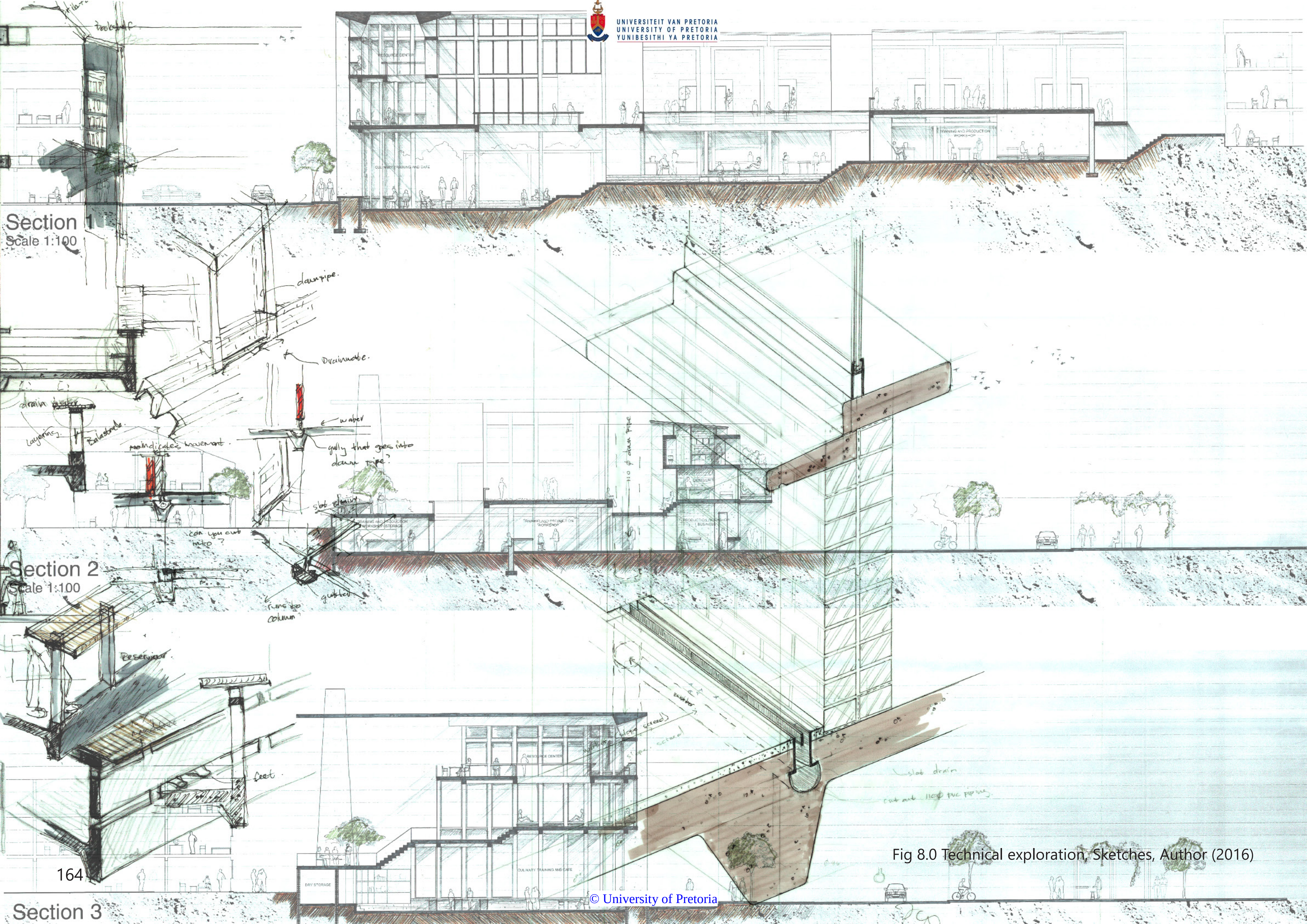
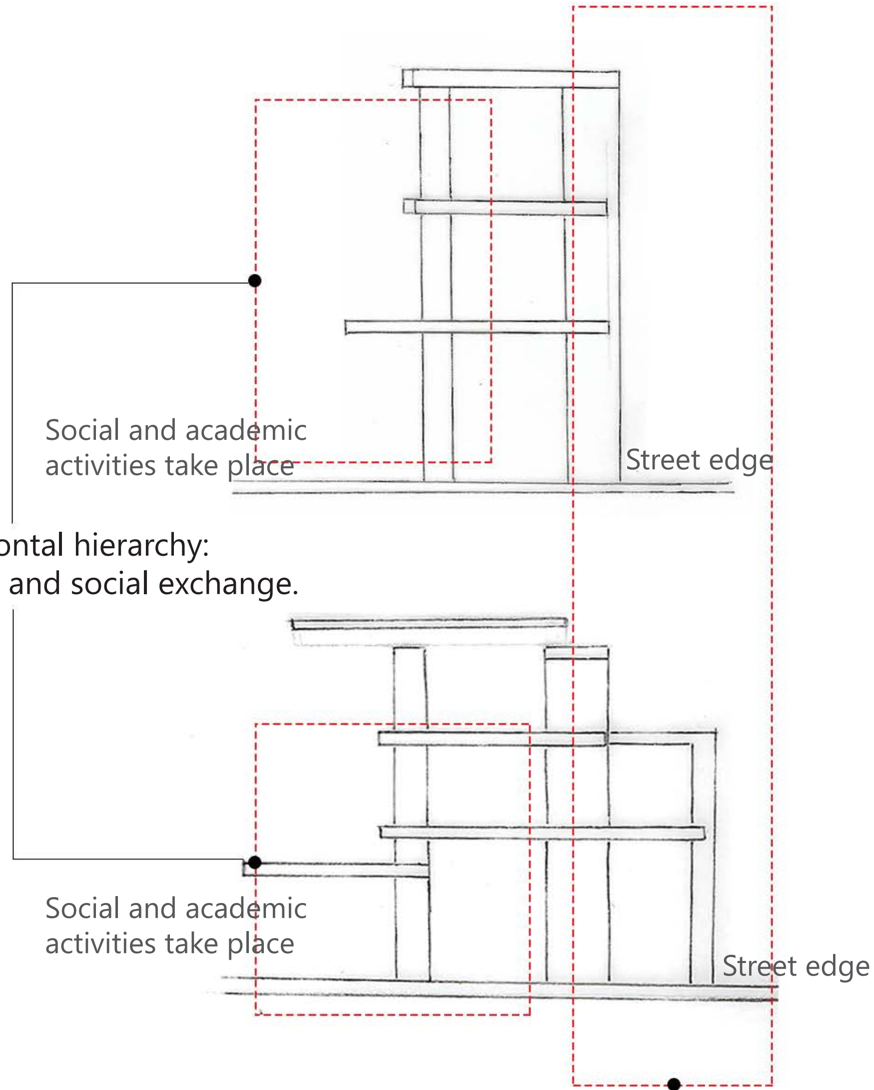


Fig 8.0 Technical exploration, Sketches, Author (2016)

8 Technical Resolution

8.1 Structural Intention



City in miniature:

The dissertation explores the components that a city comprises of by which the design is interpreted and developed as a *city in miniature.*

> *Make buildings less like objects and they become, shall we say, more open. This resembling greater accessibility comes from reading them as assemblage of components on the one hand and making them more as part of the greater totality of the city on the other* (Hertzberger 200:218).

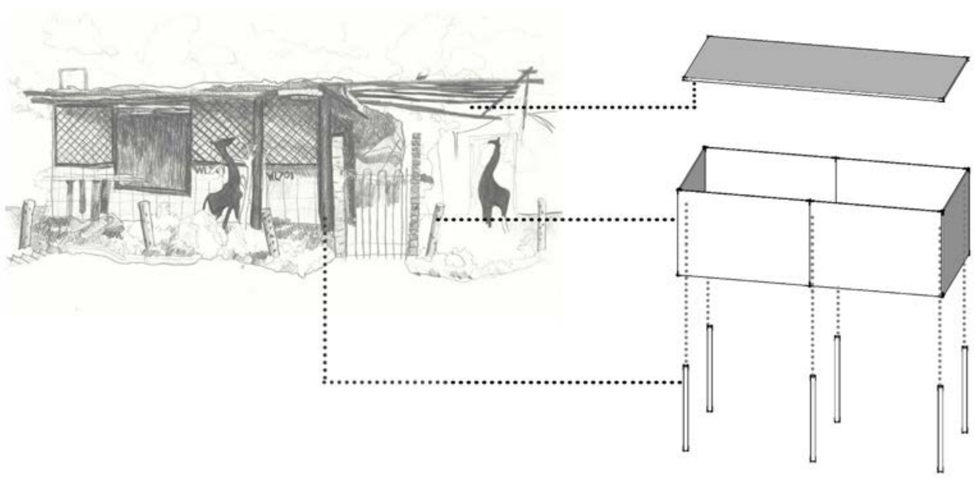
Conceptually , the proposed facility aims to strengthen social exchange between the learners and community. This translates into a spatial relationship between the building and its surrounding urban fabric. Structurally this is achieved by creating volumes of space that are layered and constructed with a hierarchy of intent in order to create a number of thresholds between users where social interaction can take place socially and academically.

In order to create an environment that resembles that of the city theorists such as Hertzberger (2000) and Lefebvre (1987) suggest that the habitable space between the structure is where *ordinary day-to-day lives* are led (Hertzberger 2000:234). Therefore the structure frames and suggests the type of activity which takes place in that space. The structure indicates movement and pause of the users throughout the design by guiding users through space and then containing the users in a central public space. This is done hierarchically by highlighting the verticality and horizontality of the structure. Thus protruding vertical elements suggest movement and accessibility into space where as horizontal cantilevered elements highlight social encounters between people, where one pauses and gathers socially.

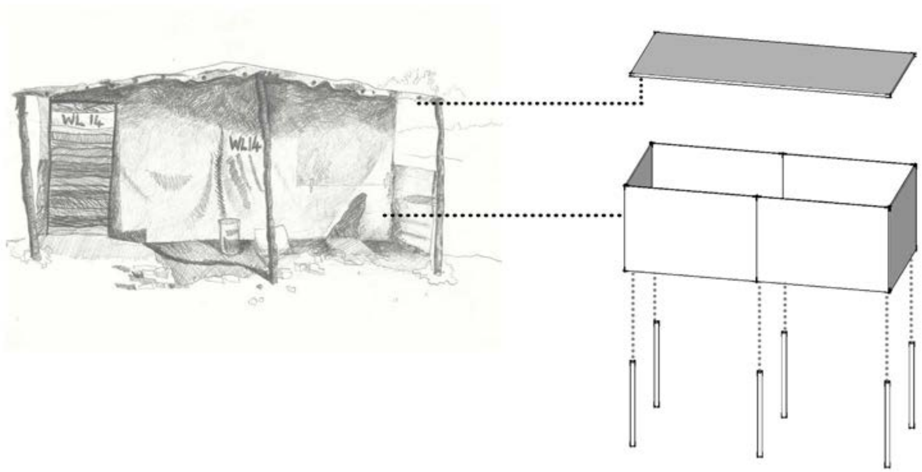
> *We have to look for space where it remains or has been left, inbetween, shaped to this end, constructed with spans or cantilevers, recesses, indentations...* (Hertzberger 2000:234).

Fig 8.1 Structural intent, Diagrams, Author (2016)

Exposed frame and infill



Hidden frame and infill



Contextual informants

In support of studying the spatial patterns created by those that live and create spaces within informal settlements, the structural techniques are explored and studied further. Similar construction techniques have been identified in Alaska, Mamelodi and Plastic View in Moreleta Park thus indicating a similar building typology.

Two structural conditions have been identified: the first consists of an exposed frame and infill technique, the second a hidden frame and infill technique it used.

This approach to building construction implies that the frame, which is structural, is more permanent and frames that of the infill which is adaptable and more temporary in nature. This form of construction informs the structural composition of the project as the primary components are the structural elements and the secondary components the infill.

Fig 8.2 Exposed and hidden frame and infill, Diagrams, Author (2016)


Bus stop

Urban framework

The urban framework identifies that Plastic View in Moreleta Park is situated on a site which is spatially fragmented and segregated from its surrounding urban fabric. The intent of the urban framework aims to improve spatial integration between the site Plastic View is situated on and it's urban surroundings.

The urban intention of creating a site of conciliation has a direct implication on the language that the projects speak as a whole within the urban vision. Therefore the material choices have been determined as a group as this visually ties a thread between projects suggesting a continuity and spatial wholeness throughout the context.

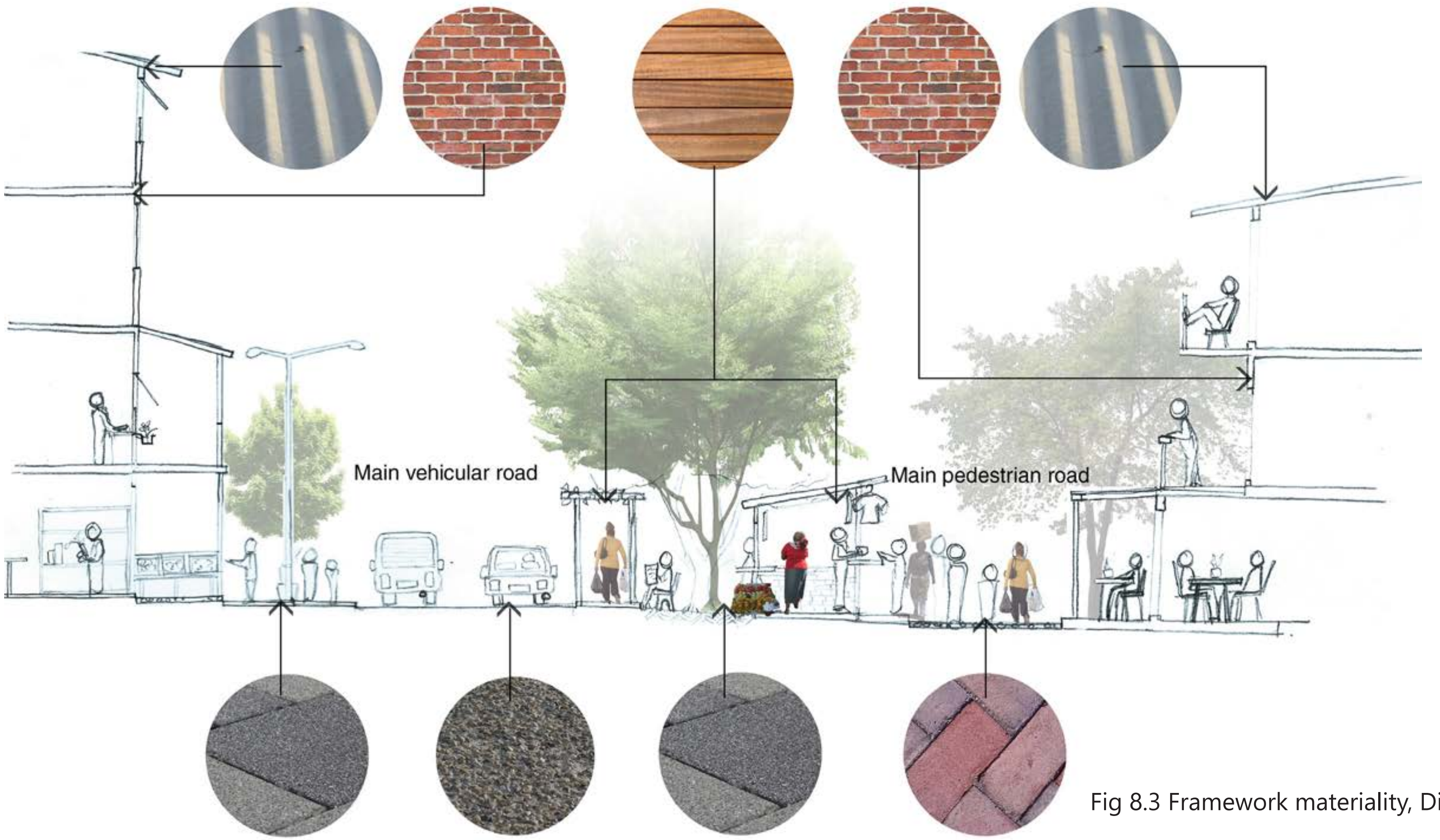


Fig 8.3 Framework materiality, Diagrams, Author (2016)

Layering, heirarchy and depth of space

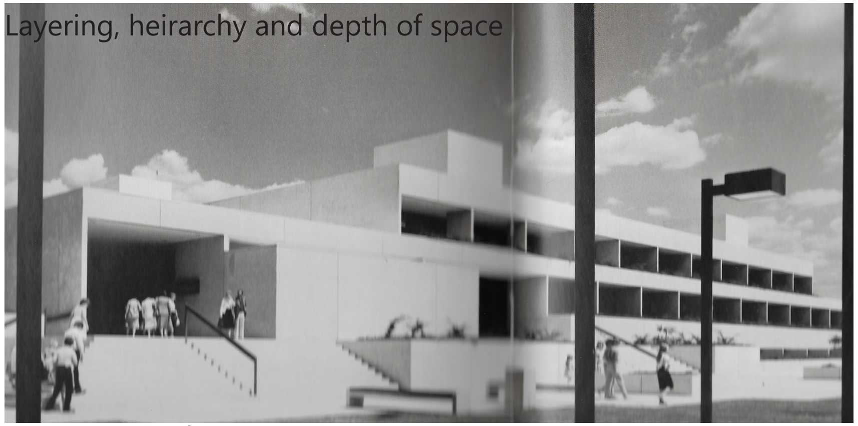


Fig 8.4 Depth of space, Brisbane art gallery, visitbrisbane.com.au (2016)

Horizontal structural elements

Fig 8.5 Horizontality is expressed, Forum Homini Hotel, architizer.com (2016)

Light weight steel roof

Fig 8.6 Light weight roof structure, Picture, Author (2016)

8.2 Structural Composition

Primary Components

Horizontal and vertical structural concrete elements: The horizontal and vertical structural elements of the building frame space and activities which takes place. As mentioned above the vertical elements signify movement and access into space. The horizontal elements signify pause by containing people in space.

- Vertical structural concrete column sizes: 300x2000mm, 300x1000mm and 300x300mm. With an off shutter concrete finish.
- Horizontal 255mm reinforced concrete floor slabs are cast in place. The slab is either power floated or a 25mm screed is put on top of concrete surface with flooring material as a finish.

Concrete roof structure (resource centre): the intention of the roof structure is to become an extension of, and finish off the facade of the building. The concrete roof over the resource centre can also, in the future, become a floor slab to a new level if more space is required.

- 255mm reinforced cast in place concrete roof with 80mm “lambda board” insulation layer, followed by screed to fall min 25mm, a “Torch on” waterproofing layer on top of screed, the entire waterproofed area to have a crushed stone overlay.
- 500mm Reinforced cast in place concrete up stand beam on inner concrete roof edge, with precast concrete coping over concrete up stand.

light weight steel roof structure (Live/ work units): The reason the roof over the live/ work units is of light weight construction is to allow for the spaces to be able to be adapted and changed more easily over time, a leading theme within the dissertation which supports the need for space to be adaptable in the future if need be.

- “Klip-lok” 406 profile roof sheeting @ min 2 degree pitch with global coat finish
- 150x75x20x3,5 Cold formed lipped channel purlins that offer support for the roof sheeting, 80mm structural “lambda board” insulation to be installed over the purlin.
- 254x146 Galvanized mild steel parallel flange section with tapered ends used to support purlin and roof sheeting.

Fig 8.7 Primary components, sketch, Author (2016)

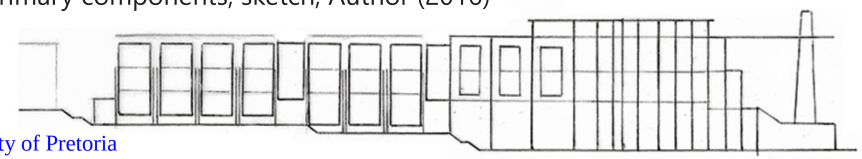


Fig 8.8 Secondary cotmponents, Brick Tongjiang Recycled brick school, archdaily.com (2016)

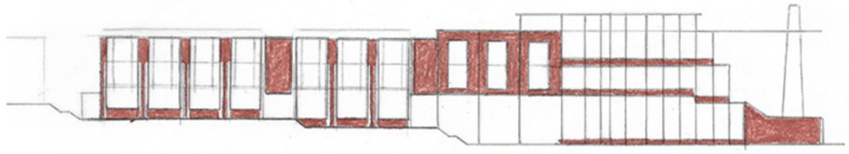
Secondary Components

Brick: The infill which either conceals or exposes the primary elements. Concealing elements emphasize a language of flow and movement through space which is not broken up by the primary components.

Exposing elements suggests a hierarchy in space specifically when the components are layered within space.

- Non load bearing 230mm brick walls to acts as infill structure.
- Face brick Roan travertine red brick, stretcher bond, racked joint finish.

Fig 8.9 Secondary components, Sketch, Author (2016)

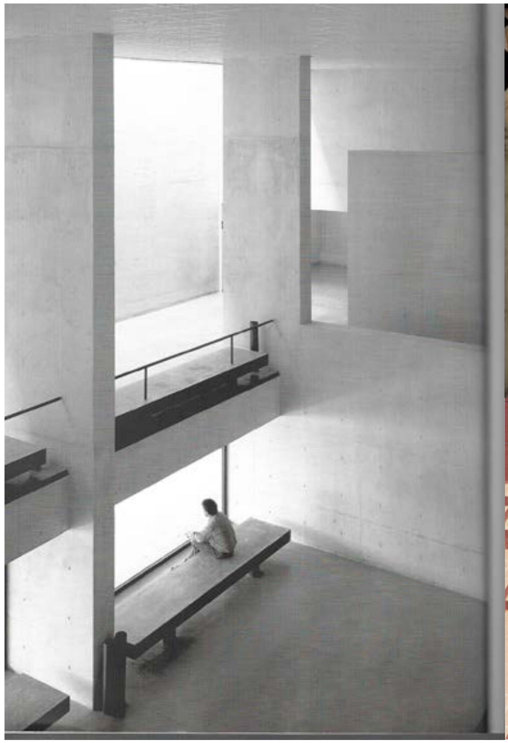


Tertiary Components

The finishes of the building have specific haptic and tactile qualities as they are the components of the building which suggest social significance and encounters (seating, eating, working). The components which highlight spaces for social exchange is expressed through materiality change keeping in mind the robust quality needed.

- Precast concrete seating with intermediate concrete support
- Brick on edge stair nosing
- Intensive green roofs are used that act as roof insulation as well as help dampen sound produced in the workshops.

Fig 8.13 Tertiary components, Sketch, Author (2016)



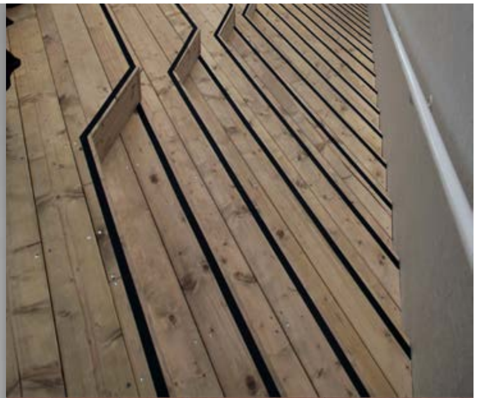
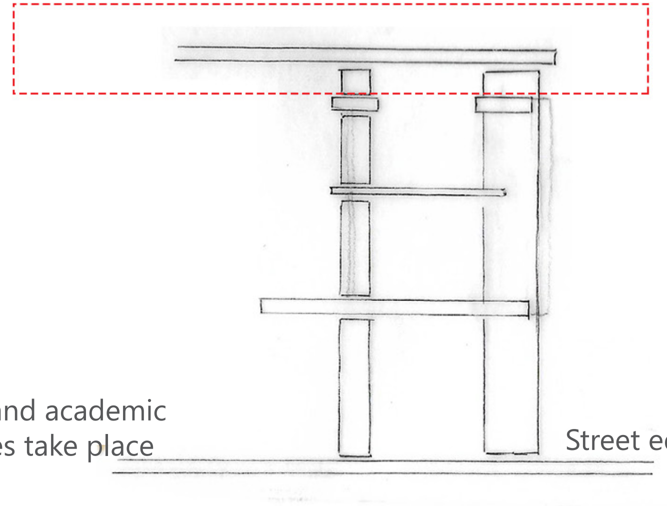


Fig 8.10 Brick steps used to create seating, Charles Corres, pinterest.com (2016)
Fig 8.11 Timber finish on seating, Photograph, herzogdemeuron.com (2016)
Fig 8.12 Concrete seating, Photograph, Bennett (2001)

Public and communal condition



Residential and business condition

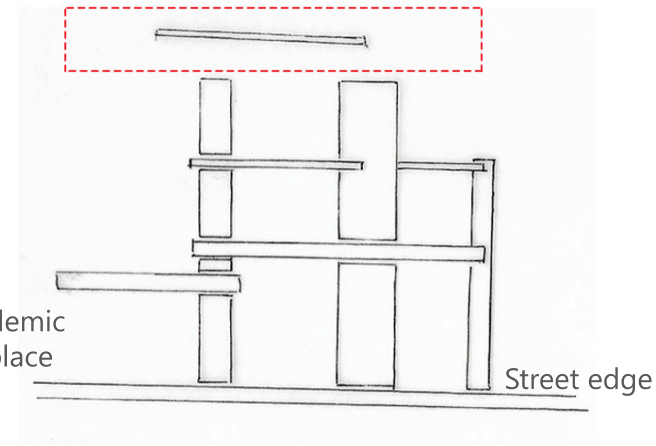


Fig 8.14 Structural intent proposal 1, Diagrams, Author (2016)

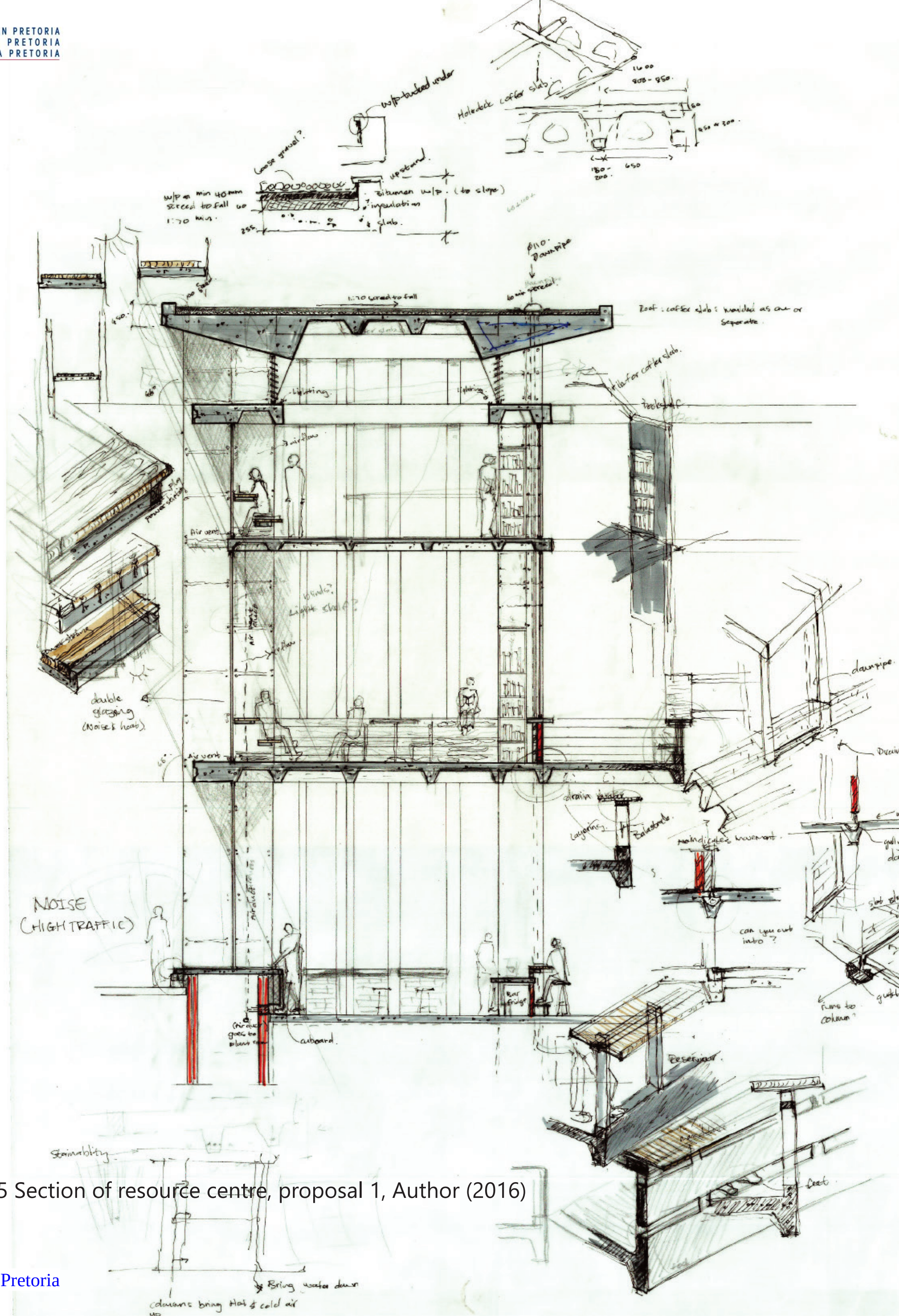
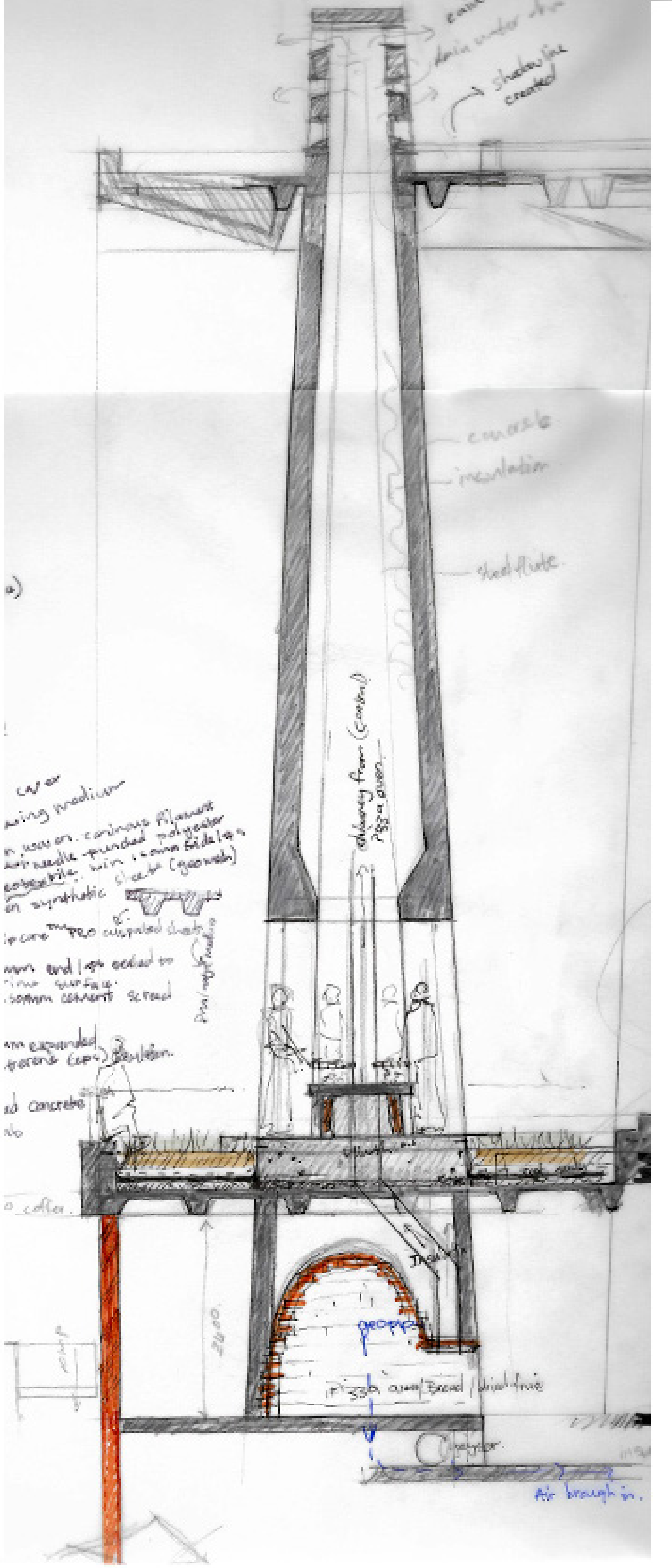


Fig 8.15 Section of resource centre, proposal 1, Author (2016)



8.3 Structural Iterations

Roof Development

First Iteration: coffer slab construction

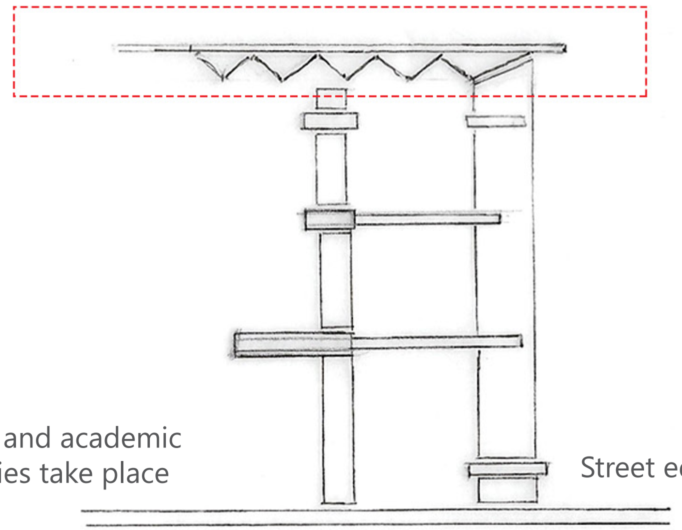
Coffer slabs were used throughout the design in order to express the design and structural intent, which was to frame and define space through the structure. The idea was that the coffer slab could be manipulated to shape space.

The critique received highlighted that the concrete coffer roof slab made the spaces feel unnecessarily heavy and that a light weight roof structure should be considered.

Fig 8.16 Section of furnace, proposal 1, Author (2016)

Fig 8.17 Model Development, proposal 1, Author (2016)

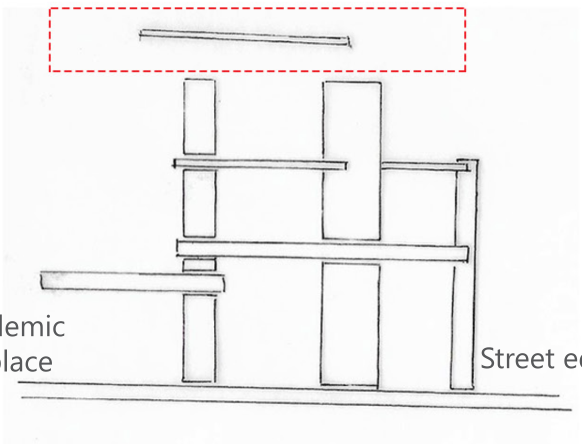
Public and communal condition



Social and academic activities take place

Street edge

Residential and business condition



Social and academic activities take place

Street edge

Fig 8.18 Structural intent proposal 2, Diagrams, Author (2016)

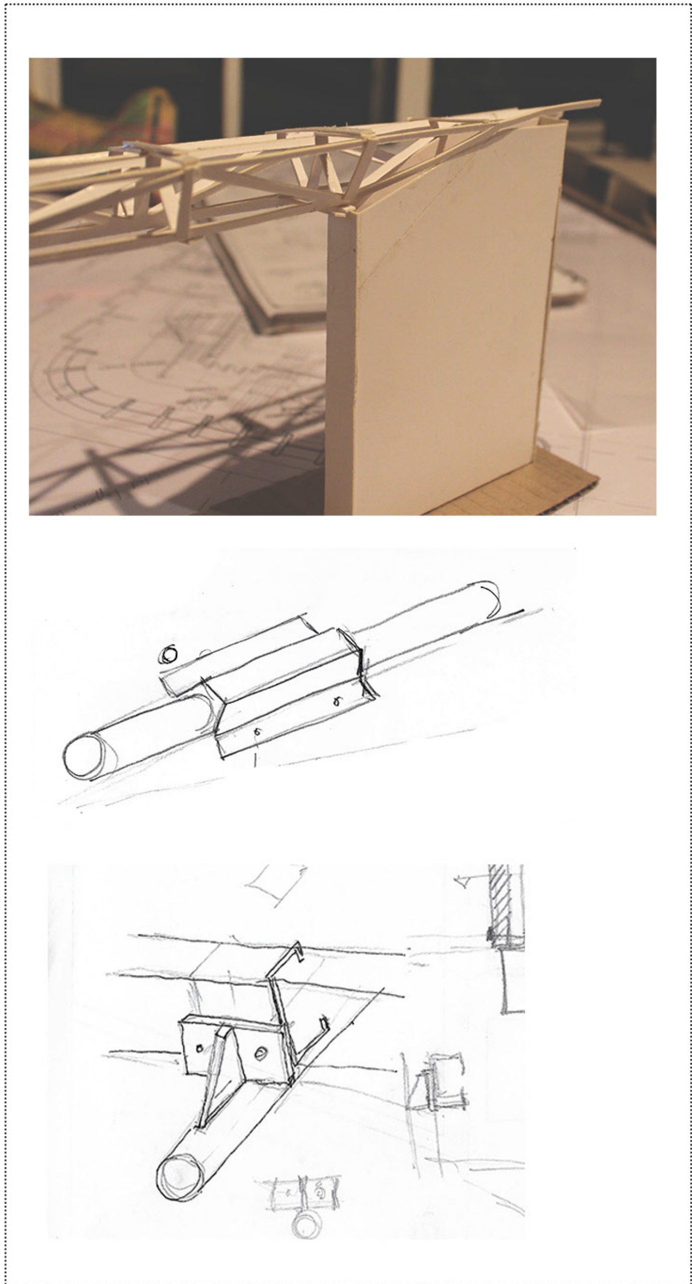
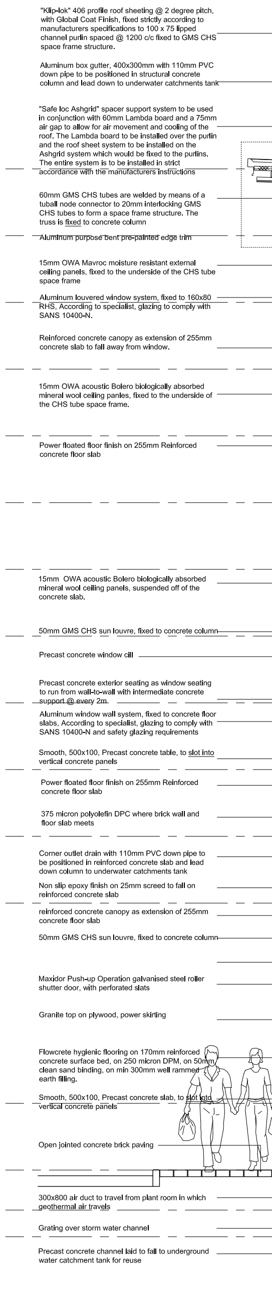


Fig 8.19 Space frame model and detail connections, proposal 2, Author (2016)



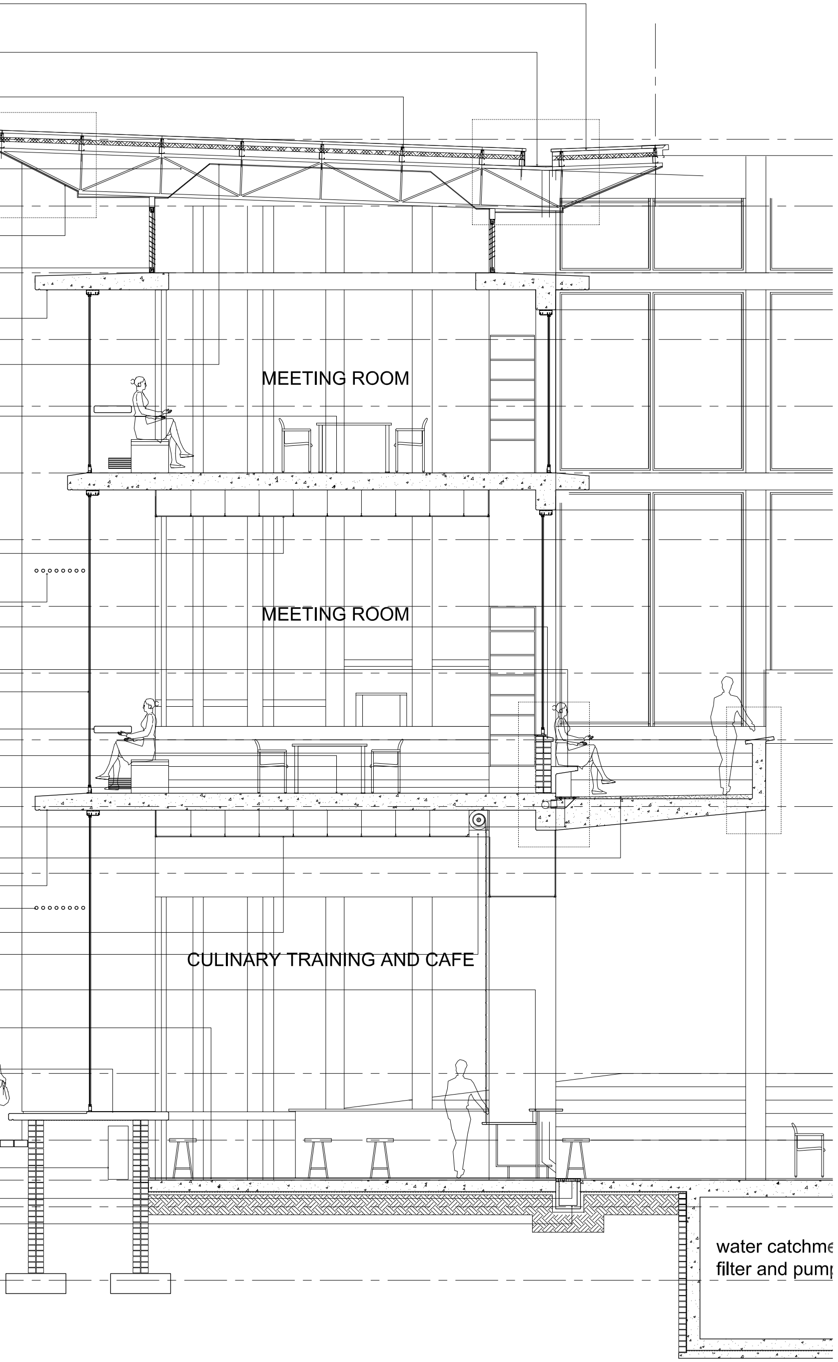


Fig 8.20 Sectional development, proposal 2, Author (2016)

Second Iteration: Light weight steel structure and space frame

The intention of the roof structure is to create a unifying element which ties the spaces together, signifying social cohesion by suggesting that various activities and social encounters take place under one roof.

A Circular Hollow Section (CHS) light weight roof structure and space frame structure were considered in this iteration. The light weight steel structure allowed more freedom with regards to the design of the roof. The roofs over the accommodation were expressed differently (wavy form) in order to define the accommodation as an individual entity within the greater whole.

The CHS light weight roof truss proved to be problematic at junctions where the internal structure needed to be closed from external conditions as thermal bridging would occur. It was proving difficult to fix components, like lipped channel purlins to the CHS frame structure.

Fig 8.21 Model development, proposal 2, Author (2016)

Fig 8.22 Double roof construction, Picture, Francis Kere, Laongo Opera Village (2016)

Fig 8.23 Exploration of roof on elevation, Sketch, Author (2016)

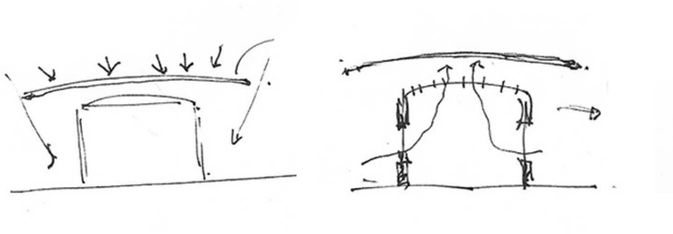


Fig 8.24 Double roof creates stack ventilation effect, Sketch, Author (2016)

Fig 8.25 Roof used as unifying element, Sketch, Author (2016)

Fig 8.26 Exploration of roof, model, Author (2016)

Third Iteration: Space frame structure

Following the critique on the problematic junctions that arose with the CHS light weight roof truss, when trying to close up internal and external spaces, it was suggested that the roof structure be thought of differently. Similar to that of Francis Kere's iconic roofs, the concrete structure should be contained as an entity meaning that a concrete roof be laid and that the light weight roof, held by a space frame truss, act simply as a shading device and unifying element which extends over the concrete roof.

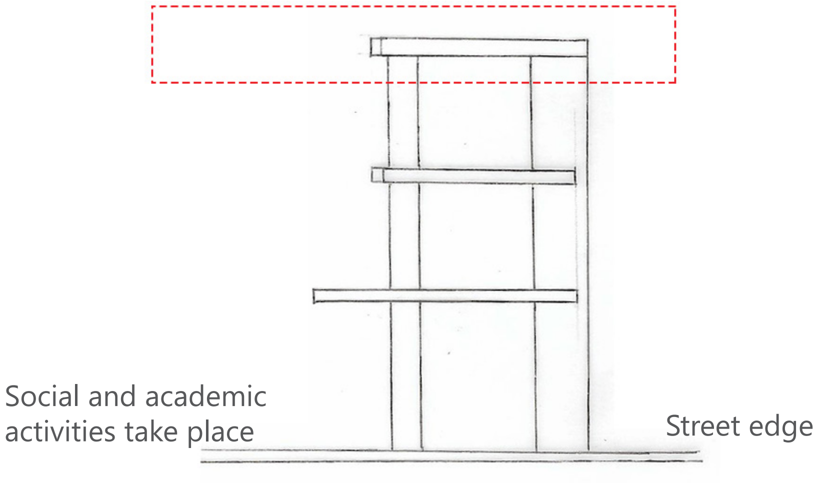
Upon further research on the ventilation principles behind the double roof system used by Francis Kere. It was discovered firstly that the stack ventilation principle works most effectively when the entire building is shaded by the roof in order to cool the walls and air that passes through the space therefore the space frame structure is an ideal solution as it can span great lengths with less vertical structural support (Lan 1999). Secondly in order for the stack effect to occur the first roof has to be perforated in order to release the hot air out and pulling fresh air in (stylepark.com).

The research proved to be valuable as it allowed the author to reconsider the need for the double roof system. The space over which this system would be used is a resource centre where computers and books are situated and the concern of not being able to waterproof the roof was not practical or sensible. A re-evaluation of the roofs intent was needed.

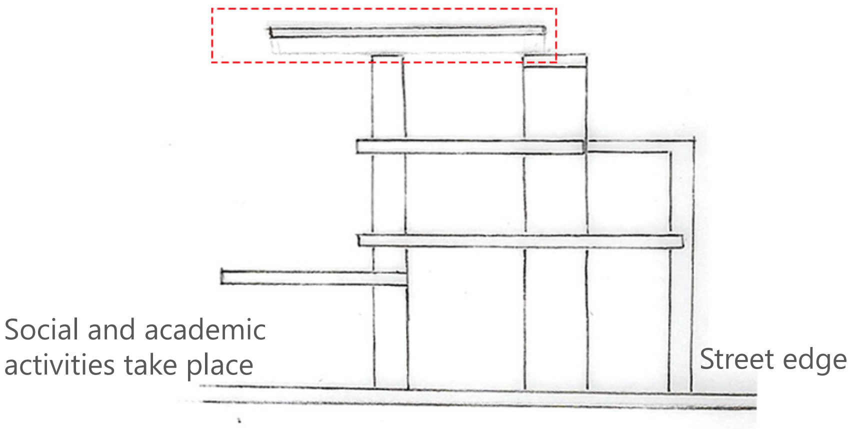
It was realized that the idea of having the roof as a unifying element needed to be reconsidered as it did not fit the architectural language and intent of the facade.

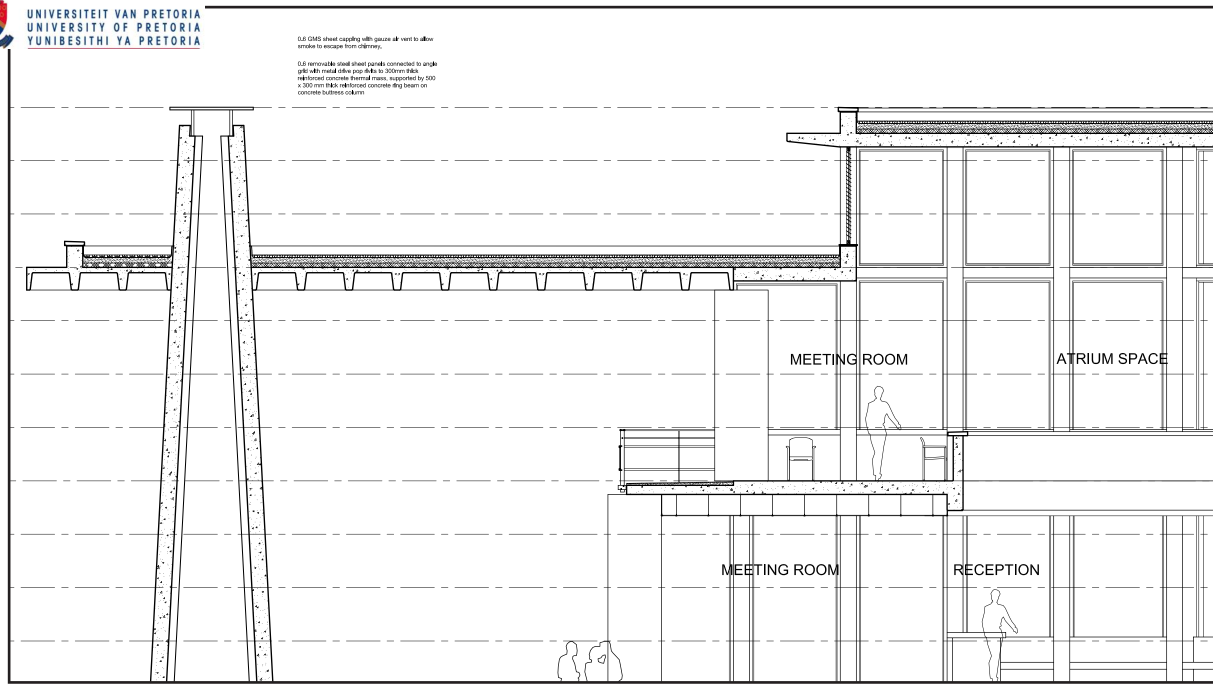
A roof as a unifying element which ties everything underneath it together is fitting for a market for example. Here a mismatch of people, products, stalls are situated underneath one roof, and the roof becomes a unifying element.

Public and communal condition



Residential and business condition





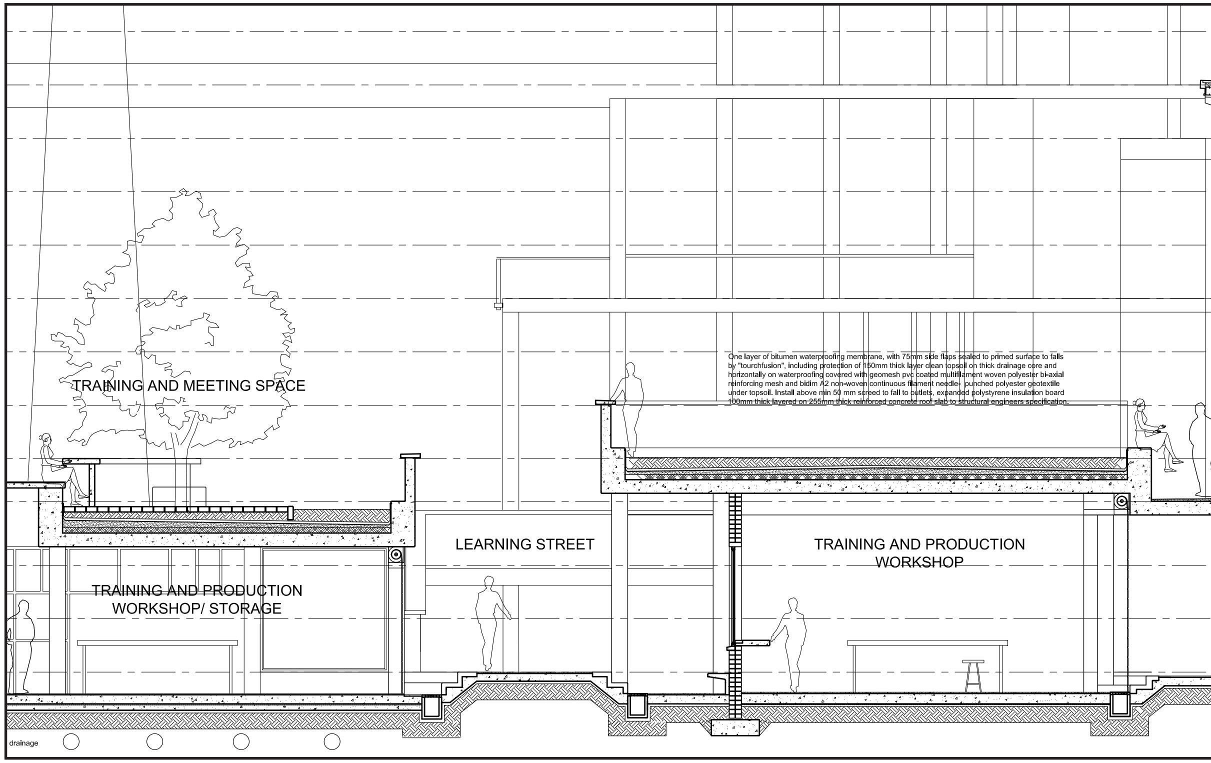
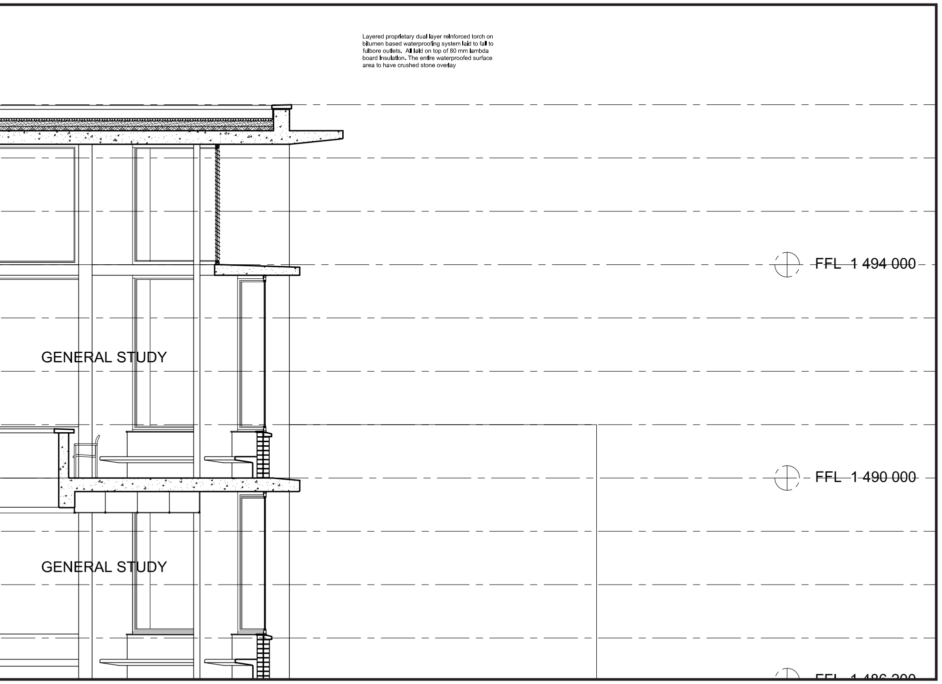
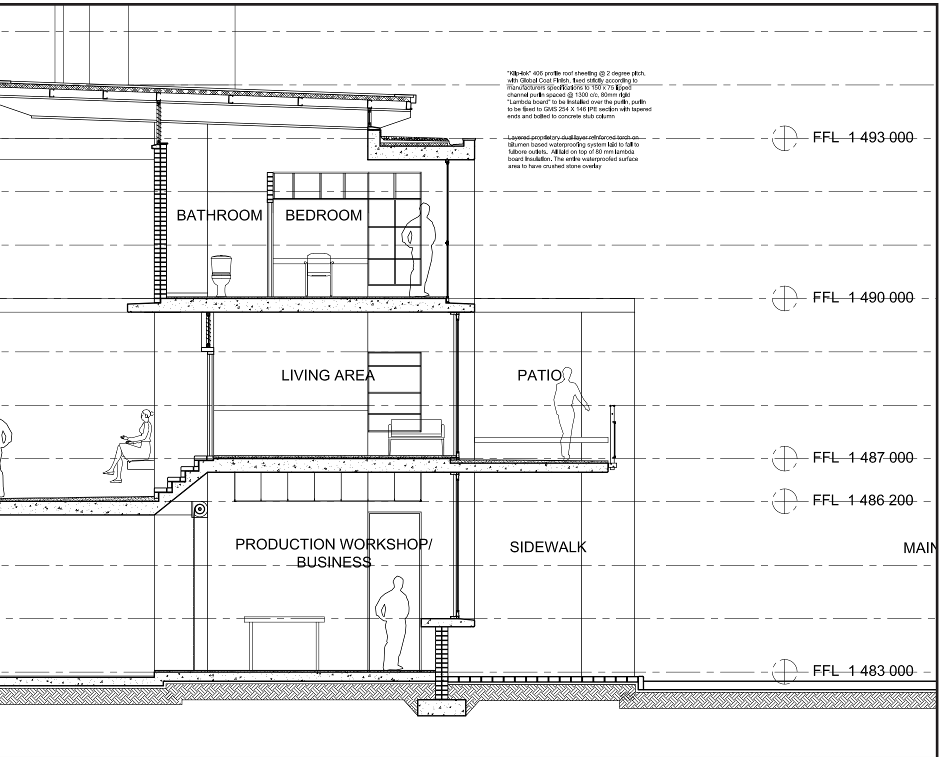


Fig 8.27 Structural intent proposal 4, Diagrams, Author (2016)

Fig 8.28 Roof development on section, Author (October 2016)



Section through concrete roof, Resource centre



Section through light weight roof, Live/ work units and production space

Fourth Iteration: Concrete and light weight steel roof

Concrete roof

The architectural language of the CFV explores the idea of repetition and order throughout the facade, this repetition of elements signifies social cohesion. Therefore a roof that acts as a unifying element is not needed as the ordered facade condition does this already. The roof becomes an extension of and ends off the facade of the building by expressing the individual components that make up the whole. The concrete roof, in the future, can also become a floor slab to a new level if more space is required.

Light weight roof structure

The accommodation is defined differently to the public facilities by using a light weight roof structure. The light weight roof extends over the units while allowing soft light into the accommodation through clerestory windows. The light weight roof structure also allows the spaces to be able to be adapted and changed more easily over time, a leading theme within the dissertation which supports the need for adaptable space within the facility.

Fig 8.29 Model development, Proposal 3, Author (2016)

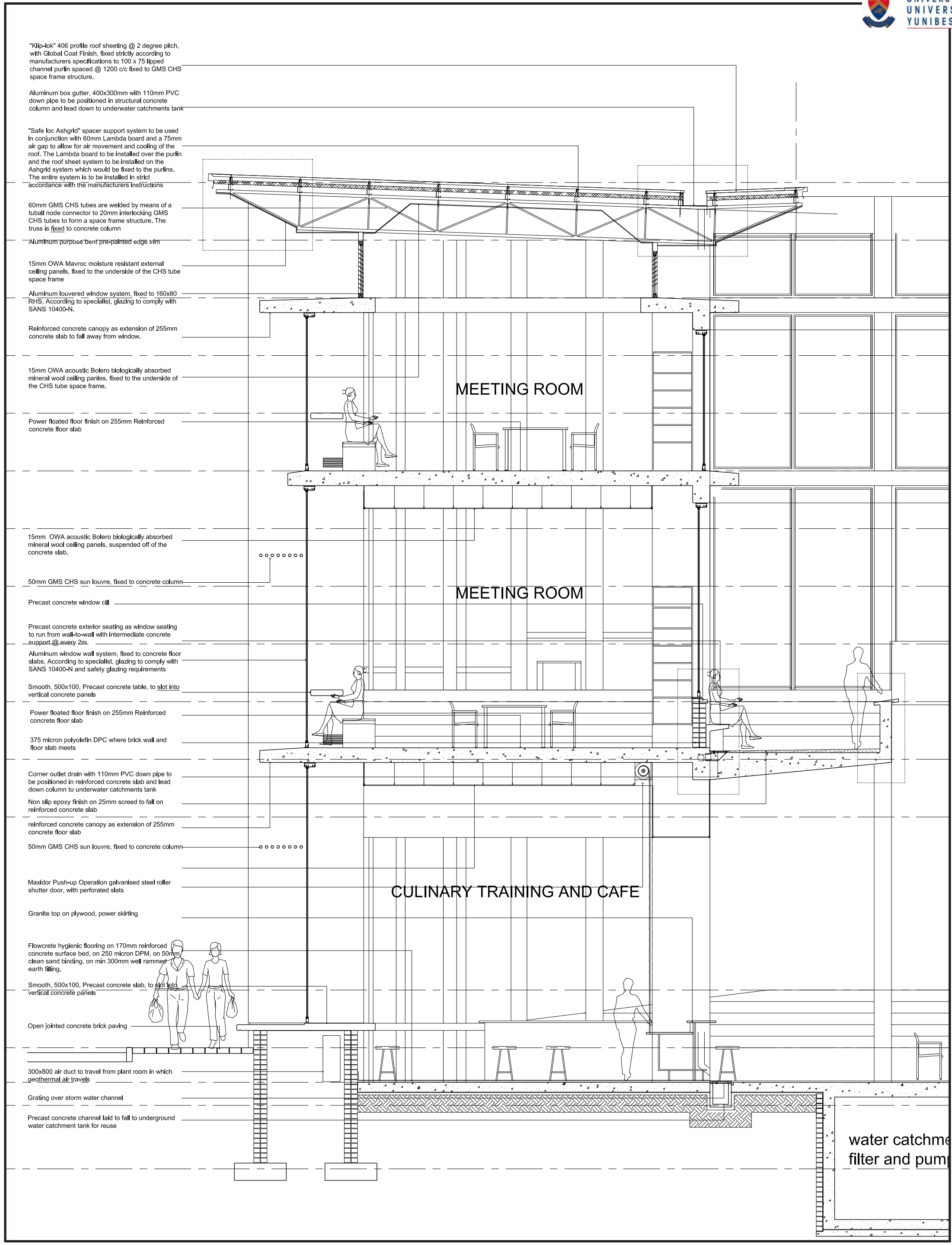


Fig 8.30 Section iteration 1, Author (August 2016)

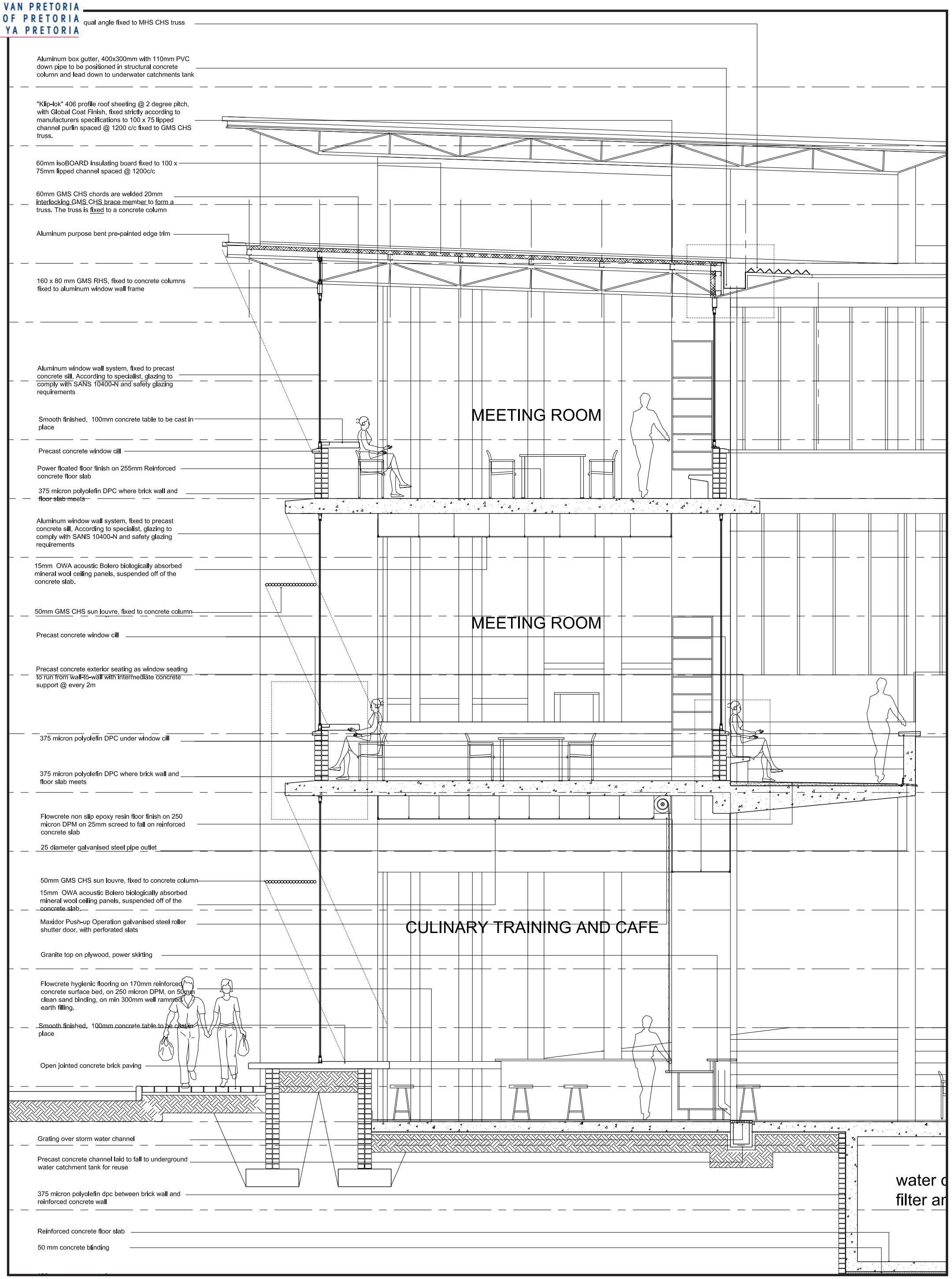


Fig 8.31 Section iteration 2, Author (September 2016)

Sectional Development

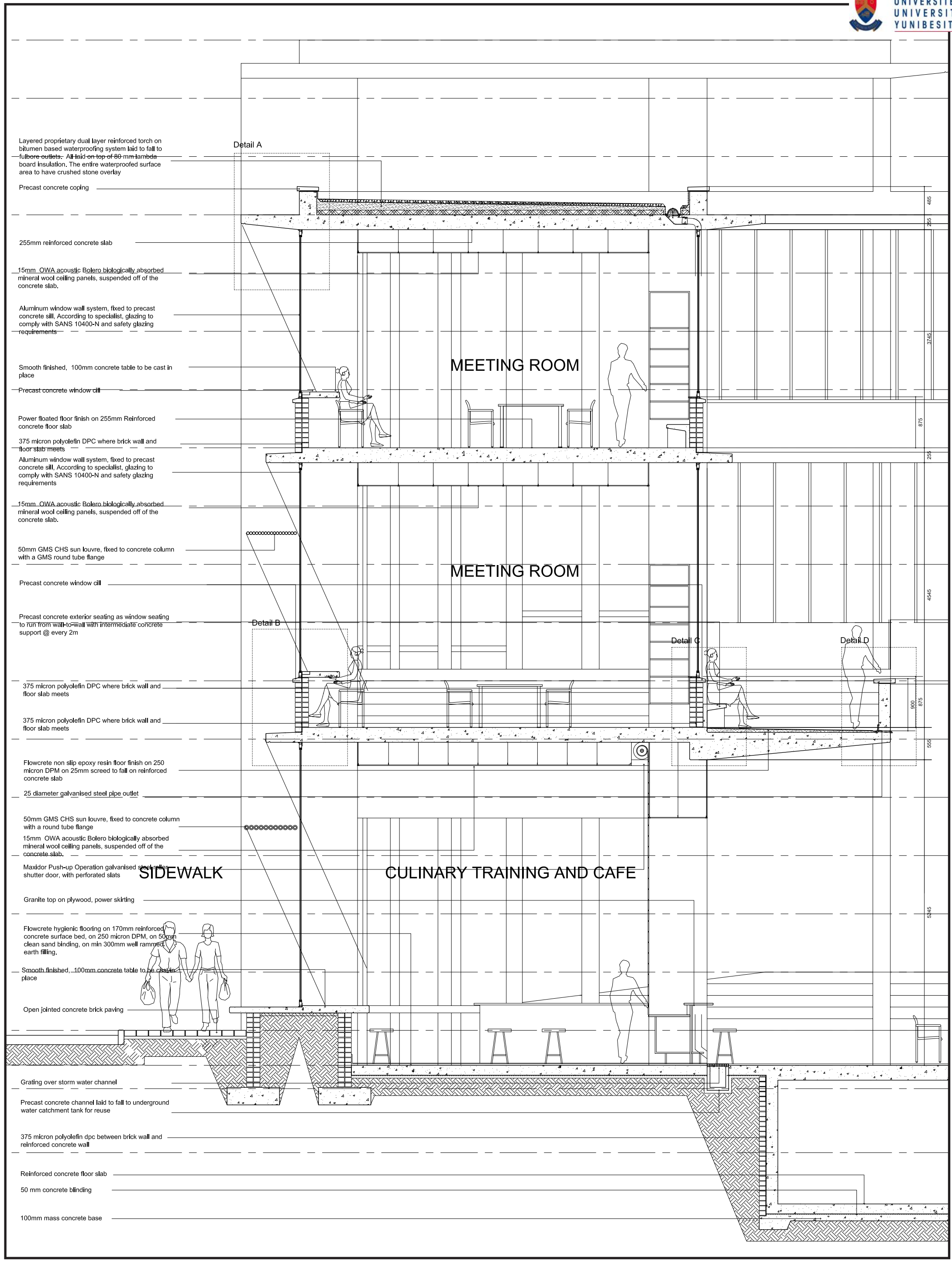


Fig 8.32 Section iteration 3, Author (October 2016)

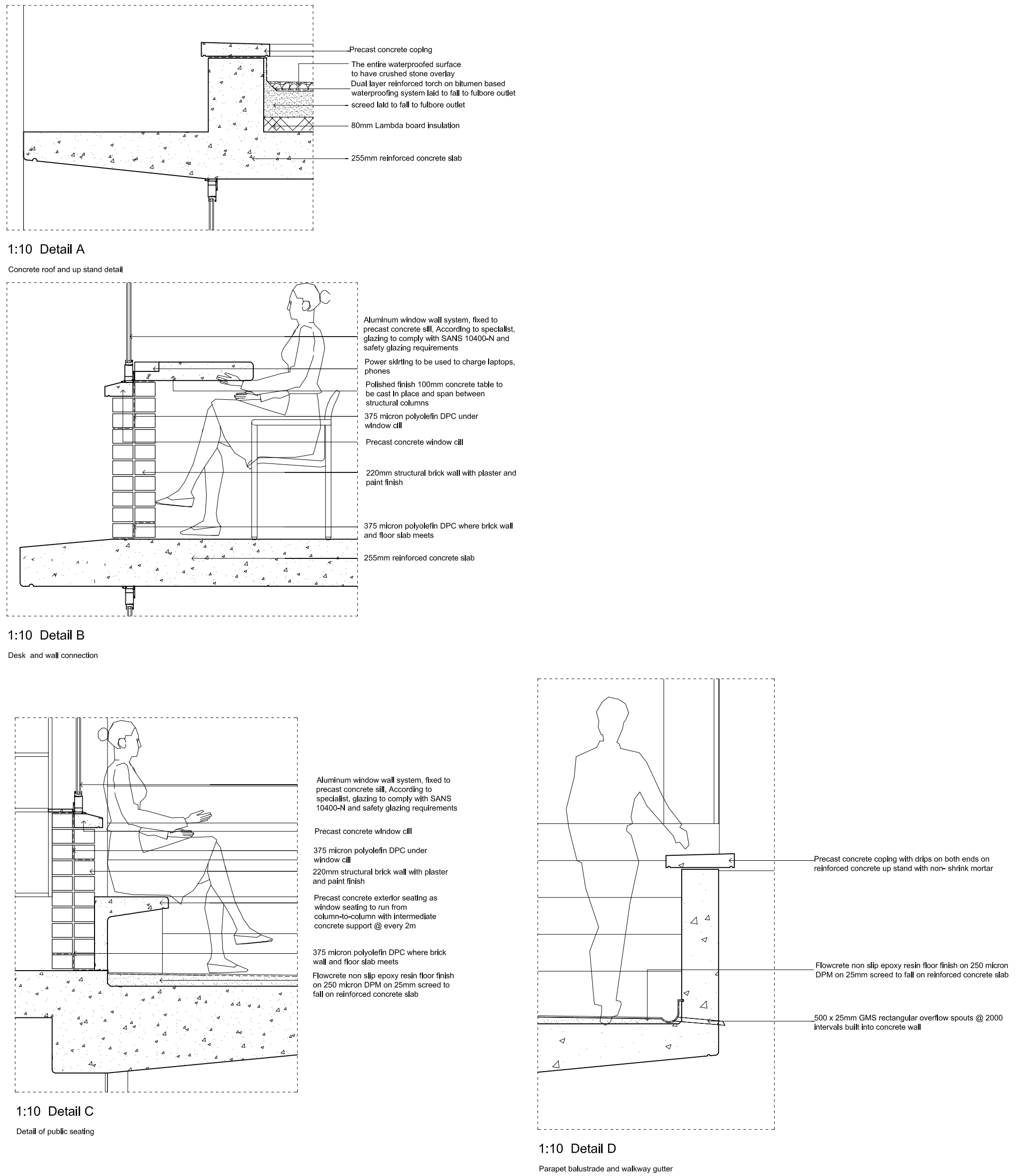


Fig 8.33 Details, Author (2016)

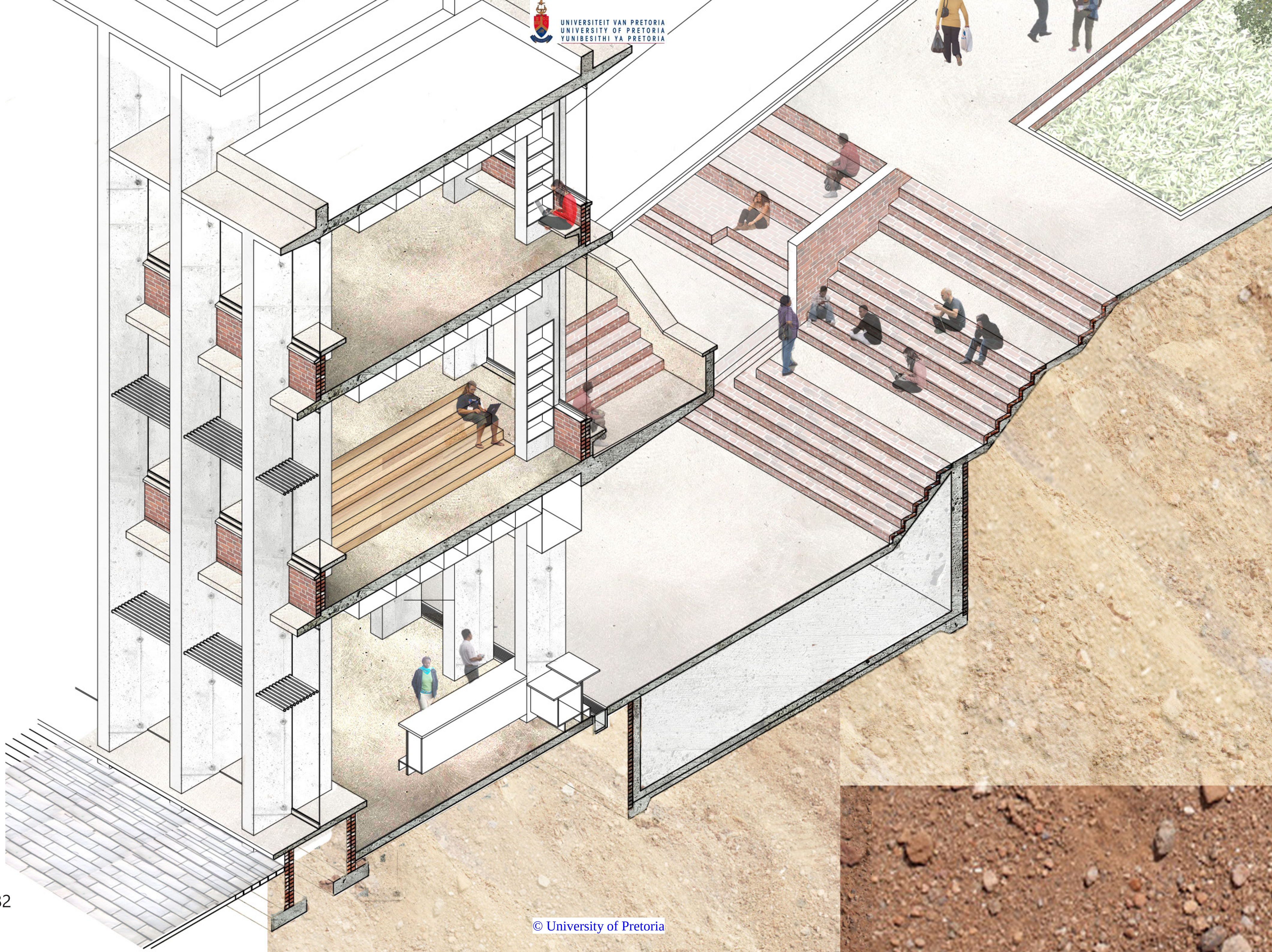


Fig 8.34 Axonometric of Resource Centre, Author (2016)

8.4 Environmental Considerations

Water Strategy

The water strategy includes collecting rainwater from roof surfaces, floor surfaces and planted roofs throughout the facility. The water is stored in an underground reservoir tank which is located at the lowest point of the site. The water located in the underground reservoir (2nd tank) tank is then pumped up to a smaller tank (3rd tank) located between the residential units which is used daily for portable use by the residents. The water from the underground reservoir (2nd tank) is also used in the kitchen and public ablutions in the facility. A reservoir tank (1st tank) is located on the main island and forms part of the greater urban vision. This tank mainly collects surface runoff from the broader urban surroundings. This underground reservoir tank serves as a backup water supply and when needed will pump water into the underground reservoir (2nd tank) tank on site and used accordingly.

It is proposed that low consumption fittings and appliances be used to reduce the volume of water used.

The rain water is pre-filtered through various means of filters (gutter screen, downspout) which helps reduce the sediment backup as well as smells (rainhar-vest.co.za) . A biological filter purification system is then used to purify the rain water that is collected. The water is purified by means of a biosand purification filter (rainharvest.co.za) that is located next to the second underground storage tank. The rain water, and water collected from the first tank goes though the biosand filter before being collected in the second tank. The uncontaminated water is then used on site and pumped up to third tank.

Grey water from the hand basins is stored under the basins and used to flush the toilets. The excess grey water (kitchen) is diverted and contained underground (in the same basement as the second tank is located) from which it is filtered through a sand filter and then used for irrigation purposes. Fat traps need to be installed in all drains in order to trap the fats (soap, food) that cause the water to smell and negatively affect the vegetation it is used to water (rainharvest.co.za) .

Water calculations:

(gauge.co.za)

Rainwater harvesting capacity: Roof: 745 m2x 90% = 670.5 m2
Paving: 961 m2 x 80%= 770 m2 lawn: 772 m2 x 10%= 72 m2
Total catchment area: 1513 m2
Annual rainfall: 573mm x 1513 m2 = 870 000 L

Grey water:
150L + 280L + 400 = 830 L per day
Toilets require 450 L of the grey water per day.

Rain water harvesting tanks:
Required capacity: No. of month low/no rainfall: 5 x 38 400 = 192 000 L
(2): Tank size = 8m x 8m x 2m
(3): Tank size= 4mx4mx3m

Water consumption:

Water consumption device	Water consumption (L)	No. of uses per day	Water consumption (L)
Flush toilet	9	50	450
Hand basins	3	50	150
Shower	40	7	280
Washing/ cleaning	20	20	400
		Consumption per day	1280
		Consumption per month	38 400

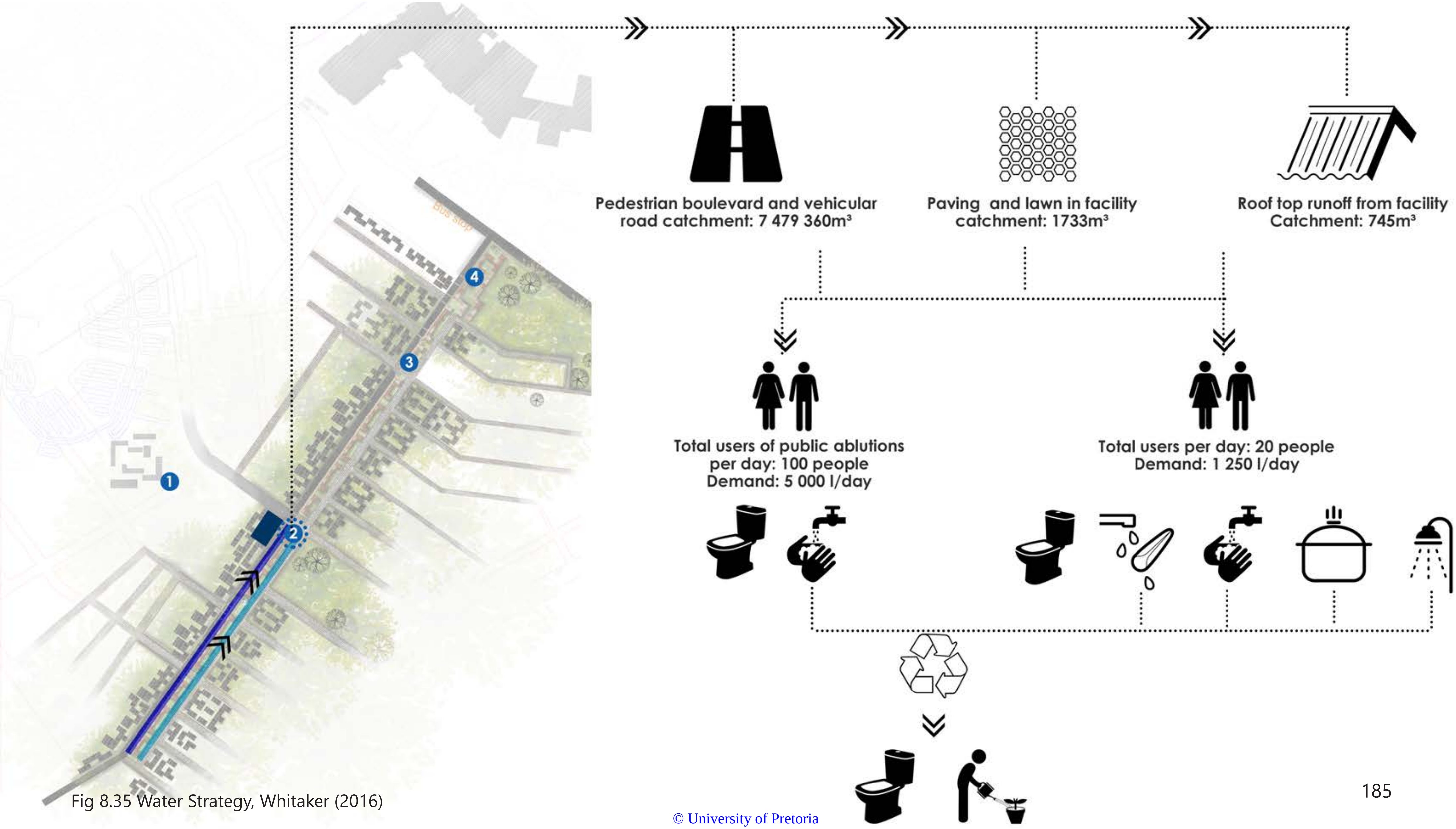


Fig 8.35 Water Strategy, Whitaker (2016)

On site

Fig 8.36 Water strategy, Diagrams, Author (2016)

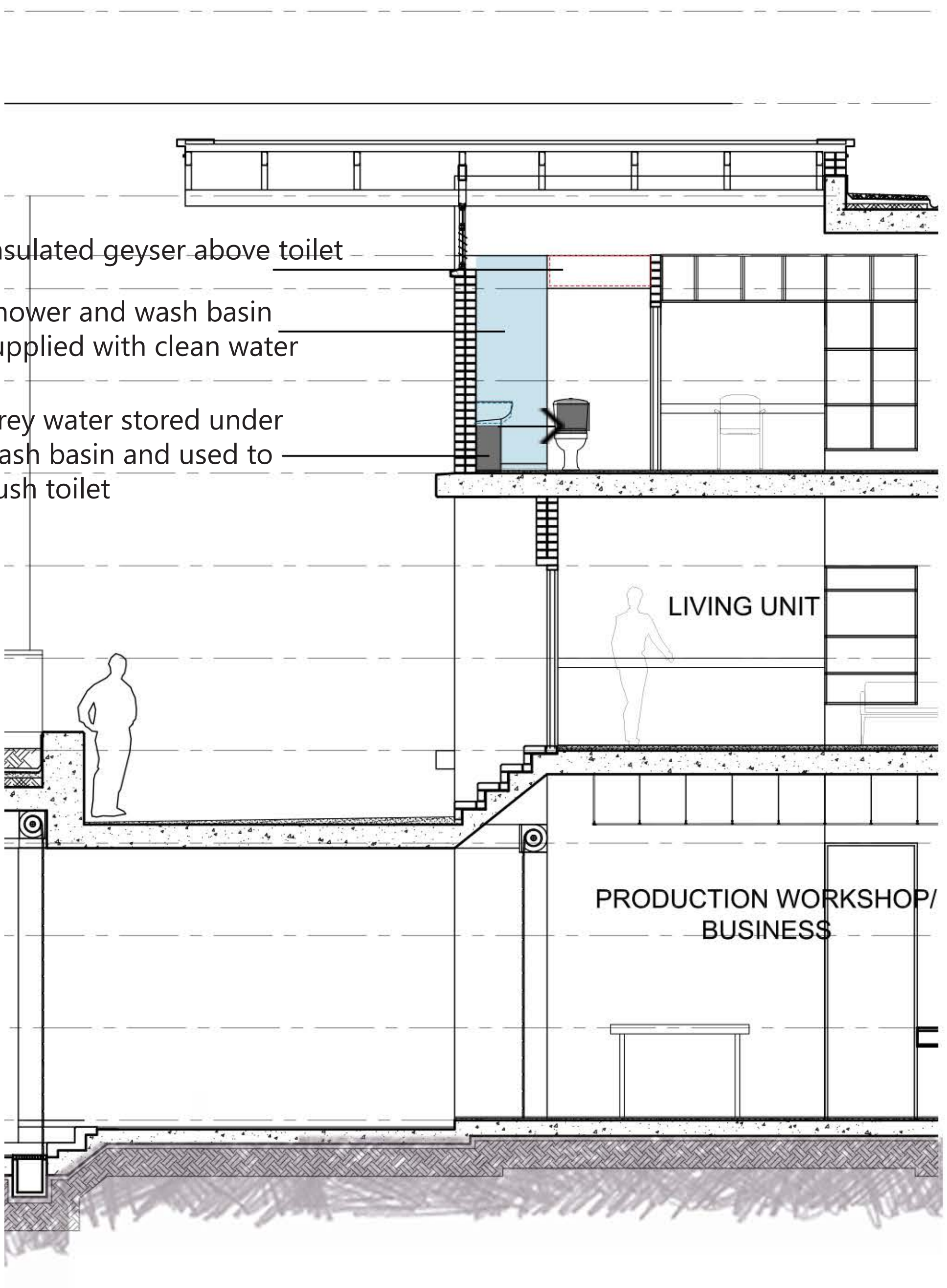


Fig 8.37 Section through accommodation unit highlighting grey water strategy, Author (2016)

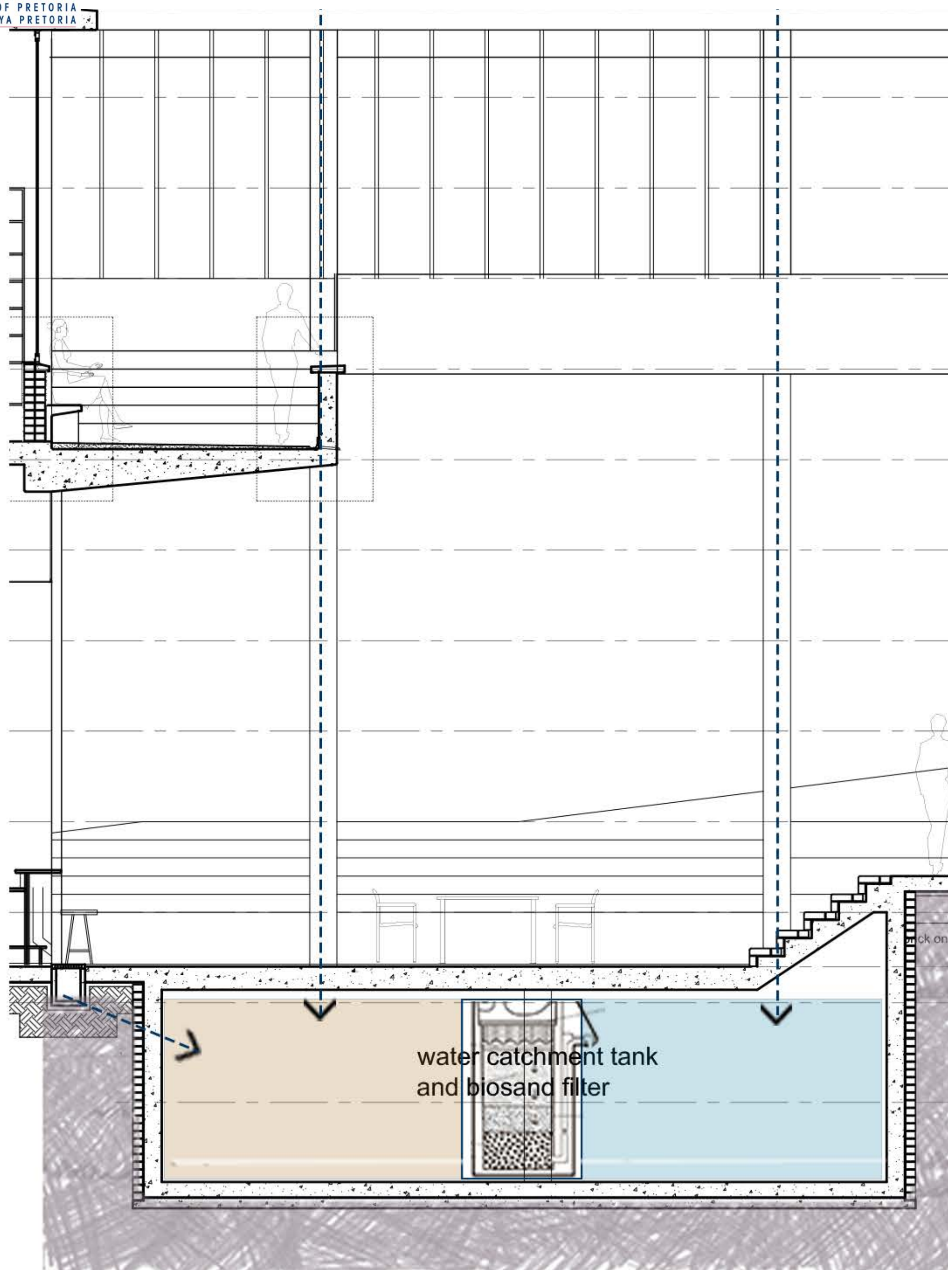


Fig 8.38 Section through underground water catchment tank, Author (2016)

Biosand filter: practicalaction.org/image/bio-sand-filter-technical-plan.jpg

Energy Strategy

A biodigester is a self-sustaining alternative energy generating process that allows the users to reduce their dependency on grid electricity. Biodigesters decompose organic material in an anaerobic process, meaning that it is a closed system that doesn't need oxygen for the process to occur. The anaerobic process produces methane and carbon dioxide known as biogas. The biogas is then converted, by means of a methane generator, to electricity for lighting and the heat energy for heating of water (Src.sk.ca 2015) (Simgas 2015).

The Biodigester is located on the main island and forms part of the greater urban vision which suggests that three biodigesters are located along the main island, providing alternative energy to the three projects on site.

The biodigester is stored under the main boulevard where it is able to be accessed for maintenance purposes. It is a closed system and therefore smells are only an issue when the biodigester is opened.

Calculations:

(Mukumba. J, Makaka. G, et al. 2013: 12-21)

Total electricity demand a day: 253 kwh
Manure: 500 (amount of people use ablutions per day) x 0.7 = 0.35 m3
Urine: 500 x 1 = 0,5 m3
Kitchen: 0.404 m3

Total waste produced daily: 1,254 m3 per day
Kitchen: 0.5 x 0.404 = 20.2 m3
Manure: 350 x 0.078 = 27 m3

Total gas produced daily: 47.5 m3
If 1m3 of gas gives you 9 kwh:
Total energy produced per day: 47.5 x 9 = 427.5 kwh
Thermal energy 60% = 258 kwh
Mechanical energy 40% = 172 kwh

Grid electricity needed: 253-172= 81 kwh per day
Tank size (7 x 7 x 2m)
Because waste is wet 1:1 ratio, volume of daily waste: 2,508 x 40 = 100 m3

The facility would receive 172 kwh a day of usable energy from the biodigester. A total of 253 kwh per day of electricity is needed to run the facility therefore the biodigester will not be able to meet the full energy requirements of the facility but does contribute extensively to the facilities dependency on grid electricity.

Urban Framework

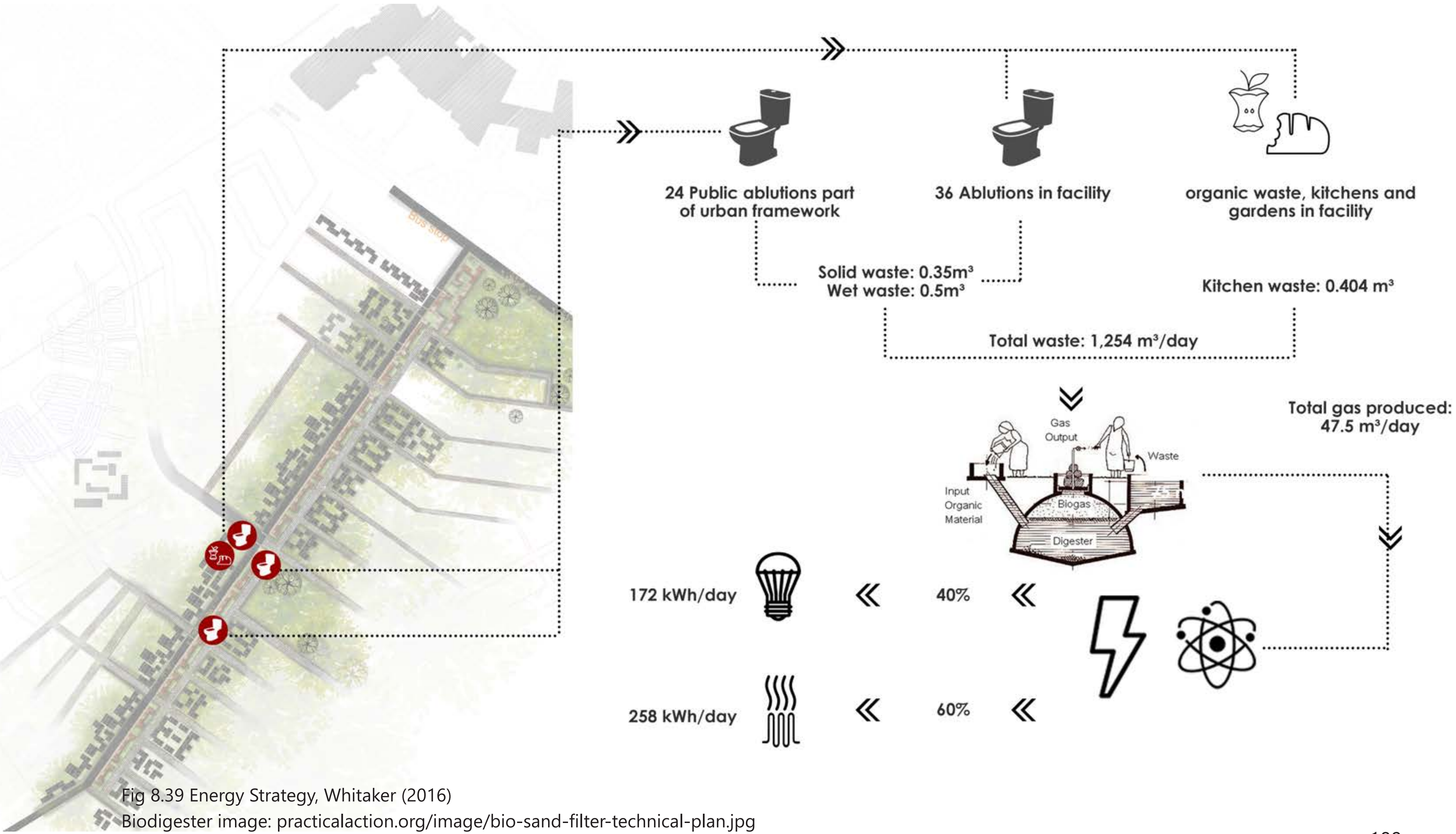
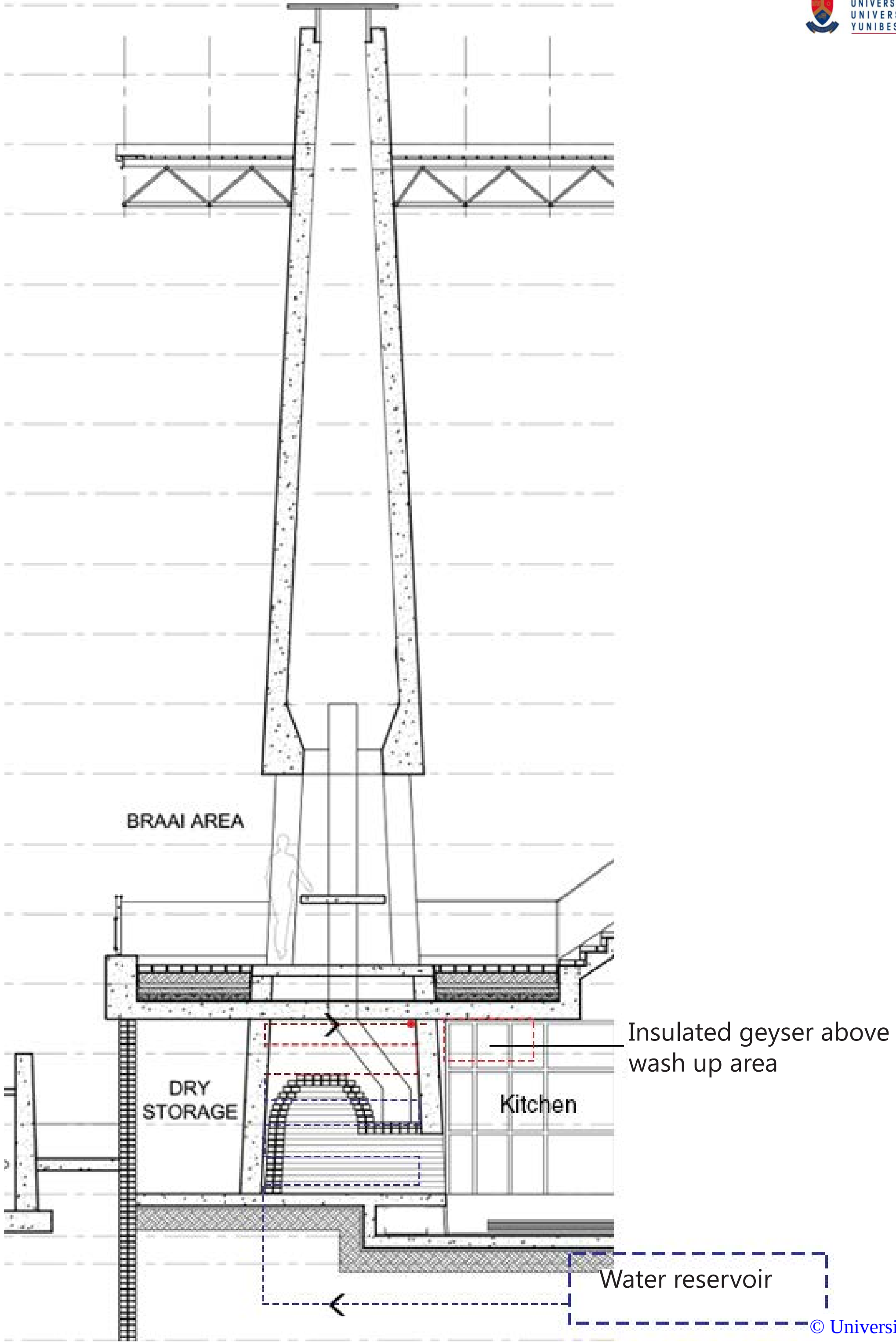


Fig 8.39 Energy Strategy, Whitaker (2016)
Biodigester image: practicalaction.org/image/bio-sand-filter-technical-plan.jpg

On site

Fig 8.40 Energy strategy, Diagrams, Author (2016)



Heating water by means of the furnace

Purified water, that is collected and stored in underground reservoir tanks, is pumped through copper coils, the coils are heated by the fire of the pizza oven and stored in insulated geysers. This water can then be used in the kitchen for cooking, washing of dishes and cleaning.

This method of heating water is an alternative option to heating water by means of the biodigester which can use up to 258 kwh of energy per day to heat water through thermal energy.

Accommodation: Solar geysers

Solar geysers offer an alternative means of heating water and decreasing the facilities dependency on grid electricity. A direct solar geyser system is used which pumps water into the solar panels which is heated and stored in an insulated geyser (sustainable.co.za).

Two solar geysers of 300 L each (ecosales.co.za) are situated on a concrete roof above the third water tank which supplies the accommodation units with water. The solar heater is used to warm the water needed in the accommodation units.

Fig 8.41 Section of furnace that heats water. Diagrams, Author (2016)

Natural Ventilation

Within Pretoria the windrose indicates a predominant North East to South East summer wind direction (Holm 1996:70).

Ventilation Strategy:

• Natural cross ventilation is the primary passive ventilation principles used in the design. Outside air movement and pressure difference is used to cool and ventilate the interior spaces. The interior spaces are mostly shaded with overhangs which allows the air to cool before entering the interior.

• Courtyard landscaping and green roofs help cool air down before entering the interior cross ventilated spaces.

• The principles of stack ventilation and wind are applied to the resource centre. The stack ventilation principle uses air pressure difference due to height to pull air through the building. The hot air rises, becoming lower in pressure as it heats which helps pull in air from lower in the building which is of a positive pressure (cooler) (Autodesk sustainability workshop 2016) . The atrium space is used and extended higher than the opposite roofs in order for a greater stack effect to occur. Air from both sides of the resource centre is pulled in and drawn through the atrium space which is located in the middle, therefore keeping all the spaces well ventilated. When Pretoria is windy the Bernoullis principle can help the stack effect as the difference in air speed helps move air through space. The extended atrium space is located on the NE corner (the windward side of the building) therefore the faster air on windy days will help pull air up and out of the building.

• Night purge ventilation is used to flush hot air out of the building and cool the thermal mass for the next day. The air is flushed by wind ventilation and stack ventilation by leaving the clerestory windows open on the highest floor.

(Autodesk sustainability workshop 2016)

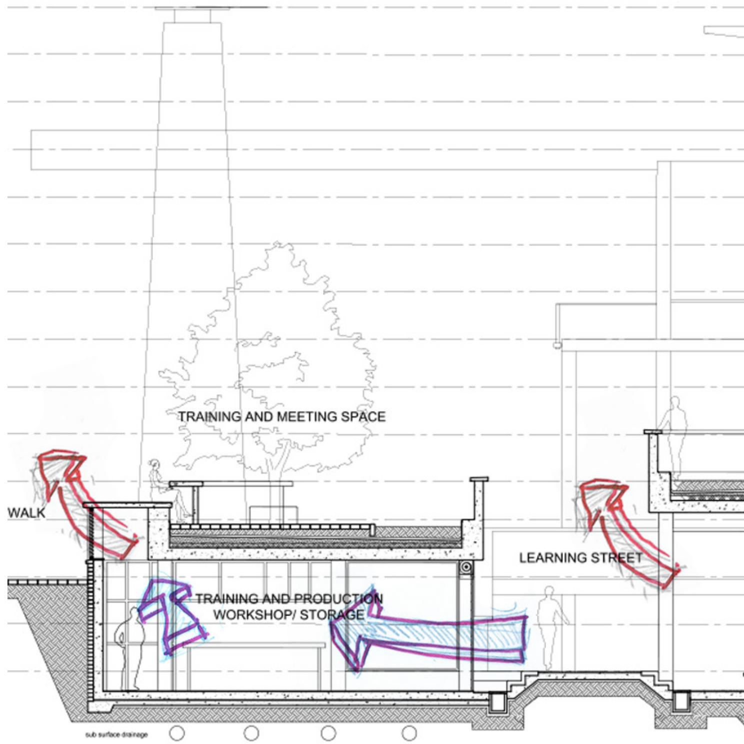


Fig 8.42 Section showing cross ventilation through workshops and accommodation. Diagrams, Author (2016)

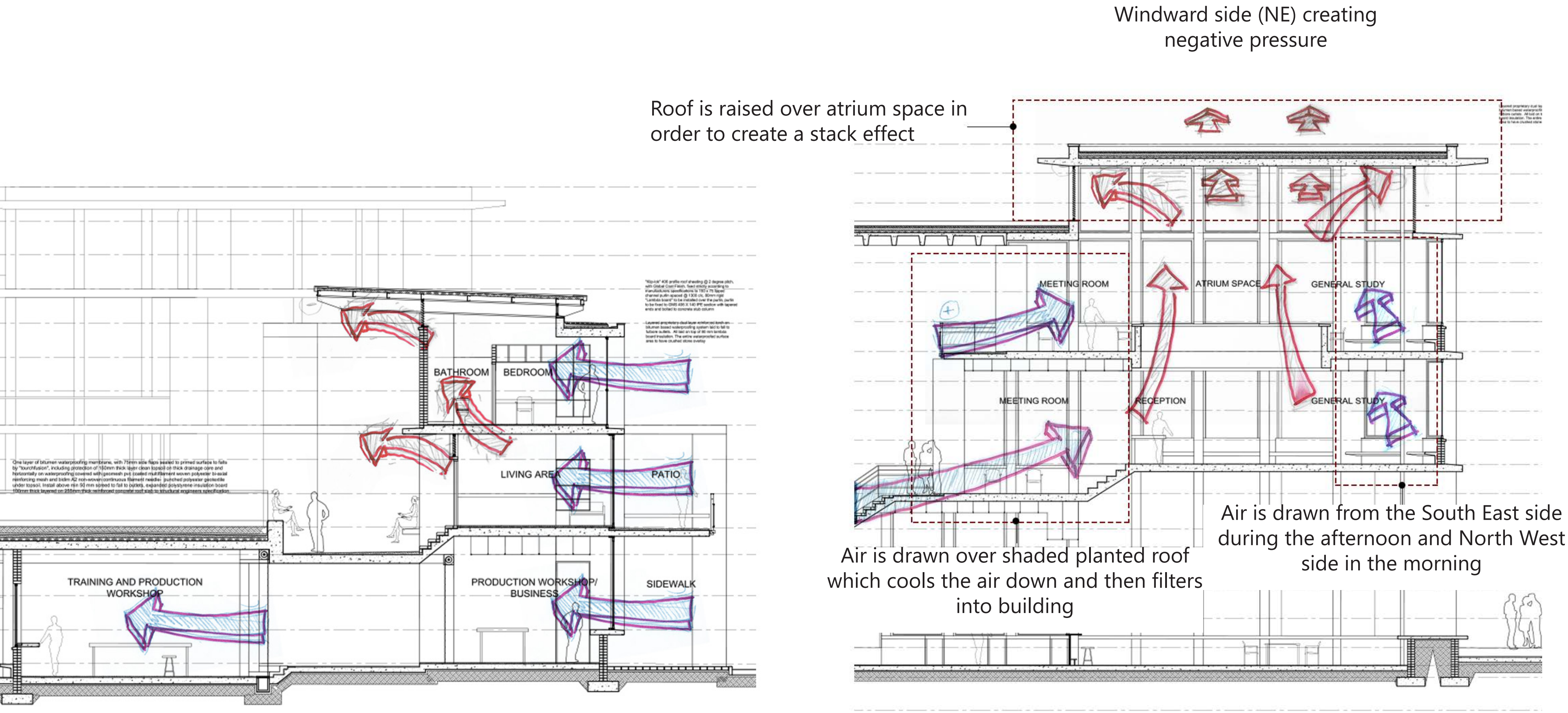


Fig 8.43 Section showing stack ventilation principles in the resource centre, Diagrams, Author (2016)

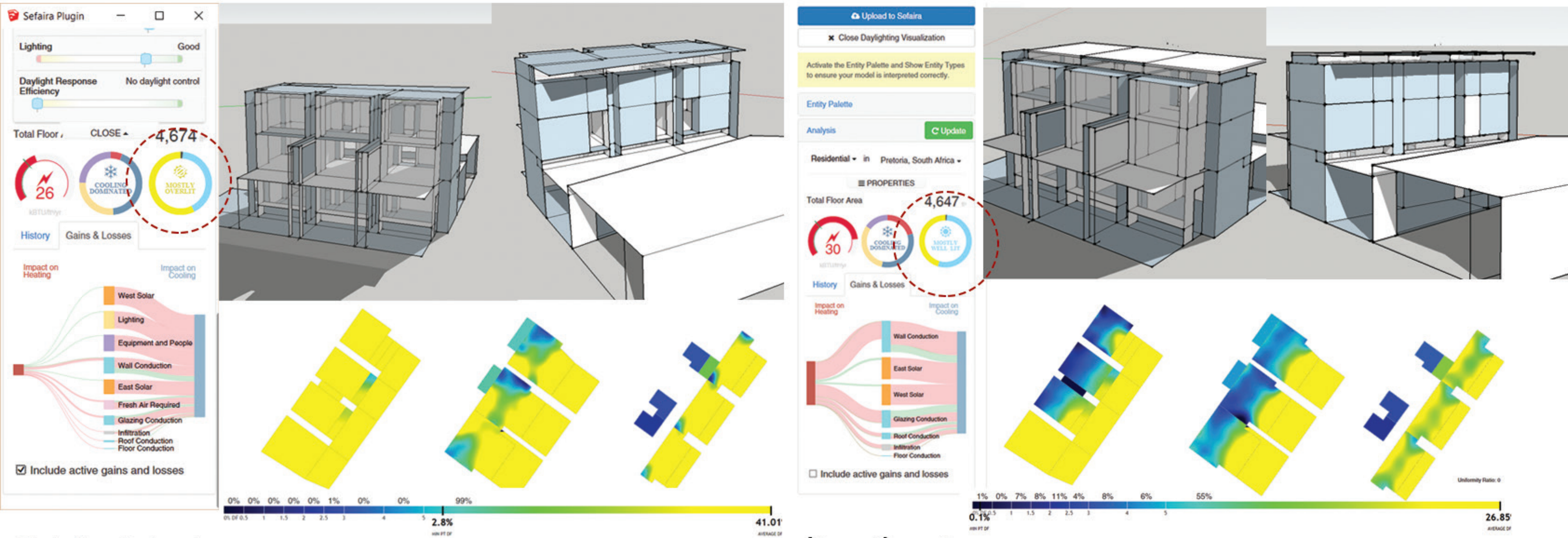
Sefaira® : accommodation units

Sefaria®, which is a performance based analysis, was used to pick up problem areas in the design. Sefaria® is used to measure interior daylight factors, the energy usage and whether or not it is a cool or heat dominated space. The accommodation units which face an undesired South East and North West angle were analysed further.

Daylight Factor:

Original Design: The spaces are mostly over lit with a daylight factor of over 5% in some of the internal spaces. The desired daylight factor for internal spaces is between 2-5%, anything more than 5% begins to cause glare (Sefaria 2016).
Containing heat in the accommodation units was of most concern and needed to be considered in the iteration.

Iteration: Design improvements were needed in order to decrease the interior daylight factor, this was done by minimizing the glazing and increasing the wall area and altering the roof condition which shades the unit more.
The spaces are shown to be well lit with a daylight factor of above 2 % and below 5%.



Original design

Iteration 1

Minimizing heat loss in winter:

In an attempt to minimize heat loss in winter the materials that lose heat due to conduction were targeted. The roof according to SANS 10400- XA (SANS10400.co.za 2016) needs a minimum R-value of 3,2 m2k/w in Pretoria, a concrete slab has a R-value of 0.4 m2k/w therefore additional insulation is needed that amounts to more than 2,85 m2k/w. A 80mm lambda board insulation with an R-value of 3,33 m2k/w was used which is more than the SANS requirements.

The heat lost due to conduction through glazing was minimized by recommending that uPVC window frames are installed as research suggests that the frames are more air tight than aluminum or timber frames (Mybuilder.com 2011) with U values as low as 3.2 W/m2k when using single low E glazing. Low E glazing is recommended as the coating minimizes heat gain and heat loss by reflecting the heat either back into the external or internal spaces.

And finally the floor conduction loss is minimized by introducing additional insulation. SANS 10400- XA (SANS10400.co.za 2016) states that a minimum floor R-value of 1 m2k/w is required, a 255mm concrete slab has a R-value of 0.17m2k/w, bearing in mind the unit is located on the first floor, additional insulation is needed. A 25mm Lambda board insulation with an R-value of 1,04 m2k/w is suggested.

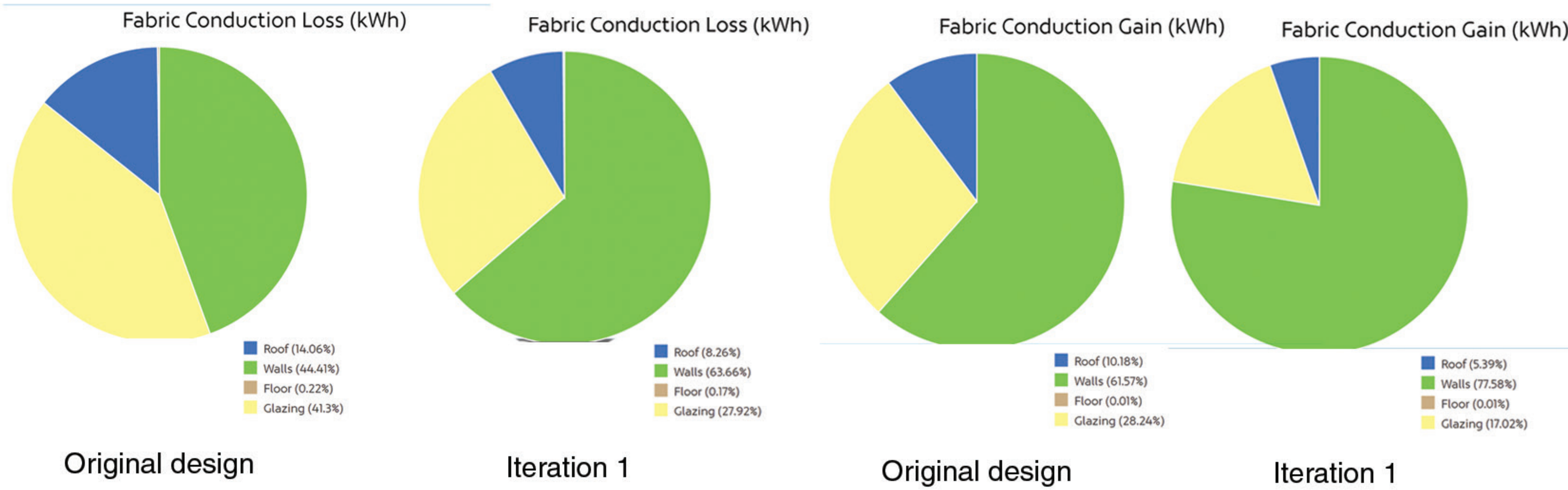


Fig 8.44 Sefaira analysis showing heat loss and gain, graph, sefaira.com (2016)

Fig 8.45 Sefaira analysis showing daylight factor, graph, sefaira.com (2016)

- Minimise roof conduction loss
SANS 10400: Min roof R-Value 3.2 m2K/W
Additional isulation needed min R= 2.85 m2K/W
80mm lambda board insulaiton used R= 3.33 m2K/W

- Minimise glazing conduction loss:
uPVC frames are used as they are more air tight than aluminium or timber frames.
low-E glass is used.

-Minimise floor conduction loss (on first and second floor):
SANS 10400: min floor R- value 1 m2K/W.
255mm concrete slab R= 0.17m2K/W.
Additional 25mm insulation (lambda board) R=1.04 m2K/W
Total R- value= 1.21 m2K/W

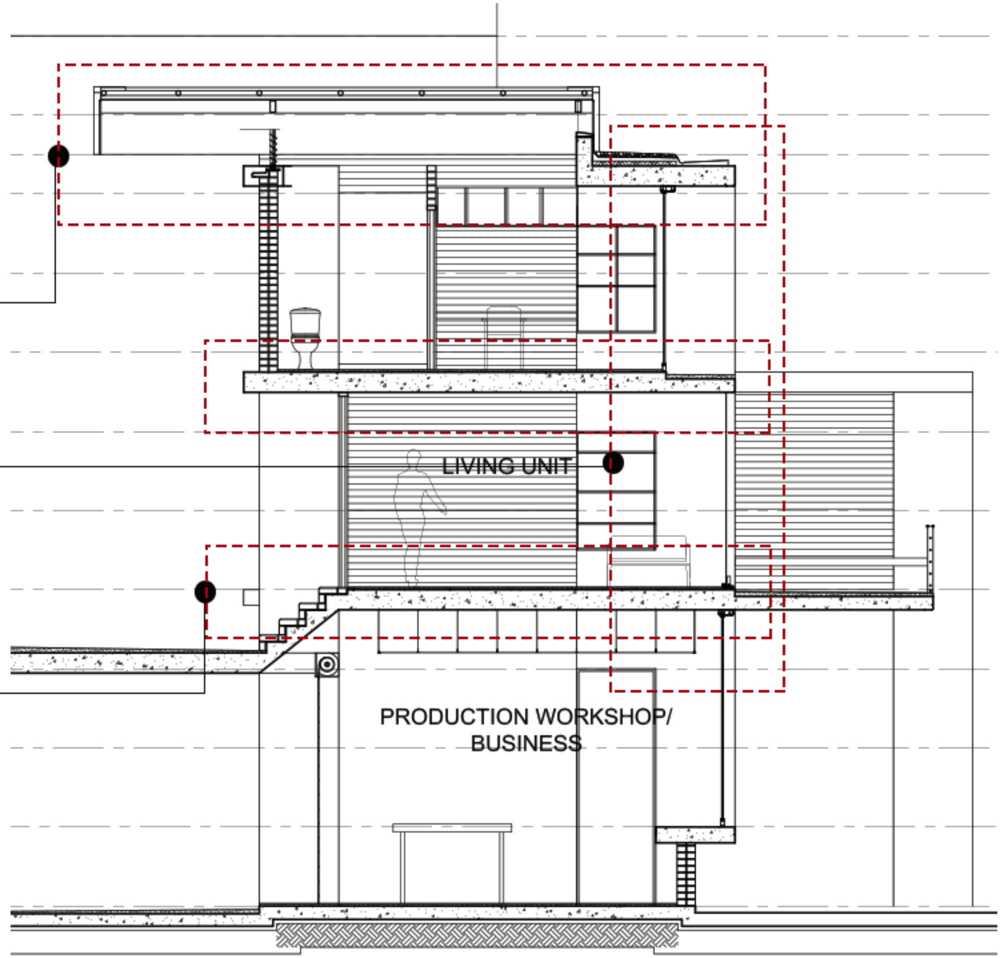


Fig 8.46 Sefaira analysis and material specifications, Section, sefaira.com (2016)

SUSTAINABLE BUILDING ASSESSMENT TOOL RESIDENTIAL
1.04

SBAT Building Saftey Assessment Tool

		Achieved
SB	**SBAT REPORT**	**4.4**

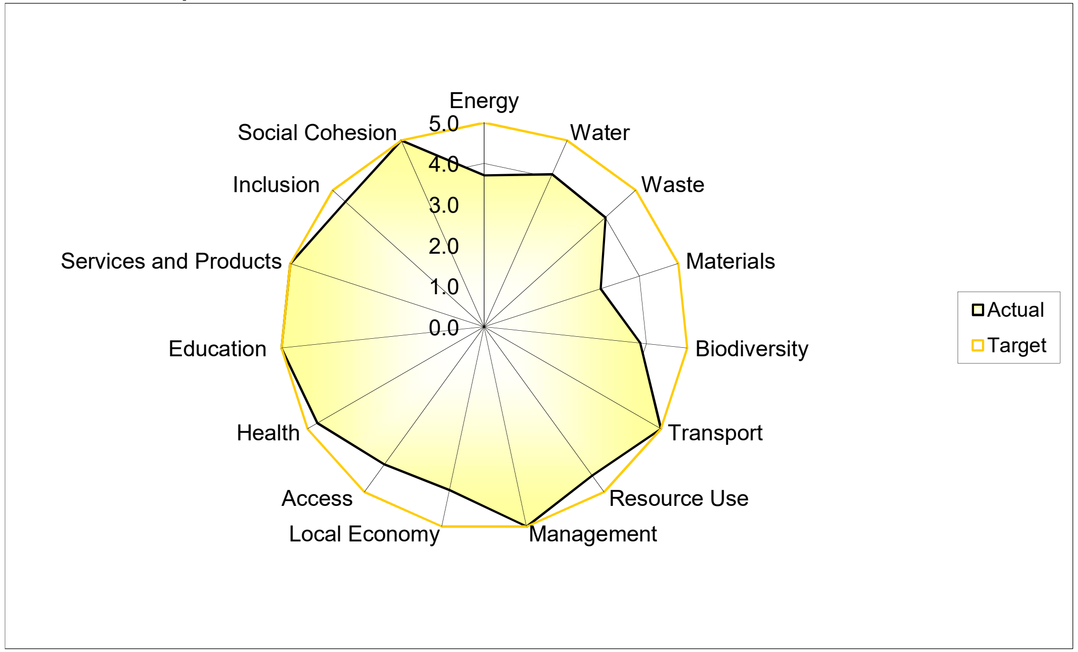
SB1 Project

Plastic View, Common Ground

SB2 Address

MoreletaPark

SB3 SBAT Graph



SB4 Environmental, Social and Economic Performance	Score
Environmental	3.7
Economic	4.6
Social	4.9
SBAT Rating	4.4

SB5 EF and HDI Factors	Score
EF Factor	4.2
HDI Factor	4.6

SB6 Targets	Percentage
Environmental	75
Economic	91
Social	97

Fig 8.47 SBAT Analysis, gauge.co.za (2016)