require its first repaint after 15-18 years then every 10 years after.
- Staining a product requires high levels of maintenance; staining is required every 5 years.

“Decisions are usually not made solely on cost. Appearance is also important to the owner. The more expensive, longer-lasting products usually maintain their appearance better than cheaper materials.” (Page, 2015, p. 72)

House 4.1

Interior Materials and Cost Implications

Interior Option 1

Figure 4.34 Full raw plywood interior with polished concrete flooring.

Cost per m² = \$315.80
Total cost = \$11,020.80

Interior Option 2

Figure 4.35 Hybrid plywood and gib interior with polished concrete flooring

Total cost per m² = \$298.90
Total cost = \$10,623.90

Interior Option 3

Figure 4.36 Gib interior with tiled flooring

Total cost per m² = \$333
Total cost = \$10,765

Interior Option 4

Figure 4.37 Hybrid Gib and Zinalume interior with timber flooring.

Total cost per m² = \$332.10
Total cost = \$10,591.10

House 4.1.1

Interior Materials and Cost Implications

The aim of this exercise was to gain an understanding of aesthetic appeal and cost implications within the ground floor of house 4.1. The exercise explored four different variations in the kitchen and living spaces including; Option 1 a full plywood interior with a polished concrete floor, Option 2 hybrid plywood and gib interior with a polished concrete floor, option 3 gib interior with tiled flooring and a gib. Option 4 Zinalume hybrid with timber flooring. A material change of carpet is used in the living are, indicating a space and level change. All costing was estimated through the use of BIM through Revit.

Findings:

- Tiled and timber flooring costs more than polished concrete. Timber is the highest cost out of the three
- Exposed concrete holds thermal mass properties for passive solar architecture
- Plywood as an interior lining costs more than gib stopped and finished
- Zinalume is the cheapest option for a ceiling finish
- Allowing for a small pallet of interior fitouts to choose from, ensures the house is seen as an architectural product that caters to a range of clients and their preferred aesthetics.

Overall there is a very small price difference between Option 2,3 and 4. The reason Option 1 is the most expensive is the use of plywood on both the floors and walls instead of a hybrid combination.

Exterior Materials and Cost Implications

House 4.1.1

Exterior Option 1

Figure 4.38 Linea weatherboard and cedar

\$62,048
\$27,007
\$89,055

- Maintenance Requirements:
- 4 repaints on Linea Weatherboard, \$45 per m²
 - 9 cedar restains, \$28.40 per m²

Exterior Option 2

Figure 4.39 Cedar weatherboard

\$69,629
\$37,062
\$106,691

- Maintenance Requirements:
- 9 cedar restains, \$28.40 per m²

Exterior Option 3

Figure 4.40 Colour Steel and Titan Board

\$39,192
\$11,251
\$50,443

- Maintenance Requirements:
- 3 repaints of Coloursteel, \$20.90 per m²
 - 4 repaints of Titan Facade Panel, \$45 per m²

Exterior Option 4

Figure 4.41 Embossed and painted insulated concrete

\$70,615
\$20,300
\$90,915

- Maintenance Requirements:
- 4 repaints of concrete, \$35 per m²

Exterior Option 5

Figure 4.42 Board and batten plywood

\$45,472
\$24,012
\$69,484

- Maintenance Requirements:
- 9 restains on plywood, \$18.40 per m²

Exterior Materials and Cost Implications

House 4.1.1

This rendering exercise was aimed at understanding the value of the cost implications and aesthetics of five cladding options on house 4.1. Architectural products typically have a number of cladding options per design for clients to select. Cost implications are understood through the upfront costs, lifecycle costs including repainting or staining over 50 years, and finally the combined cost. All products selected for this exercise have a life span of at least 50 years.

Findings:

- Full cedar cladding is the most expensive and requires a higher level of maintenance, with staining required every 5 years.
- Embossed insulated concrete panels have the highest upfront costs, however, have lower maintenance costs and requirements with a longer lifespan than all materials tested.
- Reducing the area of cedar to 12m² has significantly reduced costs by \$7000 with the use of Linea Weatherboard on the remaining external wall area.
- Plywood with battens is the second most economical option however requires twice the maintenance with staining required every 5 years. Painting the plywood would halve the maintenance requirements; to 10 years, although gives a different aesthetic.
- Coloursteel is the most economical cladding, requiring minimal maintenance. A 12m² area of Titan Facade Panel is used for aesthetic purposes.

Figure 4.43 House 4.1 Exterior

House 4.1

House 4.1.1 consists of a timber framed construction according to NZS3604 and is a 2 bedroom 1 bathroom home. The weaknesses in the plan for House 3.1.1 in Phase 3 Included: habitation within the living space, stair tread heights and landscaping.

Developments:

- Laundry located under the stair cavity to create more floor space.
- Joinery designed for the stairs including storage, shelving and timber panelling.
- Joinery in bedrooms.
- Floor area increased allowing all spaces to function ergonomically and efficiently.
- Step down into the living room module to break spaces up.
- Basic landscaping.
- Stair tread issue resolved with curving stairs and a new landing.

Figure 4.44 Elevations

Figure 4.45 House 3.1.1 plans sketched over

House 4.1

Plans + Sections

Figure 4.46 Ground Floor Plan

Figure 4.47 First Floor Plan

Key:

1. Entrance
2. Kitchen + Dining
3. Living
4. Laundry
5. Outdoor Living
6. Circulation
7. Bathroom
8. Bedroom 1
9. Master Bedroom
10. Balcony

Figure 4.48 Section A-A

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Figure 4.49 Section B-B

93m²

Figure 4.50 House 4.2 Exterior

House 4.2

House 4.2 is a 3 bedroom 1 bathroom home, designed with a concrete construction and a light roof framed with Posi-Struts. Achieving longer spans than typical timber framing. The floor plan has been rearranged and the purpose designed furniture creates an efficient use of space.

Developments:

- The circulation space on first floor doubles as a storage and study area.
- Expanded floor area ensuring functionality.
- Plumbing walls aligned with the bathroom moved to the south-west corner.
- Bedrooms located along the northern wall.
- Laundry and storage spaces located under the stairs.
- Joinery behind the bed in the master bedroom allowing more space next to the bed.
- Stair joinery with panelling duplicated from house 4.1.
- Purpose designed couch to fit the living area with additional storage at the base.
- Shelving unit used as a divide between living and dining spaces.

Figure 4.52 Elevations

Figure 4.51 House 3.2.1 plans sketched over

WHAT IS MISSING?

- DESH SPACE
- STORAGE
- LINE UP PLUMBING WALLS.
- LANDSCAPING.
- FIX MISTAKE IN STAIRS.

Figure 4.53 Ground Floor

Figure 4.54 First floor

Key:

1. Entrance
2. Kitchen + Dining
3. Living
4. Laundry
5. Outdoor Living
6. Circulation
7. Study Area
8. Bathroom
9. Bedroom 1
10. Bedroom 2
11. Master Bedroom

Figure 4.55 Section A-A

Figure 4.56 Section B-B

85m²

Figure 4.57 House 4.3 Exterior

House 4.3

House 4.3 contains 2 bedrooms and 1 bathroom and is constructed of precast concrete panels with a light Posi-strut framed roof. The initial floor plan contained weaknesses with the size of the living area and balcony. These were extended to create comfortable spaces.

Developments:

- Seed design of stair joinery replicated with perforated steel panelling reflected from the exterior, allowing space under stairs to be utilised as storage.
- Daybed, desk and additional bench and storage in kitchen.
- Balcony widened to allow comfortable habitation with furniture.
- Widened living area and kitchen.
- Stair tread amended and first floor rearranged to accommodate stair height.
- Joinery designed in bedrooms.

Figure 4.58 Elevations

Figure 4.59 House 3.3.1 plans sketched over

House 4.3

Plans + Sections

Figure 4.60 Ground Floor

Figure 4.61 First Floor

Key:

- 1. Entrance
- 2. Kitchen + Dining
- 3. Daybed
- 4. Desk
- 5. Living
- 6. Laundry
- 7. Outdoor Living
- 8. Circulation
- 9. Bathroom
- 10. Bedroom 1
- 11. Master Bedroom
- 12. Balcony

Figure 4.62 Section A-A

Figure 4.63 Section B-B

85m²

Figure 4.64 House 4.4 Exterior

House 4.4

House 4.4 contains a hybrid construction of timber and concrete, with 2 bedrooms and 1 bathroom. The dwelling has adopted a similar layout to house 4.2 on the first floor, with the same master bedroom layout and desk located in the circulation space. The initial floor plan did not contain enough storage and additional width was needed on the ground floor plan.

- A larger balcony, that is user friendly and can now contain furniture.
- Seed joinery for TV storage, stairs and laundry. Space under the stairs is now utilised as storage.
- Specific designed L shaped couch to fit the space, containing additional storage at the base.

Figure 4.65 Elevations

Figure 4.66 House 3.4.1 plans sketched over

House 4.4

Plans + Sections

Figure 4.67 Ground floor

Figure 4.68 First floor

Key:

1. Entrance
2. Kitchen + Dining
3. Living
4. Outdoor Living
5. Circulation
6. Study Area
7. Bedroom 1
8. Bathroom
9. Master Bedroom
10. Balcony

Figure 4.69 Section A-A

Figure 4.70 Section B-B

58m²

Figure 4.71 House 4.5 Exterior

House 4.5

House 4.5 is a one storey 1 bedroom home constructed of timber framing, cladd in Coloursteel. The dwelling is designed to face north with a south facing entrance on site A. This dwelling is one of the two new designs introduced and is aimed at those looking for a smaller dwelling. The design is future proofed, with the potential to add a second bedroom. There is minimal usage of an irregular angular window on the northern face, used to achieve the desired architectural outcome.

Architectural Elements:

- Seed joinery replicated within the interior.
- Angled wall along the northern face for architectural aesthetic purposes, squared off in the bedroom for functionality.
- Minimal use of cedar on the entrance.
- A clear storey to the east allowing morning sun to enter.

Figure 4.72 House 4.5 Elevations

House 4.5

Plans + Sections

Figure 4.73 Ground floor

Key:

1. Entrance
2. Living
3. Kitchen
4. Desk
5. Storage + Hotwater Cylinder
6. Outdoor Living
7. Bathroom + Laundry
8. Master Bedroom
9. Future Bedroom

Figure 4.74 Section A-A

Figure 4.75 Section B-B

73m²

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Figure 4.76 House 4.6 Exterior

House 4.6

House 4.6 is derived from house 5 from the series of house designs exercise. Constructed of timber framing and clad with Coloursteel and cedar. It is designed to be adaptable working with a number of west sloping sites. Containing 2 bedrooms and 1 bathroom, located across 3 levels that are divided into two main wings. An entrance wing, divides public and private spaces.

Architectural Elements:

- Large windows along the east face allowing morning sun to enter the dwelling.
- Roof overhang ensures spaces will not be exposed to overheating with the large glazed areas.
- Seed designed plywood joinery as storage and shelving within the interior.
- Irregular shaped windows along the north and south faces. These cost 30% more than standard windows.
- Located on timber piles for economic reasoning, reducing on site excavation.
- The mid floor roof slopes towards the entrance, eliminating the need for an uneconomical membrane roof and internal gutter.

Figure 4.77 Elevations

House 4.6

Plans + Sections

Figure 4.78 Floor plan

Key:

- 1. Entrance
- 2. Living
- 3. Kitchen
- 4. Desk
- 5. Outdoor Living
- 6. Circulation
- 7. Bathroom
- 8. Laundry
- 9. Master Bedrom
- 10. Bedroom 1

Figure 4.79 Section A-A

[Next Generation Architect]

Figure 4.80 Section B-B

A Selection of Interior Renders

Figure 4.81 Houses 4.2 & 4.4 upstairs circulation and desk space.

Figure 4.82 House 4.2 lounge joinery and additional built in storage.

Figure 4.83 House 4.1, seed design of understair TV and storage joinery.

Figure 4.84 House 4.5, clear story & irregular windows, and joinery.

First Cost Estimates

Upfront and Lifecycle Costing

In addition to the first cost estimate of all six housing typologies designed, lifecycle costing of materials was introduced to cover a 50-year lifespan. This created an understanding into quality long lasting materials, maintenance requirements and lifecycle economics of materials. Final materials were carefully selected, considering both cost and quality over the 50-year lifespan. Costs were estimated through Revit schedules providing material quantities and cost data from QV costbuilder. It was then placed into spreadsheets that used BRANZ, clause B2 and specific manufacturers data surrounding maintenance and lifespan costs, broken down within the spreadsheets. The elements costed, include labour, joinery, cladding, roofing, flooring, painting and floor materials. It excludes inflation over the 50-year period, hardware, household appliances, plumbing, electrical, dwellings outside normal climatic conditions and presumes required maintenance is undertaken.

BIM through the use of Revit, continued to be used as a costing tool for the first cost estimate, aided by spreadsheets (house 4.1 is used as an example in figures 4.86 - 4.88) to cost additional elements and professional fees. The first cost estimate excluded land, landscaping, additional interior fixtures, special hardware and lighting fixtures, margins and overheads, and project specific site preparation costs. Spreadsheets are located in appendix 3.

Architects must be smart with material selection, ensuring cost efficiency and value over time. The designs implement value using above code insulation on external walls, roofing and flooring. Well insulated homes provide year-round comfort and provide economic benefits surrounding heating and cooling. Thermal mass is explored through the use of concrete slabs. Typical timber framing acts as a thermal bridge as heat flows easier through timber than insulation. Thermal bridging is reduced by using stronger framing; achieved by moving a 90mm wall to a 140mm deep wall at wider spacings, allowing for more insulation which results in a higher thermal performance. (Smarter Homes, 2019)

Timber framed dwellings clad in colour steel followed by Linea weatherboard contain the lowest upfront costs. These dwellings also contain the smallest floor areas. Small areas of cedar are used in a number of dwellings to maximise the budget.

The average cost per m² is \$3400. Houses with smaller floor areas contain higher costs per m², due to the cost of essential components such as the kitchen and bathroom being spread across a smaller area. House 4.6 has a higher cost due to the larger areas of roofing and decking.

Dwelling 4.5 holds the lowest lifecycle cost due to the small size of the dwelling. Concrete with an acid wash requires the lowest maintenance. Insulated concrete panels contain a high upfront cost but have a larger lifespan and require less maintenance. An acid wash allows the flexibility for change in the future to a paint finish.

Overall timber framed homes clad predominantly in coloursteel are the most economical, followed by concrete and finally weatherboard. The hybrid combination is the most expensive overall due to the maintenance surrounding the weatherboard staining.

House 4.1 Costing

Overall Costs and Lifespan

Figure 4.86 First Cost 4.1

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House 4.1 Costing Breakdown		80 m2	Timber Construction with concrete slab		
Element	Item Description	Area m2	Cost (\$)	Total Cost Per m2	Totals
Doors					
Revit Calculation - see Revit schedule for full costing breakdown per item					
	Exterior and interior doors		\$7,944		
Total Cost Doors					
					\$7,944
Windows					
Revit Calculation - see Revit schedule for full costing breakdown per item					
	Exterior aluminium joinery		\$10,706.34		
Total Cost Windows					
					\$10,706.34
Wall Schedule					
Revit Calculation - see Revit schedule for full costing breakdown per item					
	See additional information for full breakdown includes exterior and interior walls				
Total Cost Walls					
			\$70,818.00		\$70,818.00
Roof Schedule					
Revit Calculation - see Revit schedule for full costing breakdown per item					
	Roofing with timber framing, insulation and ceiling for floor below				
	Spouting costs per m includes eaves gutters (fascia/ concealed gutter system, with external angles and downpipe droppers.	11m		\$416.90	
	1. offset 3m drop	5.2m		\$332.80	
Total Cost Roof					
					\$16,320.28
Floor Schedule					
Revit Calculation - see Revit schedule for full costing breakdown per item					
	All flooring, timber mid floor including balcony, concrete slab, concrete pathway and timber decking				
	Carpet. 100% wool, heavy duty cut pile	20	\$68	\$1,360	
	Carpet. 100% wool, heavy duty cut pile Stain	33	\$68	\$2,244	
	Large format tiles (ceramic, porcelain or stone adhesive fixed, with allowance for coving)	3	\$18.40	\$55.20	
	Decking tongue and groove siberian ash timber (fixed in place)	4.2	\$155	\$651	
		4	\$158	\$632	

Balcony build up	30% added on top of timber flooring cost - \$45 plywood	4	\$42	\$168	
Total Cost Flooring					

\$26,944.20

Joinery					
Stairs with handrail (Cost per m)	Pine stringers with MDF treads with handrail	3	\$413	\$1,239	
Stained timbers feature on stairs	Timber lengths with stain	1 x Fitout	\$336	\$336	
Kitchen Fitout	Kitchen joinery cupboards + drawers, sink + tap, rangehood, oven + stove, fridge, pantry and desk	1 x Fitout	\$9,465	\$9,465	
Lounge Joinery	TV unit with drawers and shelves, and additional small shelving unit	1 x Fitout	\$2,500	\$2,500	
Bathroom Fitout	Vanity unit with sink, tapware mirror, toilet and shower	1 x Fitout	\$5,190	\$5,190	
Master bedroom wardrobe	Double wardrobe + drawer unit with additional storage above wardrobe	1 x Fitout	\$2,500	\$2,500	
Bedroom 1 wardrobe	Wardrobe + drawer unit	1 x Fitout	\$1,036	\$1,036	
Balustrade Balcony	Timber Balustrade	4.5	\$230	\$1,034.10	
Total Cost Joinery					\$23,300

Heating					
Standard Heatpump	1x heatpump		\$4,500	\$4,500	
Gas hot water	Rinnal Infinity 26L continuous flow hot water heater LPG or Natural Gas	1x	\$3,395	\$3,395	
Total Cost Heating					\$7,895

Elemental Costing					
Site Preparation		80	\$17.15	\$1,372.00	
Sanitary Plumbing		80	\$144.55	\$11,564.00	
Electrical Services		80	\$90.65	\$7,252.00	
Drainage		80	\$31.85	\$2,548.00	
Excavation		20m3	\$16.90	\$338	
Total Cost Elemental					\$23,074.00

Total Cost Minus Professional Fees and GST					\$ 187,001.92
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Professional Fees					
Architect	6%	0.06 \$	187,001.92 \$	11,220.12	
Geotechnical	2.50%	0.025 \$	187,001.92 \$	4,675.05	
Building Consent Wellington City Council	WCC Rates			\$4,025	
Contingency	6%	0.06 \$	187,001.92 \$	11,220.12	
Engineer	8%	0.08 \$	187,001.92 \$	14,960.15	
Extra Building Fees	Insurance, site shed, temporary power + water and skips			\$4,300	
Total Cost Professional Fees					\$ 50,400.43
Total Costs					

Total Cost Excl GST	\$	237,402.35
GST	\$	35,610.35
Total Cost Incl GST	\$	273,012.70
Total Cost Per m2	\$	3,412.66
Deposit (20%)	\$	54,602.54

Figure 4.87 Lifecycle cost 4.1

House 4.1 Lifecycle Costing Breakdown					
Element	Item Description	Lifespan	Information	Cost of elements involved	Cost Over 50 Year period
Aluminium Joinery					
External Doors	1x sliding door, 1x bifold door, 1x front door	35 years	All double glazed with aluminium joinery	Sliding Door = \$2571, Bifold = \$2571, Front Door = \$2040 per item	Full replacement at 35 years, full wash down every 3 months, hardware may require earlier replacement
	All external windows	35 Years	All double glazed with aluminium joinery	Opening double glazed = \$556 per m2	Full replacement at 35 years, full wash down every 3 months, hardware may require earlier replacement
Total Lifecycle Cost Aluminium Joinery					\$17,888.34
Exterior Cladding					
135mm Linea Weatherboard		50 Years on material +15 years on initial paint then repaint every 10 years after	Weatherboard with paint finish	Repaint x4 = \$45 per m2 of wall for repaint (wall area = 15m2) Restain (every 5 years) x9 \$28.40 per m2 for oil based weatherboard stain (wall area = 12m2)	Repaint at 15 years then every 10 years after, material should last at least 50 years before needing replacement. Maintenance requirement is a full low pressure water and brush wash down annually \$27,360
150mm Cedar Weatherboard		50 years on material, restain at least every 5 years	Weatherboard with stain		Repaint at 15 years then every 10 years after, material should last at least 50 years before needing replacement. Maintenance requirement is a full low pressure water and brush wash down annually \$3,067.20
Total Lifecycle Cost Exterior Cladding					\$30,427.20
Roofing					
Colour Steel Endura 0.4mm Roofing Iron		50 years on material and 20 years on initial paint repaint every 10 years after	Roofing Iron	Repaint x3 = Acrylic degrease, etch primer and 2 coats to roofing \$20.90 per m2. (Roof area = 47m2)	Repaint at 20 years then every 10 years after. No maintenance requirements rain washing only
Marley Ovaton Downpipe		25 Years Maximum	Fixture	Replace at 25 years	\$662 Replace at 25 years annual cleaning, check for blockages
Marley Stormcloud Spouting		25 Years Maximum	Fixture	Replace at 25 years	\$219.30 Replace at 25 years annual cleaning, check for blockages
Total Lifecycle Cost Roofing					\$3,828.20
Exterior Decking + Balcony					
Timber Decking		Replace at 25 Years, restain at 10 years		Stain every 5 years (\$28.40 per m2) = 9x, replace material at 25 years 1x replace (\$69). Decking area = 15m2. \$	Annual Washdown and restain every 5 years 4,869.00
Balcony Timbers		Replace at 25 Years, restain at 10 years		Stain every 5 years (\$28.40 per m2) = 9x, replace material at 25 years 1x replace (\$158). Decking area = 4m2.	\$1,654.00
Total Lifecycle Cost Exterior Decking + Balcony					\$ 6,523.00
Interior					
Interior wall paint		Repaint every 10 years	Interior paint	\$34 across floor area = 80 m2	\$2,720
Floor Polish Concrete		Every 15 years	Reseal	4x reseal \$35 per m2, 16m2 floor area	\$2,240
Carpet		Replace every 10 years	Replace	4x replacements = \$68 per m2, 53m2 floor area	\$10,812
Plywood Stain Floor		Every 10 years	Restain	4x restain \$18.40, 3m2 floor	\$220.80
Plywood Stain Ceiling		Every 15 years	Restain	3x restain \$18.40, 65m2	\$3,588
Joinery		30% of upfront cost for maintenance over 50 year period		Maintenance	\$6,500
Total Lifecycle Cost Interior					\$26,080.80
Total Lifecycle Costs					
Total Cost Excl GST				\$84,747.54	
GST				\$12,712.13	
Total Cost Incl GST				\$97,459.67	
Total Cost Per Year				\$1,949.19	
Overall costs including lifecycle over 50 year period				\$370,472.38	

Figure 4.88 Revit schedules screenshot 4.1

<Door Schedule>		
A	B	C
Family and Type	Cost	Total Cost
Ext Bifold3-1Lite(NZ): Bifold double glazed with Aluminium Joinery. 2100 x 1980		
Ext Bifold3-1Lite(NZ): Bifold double glazed with	\$2571.00	\$2571.00
Ext Single In-Timber-1Lite (NZ): Glazed Front Door with Aluminium Joinery860 x 2030		
Ext Single In-Timber-1Lite (NZ): Glazed Front	\$2040.00	\$2040.00
Exterior_Sliding_Door_3843: Double glazed sliding door with aluminium joinery		
Exterior_Sliding_Door_3843: Double glazed sli	\$2571.00	\$2571.00
Int Single-Flush (NZ): Standard flush interior door. 710 x 1980		
Int Single-Flush (NZ): Standard flush interior do	\$254.00	\$254.00
Int Single-Flush (NZ): Standard flush interior do	\$254.00	\$254.00
Int Single-Flush (NZ): Standard flush interior do	\$254.00	\$254.00
Grand total: 6		\$7944.00

<Wall Schedule>			
A	B	C	D
Family and Type	Area	Cost	Total Cost
Basic Wall: 135mm Linea Weatherboard full build up incl interior Gib			
Basic Wall: 135mm Linea Weatherbo	13 m²	\$423.20	\$5519.37
Basic Wall: 135mm Linea Weatherboard fu	9 m²	\$423.20	\$3937.82
Basic Wall: 135mm Linea Weatherboard fu	6 m²	\$423.20	\$2582.84
Basic Wall: 135mm Linea Weatherboard fu	11 m²	\$423.20	\$4785.38
Basic Wall: 135mm Linea Weatherboard fu	12 m²	\$423.20	\$5017.33
Basic Wall: 135mm Linea Weatherboard fu	10 m²	\$423.20	\$4399.22
Basic Wall: 135mm Linea Weatherboard fu	2 m²	\$423.20	\$705.78
Basic Wall: 135mm Linea Weatherboard fu	1 m²	\$423.20	\$555.87
Basic Wall: 135mm Linea Weatherboard fu	1 m²	\$423.20	\$531.33
Basic Wall: 135mm Linea Weatherboard fu	2 m²	\$423.20	\$1056.31
Basic Wall: 135mm Linea Weatherboard fu	2 m²	\$423.20	\$823.84
Basic Wall: 135mm Linea Weatherboard fu	2 m²	\$423.20	\$950.68
Basic Wall: 135mm Linea Weatherboard fu	14 m²	\$423.20	\$6088.15
Basic Wall: 135mm Linea Weatherboard fu	15 m²	\$423.20	\$6387.06
Basic Wall: 135mm Linea Weatherboard fu	3 m²	\$423.20	\$1071.01
Basic Wall: 135mm Linea Weatherboard fu	2 m²	\$423.20	\$761.13
Basic Wall: 135mm Linea Weatherboard fu	15 m²	\$423.20	\$6353.16
Basic Wall: 135mm Linea Weatherboard fu	10 m²	\$423.20	\$4056.06
Basic Wall: 135mm Linea Weatherboard fu	1 m²	\$423.20	\$485.81
Basic Wall: 135mm Linea Weatherboard fu	2 m²	\$423.20	\$841.14
Basic Wall: 135mm Linea Weatherboard including full build up with aqualine Gib interior			
Basic Wall: 135mm Linea Weatherboard in	2 m²	\$432.20	\$713.62
Basic Wall: 135mm Linea Weatherboard in	2 m²	\$432.20	\$686.16
Basic Wall: 135mm Linea Weatherboard in	3 m²	\$432.20	\$1473.45
Basic Wall: 150mm Cedar weatherboard with build up including standard Gib			
Basic Wall: 150mm Cedar weatherboard w	6 m²	\$480.20	\$2825.12
Basic Wall: 150mm Cedar weatherboard w	6 m²	\$480.20	\$2777.75
Basic Wall: Standard 90 x 45 interior framed walls with gib on bothsides			
Basic Wall: Standard 90 x 45 interior frame	1 m²	\$185.50	\$273.47
Basic Wall: Standard 90 x 45 interior frame	10 m²	\$185.50	\$1817.59
Basic Wall: Standard 90 x 45 interior frame	2 m²	\$185.50	\$312.45
Basic Wall: Standard interior wall with Aqualine			
Basic Wall: Standard interior wall with Aqu	7 m²	\$198.80	\$1378.68
Basic Wall: Standard interior wall with Aqu	5 m²	\$198.80	\$1039.45
Basic Wall: Standard interior wall with Aqu	3 m²	\$198.80	\$611.58
Grand total: 31			\$70818.62

<Floor Schedule>			
A	B	C	D
Family and Type	Area	Cost	Total Cost
Floor: Decking, timber framed with timber topping			
Floor: Decking, tim	11 m²	\$168.00	\$1779.80
Floor: Generic 150mm			
Floor: Generic 150	20 m²	\$150.00	\$3012.24
Floor: Path			
Floor: Path	7 m²	\$59.00	\$388.52
Floor: Polished Concrete Entry, Kitchen and Dining			
Floor: Polished Co	19 m²	\$270.00	\$5008.36
Floor: timber framed step with timber decking			
Floor: timber frame	4 m²	\$168.00	\$711.92
Floor: Timber mid floor including build up, insulation and ground floor ceiling			
Floor: Timber mid fl	37 m²	\$298.00	\$10932.72
Grand total: 6			\$21833.57

<Window Schedule>					
A	B	C	D	E	F
Family and Type	Height	Width	Window Area	Cost	Total Cost
3 window: Standard 3 panel 600 x 900					
3 window: Standar	1980	600	1.188	\$556.00	\$660.53
3 window: Standar	1980	600	1.188	\$556.00	\$660.53
3 window: Standar	1980	600	1.188	\$556.00	\$660.53
3 window: Standar	1980	600	1.188	\$556.00	\$660.53
3 window: Standar	1980	600	1.188	\$556.00	\$660.53
3 window: Standar	1980	600	1.188	\$556.00	\$660.53
3 window: Standar	1980	600	1.188	\$556.00	\$660.53
FL 1 Aluminum-Grooved (NZ): Balcony window master bedroom					
FL 1 Aluminum-Gr	2100	500	1.05	\$556.00	\$583.80
FL 1 Aluminum-Grooved (NZ): Large windows in recess					
FL 1 Aluminum-Gr	2200	800	1.76	\$556.00	\$978.56
FL 1 Aluminum-Grooved (NZ): Large windows in recess first floor					
FL 1 Aluminum-Gr	2200	800	1.76	\$556.00	\$978.56
FL 1 Aluminum-Gr	2200	800	1.76	\$556.00	\$978.56
Multi-Panel_Awning_1958: Kitchen, dining 2 panel window					
Multi-Panel_Awnin	600	1800	1.08	\$556.00	\$600.48
Multi-Panel_Awnin	600	1800	1.08	\$556.00	\$600.48
Multi-Panel_Awning_1958: Living Room long 700 x 3500					
Multi-Panel_Awnin	700	3500	2.45	\$556.00	\$1362.20
					\$10706.34

[Next Generation Architect]

<Roof Schedule>			
A	B	C	D
w	Area	Cost	Total Cost
Basic Roof: Timber framed roofing with colour steel endura, insulation and ceiling below			
Basic Roof: Timber	47 m²	\$330.30	\$15570.58
Grand total: 1			\$15570.58

<div>EXTERIOR WALLS</div> <div> </div> <div>WEATHERBOARDS, TIMBER FRAMING, INSULATION, GIB, PAINT FINISH</div>	<div>INTERIOR WALLS</div> <div> </div> <div>TIMBER FRAMING, INSULATION, GIB BOTH SIDES, PAINT FINISH</div>	<div>FLOORING</div> <div> </div> <div>SLABS, DECKING, BALCONY, FIRST FLOOR, FINISHES, INSULATION, FRAMING, CEILINGS</div>	<div>ROOFING</div> <div> </div> <div>ROOFING BUILD UP, SPOUTING, TIMBER FRAMING, CEILING FRAMING</div>	<div>LIFECYCLE</div> <div> </div> <div>MATERIAL LIFECYCLE, MAINTENANCE AND REPLACEMENT COSTS</div>
<div>GLAZING</div> <div> </div> <div>EXTERIOR WINDOWS + GLAZED DOORS</div>	<div>DOORS</div> <div> </div> <div>INTERIOR + ALUMINIUM AND TIMBER EXTERIOR DOORS</div>	<div>ELEMENTAL COSTS</div> <div> </div> <div>BUILDING SERVICES; ELEMENTAL PLUMBING, DRAINAGE, ELECTRICITY, SITE WORKS</div>	<div>PROFESSIONAL FEES</div> <div> </div> <div>ARCHITECT, GEOTECHNICAL, BUILDING FEES, CONTINGENCY, CONSENTS</div>	<div>JOINERY</div> <div> </div> <div>JOINERY, BALUSTRADES, STAIRS, HEATING</div>
COSTING BREAKDOWN				QV COST DATABASE

Costing Diagram

Figure 4.89 Elements costed diagram

Findings and Reflection

Next Generation Architect

A Next Generation Architect will have the knowledge to advise their clients on the most economical materials and construction techniques. It is crucial that the lifespans of materials, upfront and lifecycle costs and implications of selected products is understood, when considering the overall value, ongoing costs and future resale value of a dwelling. Lifecycle costs were analysed and applied to designs, considering the upfront and maintenance costs required. The exercise undertaken on house 4.1 testing five cladding types was successful in gaining an understanding into the economics of design concepts, detail, materials, or the best way to utilise materials such as a small area of expensive materials like cedar. The concept of value in design is explored in this design phase through the use of standard detailing, allowing architects to store libraries of details to be used across future projects, saving documentation time.

Design Phase Four introduced two new housing typologies and the development of the four houses designed in Phase Three. The two new designs gave a 1 bedroom option with consideration into the future with space to add an additional bedroom. The split level portrayed a site-specific option that can be amended to suit other west sloping sites. The interiors of the dwellings are now felt as habitable spaces. This is achieved through the design of joinery, storage, furniture and material usage, illustrated through plans, sections and renders. Seed designs containing stair joinery, panelling, shelving and furniture containing storage were repeated across all dwellings as standard items. House 4.1 explored four interior fit out options and five exterior options; this gave the architectural product a number of aesthetic choices for clients to choose from.

07

Conclusion

How can architects work with value to optimise design?

Seven conclusions are drawn from this research, drawn from each design phase. They demonstrate how an architect can work with value more accurately. They include architecture as a product, BIM, simplicity, standard detailing, lifecycle and time.

The Next Generation Architect has the role architect as a maker. Linking both the design and construction as a whole, rather than individual processes, similar to the young practice, Makers of Architecture. This allows the architect to work seamlessly alongside a builder or fabricator. By combining both processes it allows for cost implications and construction techniques to be understood and utilised from the start of a project. In a time of fragmentation of architecture services and partial architecture services, this also restores a continuity of architectural practice right through the design and build process.

An architect cannot control the cost of land, however they can control the utilisation and efficiency of its usage. Controlling the overall costs of the architectural product is achieved through material selection, including consideration of lifespan, maintenance, quality, modular design, and optimising usable floor area. Simplicity was considered through six housing typologies, designed with special elements of each house carefully selected and utilised to ensure the outcomes are both economical and architectural. The first cost estimates within each design phase explored definitions of value. By creating a cost library and understanding the up to date costing of each element of a design, it allows for design decisions to be made that work with a set budget. All housing typologies designed were costed to be affordable and under \$500,000 as a first cost estimate.

Architecture as product:

Architects can work with value by designing and documenting architecture as product. Architecture as product is illustrated through the use of the pattern book in Design Phase Two. This is a key way architects can work with value to optimise design. A number of New Zealand architects are already working with this concept of architecture as product creating cost effective dwellings, seen through the Snug Homes, Herbst architect's Te Modular and Andre Hodgkin's iPad. The pattern book created a number of housing typologies that are versatile across a number of sites. There are minimal variations to construction type, material, foundations and window placement. Repetition is key for any product, including products of architecture. Repeating designs also allows for the multi-proof consent system to be used saving clients' money and time through the speed of construction. Repetition with minimal charges around bespoke selections and material fit outs allows the architecture to remain a product where all cost implications are understood. Without turning each project into a bespoke home, professional fees and time are saved.

BIM:

BIM through the use of computer modelling software such as Revit, or ArchiCAD, allows architects to see the implications of value from the conceptual phase through to the final design of a project. This gives architects a first cost estimate to what elements are costing before progressing the design into a developed form, which also considers both cost and design. Storing referenced cost data in libraries allows architects to access these records and apply them into BIM software, such as Revit Schedules. BIM provides accurate cost estimates through the use of a digital model; this eliminates the number of mistakes within a project when costing. Collaboration and communication across disciplines in the real world, allows for multiple professionals to work seamlessly on the same file. This is also a way that mistakes can be highlighted and eliminated before construction begins, saving rework in the design phase. This ensures confidence in the Next Generation Architect.

Simplicity:

To keep dwellings economical, architects need to consider simplicity within the design. Value is explored through the design, with the use of modular forms across all six housing typologies, including standard wall to floor heights that work with standard sheet sizes. A minimal material pallet was explored, with a maximum of two materials on the external envelope of the dwellings. This was also the case with the interiors, where a number of fit out options were explored. Floor areas provide an illusion of space while using minimal area, to ensure there is no wasted space. Within each room clever storage systems, joinery and furniture were designed to save space within each dwelling.

Standard detailing:

Standard detailing and construction processes of a dwelling allow architects to achieve an economic outcome that considers value and accuracy of the design. This is achieved through sharing libraries of details across a number of projects. This saves time and money that can be spent elsewhere within the design, and provides a clear and accurate process for builders and councils to follow. Keeping irregular details and elements to a minimum, is an economical choice that reduces the complexity of a project. Architectural homes can be achieved through the use of standard detailing. This is seen through the Eames house, that is a bespoke outcome of the case study house program. The Eames house using standard steel framing and a modular form, mixed with the use of carefully selected materials, created a successful outcome. Construction processes that have been considered throughout the six housing typologies include precast concrete, timber framing and a hybrid of the two. Posi-Struts are a standard construction process, applied to dwellings where larger spans of flooring and roofing are needed.

Lifecycle:

Considering the lifecycle of a building is a vital way that architects can work with value, to optimise design over time. Lifecycle costings of the dwellings considered material, maintenance and replacement, upfront and whole life costing. Having an understanding of materials and their maintenance requirements, is a crucial element of value for architects to understand. Materials have a number of cost implications involved with them, including upfront costs, maintenance, warranty and replacement that affect the overall value. A Next Generation Architect will inform their client on the most economic materials that require a long lifespan and minimal maintenance with the cost implications illustrated over a 50-year period.

Time:

Time is critical when considering the value of a project. Time equals cost therefore a faster design and construction phase will provide clients with a number of savings. Time, is saved through the use of architecture as product, standard detailing and the use of BIM. Reflecting on the cost quality and time equation architects will typically consider quality within bespoke design over the other values. When designing, a Next Generation Architect will work with the parameters of the seven findings while valuing cost, time and quality.

Figure 4.90 Cost, quality time diagram

The combination of these seven key aspects are key findings as to how a Next Generation Architect can work with value to optimise design. The client can have faith that the historic reputation of a stereotypical architect is refute. That their architect is competent to balance time, quality and cost, ensuring value is understood through all aspects of design.

A Next Generation Architect will be aware of cost at all times, aided by the use of smart software. Compromises within the design will not occur, as a Next Generation Architect will always be aware of the cost and the budget as they are designing. The awareness towards cost allows the trust to be restored with an architect and their services.

Further Research

A number of questions have been generated throughout this research with possible further exploration. The following aspects could be developed further, if time permitted. These include understanding to a greater extent the effects of energy costs, passive solar design and prefabricated construction techniques.

Next Generation Architect

A Next Generation Architect will be conscious towards cost, quality and time. There will be a merge of the design and construction phases, resulting in less external consultants 'clipping the ticket', that add to overall costs. When approaching their services, there will be a choice of selecting an architectural product or a bespoke design based on the client's requirements and budget. Advice will be given surrounding economical construction techniques, design decisions and materials that best suit the client's needs and overall lifecycle of the building. This will help restore the reputation of the architectural profession as ethical, responsible and capable designers who can deliver outstanding design to meet a budget.

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Appendix 1

Library of Costs

Figure 4.91 Costing library using data from QV Costbuilder

Material Costing Library	All pricing from QV Costbuilder	(Quotable Value Limited, 2019)		
Exterior Cladding				
Material	Cost Per M2	Lifespan	Maintenance Requirements	Warranty (if applicable)
All costs include full wall build up timber framing 90 x 45 studs and dwangs @ 600 crs, cavity batten, DPC, bracing, building paper	\$65 added for timber build up within the following cladding costs (add 88 for 140 x 45 timbers minus 65)	According to BRANZ and Manufacturers	Manufacturers requirements for warranty	
James Hardie weatherboard 180mm	\$122 50 Years		Wash down with soft brush and low pressure water annually	25 Years
135mm Linea weatherboard	\$282 50 Years		Wash down with soft brush and low pressure water annually	25 Years
150mm Timber weatherboard pine	\$252 50 Years		Wash down with soft brush and low pressure water annually	Dependant on Manufacturer
150mm Timber weatherboard cedar	\$316 50 Years		Wash down with soft brush and low pressure water annually	Dependant on Manufacturer
Colour Steel Zincalume 0.4mm corrugate	\$111 25 Years		Wash down with soft brush and low pressure water annually	Perforation 15 Years
Colour Steel Zincalume 0.4mm DP955 Profile	\$134 25 Years		Wash down with soft brush and low pressure water annually	Perforation 15 Years
Colour Steel Zincalume 0.55mm corrugate	\$132 35 Years		Wash down with soft brush and low pressure water annually	Perforation 15 Years
Colour Steel Endura 0.4mm corrugate	\$140 50 Years		Wash down with soft brush and low pressure water annually	Perforation 15 Years, Paint 15 Years
Colour Steel Endura 0.4mm DP955 Profile	\$147 50 Years		Wash down with soft brush and low pressure water annually	Perforation 15 Years, Paint 15 Years
Insulated Concrete Panels + paint includes int GIB + build up	\$452 100 Years			Dependant on Manufacturer
Embossed Insulated Concrete Panels + paint or acid wash includes int GIB + build up	\$487 100 Years			Dependant on Manufacturer
Plywood with battens	\$176 50 Years			
James Hardie Titan Board	\$231 50 Years		Wash down with soft brush and low pressure water annually	25 Years
Roofing	Cost Per M2	Lifespan	Maintenance Requirements	Warranty (if applicable)
Material				
Rates include roofing and fixing to roof, flashings and underlay		According to BRANZ and Manufacturers	Manufacturers requirements for warranty	
Colour Steel Zincalume 0.55mm	\$50 25 Years		Rainwashing	Perforation 15 years
Colour Steel Endura 0.4mm	\$58 50 Years		Rainwashing	Perforation 30 years, paint 18 years
Butyl Membrane	\$119 25 Years		Rainwashing	Dependant on Manufacturer
Eaves Gutters (fascia/concealed gutter system, with external and internal angles, and downpipe droppers				
Marley Stormcloud	\$37.90 per m			
Marley Ovation downpipe (1 offset 3m drop)	\$64 per m			
Eaves facing and soffits, 4.5mm hardiesoffit 600mm wide (residential soffit with 75mm x 40mm framing 150mm x 40mm fascia and lining).	\$109 per m			
Interior Linings	Cost Per M2	Lifespan	Maintenance Requirements	Warranty (if applicable)
Material				

Plasterboard f4 finish fixed to timber framing, with cornice, skirting, external angles and painting	10mm Gib Plasterboard	\$61	50 Years	Perforation 15 Years
	10mm Gib Aqualine	\$70	50 Years	
	10mm Gib Fyreline	\$62	50 Years	
	12mm Plywood	\$44	50 Years	
	Small format tile finish (includes ceramic, porcelain or stone, adhesive fixed, with skirtings)	\$110		
	Medium format tile finish (includes ceramic, porcelain or stone, adhesive fixed, with skirtings)	\$151		
	10mm Standard Gib Ceiling (stopped and painted with f4 finish)	\$49		
	10mm Aqualine Gib Ceiling	\$57.20	50 Years	
	Zincalume Ceiling	\$21.10	50 Years	
	Polished Concrete Wall	\$120		
Timber framed partitions with linings (costs based on overall area including openings. Partition 2400/3000mm high 90 x 45 timber frame lined 2 sides with 10mm standard Gib with paint finish) add \$13.80 for insulation				
		172 aqualine one side =185	50 years Gib and Framing, 10 Years Paint	

Interior Doors				
Material	Cost Per M2	Lifespan	Maintenance Requirements	Warranty (if applicable)
Interior Doors (Standard flush door 1980mm x 460mm to 810mm x 36mm thick, faced both sides with a paint finish).		\$174		
Interior Cavity Sliders (Prefabricated sliding door frame and track single door up to 860mm wide with paint finish and hardware)		\$658		
Interior Door Handles (medium quality)		\$80		

Floor Finishes				
Material	Cost Per M2	Lifespan	Maintenance Requirements	Warranty (if applicable)
Decking, grip tread radiata pine H3.2		\$69	25 Years	
Decking tongue and grove siberian ash timber (fixed in place)		\$158	25 Years	
Carpet. 100% wool, heavy duty cut pile		\$68	15 Years	
Radiata pine, clears H3		\$194		
Small format tiles (ceramic, porcelain or stone adhesive fixed, with allowance for coving)		\$132		
Large format tiles (ceramic, porcelain or stone adhesive fixed, with allowance for coving)		\$155		
Polished concrete flooring finish		\$120		

Paint Finishes			
Material	Cost Per M2	Lifespan	Maintenance Requirements
Interior wall paint (across house floor area)		\$34 10 years	
Concrete Floor Polish, maintenance- resurface		\$35 15 Years	
Wood Stain		\$42.20	
Decking Resurface		\$28.40	
Roof repaint corrugate - Acrylic, degrease, etch primer and 2 coats to roofing)		\$20.90 10 Years	
Weather Boards , three coats to linea weather boards		\$45	
Oil Based weatherboard stain		\$28.40	
Plywood Stain		\$18.40	
Concrete Painting		\$25	
Acid wash concrete		\$35	
Painting full interior across floor area		\$34	

Aluminium Joinery			
Material	Cost Per M2	Lifespan	Maintenance Requirements
Bi-fold doors (including hardware)		\$2,571 35 Years	
Sliding Doors (including hardware)		\$2,571 35 Years	
Front Door Glazed (including hardware)		\$2,040 35 Years	
Front door aluminium (including hardware)		\$870 35 Years	
Windows double glazed opening		\$556 35 Years	
Windows double glazed fixed		\$469 35 years	

Flooring Structural Build Up			
Material	Cost Per M2	Lifespan	Maintenance Requirements
Insulated Concrete Slab (100mm slab, polythene, 150mm hardfill and edge footings with reinforcing)		\$150 100 Years	
Subfloor Jack Studs		\$20.70	
Timber Pile, H5 125mm x 125mm, 900mm long, concrete footing	\$34.50 per timber pile		Used for decking
Floor Joists		No less than 50 Years	
140 mm x 35 mm		\$14.10 per m	
90mm x 45 mm		\$12.50 per m	
140mm x 45 mm		\$17.30 per m	
190mm x 45 mm		\$20.80 per m	
240 mmx 45 mm		\$26.90 per m	
290mm x 45 mm		\$30.40 per m	

Mid Floor Joists		No less than 50 Years	
90mm x 35mm		\$11.40 per m	

140mm x 35mm	\$15 per m
90mm x 45mm	\$13.50 per m
140mm x 45mm	\$18.60 per m
190mm x 45mm	\$22.40 per m
240mm x 45mm	\$26.60 per m
290mm x 45mm	\$30.60 per m
Studs	No less than 50 Years
140mm x 45mm	\$17.60 per m
140mm x 70mm	\$21.60 per m
Ceiling Battens	No less than 50 Years
70mm x 35mm	\$7.60 per m
Framing Roof Rafters	No less than 50 Years
90mm x 45mm	\$16.10 per m
140mm x 45mm	\$20.90 per m
190mm x 45mm	\$25.40 per m
240mm x 45mm	\$30.80 per m
290mm x 45mm	\$35.30 per m
Purlins	No less than 50 Years
70mm x 45mm	\$10.70 per m
90mm x 45mm	\$13.50 per m
Eaves/ Soffit Beams	No less than 50 Years
45mmx35mm	\$9.70
70mm x 35mm	\$10.60
Wall Framing (plates/studs/jack studs)	No less than 50 Years
90mmx 45mm	\$13.70 per m
140mm x 45 mm	\$18.70 per m
Lintels, Doubled	
90mm x 45mm	\$24.8 per m
140mm x 45mm	\$37.9 per m
190mm x 45mm	\$50 per m
240mm x 45mm	\$60 per m
290mm x 45mm	\$72 per m

H3.2 Construction Plywood

\$83

Ceiling Grid m2 Cost

\$38

Timber Substructure

Timber Substructure, 900mm long timber pile with concrete footing, bearers, joists, fixtures, bracing, plywood, R1.6 insulation

\$231.20 per m2

Timber Substructure, 1500mm long timber pile with concrete footing, bearers, joists, fixtures, bracing, plywood, R1.6 insulation

\$272 per m2

Insitu Concrete Paving 76mm thick no reinforcing

Ecoply Plywood

\$59

Mitek Posi Struts

\$42 per m

Concrete Midfloor + rondo ceiling with plywood finish

\$280 per m2

Concrete Midfloor + rondo ceiling with Gib finish

\$266 per m2

Joinery

Material	Cost Per M2	Lifespan	Maintenance Requirements	Warranty (if applicable)
----------	-------------	----------	--------------------------	--------------------------

Pine stairs with hand rail

\$413 per m

Balustrade square pine

\$462 per m

Lounge Joinery Across all houses

\$2500 per fitout

Kitchen Joinery Across all houses

\$7725 per fitout

Bathroom Across all houses

\$5190 per fitout

Laundry Across all houses

\$398 per fitout

Timber feature on stairs

\$335.52 per fitout

Long kitchen cost build up

Elemental

Material

Excavation

\$16.90 per m3

Site Preparation (Total Floor Area)

\$17.50 per m2

Sanitary Plumbing (Total Floor Area)

\$144.55 per m2

Electrical Services (Total Floor Area)

\$90.65 per m2

Drainage (Total Floor Area)

\$31.85 per m2

Warranty (if applicable)

Maintenance Requirements

Lifespan

Cost Per M2

Insulation

Material

Pink Batts R.4 Ultra, 190mm thick

\$12.20

Pink Batts ultra R2.6, 90mm thick

\$13.80

Pink Batts Snug Floor R1.6, 70mm thick

\$20.70

Pink Batts R3.6, 180mm thick

\$13.40

Pink Batts R3.2, 170mm thick

\$12.50

Warranty (if applicable)

Maintenance Requirements

Lifespan

Cost Per M2

Full Element Build Up (Using all relevant costs from QV database)

Material

Exterior Walls
135mm Linea Weatherboard painted 140 x 45 timber framing @ 600 crs , dwangs, DPC building paper, battens, pink batts ultra R.4 wall insulation fitted between studs, 10mm standard gib with f4 finish with a paint finish.

\$423.20

Warranty (if applicable)

Maintenance Requirements

Lifespan

Cost Per M2

150mm Cedar Weatherboard with stain finish. 140 x 45 timber framing @600 crs, dwangs, DPC building paper, battens, pink batts ultra R.4 wall insulation fitted between studs, 10mm standard gib with f4 finish with a paint finish

135mm Linea Weatherboard painted 140 x 45 timber framing @600 crs, dwangs, DPC building paper, battens, pink batts ultra R.4 wall insulation fitted between studs, 10mm **gib aqualine** with f4 finish with a paint finish.

150mm Timber weatherboard pine with stain finish. 140 x 45 timber framing @600 crs, dwangs, DPC building paper, battens, pink batts ultra R.4 wall insulation fitted between studs, 10mm standard gib with f4 finish with a paint finish

James Hardie Titan Board painted 140 x 45 timber framing @600 crs, dwangs, DPC building paper, battens, pink batts ultra R.4 wall insulation fitted between studs, 10mm standard gib with f4 finish with a paint finish.

\$480.20

\$432.20

\$377.80

\$393.20

Heating Material	Cost Per M2	Lifespan	Maintenance Requirements	Warranty (if applicable)
------------------	-------------	----------	--------------------------	--------------------------

Hot Water Cylinder. Mains pressure water heater, eth supply amd drain pipework 3 in 1 filter stop and non-return valve, cold water expansion valve tempering value and two ball valves

90 L Hot Water Cylinder

180L Hot Water Cylinder

Standard Heatpump

Rinnai infinity 26L continuous flow hotwater heater

LPG or natural gas

\$2,490

\$2,730

\$4,500

\$3,395

Lifecycle Referencing for specific manufacturers products only

Material	Reference	Lifespan	Maintenance Requirements	Warranty (if applicable)
Colour Steel Endura	(ColourSteel, n.d.) + (Brudson, 2017)		50 Rainwashing	Perforation 30 years, paint 18 years
Colour Steel Zincalume	(ColourSteel, n.d.) + (Brudson, 2017)		25 Rainwashing	Perforation 15 years
James Hardie Linea Weatherboard	(James Hardie, n.d.)		50 Annual washdown	25 years – first repaint at 15 years then every 10 after
James Hardie Titan Façade Board	(James Hardie, n.d.)		50 Annual washdown	25 years
Interior elements + decking	(S. Le Compte, personal conversation, September 15, 2019) Conversation with a master builder surrounding typical interior maintenance over 50 years		Joinery = 30% of original cost over 50 years for maintenance, decking timbers standard grip tread 25 years + staining every 5, polished concrete walls + flooring interior resal every 15 years, interior ceilings retain 15 years for plywood	Assumptions
Carpet	(Consumer NZ, n.d.)		Carpet should last at least 10 years according to consumer NZ. However can last longer if it is looked after	10 years

Appendix 2

Design Phase 3 Costing Breakdown

Figure 4.92 House 3.2.1 and 3.2.2 Costing Breakdown

House 3.2.1 + 3.2.2 Costing Breakdown					Concrete Construction	
Element	Item Description	Area m2	Cost (\$)	Per m2	Total Cost Per m2	Totals
Doors						
Revit Calculation	Exterior and interior doors				\$5,015	
Total Cost Doors						\$5,015
Windows						
Revit Calculation	Exterior aluminium joinery				\$9,409.90	
Total Cost Windows						\$9,409.90
Wall Schedule						
Revit Calculation	See additional information for full breakdown includes exterior and interior walls				\$86,420.62	
Total Cost Walls						\$86,420.62
Roof Schedule						
Revit Calculation	Roofing with timber framing, insulation and ceiling for floor below				\$15,412.90	
Marley Stormcloud spouting Marley Ovation downpipe	Spouting costs per m includes eaves gutters (fascia/ concealed gutter system, with external angles and downpipe droppers. 1 offset 3m drop	5.4m 5.5m	\$37.90 per m \$64 per m		\$204.66 \$352.00	
Total Cost Roof						\$15,969.56
Floor Schedule						
Revit Calculation	All flooring, timber mid floor including balcony, concrete slab, concrete pathway and timber decking				\$21,335.20	
Carpet	Carpet, 100% wool, heavy duty cut pile	50		\$68		\$3,400
Tiles	Large format tiles (ceramic, porcelain or stone adhesive fixed, with allowance for coving)	28		\$155		\$4,340
Total Cost Flooring						\$29,075.20

Joinery					
Stairs with handrail (Cost per m)	Pine stringers with MDF treads with handrail	3	\$413	\$1,239	
Kitchen Fitout	Kitchen Joinery cupboards + drawers, sink + tap, rangehood, oven + stove, fridge, pantry and desk	1 x Fitout	\$11,424	\$11,424	
Bathroom Fitout	Vanity unit with sink, tapware mirror, toilet and shower	1 x Fitout	\$5,190	\$5,190	
Wardrobe Doors	Sliding WD Doors	4x	\$150	\$600	
Total Cost Joinery				\$18,453	
Heating					
Standard Heatpump	1x heatpump		\$4,500	\$4,500	
Gas hot water	Rinnal Infinity 26L continuous flow hot water heater LPG or Natural Gas	1x	\$3,395	\$3,395	
Total Cost Heating				\$7,895	
Elemental Costing					
Site Preparation		93	\$17.15	\$1,594.95	
Sanitary Plumbing		93	\$144.55	\$13,443.15	
Electrical Services		93	\$90.65	\$8,430.45	
Drainage		93	\$31.85	\$2,962.05	
Excavation		0m3	\$16.90	\$0	
Total Cost Elemental				\$26,430.60	
Total Cost Minus Professional Fees and GST				\$	198,668.88
Professional Fees					
Architect		0.06 \$	198,668.88 \$	11,920.13	
Geotechnical		0.025 \$	198,668.88 \$	4,966.72	
Building Consent Wellington City Council				\$4,025	
Contingency	WCC Rates	0.06 \$	198,668.88 \$	11,920.13	
Engineer		0.08 \$	198,668.88 \$	15,893.51	
Extra Building Fees	Insurance, sited shed, temporary power + water and skips			\$4,300	
Total Cost Professional Fees				\$	53,025.50
Total Costs					

Total Cost Excl GST	\$	251,694.38
GST	\$	37,754.16
Total Cost Incl GST	\$	289,448.53
Total Cost Per m2	\$	3,112.35
Deposit (20%)	\$	57,889.71

Figure 4.93 Houses 3.2.3 - 3.2.6 costing breakdown

House 3.2.3 Breakdown	93m2	Designed for west Sloping Hills	Timber Construction
Developments for hill site specifications	ALL SPECIFICATIONS REMAIN THE SAME UNLESS OTHERWISE STATED		See Revit Schedules for breakdown
Exterior Walls			Includes: 135mm Linea Weatherboard and Titan Board painted/stained on 140 x 45 timber framing @600 crs, dwangs, DPC building paper, battens, pink batts ultra R 4 wall insulation fitted between studs, 10mm standard gib or aqualine gib in wet areas with f4 finish with a paint finish. Interior Walls include 90 x 45 timber framing @600 crs with pink batts R2.6 insulation, gib (standard or aqualine) on both sides with f4 finish with a paint finish.
			\$ 79,107.64
Flooring Window Placement Additions			Includes: Timber Framed Mid Floor Ecoply surface on 290 x 45 joists @ 400 crs, pink batts snug floor R1.6 insulation, ceiling grid for the floor below with 70 x 45 ceiling battens with GIB ceiling. Timber substructure and flooring build up including insulation + piles. Timber framed decking and balcony with grip tread finish. Developed for site orientation Railing + decking at entrance
			\$ 28,369.49
			Total Cost Excl GST \$ 248,416.19 GST \$ 37,262.43 Total Cost Incl GST \$ 285,678.62
			Total Cost Per m2 \$ 3,071.81 Deposit (20%) \$ 57,135.72
House 3.2.4 Breakdown	93m2	Designed for west Sloping Hills	Timber Construction
Developments for hill site specifications	ALL SPECIFICATIONS REMAIN THE SAME UNLESS OTHERWISE STATED		See Revit Schedules for breakdown
Exterior Walls			Includes: 135mm Linea Weatherboard and Titan Board painted/stained on 140 x 45 timber framing @600 crs, dwangs, DPC building paper, battens, pink batts ultra R 4 wall insulation fitted between studs, 10mm standard gib or aqualine gib in wet areas with f4 finish with a paint finish. Interior Walls include 90 x 45 timber framing @600 crs with pink batts R2.6 insulation, gib (standard or aqualine) on both sides with f4 finish with a paint finish.
			Includes: Timber Framed Mid Floor Ecoply surface on 290 x 45 joists @ 400 crs, pink batts snug floor R1.6 insulation, ceiling grid for the floor below with 70 x 45 ceiling battens with GIB ceiling. Timber substructure and flooring build up including insulation + piles. Timber framed decking and balcony with grip tread finish. Developed for site orientation Railing + decking at entrance + Skylight on roof
Flooring Window Placement Additions			
			Total Cost Excl GST \$ 249,232.59 GST \$ 37,384.89 Total Cost Incl GST \$ 286,617.48
			Total Cost Per m2 \$ 3,081.91 Deposit (20%) \$ 57,323.50

House 3.2.5 Breakdown	186m2	Concrete Construction
Duplex Housing 3.2.4		All specifications remain the same as 3.2.1, all elements doubled minus one external wall now acting as an internal wall between dwellings.

Total Cost Excl GST	\$	426,024.80
GST	\$	63,903.72
Total Cost Incl GST	\$	489,928.52

Total Cost Per m2	\$	2,634.02
Deposit (20%)	\$	97,985.70

House 3.2.6 Breakdown	186m2	Concrete Construction
Duplex Housing 3.2.4		All specifications remain the same as 3.2.1, all elements doubled minus one external wall now acting as an internal wall between dwellings.
Additions		Dwellings slide to create more privacy. More building materials are needed

Total Cost Excl GST	\$	431,122.12
GST	\$	64,668.32
Total Cost Incl GST	\$	495,790.44

Total Cost Per m2	\$	2,665.54
Deposit (20%)	\$	99,158.09

Figure 4.94 House 3.3.1 costing breakdown

House 3.3.1 Costing Breakdown			82 m2	Concrete Construction		
Element	Item Description	Area m2	Cost (\$) Per m2	Total Cost Per m2	Totals	Additional Information
Doors						
Revit Calculation	Exterior and interior doors			\$7,332		Interior doors include standard flush timber door with frame and hardware. Exterior doors include aluminium joinery with double glazing and hardware. aluminium front door x1 and double sliding door x2.
Total Cost Doors					\$7,332	
Windows						
Revit Calculation	Exterior aluminium joinery		*calculated under walls as curtain walls	\$6,422.92		All windows are opening, doubled glazed with aluminium joinery and hardware. One irregular window which costs 30% more
Total Cost Windows					\$6,422.92	
Wall Schedule						
Revit Calculation	See additional information for full breakdown includes exterior and interior walls			\$69,484.32		Includes: Insulated concrete panels 150mm with acid wash, timber paneling. Interior Walls include 90 x 45 timber framing @ 600 crs with pink batts R2.6 insulation, gib (standard or aqualine) on both sides with f4 finish with a paint finish and tiles in bathroom.
Balcony Timbers	Laminated timber posts exterior quality (88 x 88mm)		53 per m (27m required)	\$1,431.00		
Total Cost Walls					\$70,915.32	
Roof Schedule						
Revit Calculation	Roofing with timber framing, insulation and ceiling for floor below. Spouting costs per m includes eaves gutters (fascia/ concealed gutter system with external angles and downpipe droppers. 1 offset 3m drop			\$13,300.00		Includes: 0.4mm Colour Steel Zincalume Roofing iron with netting underlay and flashings. 70 x 45 purlins at 900 crs on 290 x 45 rafters with Pink Batts R3.6 ceiling insulation, on 70 x 45mm timber ceiling battens with stained plywood ceiling.
Marley Stormcloud spouting Marley Ovaton downpipe		8.5 m 5.6m	\$37.90 per m \$64 per m	\$322.15 \$358.40		
Total Cost Roof					\$13,980.55	
Floor Schedule						
Revit Calculation	All flooring, timber mid floor including balcony, concrete slab, concrete pathway and timber decking			\$25,640.00		Includes: Concrete mid floor, Insulated concrete slab including foundations, polish in entrance and kitchen. Timber framed decking with grip tread.
Carpet	Carpet - 100% wool, heavy duty cut pile		37.2	\$68	\$2,530	
Tiles	Large format tiles (ceramic, porcelain or stone adhesive fixed, with allowance for coving)		22.8	\$155	\$3,534	
Total Cost Flooring					\$31,703.60	

Joinery						
Stairs with handrail (Cost per m)	Pine stringers with MDF treads with handrail	3	\$413		\$1,239	
Kitchen Fitout	Kitchen joinery cupboards + drawers, sink + tap, rangehood, oven + stove, fridge, pantry, desk and day bed	1 x Fitout	\$12,000		\$12,000	
Lounge Joinery	TV unit	1 x Fitout			\$1,800	
Bathroom Fitout	Vanity unit with sink, tapware mirror, toilet and shower	1 x Fitout	\$5,190		\$5,190	
Wardrobe Doors	Sliding WD	1x			\$150	
Total Cost Joinery						\$20,379
Heating						
Standard Heatpump	1x heatpump		\$4,500		\$4,500	
Gas hot water	Rinnal Infinity 26L continuous flow hot water heater LPG or Natural Gas	1x	\$3,395		\$3,395	
Total Cost Heating						\$7,895
Elemental Costing						
Site Preparation		82	\$17.15		\$1,406.30	
Sanitary Plumbing		82	\$144.55		\$11,853.10	
Electrical Services		82	\$90.65		\$7,433.30	
Drainage		82	\$31.85		\$2,611.70	
Excavation		0m3	\$16.90		\$0	
Total Cost Elemental						\$23,304.40
Total Cost Minus Professional Fees and GST						
					\$	181,932.79
Professional Fees						
Architect		0.06 \$	181,932.79 \$		10,915.97	
Geotechnical		0.025 \$	181,932.79 \$		4,548.32	
Building Consent Wellington City Council						
Contingency	WCC Rates	0.06 \$	181,932.79 \$		\$4,025	
Engineer		0.08 \$	181,932.79 \$		14,554.62	
Extra Building Fees	Insurance, site shed, temporary power + water and skips				\$4,300	
Total Cost Professional Fees					\$	49,259.88
Total Costs						
						Total Cost Excl GST
						\$ 231,192.67
						GST
						\$ 34,678.90
						Total Cost Incl GST
						\$ 265,871.57
						Total Cost Per m2
						\$ 3,242.34
						Deposit (20%)
						\$ 53,174.31

Figure 4.95 Houses 3.3.2 and 3.3.3 costing breakdown

House 3.3.2 Breakdown		82m2		Designed for West Sloping Hills	
4.3.2		Developments for hill site

Figure 4.96 Houses 3.4.2 and 3.4.3 costing breakdown

House 3.4.2 Breakdown		80m2	Designed for West Sloping Hills	
4.3.2	Developments for hill site			
Flooring				
External Walls Additions				
Total Cost Excl GST		\$	228,988.43	
GST		\$	34,348.26	
Total Cost Incl GST		\$	263,336.69	
Total Cost Per m2		\$	3,291.71	
Deposit (20%)		\$	52,667.34	
House 3.4.3 Breakdown		160m2	Hybrid Construction - Timber + Concrete	
4.4.3 Duplex	Specifications remain the same as 3.4.1, everything doubled, minus one external wall now acting as an internal wall for both dwellings.			
Total Cost Excl GST		\$	407,790.37	
GST		\$	61,168.56	
Total Cost Incl GST		\$	468,958.93	
Total Cost Per m2		\$	2,930.99	
Deposit (20%)		\$	93,791.79

Figure 4.97 Houses 3.4.1 costing breakdown

House 3.4.1 Costing Breakdown			80 m2	Hybrid Construction - Timber + Concrete		
Element	Item Description	Area m2	Cost (\$) Per m2	Total Cost Per m2	Totals	Additional Information
Doors						
Revit Calculation	Exterior and interior doors			\$7,332		Interior doors include standard flush timber door with frame and hardware. Exterior doors include aluminium joinery with double glazing and hardware, glazed front door 1x, glazed bifold door x1 and double sliding door x1.
Total Cost Doors					\$7,332	
Windows						
Revit Calculation	Exterior aluminium joinery	* Costed under curtain walls in Revit		\$6,422.92		All windows are opening, doubled glazed with aluminium joinery and hardware. Includes sliding door x1 with aluminium joinery and hardware
Total Cost Windows					\$6,422.92	
Wall Schedule						
Revit Calculation	See additional information for full breakdown includes exterior and interior walls			\$69,484.32		Includes: 150mm Insulated concrete panels with acid wash, 150mm Pine Weatherboard painted/stained on 140 x 45 timber framing @600 crs, dwangs, DPC building paper, battens, pink batts ultra R.4 wall insulation fitted between studs, 10mm standard gib or aqualine gib in wet areas with f4 finish with a paint finish. Interior Walls include 90 x 45 timber framing @600 crs with pink batts R2.6 insulation, gib (standard or aqualine) on both sides with f4 finish with a paint finish.
Total Cost Walls					\$69,484.32	
Roof Schedule						
Revit Calculation	Roofing with timber framing, insulation and ceiling for floor below			\$13,300.89		Includes: 0.4mm Colour Steel Zincalume Roofing/iron with netting underlay and flashings, 70 x 45 purlins at 900 crs on 290 x 45 rafters with Pink Batt R3.6 ceiling insulation, on 70 x 45mm timber ceiling battens with stained plywood ceiling.
Marley Stormcloud spouting	Spouting costs per m includes eaves gutters (fascia)/concealed gutter system, with external angles and downpipe droppers.	9m	\$37.90 per m	\$341.10		
Marley Ovaton downpipe	1 offset 3m drop	6.5m	\$64 per m	\$416.00		
Total Cost Roof					\$14,057.99	
Floor Schedule						
Revit Calculation	All flooring, timber mid floor including balcony, concrete slab, concrete pathway and timber decking			\$18,625.89		Includes: Timber Framed Mid Floor with 290 x 45 joists, Ecoply surface on 290 x 45 joists @ 600 crs, pink batts snug floor R1.6 insulation, ceiling grid for the floor below with 70 x 45 ceiling battens with stained plywood ceiling. Insulated concrete slab including foundations, polish in entrance and kitchen. Timber framed decking with grip tread radiata pine finish.
Carpet	Carpet, 100% wool, heavy duty cut pile	36	\$68	\$2,448		
Tiles	Large format tiles (ceramic, porcelain or stone adhesive fixed, with allowance for coving)	26	\$155	\$4,030		
Timber - Balcony	Decking tongue and groove siberian ash timber (fixed in place)	5	\$158	\$790		
Total Cost Flooring					\$25,893.89	

Joinery					
Stairs with handrail (Cost per m)	Pine stringers with MDF treads with handrail	3	\$413	\$1,239	
Kitchen Fitout	Kitchen joinery cupboards + drawers, sink + tap, rangehood, oven + stove, fridge, pantry and desk	1 x Fitout	\$11,424	\$11,424	
Lounge Joinery	TV unit	1 x Fitout	\$2,000	\$1,800	
Bathroom Fitout	Vanity unit with sink, tapware mirror, toilet and shower	1 x Fitout	\$5,190	\$5,190	
Wardrobe Doors	3x Sliding WD Doors	3x	\$150	\$450	
Total Cost Joinery				\$20,103	
Heating					
Standard Heatpump	1x heatpump		\$4,500	\$4,500	
Gas hot water	Rinnai Infinity 26L continuous flow hot water heater LPG or Natural Gas	1x	\$3,395	\$3,395	
Total Cost Heating				\$7,895	
Elemental Costing					
Site Preparation		80	\$17.15	\$1,372.00	
Sanitary Plumbing		80	\$144.55	\$11,564.00	
Electrical Services		80	\$90.65	\$7,252.00	
Drainage		80	\$31.85	\$2,548.00	
Excavation		0m3	\$16.90	\$0	
Total Cost Elemental				\$22,736.00	
Total Cost Minus Professional Fees and GST				\$	173,925.12
Professional Fees					
Architect	6%	0.06 \$	173,925.12 \$	10,435.51	
Geotechnical	2.50%	0.025 \$	173,925.12 \$	4,348.13	
Building Consent Wellington City Council	WCC Rates			\$4,025	
Contingency	6%	0.06 \$	173,925.12 \$	10,435.51	
Engineer	8%	0.08 \$	173,925.12 \$	13,914.01	
Extra Building Fees	Insurance, site shed, temporary power + water and skips			\$4,300	
Total Cost Professional Fees				\$	47,458.15
Total Costs					

Total Cost Excl GST	\$	221,383.27
GST	\$	33,207.49
Total Cost Incl GST	\$	254,590.76
Total Cost Per m2	\$	3,182.38
Deposit (20%)	\$	50,918.15

Appendix 3

Design Phase 4 Costing Breakdown

House 4.2 Costing

Overall Costs and Lifespan

Figure 4.98 Revit schedules screenshot 4.2

<Wall Schedule>			
A	B	C	D
Family and Type	Area	Cost	Total Wall Cost
Basic Wall: 10mm Gib with paint finish both sides			
Basic Wall: 10mm	14 m²	\$189.80	\$2624.21
Basic Wall: 10mm	10 m²	\$189.80	\$1980.07
Basic Wall: 10mm	8 m²	\$189.80	\$1459.75
Basic Wall: 10mm standard Gib with one aqualine side			
Basic Wall: 10mm	4 m²	\$289.80	\$1158.23
Basic Wall: 10mm	6 m²	\$289.80	\$1614.27
Basic Wall: 70T_10Gb-BS			
Basic Wall: 70T_1	43 m²		
Basic Wall: 150 Insualted Concrete embossed with paint finish on int and ext			
Basic Wall: 150 In	14 m²	\$487.00	\$6994.68
Basic Wall: 150 In	27 m²	\$487.00	\$13290.56
Basic Wall: 150 In	11 m²	\$487.00	\$5445.05
Basic Wall: 150 In	30 m²	\$487.00	\$14673.26
Basic Wall: 150 In	7 m²	\$487.00	\$3367.76
Basic Wall: 150mm Insulated Concrete ext with acid wash and int paint finish			
Basic Wall: 150mm	10 m²	\$452.00	\$4340.08
Basic Wall: 150mm	20 m²	\$452.00	\$8940.25
Basic Wall: 150mm	12 m²	\$452.00	\$5375.05
Basic Wall: 150mm	18 m²	\$452.00	\$7931.82
Curtain Wall: Exterior Glazing			
Curtain Wall: Exteri	2 m²	\$556.00	\$1268.90
Grand total: 16			\$80463.94

<Window Schedule>					
A	B	C	D	E	F
Family and Type	Cost	Width	Height	Area	Total Cost
AW 1 Aluminum-Grooved (NZ): Large					
AW 1 Aluminum-G	\$556.00	500	3530	1.765	981.34
AW 1 Aluminum-Grooved (NZ): Large 3					
AW 1 Aluminum-G	\$556.00	700	700	0.49	272.44
AW 1 Aluminum-Grooved (NZ): Normal					
AW 1 Aluminum-G	\$556.00	2200	700	1.54	856.24
AW 1 Aluminum-G	\$556.00	2200	700	1.54	856.24
AW 1 Aluminum-G	\$556.00	2200	700	1.54	856.24
AW 1 Aluminum-G	\$556.00	2200	700	1.54	856.24
AW 1 Aluminum-G	\$556.00	2200	700	1.54	856.24
AW 1 Aluminum-Grooved (NZ): Square					
AW 1 Aluminum-G	\$556.00	700	1200	0.84	467.04
AW 1 Aluminum-G	\$556.00	700	1200	0.84	467.04
AW 1 Aluminum-Grooved (NZ): Square 2					
AW 1 Aluminum-G	\$556.00	1400	1800	2.52	1401.12
Multi-Panel_Awning_1958: long Double					
Multi-Panel_Awinin	\$556.00	4400	700	3.08	1712.48
Grand total: 11					9582.66

<Door Schedule>		
A	B	C
Family and Type	Cost	Total Cost
Ext Bifold3-1Lite(NZ): Bifold 2100 x 1980		
Ext Bifold3-1Lite(NZ)	\$2571.00	\$2571.00
Int Single-Flush (NZ): Interior doors flush 710 x 1980		
Int Single-Flush (NZ)	\$254.00	\$254.00
Int Single-Flush (NZ)	\$254.00	\$254.00
Int Single-Flush (NZ)	\$254.00	\$254.00
Int Single-Flush (NZ)	\$254.00	\$254.00
Single_hung_door_CR4: Aluminium Front Door		
Single_hung_door_C	\$870.00	\$870.00
Grand total: 6		\$4457.00

<Floor Schedule>			
A	B	C	D
Family and Type	Area	Cost	Total Cost
Floor: Entrance Insitu concrete paving			
Floor: Entrance Ins	2 m²	\$56.00	\$92.96
Floor: Entrance Ins	2 m²	\$56.00	\$92.96
Floor: Entrance Ins	2 m²	\$56.00	\$92.96
Floor: First Floor Concrete + Ceiling Cost			
Floor: First Floor C	46 m²	\$280.00	\$12962.38
Floor: Insulated concrete slab with polished finish			
Floor: Insulated co	38 m²	\$270.00	\$10232.32
Floor: Timber Deck			
Floor: Timber Deck	10 m²	\$168.00	\$1681.68
Floor: Timber Deck	4 m²	\$168.00	\$609.84
Grand total: 7			\$25765.10

<Roof Schedule>			
A	B	C	D
Family and Type	Area	Cost	Total Cost
Basic Roof: Roofing + Posi Strut framing + Ceiling			
Basic Roof: Roofin	54 m²	\$253.40	\$13703.95
Grand total: 1			\$13703.95

Figure 4.99 First Cost 4.2

House 4.2 Costing Breakdown				93 m2	Concrete Construction	
Element	Item Description	Area m2	Cost (\$)	Per m2	Totals	Additional Information
Doors						
Revit Calculation - see Revit schedule for full costing breakdown per item	Exterior and interior doors				\$4,457	Interior doors include standard flush timber door with frame and hardware. Exterior doors include aluminium joinery with double glazing and hardware, aluminium front door 1x, glazed bifold door x1
Total Cost Doors						
						\$4,457
Windows						
Revit Calculation - see Revit schedule for full costing breakdown per item	Exterior aluminium joinery				\$10,851.00	All windows are opening, doubled glazed with aluminium joinery and hardware
Total Cost Windows						
						\$10,851.00
Wall Schedule						
Revit Calculation - see Revit schedule for full costing breakdown per item	See additional information for full breakdown includes exterior and interior walls				\$79,195.00	Includes: Insulated concrete panels with acid wash or embossed paint finish with interior paint finish. Interior Walls include 90 x 45 timber framing @600 crs with pink batts R2.6 insulation gib (standard or aqualine) on both sides with f4 finish with a paint finish. Bathroom includes small format wall tiles.
Total Cost Walls						
						\$79,195.00
Roof Schedule						
Revit Calculation - see Revit schedule for full costing breakdown per item	Roofing with timber framing, insulation and ceiling for floor below				\$13,703.95	Includes: 0.4mm Colour Steel Endura Roofing iron with netting underlay and flashings, 70 x 45 purlins at 600 crs on Mitek Post Struts with Pink Batt R3.6 ceiling insulation, on 70 x 45mm timber ceiling battens with stained plywood ceiling, gib aqualine in bathroom
Marley Stormcloud spouting	Spouting costs per m includes eaves gutters (fascia/concealed gutter system, with external angles and downpipe droppers.	5.4m		\$204.66		
Marley Ovation downpipe	1 offset 3m drop	5.5m		\$352.00		
Total Cost Roof						
						\$14,260.61
Floor Schedule						
Revit Calculation - see Revit schedule for full costing breakdown per item	All flooring, timber mid floor including balcony, concrete slab, concrete pathway and timber decking				\$25,765.00	Includes: Concrete mid floor with GIB rondo system including insulation and stained ply ceiling, Insulated concrete slab including foundations, polish in entrance and kitchen, Timber framed decking with grip tread radiata pine finish. Insitu concrete pathway to entrance.
Carpet - Lounge	Carpet, 100% wool, heavy duty cut pile	12		\$68		
Carpet - Bedroom	Carpet, 100% wool, heavy duty cut pile	34		\$68		
Plywood Stain- Upstairs	Stain	3		\$18.40		
	Large format tiles (ceramic, porcelain or stone adhesive fixed, with allowance for coving)					
Tiles - Bathroom		5		\$155		
						\$775

Figure 4.100 Lifecycle cost 4.2

House 4.2 Lifecycle Costing Breakdown					
Element	Item Description	Lifespan	Information	Cost of elements involved	Cost Over 50 Year period
Aluminium Joinery					
External Doors	1x bifold door, 1x front door	35 years	All double glazed with aluminium joinery	Bifold = \$2571, Front Door = \$870 per item	Full replacement at 35 years, full wash down every 3 months, hardware may require earlier replacement \$4,457
Windows	All external windows	35 years	All double glazed with aluminium joinery	Opening double glazed = \$556 per m2	Full replacement at 35 years, full wash down every 3 months, hardware may require earlier replacement \$10,851.00
Total Lifecycle Cost Aluminium Joinery					\$15,308.00
Exterior Cladding					
Concrete repaint	Paint	10 years for paint	Embossed concrete panel with paint	Repaint x 4 = \$ 25 per m2 of wall for repaint (wall area = 89 m2)	Repaint at 15 years then every 10 years after, material should last at least 50 years before needing replacement. Maintenance requirement is a full low pressure water and brush wash down annually \$8,900
Total Lifecycle Cost Exterior Cladding					\$8,900.00
Roofing					
Colour Steel Endura 0.4mm Roofing		50 years on material and 20 years on initial paint repaint every 10 years		Repaint x3 = Acrylic degrease, etch primer and 2 coats to roofing \$20.90 per m2. (Roof area = 54m2)	Repaint at 20 years then every 10 years after. No maintenance requirements rain washing only \$3,385.80
Iron Marley Ovation Downpipe	Roofing Iron with precoated paint finish	25 Years Maximum	Roofing Iron Fixture	Replace at 25 years	Replace at 25 years annual cleaning, check for blockages \$352.00
Marley Stormcloud Spouting	Downpipe Spouting	25 Years Maximum	Fixture	Replace at 25 years	Replace at 25 years annual cleaning, check for blockages \$204.66
Total Lifecycle Cost Roofing					\$3,942.46
Exterior Decking					
Timber Decking	Grip tread radiata pine H3.2	Replace at 25 Years, restrain at 10 years		Stain every 5 years (\$28.40 per m2) = 9x, replace material at 25 years 1x replace (\$69). Decking area = 14m2.	Water clean down annually, restrain every 5 years, replace material at 25 years \$ 4,544.00
Total Lifecycle Cost Exterior Decking					\$ 4,544.00
Interior					
Interior wall paint	Interior paint	Repaint every 10 years		\$34 across floor area = 92 m2	Repaint every 10 years \$12,512
Floor Polish Concrete	Reseal	Every 15 years	3x reseal \$35 per m2, 16m2 floor area	4x replacements = \$68 per m2, 46m2 floor area	Reseal every 15 years \$1,680
Carpet	Replace	Replace every 10 years		3x restrain \$18.40, 100m2	Replace every 10 years \$12,512
Plywood Stain Ceiling	Restain	Every 15 years			\$5,520
Joinery	30% of upfront cost for maintenance over 50 year period			Maintenance	\$7,604
Total Lifecycle Cost Interior					\$34,307.50
Total Lifecycle Costs					
				Total Cost Excl GST	\$67,001.96
				GST	\$10,050.29
				Total Cost Incl GST	\$77,052.25
				Total Cost Per Year	\$1,541.05
Overall costs including lifecycle over 50 year period					\$366,963.61

House 4.3 Costing

Overall Costs and Lifespan

Figure 4.101 Revit schedules screenshot 4.3

<Wall Schedule>			
A	B	C	D
Family and Type	Area	Cost	Total Cost
Basic Wall: 90T_10Gb-BS			
Basic Wall: 90T_10 4 m²		185.80	\$651.27
Basic Wall: 90T_10 8 m²		185.80	\$1399.41
Basic Wall: 90T_10 12 m²		185.80	\$2163.56
Basic Wall: 90T_10 1 m²		185.80	\$170.68
Basic Wall: 150 Concrete polish one side raw ext 3			
Basic Wall: 150 Co 12 m²		505.00	\$6202.03
Basic Wall: 150 Insulated Concrete paint finish			
Basic Wall: 150 Ins 25 m²		452.00	\$11105.64
Basic Wall: 150 Ins 8 m²		452.00	\$3615.56
Basic Wall: 150 Ins 2 m²		452.00	\$1058.17
Basic Wall: 150 Ins 3 m²		452.00	\$1240.83
Basic Wall: 150 Ins 2 m²		452.00	\$796.63
Basic Wall: 150 Ins 8 m²		452.00	\$3756.75
Basic Wall: 150 Ins 16 m²		452.00	\$7336.46
Basic Wall: 150 Ins 19 m²		452.00	\$8767.10
Basic Wall: 150 Ins 12 m²		452.00	\$5277.33
Basic Wall: 150 Insulated Concrete polish one side raw ext 2			
Basic Wall: 150 Ins 46 m²		452.00	\$20807.51
Basic Wall: Aqualine + tiles			
Basic Wall: Aqualin 4 m²		289.80	\$1065.93
Basic Wall: Aqualin 8 m²		289.80	\$2308.56
Basic Wall: Perforation			
Basic Wall: Perfora 2 m²		143.00	\$242.76
Basic Wall: Perfora 2 m²		143.00	\$331.13
Basic Wall: Perfora 2 m²		143.00	\$342.97
Basic Wall: Perfora 2 m²		143.00	\$262.81
Basic Wall: Timber Panel			
Basic Wall: Timber 4 m²		344.40	\$1269.36
Curtain Wall: Exterior Glazing			
Curtain Wall: Exteri 1 m²		722.80	\$906.65
Grand total: 23			\$81079.08

<Window Schedule>					
A	B	C	D	E	F
Family and Type	Cost	Width	Height	Area	Total Cost
AW 1 Aluminum-Grooved (NZ): front					
AW 1 Aluminum-G 556.00	2400	700	1.68		\$934.08
AW 1 Aluminum-G 556.00	2400	700	1.68		\$934.08
AW 1 Aluminum-Grooved (NZ): front 2					
AW 1 Aluminum-G 556.00	1800	700	1.26		\$700.56
FL 1 Aluminum-Grooved (NZ): Balcony 1					
FL 1 Aluminum-Gr 556.00	1500	500	0.75		\$417.00
FL 1 Aluminum-Gr 556.00	1500	500	0.75		\$417.00
FL 1 Aluminum-Gr 556.00	1500	500	0.75		\$417.00
FL 1 Aluminum-Gr 556.00	1500	500	0.75		\$417.00
FL 1 Aluminum-Grooved (NZ): Balcony 2					
FL 1 Aluminum-Gr 556.00	1500	2100	3.15		\$1751.40
FL 1 Aluminum-Gr 556.00	1500	2100	3.15		\$1751.40
FL 1 Aluminum-Grooved (NZ): Standard Square					
FL 1 Aluminum-Gr 556.00	1000	1400	1.4		\$778.40
FL 1 Aluminum-Grooved (NZ): Standard Square Small					
FL 1 Aluminum-Gr 556.00	500	1200	0.6		\$333.60
FL 1 Aluminum-Gr 556.00	500	1200	0.6		\$333.60
Grand total: 12					\$9185.12

<Roof Schedule>			
A	B	C	D
Family and Type	Area	Cost	Total Cost
Basic Roof: Colour steel roofing with timber build up, including ceiling			
Basic Roof: Colour 50 m²		253.00	\$12602.29
Grand total: 1			\$12602.29

<Floor Schedule>			
A	B	C	D
Family and Type	Area	Cost	Total Cost
Floor: 150mm Insulated concrete slab with polished finish			
Floor: 150mm Insulated co 39 m²		270.00	\$10518.26
Floor: Balcony			
Floor: Balcony 9 m²		296.00	\$2707.36
Floor: Concrete Mid floor + ceiling build up			
Floor: Concrete Mid floor + 33 m²		280.00	\$9258.78
Floor: Timber Decking			
Floor: Timber Decking 19 m²		168.00	\$3155.67
Grand total: 4			\$25640.07

<Door Schedule>		
A	B	C
Family and Type	Cost	Total Cost
Exterior_Sliding_Door_3843: Small		
Exterior_Sliding_D 2571.00		\$2571.00
Exterior_Sliding_D 2571.00		\$2571.00
Int Single-Flush (NZ): 710 x 1980		
Int Single-Flush (N 254.00		\$254.00
Int Single-Flush (N 254.00		\$254.00
Int Single-Flush (N 254.00		\$254.00
Single_hung_door_CR4: Aluminium Front Door		
Single_hung_door_870.00		\$870.00
Grand total: 6		\$6774.00

[Next Generation Architect]

Figure 4.102First Cost 4.3

House 4.3 Costing Breakdown			85 m2	Concrete Construction		
Element	Item Description	Area m2	Cost (\$)	Per m2	Total Cost Per m2	Totals
Doors						
Revit Calculation - see Revit schedule for full costing breakdown per item						
	Exterior and interior doors				\$6,774	
Total Cost Doors						
						\$6,774
Windows						
Revit Calculation - see Revit schedule for full costing breakdown per item						
	Exterior aluminium joinery				\$10,092.00	
Total Cost Windows						
						\$10,092.00
Wall Schedule						
Revit Calculation - see Revit schedule for full costing breakdown per item						
	See additional information for full breakdown includes exterior and interior walls				\$81,001.00	
Includes: Insulated concrete panels 150mm with acid wash, timber paneling Interior Walls include 90 x 45 timber framing @600 crs with pink batts R2.6 insulation, gib (standard or aqualine) on both sides with f4 finish with a paint finish and tiles in bathroom.						
Balcony Timbers						
	Laminated timber posts exterior quality (88 x 88mm)		53 per m (27m required)		\$1,431.00	
Total Cost Walls						
						\$82,432.00
Roof Schedule						
Revit Calculation - see Revit schedule for full costing breakdown per item						
	Roofing with timber framing, insulation and ceiling for floor below gutter's fascia/ concealed gutter system, with external angles and downpipe droppers.				\$12,602.29	
	1 offset 3m drop					
	Marley Stormcloud spouting	8.5 m	\$37.90 per m		\$322.15	
	Marley Ovation downpipe	5.6m	\$64 per m		\$358.40	
Total Cost Roof						
						\$13,282.84
Floor Schedule						
Revit Calculation - see Revit schedule for full costing breakdown per item						
	All flooring, timber mid floor including balcony, concrete slab, concrete pathway and timber decking				\$25,640.00	
	Carpet - Lounge	Carpet. 100% wool, heavy duty cut pile	11	\$68		\$748
	Carpet - Bedroom	Carpet. 100% wool, heavy duty cut pile	25	\$68		\$1,700
	Plywood Stair- Upstairs	Stain	2	\$18.40		\$36.80
Includes: Concrete mid floor, insulated concrete slab including foundations, polish in entrance and kitchen. Timber framed decking with grip tread radiata pine finish.						

Tiles - Bathroom Large format tiles (ceramic, porcelain or stone adhesive fixed, with allowance for coving) 5 \$155 \$775

Total Cost Flooring \$27,579.80

Joinery

Stairs with handrail (Cost per m)	Pine stringers with MDF treads with handrail	3	\$413	\$1,239
Perforated Panel on Stairs	Steel panel with powdercoating	1 x Fitout	\$1,160	\$1,160
Kitchen Fitout	Kitchen joinery cupboards + drawers, sink + tap, rangehood, oven + stove, fridge, pantry, desk and daybed	1 x Fitout	\$12,000	\$12,000
Lounge Joinery	TV unit with drawers and shelves, and additional small shelving unit	1 x Fitout	\$200	\$2,000
Bathroom Fitout	Vanity unit with sink, tapware mirror, toilet and shower	1 x Fitout	\$5,190	\$5,190
Master bedroom wardrobe	Double wardrobe + drawer unit with additional storage above wardrobe	1 x Fitout	\$2,500	\$2,500
Bedroom 1 wardrobe	Wardrobe + drawer unit + desk	1 x Fitout	\$1,500	\$1,500

Total Cost Joinery \$25,589

Heating

Standard Heatpump	1x heatpump		\$4,500	\$4,500
Gas hot water	Rinnal Infinity 26L continuous flow hot water heater LPG or Natural Gas	1x	\$3,395	\$3,395

Total Cost Heating \$7,895

Elemental Costing

Site Preparation	85	\$17.15	\$1,457.75
Sanitary Plumbing	85	\$144.55	\$12,286.75
Electrical Services	85	\$90.65	\$7,705.25
Drainage	85	\$31.85	\$2,707.25
Excavation	0m3	\$16.90	\$0

Total Cost Elemental \$24,157.00

Total Cost Minus Professional Fees and GST

\$ 197,801.64

Professional Fees

Architect	6%	0.06	\$	197,801.64	\$	11,868.10
Geotechnical	2.50%	0.025	\$	197,801.64	\$	4,945.04
Building Consent Wellington City Council	WCC Rates					\$4,025
Contingency	6%	0.06	\$	197,801.64	\$	11,868.10
Engineer	8%	0.08	\$	197,801.64	\$	15,824.13

Extra Building Fees Insurance, site shed, temporary power + water and skips \$4,300

Total Cost Professional Fees

\$ 52,830.37

Total Costs

Total Cost Excl GST	\$	250,632.01
GST	\$	37,594.80
Total Cost Incl GST	\$	288,226.81
Total Cost Per m2	\$	3,390.90
Deposit (20%)	\$	57,645.36

Figure 4.103 Lifecycle cost 4.3

House 4.3 Lifecycle Costing Breakdown					
Element	Item Description	Lifespan	Information	Cost of elements involved	Cost Over 50 Year period
Aluminium Joinery					
External Doors	2x sliding door, 1x front door	35 years	All double glazed with aluminium joinery	Sliding Door = \$2571 x2, Front Door = \$875 per item	Full replacement at 35 years, full wash down every 3 months, hardware may require earlier replacement
Windows	All external windows	35 years	All double glazed with aluminium joinery	Opening double glazed = \$556 per m2, irregular = 30% more	Full replacement at 35 years, full wash down every 3 months, hardware may require earlier replacement
Total Lifecycle Cost Aluminium Joinery					\$16,104.00
Exterior Cladding					
Cedar Panel	Raw with stain	50 years on material, restain at least every 5 years	Timber with stain	Restain (every 5 years) x 9 \$28.40 per m2 for oil based weatherboard stain (wall area = 8m2)	Restain every 5 years material should last 50 years
Stain on Balcony Timbers	2.2m2			Restain (every 5 years) x 9 \$28.40 per m2 for oil based weatherboard stain (wall area = 2.2m2)	\$562.32
					\$3,629.52
Roofing					
Colour Steel Endura 0.4mm Roofing Iron	Roofing iron with pre-coated paint finish	50 years on material and 20 years on initial paint repaint every 10 years after	Roofing iron	Repaint x3 = Acrylic degrease, etch primer and 2 coats to roofing \$20.90 per m2. (Roof area = 50m2)	Repaint at 20 years then every 10 years after. No maintenance requirements rain washing only
Marley Ovation Downpipe	Downpipe	25 Years Maximum	Fixture	Replace at 25 years	\$3,135.00
Marley Stormcloud Spouting	Spouting	25 Years Maximum	Fixture	Replace at 25 years	\$358.40
Total Lifecycle Cost Roofing					\$322.15
					\$3,815.55
Exterior Decking + Balcony					
Timber Decking + Balcony	Grip tread radiata pine H3.2	Replace at 25 years, restain at 10 years		Stain every 5 years (\$28.40 per m2) = 9x, replace material at 25 years 1x replace (\$69). Decking area = 31m2.	Annual washdown restain every 5 years
Balcony Timbers	Laminated Timber Posts	Restain every 5 years		Stain every 5 years (\$28.40 per m2) = 9x 4m2 area	Annual washdown restain every 5 years
Total Lifecycle Cost Exterior Decking + Balcony					\$1,020.00
					\$ 11,064.00
Interior					
Interior wall paint	Interior paint	Repaint every 10 years		\$34 across floor area = 85 m2	\$11,560
Floor Polish Concrete	Resal	Every 15 years		3x resal \$35 per m2, 21 m2 floor area	\$2,205
Carpet	Replace	Replace every 10 years		4x replacements = \$68 per m2, 36m2 floor area	\$9,792
Plywood Stain Ceiling	Restain	Every 15 years		3x restain \$18.40, 83m2	\$4,582
Joinery	30% of up front cost for maintenance over 50 year period			Maintenance	\$7,677
Total Lifecycle Cost Interior					\$35,815.30
Total Lifecycle Costs					
Total Cost Excl GST					\$70,428.37
GST					\$10,564.26
Total Cost Incl GST					\$80,992.63
Total Cost Per Year					\$1,619.85
Overall costs including lifecycle over 50 year period					\$369,219.44

House 4.4 Costing

Overall Costs and Lifespan

Figure 4.104 Revit schedules screenshot 4.4

<Wall Schedule>			
A	B	C	D
Family and Type	Area	Cost	Total Cost
Basic Wall: 90T_10Gb-BS			
Basic Wall: 90T_10	5 m²	185.80	\$903.31
Basic Wall: 150 Insulated Concrete Wall			
Basic Wall: 150 Insul	15 m²	452.00	\$6559.30
Basic Wall: 150 Insul	16 m²	452.00	\$7136.66
Basic Wall: 150 Insul	2 m²	452.00	\$920.82
Basic Wall: 150 Insul	6 m²	452.00	\$2664.54
Basic Wall: 150 Insul	7 m²	452.00	\$3124.03
Basic Wall: 150 Insul	11 m²	452.00	\$4948.84
Basic Wall: AQUALINE			
Basic Wall: AQUALI	10 m²	289.80	\$3006.58
Basic Wall: AQUALI	13 m²	289.80	\$3627.73
Basic Wall: AQUALI	10 m²	289.80	\$3006.58
Basic Wall: Panelled wall			
Basic Wall: Panelled	6 m²	252.00	\$1636.28
Basic Wall: Stained pine weatherboard			
Basic Wall: Stained	16 m²	377.80	\$6196.66
Basic Wall: Stained	8 m²	377.80	\$3001.23
Basic Wall: Stained	31 m²	377.80	\$11832.81
Basic Wall: Stained	20 m²	377.80	\$7534.97
Curtain Wall: Curtain Wall			
Curtain Wall: Curtain	1 m²	108.00	\$84.56
Curtain Wall: Curtain	1 m²	108.00	\$84.29
Curtain Wall: Curtain	1 m²	108.00	\$80.81
Curtain Wall: Curtain	1 m²	108.00	\$72.17
Grand total: 19			\$66422.17

<Window Schedule>					
A	B	C	D	E	F
Family and Type	Height	Width	Cost	Area	Total cost
AW 1 Aluminum-Grooved (NZ): 800 x 1001					
AW 1 Aluminum-Gro	2200	500	556.00	1.1	\$611.60
AW 1 Aluminum-Gro	2200	500	556.00	1.1	\$611.60
AW 1 Aluminum-Grooved (NZ): 1000 x 601					
AW 1 Aluminum-Gro	800	2200	556.00	1.76	\$978.56
AW 1 Aluminum-Gro	800	2200	556.00	1.76	\$978.56
AW 1 Aluminum-Gro	800	2200	556.00	1.76	\$978.56
AW 1 Aluminum-Gro	800	2200	556.00	1.76	\$978.56
AW 1 Aluminum-Gro	800	2200	556.00	1.76	\$978.56
AW 1 Aluminum-Grooved (NZ): 1000 x 603					
AW 1 Aluminum-Gro	800	400	556.00	0.32	\$177.92
AW 1 Aluminum-Grooved (NZ): 1000 x 606					
AW 1 Aluminum-Gro	2200	800	556.00	1.76	\$978.56
AW 1 Aluminum-Gro	2200	800	556.00	1.76	\$978.56
AW 1 Aluminum-Grooved (NZ): 1000 x 611					
AW 1 Aluminum-Gro	800	2200	556.00	1.76	\$978.56
AW 1 Aluminum-Grooved (NZ): 1000 x 612					
AW 1 Aluminum-Gro	600	1100	556.00	0.66	\$366.96
AW 1 Aluminum-Grooved (NZ): 1000 x 613					
AW 1 Aluminum-Gro	600	1800	556.00	1.08	\$600.48
Sliding_Window_3_rails_3_leaves_- _KASTING: Sliding_Window_3_rails_3_leaves_- _KASTING					
Sliding_Window_3_r	2200	2000	2571.00	4.4	\$11312.40
Grand total: 14					\$21509.44

<Floor Schedule>			
A	B	C	D
Family and Type	Area	Cost	Total Cost
Floor: 150mm Concrete Slab			
Floor: 150mm Con	36 m²	270.00	\$9626.20
Floor: Paved Entrance			
Floor: Paved Entra	3 m²	59.00	\$156.13
Floor: Timber Decking			
Floor: Timber Deck	12 m²	168.00	\$2048.08
Floor: Timber Deck	6 m²	168.00	\$1056.56
Floor: Timber Midfloor + Ceiling			
Floor: Timber Midfl	45 m²	290.00	\$13170.76
Grand total: 5			\$26057.73

<Door Schedule>		
A	B	C
Family and Type	Cost	Total Cost
Ext Bifold3-1Lite(NZ): 2100 x 1980		
Ext Bifold3-1Lite(N	2571.00	2571
Int Single-Flush (NZ): 710 x 1980		
Int Single-Flush (N	254.00	254
Int Single-Flush (N	254.00	254
Int Single-Flush (N	254.00	254
Single_hung_door_CR4: Aluminium Front Door		
Single_hung_door_	870.00	870
Grand total: 5		4203

<Roof Schedule>			
A	B	C	D
Family and Type	Area	Cost	Total Cost
Basic Roof: Colour Steel Roofing + Timber build up + Ceiling build up			
Basic Roof: Colour	52 m²	300.00	15699.52
Grand total: 1			15699.52

[Next Generation Architect]

Figure 4.105First Cost 4.4

House 4.4 Costing Breakdown			85 m2	Hybrid Construction - Timber + Concrete		
Element	Item Description	Area m2	Cost (\$)/Per m2	Total Cost Per m2	Totals	Additional Information
Doors						
Revit Calculation - see Revit schedule for full costing breakdown per item						
Exterior and interior doors				\$4,203		Interior doors include standard flush timber door with frame and hardware. Exterior doors include aluminium joinery with double glazing and hardware, glazed front door 1x, glazed bifold door x1 and double sliding door x1.
Total Cost Doors						\$4,203
Windows						
Revit Calculation - see Revit schedule for full costing breakdown per item						
Exterior aluminium joinery				\$21,509.00		All windows are opening, doubled glazed with aluminium joinery and hardware. Includes sliding door x1 with aluminium joinery and hardware
Total Cost Windows						\$21,509.00
Wall Schedule						
Includes: 150mm Insulated concrete panels with acid wash, 150mm Pine Weatherboard painted/stained on 140 x 45 timber framing @600 crs, dwangs, DPC building paper, battens, pink batts ultra R4 wall insulation fitted between studs, 10mm standard gib or aqualine gib in wet areas with f4 finish with a paint finish. Interior Walls include 90 x 45 timber framing @600 crs with pink batts R2.6 insulation, gib (standard or aqualine) on both sides with f4 finish with a paint finish.						
See additional information for full breakdown includes exterior and interior walls				\$66,422.00		
Total Cost Walls						\$66,422.00
Roof Schedule						
Includes: 0.4mm Colour Steel Endura Roofing iron with netting underlay and flashings, 70 x 45 purlins @ 900 crs on Posi Strut Trusses with Pink Batt R3.6 ceiling insulation, on 70 x 45mm timber ceiling battens with stained plywood ceiling.						
Roofing with timber framing, insulation and ceiling for floor below				\$15,699.52		
Spouting costs per m includes eaves gutters (fascia)/concealed gutter system, with external angles and downpipe droppers.			9m	\$37.90 per m	\$341.10	
1 offset 3m drop			6.5m	\$64 per m	\$416.00	
Total Cost Roof						\$16,456.62
Floor Schedule						
Includes: Timber Framed Mid Floor with Posi Strut trusses, Ecoply surface on 290 x 45 joists @ 600 crs, pink batts snug floor R1.6 insulation, ceiling grid for the floor below with 70 x 45 ceiling battens with stained plywood ceiling. Insulated concrete slab including foundations, polish in entrance and kitchen. Timber framed decking with grip tread radiata pine finish. Insitu concrete pathway.						
All flooring, timber mid floor including balcony, concrete slab, concrete pathway and timber decking				\$26,057.00		
Carpet: 100% wool, heavy duty cut pile			23	\$68	\$1,564	
Stain			6	\$18.40	\$110.40	
Large format tiles (ceramic, porcelain or stone adhesive fixed, with allowance for coving)			6	\$155	\$930	
Decking tongue and groove siberian ash timber (fixed in place)			7	\$158	\$1,106	
30% added on top of timber flooring cost - \$45 plywood			7	\$42	\$294	
Total Cost Flooring						\$30,061.40

Joinery									
Stairs with handrail (Cost per m)	Pine stringers with MDF treads with handrail	3	\$413			\$1,239			
Stained timbers feature on stairs	Timber lengths with stain	1 x Fitout	\$420			\$420			
Kitchen Fitout Lounge Joinery	Kitchen joinery cupboards + drawers, sink + tap, rangehood, oven + stove, fridge, pantry and desk	1 x Fitout	\$11,424			\$11,424			
	TV unit with drawers and shelves	1 x Fitout	\$2,000			\$2,000			
	Vanity unit with sink, tapware mirror, toilet and shower	1 x Fitout	\$5,190			\$5,190			
Bathroom Fitout									
Master bedroom wardrobe	Double wardrobe + drawer unit with additional storage above wardrobe	1 x Fitout	\$2,500			\$2,500			
Bedroom 1 wardrobe	Wardrobe + drawer unit	1 x Fitout	\$1,036			\$1,036			
Total Cost Joinery						\$23,809			
Heating									
Standard Heatpump		1x heatpump	\$4,500			\$4,500			
Gas hot water	Rinnai Infinity 26L continuous flow hot water heater LPG or Natural Gas	1x	\$3,395			\$3,395			
Total Cost Heating						\$7,895			
Elemental Costing									
Site Preparation		85	\$17.15			\$1,457.75			
Sanitary Plumbing		85	\$144.55			\$12,286.75			
Electrical Services		85	\$90.65			\$7,705.25			
Drainage		85	\$31.85			\$2,707.25			
Excavation		0m3	\$16.90			\$0			
Total Cost Elemental						\$24,157.00			
Total Cost Minus Professional Fees and GST						\$ 194,513.02			
Professional Fees									
Architect		0.06 \$	194,513.02 \$			11,670.78			
Geotechnical		0.025 \$	194,513.02 \$			4,862.83			
Building Consent Wellington City Council						\$4,025			
Contingency	WCC Rates	0.06 \$	194,513.02 \$			11,670.78			
Engineer		0.08 \$	194,513.02 \$			15,561.04			
Extra Building Fees	Insurance, site shed, temporary power + water and skips					\$4,300			
Total Cost Professional Fees						\$ 52,090.43			
Total Costs									
Total Cost Excl GST						\$ 246,603.45			
GST						\$ 36,990.52			
Total Cost Incl GST						\$ 283,593.97			
Total Cost Per m2						\$ 3,336.40			
Deposit (20%)						\$ 56,718.79

House 4.4 Lifecycle Costing Breakdown

House 4.4 Lifecycle Costing Breakdown								
Element	Item Description	Lifespan	Information	Cost of elements involved	Cost Over 50 Year period	Maintenance and replacements needed over 50 year period	Total Cost	
Aluminium Joinery								
External Doors	1x bifold door, 1x front door	35 years	All double glazed with aluminium joinery	Bifold = \$2571, Front Door = \$870 per item	\$4,203	Full replacement at 35 years, full wash down every 3 months, hardware may require earlier replacement		
Windows	All external windows, 1x sliding door	35 Years	All double glazed with aluminium joinery	Opening double glazed = \$556 per m2, Sliding Door = \$2571,	\$21,509.44	Full replacement at 35 years, full wash down every 3 months, hardware may require earlier replacement		
Total Lifecycle Cost Aluminium Joinery							\$25,712.44	
Exterior Cladding								
150mm Pine Weatherboard	Raw weatherboard with stain	50 years on material, restain at least every 5 years	Weatherboard with stain	Restain (every 5 years) x 9 \$28.40 per m2 for oil based weatherboard stain (wall area = 81m2)	\$20,703.60	Repaint at 15 years then every 10 years after, material should last at least 50 years before needing replacement. Maintenance requirement is a full low pressure water and brush wash down annually		
Total Lifecycle Cost Exterior Cladding							\$20,703.60	
Roofing								
Colour Steel Endura 0.4mm Roofing Iron	Roofing Iron with pre coated paint finish	50 years on material and 20 years on initial paint repaint every 10 years after	Roofing Iron	Repaint x3 = Acrylic degrease, etch primer and 2 coats to roofing \$20.90 per m2. (Roof area = 52m2)	\$3,260.40	Repaint at 20 years then every 10 years after. No maintenance requirements rain washing only		
Marley Oastion Downpipe	Downpipe	25 Years Maximum	Fixture	Replace at 25 years	\$416.00	Replace at 25 years annual cleaning, check for blockages		
Marley Stormcloud Spouting	Spouting	25 Years Maximum	Fixture	Replace at 25 years	\$341.10	Replace at 25 years annual cleaning, check for blockages		
Total Lifecycle Cost Roofing							\$4,017.50	
Exterior Decking + Balcony								
Timber Decking	Grip tread radiata pine H3.2	Replace at 25 Years, restain at 10 years		Stain every 5 years (\$28.40 per m2) 9x, replace material at 25 years 1x replace (\$69). Decking area = 16m2.	\$5,184.00			
Balcony Timbers	Tongue and grove siberian ash timber	Replace at 25 Years, restain at 10 years		Stain every 5 years (\$28.40 per m2) 9x, replace material at 25 years 1x replace (\$158). Decking area = 7m2.	\$2,891.00			
Total Lifecycle Cost Exterior Decking + Balcony							\$ 8,075.00	
Interior								
Interior wall paint	Interior paint	Repaint every 10 years		\$34 across floor area = 85 m2	\$2,890			
Floor Polish Concrete	Reseal	Every 15 years		3x reseal \$35 per m2, 35m2 floor area	\$3,675			
Carpet	Replace	Replace every 10 years		4x replacements = \$68 per m2, 23m2 floor area	\$6,256			
Plywood Stain Floor	Restain	Every 10 years		4x restain \$18.40, 6m2 floor	\$441.60			
Joinery	30% of upfront cost for maintenance over 50 year period			Maintenance	\$7,143			
Total Lifecycle Cost Interior							\$20,405.30	
Total Lifecycle Costs								
				Total Cost Excl GST	\$78,913.84			
				GST	\$11,837.08			
				Total Cost Incl GST	\$90,750.92			
				Total Cost Per Year	\$1,815.02			

Figure 4.106 Lifecycle cost 4.4

House 4.5 Costing

Overall Costs and Lifespan

Figure 4.107 Revit schedules screenshot 4.5

<Wall Schedule>			
A	B	C	D
Family and Type	Area	Cost	Total Cost
Basic Wall: 90T_10Gb-BS			
Basic Wall: 90T_10	2 m²	185.80	\$321.70
Basic Wall: 90T_10	13 m²	185.80	\$2494.37
Basic Wall: Cedar			
Basic Wall: Cedar	10 m²	480.20	\$4939.97
Basic Wall: Cedar	2 m²	480.20	\$1114.70
Basic Wall: Colour steel ext wall build up incl int			
Basic Wall: Colour st 10 m²		237.40	\$2406.98
Basic Wall: Colour st 7 m²		237.40	\$1766.93
Basic Wall: Colour st 11 m²		237.40	\$2672.67
Basic Wall: Colour st 8 m²		237.40	\$1850.59
Basic Wall: Colour st 8 m²		237.40	\$1925.23
Basic Wall: Colour st 6 m²		237.40	\$1340.73
Basic Wall: Ext with aqualine int			
Basic Wall: Ext with	4 m²	246.40	\$1086.46
Basic Wall: Ext with	1 m²	246.40	\$260.35
Basic Wall: Ext with	11 m²	246.40	\$2592.51
Basic Wall: Interior one side aqualine + tiles			
Basic Wall: Interior o 4 m²		289.80	\$1089.02
Basic Wall: Interior o 8 m²		289.80	\$2298.66
Curtain Wall: Exterior Glazing Triangle			
Curtain Wall: Exterio	1 m²	556.00	\$302.81
Curtain Wall: Exterio	1 m²	556.00	\$302.81
Curtain Wall: Exterio	1 m²	556.00	\$302.81
Curtain Wall: Exterio	3 m²	556.00	\$1588.43
Grand total: 19			\$30657.70

<Roof Schedule>			
A	B	C	D
Family and Type	Area	Cost	Total Cost
Basic Roof: Large Roof with Colour steel + Posi Struts + Ceiling			
Basic Roof: Large	45 m²	271.00	\$12166.63
Basic Roof: Small Colour Steel Roof + timber build up + ceiling			
Basic Roof: Small	16 m²	355.30	\$5845.71
Basic Roof: Small	11 m²	355.30	\$3745.27
Grand total: 3			\$21757.61

<Door Schedule>		
A	B	C
Family and Type	Cost	Total Cost
Ext Single In-Timber-1Lite (NZ): Aluminium Front Door		
Ext Single In-Timber-1Lite (NZ): Alumi	870.00	\$870.00
Int Single-Flush (NZ): 810 x 1980		
Int Single-Flush (NZ): 810 x 1980	254.00	\$254.00
Int Single-Flush (NZ): 810 x 1980	254.00	\$254.00
Grand total: 3		\$1378.00

<Floor Schedule>			
A	B	C	D
Family and Type	Area	Cost	Total Cost
Floor: Concrete Slab			
Floor: Concrete Sl	58 m²	150.00	\$8739.91
Floor: Timber Decking			
Floor: Timber Deck	22 m²	168.00	\$3765.97
Floor: Timber Deck	2 m²	168.00	\$384.57
Grand total: 3			\$12890.45

<Window Schedule>					
A	B	C	D	E	F
Family and Type	Cost	Height	Width	Area	Total Cost
FL 1 Aluminum-Grooved (NZ): entrance					
FL 1 Aluminum-Gr	556.00	2200	200	0.44	\$244.64
FL 1 Aluminum-Grooved (NZ): half					
FL 1 Aluminum-Gr	556.00	2400	400	0.96	\$533.76
FL 1 Aluminum-Gr	556.00	2400	400	0.96	\$533.76
FL 1 Aluminum-Gr	556.00	2400	400	0.96	\$533.76
FL 1 Aluminum-Gr	556.00	2400	400	0.96	\$533.76
FL 1 Aluminum-Grooved (NZ): Longways 1					
FL 1 Aluminum-Gr	556.00	2400	800	1.92	\$1067.52
FL 1 Aluminum-Grooved (NZ): Longways 3					
FL 1 Aluminum-Gr	556.00	400	2400	0.96	\$533.76
FL 1 Aluminum-Grooved (NZ): Longways 4					
FL 1 Aluminum-Gr	556.00	400	700	0.28	\$155.68
FL 1 Aluminum-Grooved (NZ): Slim Long					
FL 1 Aluminum-Gr	556.00	600	1500	0.9	\$500.40
FL 1 Aluminum-Gr	556.00	600	1500	0.9	\$500.40
Sliding_Window_2_rails_4_leaves_-_KASTING: 4 Panel sliding door					
Sliding_Window_2	476.00	2400	4500	10.8	\$5140.80
Grand total: 11					\$10278.24

[Next Generation Architect]

Figure 4.108 First Cost 4.5

House 4.5 Costing Breakdown			58 m2	Timber Construction with concrete slab		
Element	Item Description	Area m2	Cost (\$)	Total Cost Per m2	Totals	Additional Information
Doors						
Revit Calculation - see Revit schedule for full costing breakdown per item	Exterior and interior doors			\$1,378		Interior doors include standard flush timber door with frame and hardware. Exterior doors include aluminium joinery and hardware, aluminium front door 1x
Total Cost Doors					\$1,378	
Windows						
Revit Calculation - see Revit schedule for full costing breakdown per item	Exterior aluminium joinery			\$10,278.00		All windows are opening, doubled glazed with aluminium joinery and hardware. Includes 1x glazed sliding door with aluminium joinery and hardware
Total Cost Windows					\$10,278.00	
Wall Schedule						
Revit Calculation - see Revit schedule for full costing breakdown per item	See additional information for full breakdown includes exterior and interior walls			\$27,857.14		Includes: Colour Steel Endura/ 150mm Cedar Weatherboard painted/stained on 140 x 45 timber framing @600 crs, dwangs, DPC building paper, battens, pink batts ultra R 4 wall insulation fitted between studs, 10mm standard gip or aqualine gip in wet areas with f4 finish with a paint finish. Interior Walls include 90 x 45 timber framing @600 crs with pink batts R2.6 insulation, gip (standard or aqualine) on both sides with f4 finish with a paint finish. Bathrooms walls have a tiled finish
Total Cost Walls					\$27,857.14	
Roof Schedule						
Revit Calculation - see Revit schedule for full costing breakdown per item	Roofing with timber framing, insulation and ceiling for floor below			\$21,757.61		Includes: 0.4mm Colour Steel Endura Roofing iron with netting underlay and flashings, 70 x 45 purlins at 900 crs on 240 x 45 rafters @ 400 crs with Pink Batt R3.6 ceiling insulation, on 70 x 45mm timber ceiling battens with stained plywood ceiling.
Marley Stormcloud spouting	Spouting costs per m includes eaves gutters (fascia/ concealed gutter system, with external angles and downpipe droppers.	14m	\$37.90 per m	\$530.60		
Marley Ovaton downpipe	1 offset 3m drop	6m	\$64 per m	\$384.00		
Total Cost Roof					\$22,672.21	
Floor Schedule						
Revit Calculation - see Revit schedule for full costing breakdown per item	All flooring, timber mid floor including balcony, concrete slab, concrete pathway and timber decking			\$12,890.45		Includes: Insulated concrete slab including foundations, polish in entrance and kitchen. Timber framed decking with grip tread radiata pine finish.
Carpet - Bedroom	Carpet, 100% wool, heavy duty cut pile	15	\$68	\$1,020		
Tiles - Bathroom	Large format tiles (ceramic, porcelain or stone adhesive fixed, with allowance for coving)	7	\$155	\$1,085		
Polished Concrete Finish	Polish	32	\$120	\$3,840		
Total Cost Flooring					\$18,835.45	

Joinery						
	Kitchen joinery cupboards + drawers, sink + tap, rangehood, oven + stove, fridge, pantry and desk	1 x Fitout	\$11,424			\$11,424
Kitchen Fitout Lounge Joinery	TV unit with drawers and shelves	1 x Fitout	\$2,500			\$2,500
Bathroom Fitout	Vanity unit with sink, tapware mirror, toilet and shower	1 x Fitout	\$5,190			\$5,190
Master bedroom wardrobe	Double wardrobe + drawer unit with additional storage above wardrobe	1 x Fitout	\$2,500			\$2,500
Exterior Laminated Timber Posts (88 x 88mm)	15m		\$53 per m			\$795
Timber Feature Exterior		1 x Fitout	\$985			\$985
Total Cost Joinery						\$23,394
Heating						
Standard Heatpump	1x heatpump		\$4,500			\$4,500
Hot water cylinder	90L hot water cylinder	1x	\$2,490			\$2,490
Total Cost Heating						\$6,990
Elemental Costing						
Site Preparation		58	\$17.15			\$994.70
Sanitary Plumbing		58	\$144.55			\$8,383.90
Electrical Services		58	\$90.65			\$5,257.70
Drainage		58	\$31.85			\$1,847.30
Excavation		0m3	\$16.90			\$0
Total Cost Elemental						\$16,483.60
Total Cost Minus Professional Fees and GST					\$	127,888.40
Professional Fees						
Architect	6%	0.06	\$	127,888.40	\$	7,673.30
Geotechnical	2.50%	0.025	\$	127,888.40	\$	3,197.21
Building Consent Wellington City Council	WCC Rates					\$4,025
Contingency	6%	0.06	\$	127,888.40	\$	7,673.30
Engineer	8%	0.08	\$	127,888.40	\$	10,231.07
Extra Building Fees	Insurance, site shed, temporary power + water and skips					\$4,300
Total Cost Professional Fees						\$ 37,059.89
Total Costs						

Total Cost Excl GST	\$	164,988.29
GST	\$	24,748.24
Total Cost Incl GST	\$	189,736.53
Total Cost Per m2	\$	3,271.32
Deposit (20%)	\$	37,947.31

Figure 4.109 Lifecycle cost 4.5

House 4.5 Lifecycle Costing Breakdown							
Element	Item Description	Lifespan	Information	Cost of elements involved	Cost Over 50 Year period	Maintenance and replacements needed over 50 year period	Total Cost
Aluminium Joinery							
External Doors	1x front door	35 years	All double glazed with aluminium joinery	Front Door = \$870 per item Opening double glazed = \$556 per m2. Sliding Door x1 = \$5140.80	\$1,378	Full replacement at 35 years, full wash down every 3 months, hardware may require earlier replacement	
Windows	All external windows + sliding door	35 Years	All double glazed with aluminium joinery		\$10,278.00	Full replacement at 35 years, full wash down every 3 months, hardware may require earlier replacement	
Total Lifecycle Cost Aluminium Joinery							\$11,656.00
Exterior Cladding							
Colour Steel Endura Cladding 0.4mm Timber Feature Exterior	Colour steel Timbers	50 Years on material +15 years on initial paint then repaint every 10 years after 25 years	Coloursteel Replace	Repaint x4 = Acrylic degrease, etch primer and 2 coats to roofing \$20.90 per m2. (Wall area = 76	\$6,354	Repaint at 15 years then every 10 years after, material should last at least 50 years before needing replacement. Maintenance requirement is a full low pressure water and brush wash down annually	
				Restain (every 5 years) x 9 \$985 \$28.40 per m2 for oil based weatherboard stain (wall area = 12m2)	\$985	Replace at 25 Years	
150mm Cedar Weatherboard	Raw weatherboard with stain	50 years on material, restain at least every 5 years	Weatherboard with stain		\$3,067.20	Repaint at 15 years then every 10 years after, material should last at least 50 years before needing replacement. Maintenance requirement is a full low pressure water and brush wash down annually	
Total Lifecycle Cost Exterior Cladding							\$10,405.80
Roofing							
Colour Steel Endura 0.4mm Roofing Iron Marley Ovation Downpipe Marley Stormcloud Spouting	Roofing iron with precoated paint finish after 25 Years Maximum Downpipe Spouting	50 years on material and 20 years on initial paint repaint every 10 years after 25 Years Maximum	Roofing Iron Fixture	Repaint x3 = Acrylic degrease, etch primer and 2 coats to roofing \$20.90 per m2. (Roof area = 47m2	\$2,946.90	Repaint at 20 years then every 10 years after. No maintenance requirements rain washing only	
				Replace at 25 years Replace at 25 years	\$384.00	Replace at 25 years annual cleaning, check for blockages	
Total Lifecycle Cost Roofing							\$3,861.50
Exterior Decking + Balcony							
Timber Decking	Grip tread radiata pine H3.2	Replace at 25 Years, restain at 10 years		Stain at 10 years (\$28.40 per m2) and every 10 years after = 4x, replace material at 25 years 1x replace (\$69). Decking area = 24m2.	7,845.00		
Entrance Timbers	Restain	Every 5 Years		Stain every 10 years (\$28.40 per m2) x 9, 1.2m2 area	\$306.72		
Total Lifecycle Cost Exterior Decking + Balcony							\$ 8,151.72
Interior							
Interior wall paint	Interior paint	Repaint every 10 years		\$34 across floor area = 58 m2	\$1,972		
Floor Polish Concrete	Reseal	Every 15 years		3x reseal \$35 per m2, 16m2 floor area	\$1,680		
Carpet	Replace	Replace every 10 years		4x replacements = \$68 per m2, 15m2 floor area	\$4,080		
Plywood Stain Ceiling	Restain	Every 15 years		3x restain \$18.40, 58m2	\$3,202		
Joinery	30% of upfront cost for maintenance over 50 year period			Maintenance	\$7,018		
Total Lifecycle Cost Interior							\$17,951.80
Total Lifecycle Costs							
				Total Cost Excl GST			\$52,026.82
				GST			\$7,804.02
				Total Cost Incl GST			\$59,830.84
				Total Cost Per Year			\$1,196.62
					Overall costs including lifecycle over 50 year period		
					\$249,567.38		

House 4.6 Costing

Overall Costs and Lifespan

Figure 4.110 Revit schedules screenshot 4.6

<Wall Schedule>			
A	B	C	D
Family and Type	Cost	Area	Total Cost
Basic Wall: Cedar			
Basic Wall: Cedar	480.20	3 m²	\$1249.66
Basic Wall: Cedar	480.20	4 m²	\$1893.35
Basic Wall: Cedar	480.20	6 m²	\$2719.61
Basic Wall: Colour Steel + Interior lining + painting			
Basic Wall: Colour	237.40	13 m²	\$2980.05
Basic Wall: Colour	237.40	24 m²	\$5644.29
Basic Wall: Colour	237.40	12 m²	\$2795.96
Basic Wall: Colour	237.40	6 m²	\$1493.13
Basic Wall: Colour	237.40	9 m²	\$2152.29
Basic Wall: Colour	237.40	23 m²	\$5473.16
Basic Wall: Colour	237.40	11 m²	\$2527.61
Basic Wall: Colour	237.40	9 m²	\$2049.92
Basic Wall: Colour	237.40	7 m²	\$1661.69
Basic Wall: Colour	237.40	1 m²	\$154.17
Basic Wall: Colour	237.40	2 m²	\$429.41
Basic Wall: Interior one side aqualine with tiles			
Basic Wall: Interior	289.80	9 m²	\$2707.69
Basic Wall: Interior	289.80	6 m²	\$1700.38
Basic Wall: Interior	289.80	9 m²	\$2707.69
Curtain Wall: Balcony Balustrade Glazed			
Curtain Wall: Balcon	354.00	8 m²	\$2901.49
Curtain Wall: Ext Glazing Irregular/structure required			
Curtain Wall: Ext Gl	722.80	2 m²	\$1252.66
Curtain Wall: Ext Gl	722.80	2 m²	\$1468.50
Curtain Wall: Ext Gl	722.80	2 m²	\$1387.26
Curtain Wall: Ext Gl	722.80	1 m²	\$720.81
Curtain Wall: Ext Gl	722.80	1 m²	\$720.54
Curtain Wall: Ext Gl	722.80	1 m²	\$935.14
Curtain Wall: Ext Gl	722.80	7 m²	\$5138.21
Curtain Wall: Ext Gl	722.80	1 m²	\$883.91
Curtain Wall: Exterior Glazing			
Curtain Wall: Exterio	556.00	1 m²	\$755.12
Curtain Wall: Exterio	556.00	2 m²	\$910.81
Curtain Wall: Exterio	556.00	1 m²	\$772.13
Grand total: 29			\$58186.62

<Floor Schedule>			
A	B	C	D
Family and Type	Cost	Area	Total Cost
Floor: Balcony			
Floor: Balcony	275.00	19 m²	\$5339.91
Floor: Entrance Decking			
Floor: Entrance Decking	168.00	2 m²	\$336.00
Floor: Timber Flooring + Insulation + Ply topping + subfloor framing			
Floor: Timber Flooring +	272.00	5 m²	\$1397.34
Floor: Timber Flooring +	272.00	29 m²	\$7868.97
Floor: Timber Flooring +	272.00	34 m²	\$9269.12
Grand total: 5			\$24211.34

<Door Schedule>		
A	B	C
Family and Type	Cost	Total Cost
Ext Single Out-Aluminum-Grooved (NZ): Glazed Front Door		
Ext Single Out-Alu	2040.00	\$2040.00
Int Single-Flush (NZ): 710 x 1980		
Int Single-Flush (N	254.00	\$254.00
Int Single-Flush (N	254.00	\$254.00
Int Single-Flush (N	254.00	\$254.00
Grand total: 4		\$2802.00

<Roof Schedule>			
A	B	C	D
Family and Type	Area	Cost	Total Cost
Basic Roof: Module 1 Colour steel roof + posi struts + ceiling			
Basic Roof: Modul	50 m²	270.30	\$13395.85
Basic Roof: Module 2 Colour steel roof + posi struts + ceiling			
Basic Roof: Modul	6 m²	282.30	\$1693.50
Basic Roof: Module 3 Colour steel roof + posi struts + ceiling			
Basic Roof: Modul	57 m²	271.30	\$15484.44
Grand total: 3			\$30573.80

<Window Schedule>					
A	B	C	D	E	F
Family and Type	Width	Height	Cost	Area	Total Cost
FL 1 Aluminum-Grooved (NZ): long 2					
FL 1 Aluminum-Gr	600	1800	556.00	1.08	\$600.48
FL 1 Aluminum-Gr	600	1800	556.00	1.08	\$600.48
FL 1 Aluminum-Gr	600	1800	556.00	1.08	\$600.48
FL 1 Aluminum-Gr	600	1800	556.00	1.08	\$600.48
Sliding_Window_2_rails_4_leaves_-_KASTING: Sliding Door					
Sliding_Window_2	4000	2200	580.00	8.8	\$5104.00
Grand total: 5					\$7505.92

[Next Generation Architect]

Figure 4.111 First Cost 4.6

House 4.6 Costing Breakdown			73 m2	Timber Construction			
Element	Item Description	Area m2	Cost (\$)	Per m2	Total Cost Per m2	Totals	Additional Information
Doors							
Revit Calculation - see Revit schedule for full costing breakdown per item	Exterior and interior doors				\$2,802		Interior doors include standard flush timber door with frame and hardware. Exterior doors include aluminium joinery with double glazing and hardware, aluminium front door 1x.
Windows							
Revit Calculation - see Revit schedule for full costing breakdown per item	Exterior aluminium joinery				\$10,004.00		All windows are opening, doubled glazed with aluminium joinery and hardware. Includes 1x large sliding door with hardware.
Total Cost Windows						\$10,004.00	
Wall Schedule							
Revit Calculation - see Revit schedule for full costing breakdown per item	See additional information for full breakdown includes exterior and interior walls				\$55,748.00		Includes: Colour Steel Endura precoated/ 150mm Cedar Weatherboard stained on 140 x 45 timber framing @600 crs, dwangs, DPC building paper, battens, pink batts ultra R.4 wall insulation fitted between studs, 10mm standard gfb or aqualine gfb in wet areas with f4 finish with a paint finish. Interior Walls include 90 x 45 timber framing @600 crs with pink batts R2.6 insulation, gfb (standard or aqualine) on both sides with f4 finish with a paint finish, with tiled walls in bathroom.
Total Cost Walls							
Roof Schedule							
Revit Calculation - see Revit schedule for full costing breakdown per item	Roofing with timber framing, insulation and ceiling for floor below gutters (fascia/ concealed gutter system, with external angles and downpipe droppers.				\$30,573.80		Includes: 0.4mm Colour Steel Endura Roofing iron with netting underlay and flashings, 70 x 45 purlins at 900 crs on Posi Strut Trusses with Pink Batt R3.6 ceiling insulation, on 70 x 45mm timber ceiling battens with stained plywood ceiling.
Marley Stormcloud spouting		22m	\$37.90 per m		\$833.80		
Marley Ovation downpipe	1 offset 3m drop	14m	\$64 per m		\$896.00		
Timber Beams Interior	Laminated Timber Beams 190 x 42mm	31m	\$54 per m		\$1,642.00		
Total Cost Roof						\$33,945.60	
Floor Schedule							

Total Cost Flooring					\$34,106.00
Joinery					
Stairs with handrail (Cost per m)	Pine stringers with MDF treads with handrail	1.5	\$413	\$620	
Stained timbers feature on stairs	Timber lengths with stain Kitchen joinery cupboards + drawers, sink + tap, rangehood, oven + stove, fridge, pantry and desk + additional storage	1 x Fitout	\$336	\$336	
Kitchen Fitout	TV unit with drawers and shelves	1 x Fitout	\$12,000	\$12,000	
Lounge Joinery	Vanity unit with sink, tapware mirror, toilet and shower	1 x Fitout	\$2,500	\$2,500	
Bathroom Fitout		1 x Fitout	\$5,190	\$5,190	
Master bedroom wardrobe	Double wardrobe + drawer unit with additional storage above wardrobe	1 x Fitout	\$2,500	\$2,500	
Bedroom 1 wardrobe	Wardrobe + drawer unit + desk	1 x Fitout	\$1,500	\$1,500	
Balustrade Balcony	Timber Balustrade	4.9	\$230	\$1,126.02	
Total Cost Joinery					\$25,772
Heating					
Standard Heatpump	1x heatpump		\$4,500	\$4,500	
Gas hot water	Rinnai Infinity 26L continuous flow hot water heater LPG or Natural Gas	1x	\$3,395	\$3,395	
Total Cost Heating					\$7,895
Elemental Costing					
Site Preparation		73	\$17.15	\$1,251.95	
Sanitary Plumbing		73	\$144.55	\$10,552.15	
Electrical Services		73	\$90.65	\$6,617.45	
Drainage		73	\$31.85	\$2,325.05	
Excavation		0m3	\$16.90	\$0	
Total Cost Elemental					\$20,746.60
Total Cost Minus Professional Fees and GST					\$ 191,018.72
Professional Fees					
Architect	6%	0.06 \$	191,018.72 \$	11,461.12	
Geotechnical	2.50%	0.025 \$	191,018.72 \$	4,775.47	
Building Consent Wellington City					
Council	WCC Rates			\$4,025	
Contingency	6%	0.06 \$	191,018.72 \$	11,461.12	
Engineer	8%	0.08 \$	191,018.72 \$	15,281.50	
Extra Building Fees	Insurance, site shed, temporary power + water and skips			\$4,300	
Total Cost Professional Fees					\$ 51,304.21
Total Costs					

Total Cost Excl GST	\$	242,322.93
GST	\$	36,348.44
Total Cost Incl GST	\$	278,671.37
Total Cost Per m2	\$	3,817.42
Deposit (20%)	\$	55,734.27

Figure 4.112 Lifecycle cost 4.6

House 4.6 Lifecycle Costing Breakdown							
Element	Item Description	Lifespan	Information	Cost of elements involved	Cost Over 50 Year period	Maintenance and replacements needed over 50 year period	Total Cost
Aluminium Joinery							
External Doors	1x Aluminium front door	35 years	All double glazed with aluminium joinery	Front Door = \$2040 per item	\$2,040	Full replacement at 35 years, full wash down every 3 months, hardware may require earlier replacement	
Windows	All external windows+ Sliding Door	35 Years	All double glazed with aluminium joinery	Opening double glazed = \$556 per m2+ 30% extra irregular	\$10,004.00	Full replacement at 35 years, full wash down every 3 months, hardware may require earlier replacement	
Total Lifecycle Cost Aluminium Joinery							\$12,044.00
Exterior Cladding							
Colour Steel Endura0.4mm	Colour Steel	50 years on material +20 years on initial paint then repaint every 10 years after	Iron	Repaint x4 = Acrylic degrease, etch primer and 2 coats to roofing \$20.90 per m2. (Roof area =111m2)		Repaint at 20 years then every 10 years after, material should last at least 50 years before needing replacement. Maintenance requirement is annual wash down.	
150mm Cedar Weatherboard	Raw weatherboard with stain	50 years on material, restain at least every 5 years	Weatherboard with stain	Restain (every 5 years) x 9 \$28.40 per m2 for oil based weatherboard stain (wall area = 1.1m2)	\$2,811.60	Restain every 5 years. Annual washdown	
Total Lifecycle Cost Exterior Cladding							\$12,091.20
Roofing							
Colour Steel Endura0.4mm Roofing Iron	Roofing Iron with precoated paint finish	50 years on material and 20 years on initial paint repaint every 10 years after	Roofing Iron	Repaint x3 = Acrylic degrease, etch primer and 2 coats to roofing \$20.90 per m2. (Roof area =113)		Repaint at 20 years then every 10 years after. No maintenance requirements rain washing only	
Marley Ovaton Downpipe	Downpipe	25 Years Maximum	Fixture	Replace at 25 years	\$7,085.10	Replace at 25 years annual cleaning, check for blockages	
Marley Stormcloud Spouting	Spouting	25 Years Maximum	Fixture	Replace at 25 years	\$833.80	Replace at 25 years annual cleaning, check for blockages	
Total Lifecycle Cost Roofing							\$8,814.90
Exterior Decking+ Balcony							
Timber Decking	Grip tread radiata pine H3.2	Replace at 25 Years, restain at 10 years		Stain every 5 years (\$28.40 per m2) 9x, replace material at 25 years 1x replace (\$69). Decking area =21m2.	\$ 6,816.00	Restain every 5 years. Annual washdown	\$ 6,816.00
Total Lifecycle Cost Exterior Decking + Balcony							
Interior							
Interior wall paint	Interior paint	Repaint every 10 years		\$34 across floor area = 73 m2	\$2,482		
Recoat Timber	Reseal	Every 15 years		3x reseal \$28.40 per m2, 16m2 floor area	\$3,152		
Carpet	Replace	Replace every 10 years		4x replacements = \$68 per m2, 24m2 floor area	\$6,528		
Plywood Stain Ceiling	Restain	Every 15 years		3x restain \$18.40, 113 m2	\$6,238		
Joinery	30% of upfront cost for maintenance over 50 year period			Maintenance	\$7,732		\$26,131.60
Total Lifecycle Cost Interior							
Total Lifecycle Costs							
				Total Cost Excl GST	\$65,897.70		
				GST	\$9,884.66		
				Total Cost Incl GST	\$75,782.36		
				Total Cost Per Year	\$1,515.65		
Overall costs including lifecycle over 50 year period							
\$354,453.73							