Chapter 8

Detail technical resolution

Figure 111 Closeup photograph of Livesey scrubber
Figure 112 Steel structure in Retort 2 interior
Figure 113 Livesey washer deconstructed envelope and piping exposed
Figure 114 Western entrance to Retort No 1

8.1.1 Material palette of the Gas Works

Figure 115 : CWG plant Eastern elevation with structure expressed in facade
Figure 116 Retort 1 western facade with brick-clad cross bracing expressed
Figure 117 Opening detail of Retort No 2 northern facade

8.1.2 Construction techniques and details

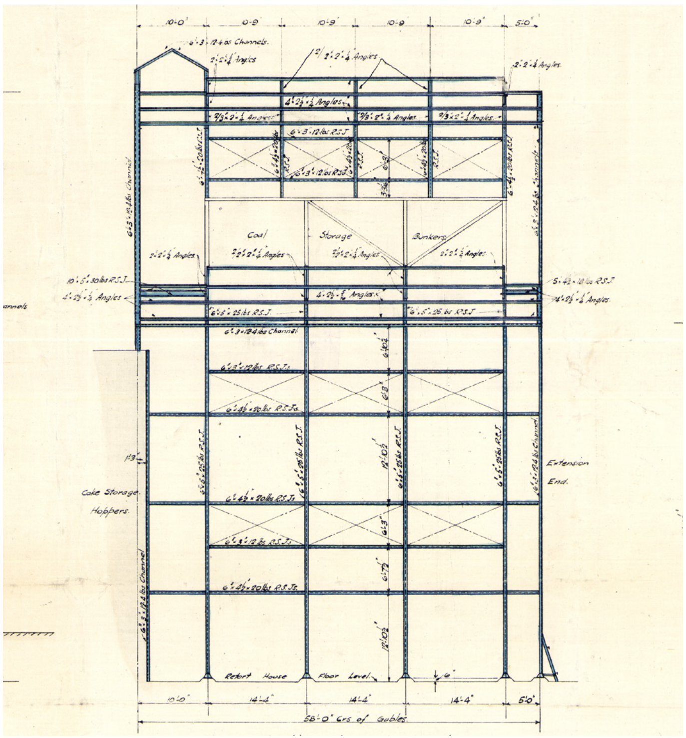


Figure 118 Steel structure of Retort No. 1

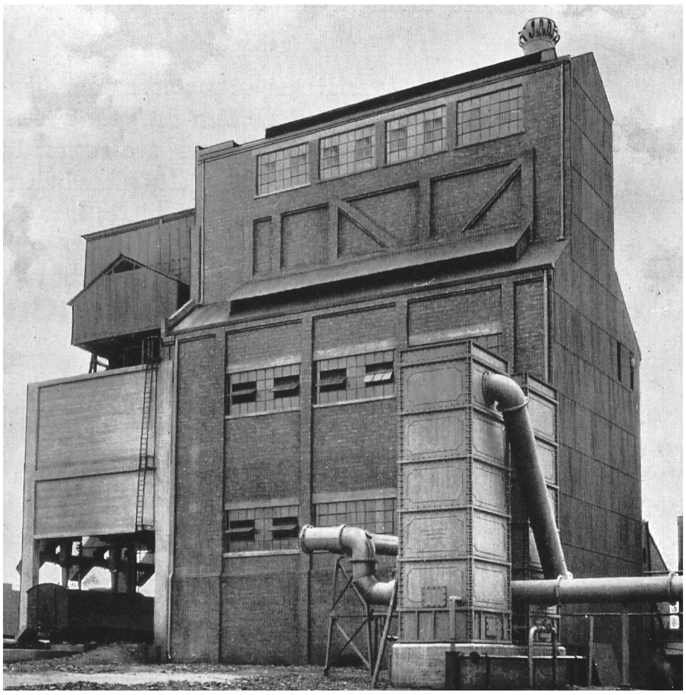


Figure 119 South-eastern facade of Retort No. 1

Before deciding on a technological concept to resolve the construction methods employed, a thorough understanding of the construction technology used on the Gasworks site is necessary. In a scheme that seeks to respond to heritage, the materiality, scale and construction need to be resolved in such a way that the uniqueness, the Genius Loci of the site is maintained whilst still standing apart as a response or a "translation" into contemporary architecture.

The most iconic buildings on the Gasworks site, the no. 1 and 2 retorts, offer a helpful understanding of how construction was used to embody the requirements of the coal to gas process. Since the process of coal burning and gas extraction required great height, steel construction was used to make the frame or skeleton of both retort buildings. Brick was used merely as an infill or envelope around the frame and it was done in such a way that the structural frame expressed itself in the facade - albeit more in the case in Retort No. 1.

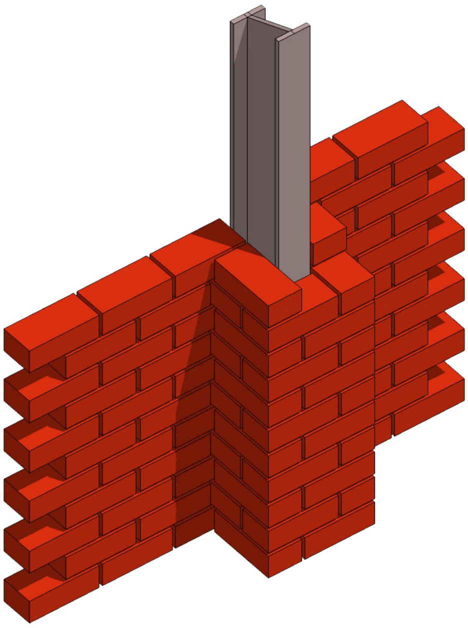


Figure 120 3D diagram illustrating facade detailing of Retort no. 1 & 2.

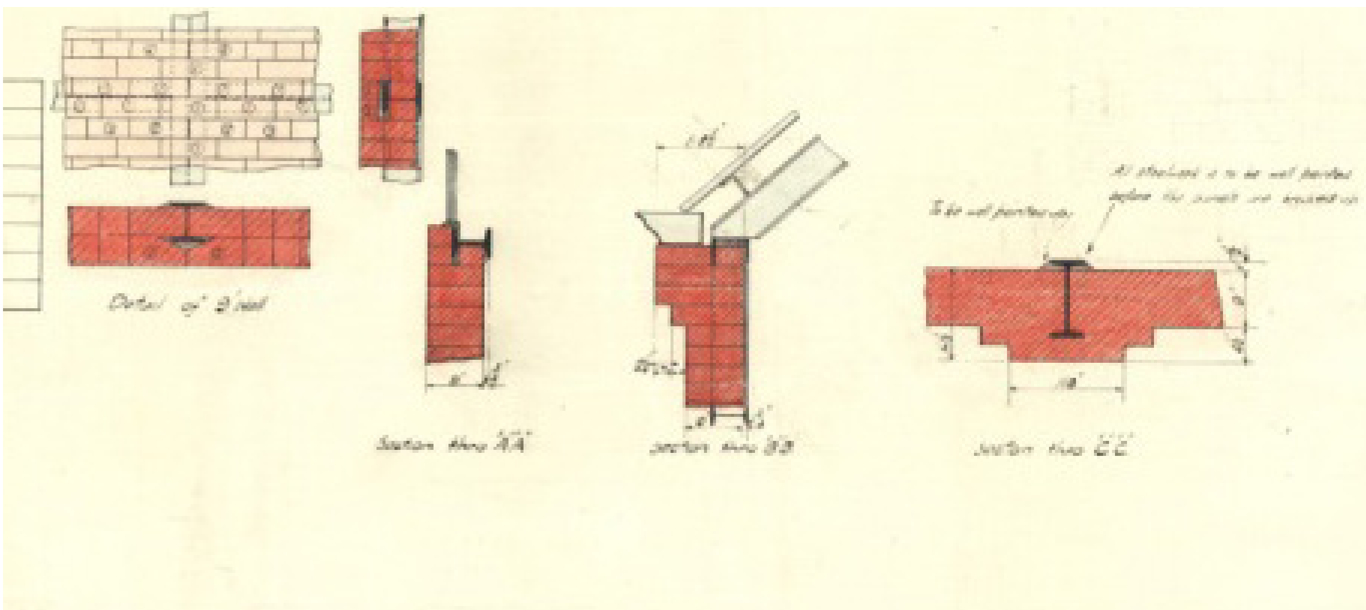


Figure 121 Steel and concrete junctions of Retort No. 1 (Lauferts le Roux & Mavunganidze 2016: 21)

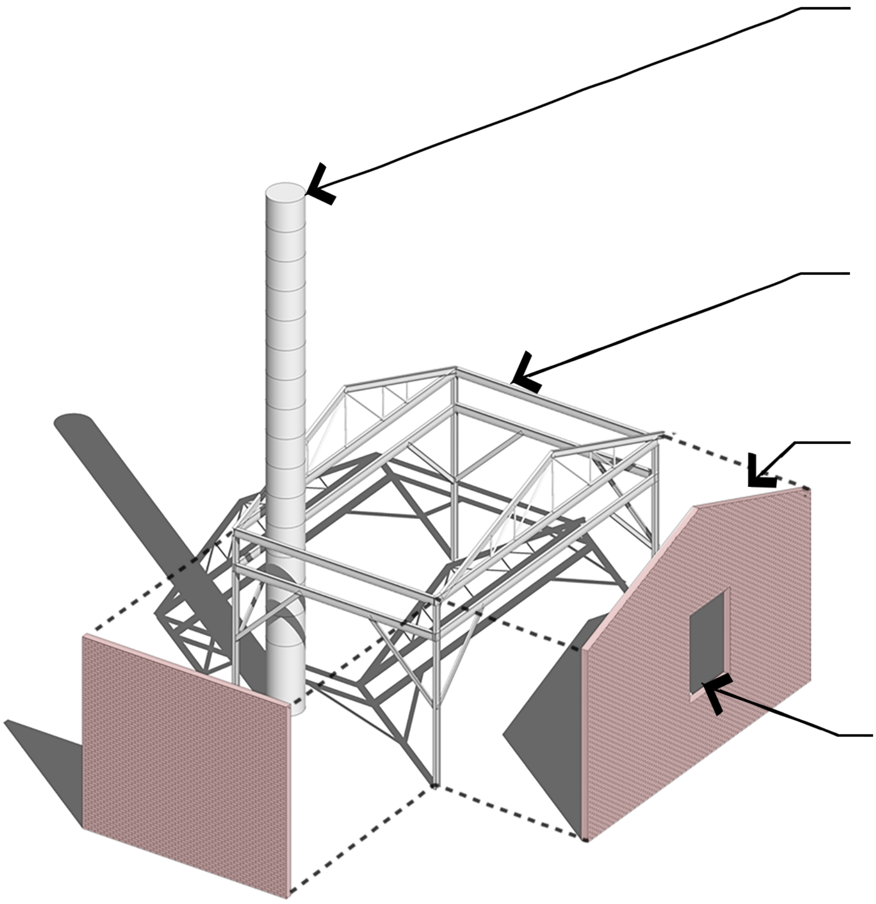
8.1.3 Translating heritage elements into design

Figure 122 Concrete detailing around openings and structural expression (Photograph by Author, 2017)

Figure 123 Chimney towers, the relationship between openings and structure (Photograph by Author, 2017)

Figure 124 Brick eave detailing (Photograph by Author, 2017)

Figure 125 Chimney flues of Retort 1 (Photograph by Author, 2017)



Verticality of the chimneys

Chimneys are an integral part of the function and architecture of the Retort buildings and offer cues for the design of pragmatic elements such as solar assisted stacks in newly built interventions.

Expression of structure

Make the structural system evident in particular elevations

Alternative brickwork as cladding

The typical stretcher bond seen in the brick heritage buildings adds a certain rigidity to the elevation. It was prioritised to employ alternative brick shapes and bonds to make a distinction between the nature of the old and new industries

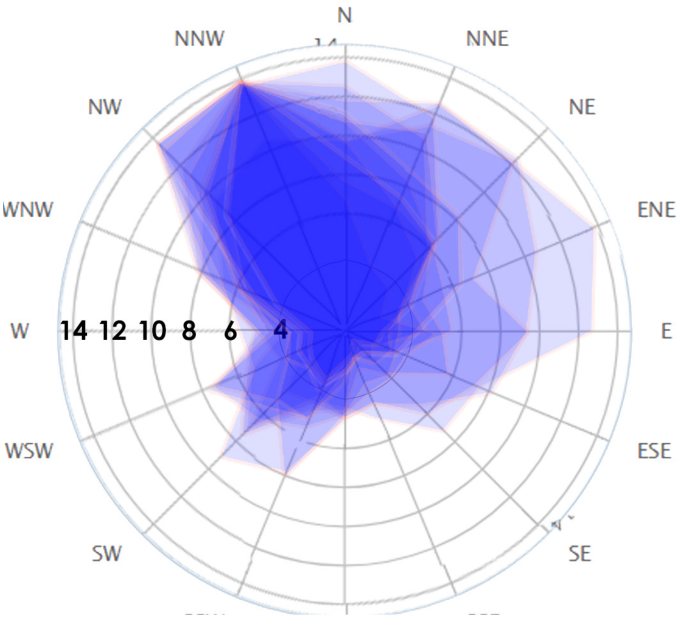
Particular details

Paying respect to specific details such as eave details, roof details, window sill and lintel details seeks to tie new built interventions to heritage buildings more succesfully.

Figure 126 Construction elements of Gas Works site deconstructed (Author, 2017)

Below: **Figure 127** Wind direction distribution of Johannesburg showing 12 month overlaid. Image sourced from

8.2 Climatic analysis



Conclusions

Following the climatic analysis of the site it was found that in the detail technical resolution stage of design development north-northwestern wind would have to controlled since a significant access route and recreational open space (water park) was aligned according to this direction.

Johannesburg is located within the cold interior climatic zone of South Africa (SANS10 400-XA:2011). This, coupled with the fact that building No. 2 (northernmost on Figure 130) has a large excavated services floor, the main passive strategy employed for both buildings was passive ventilation through Trombe assisted stacks and geothermal piping.

Figure 128 Summer solstice shadow paths

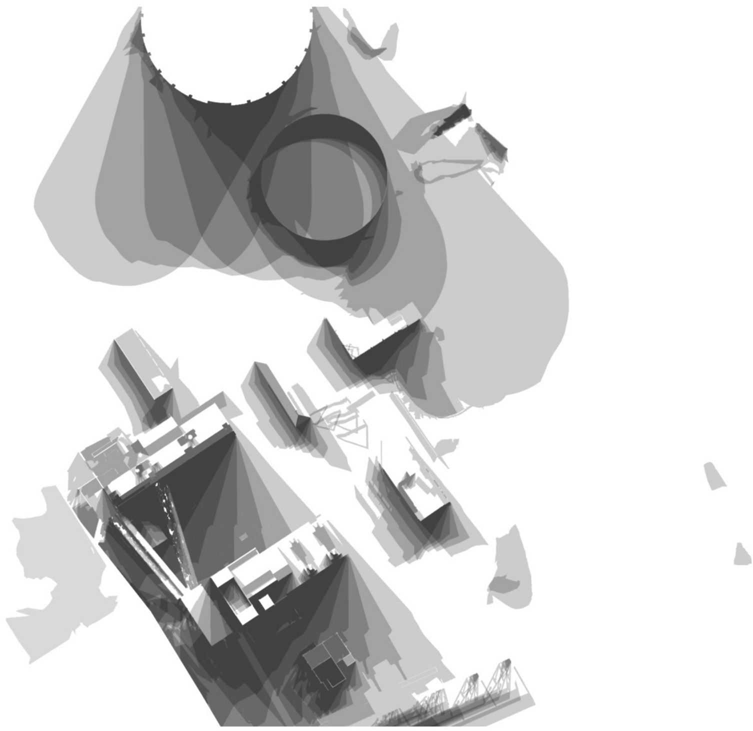
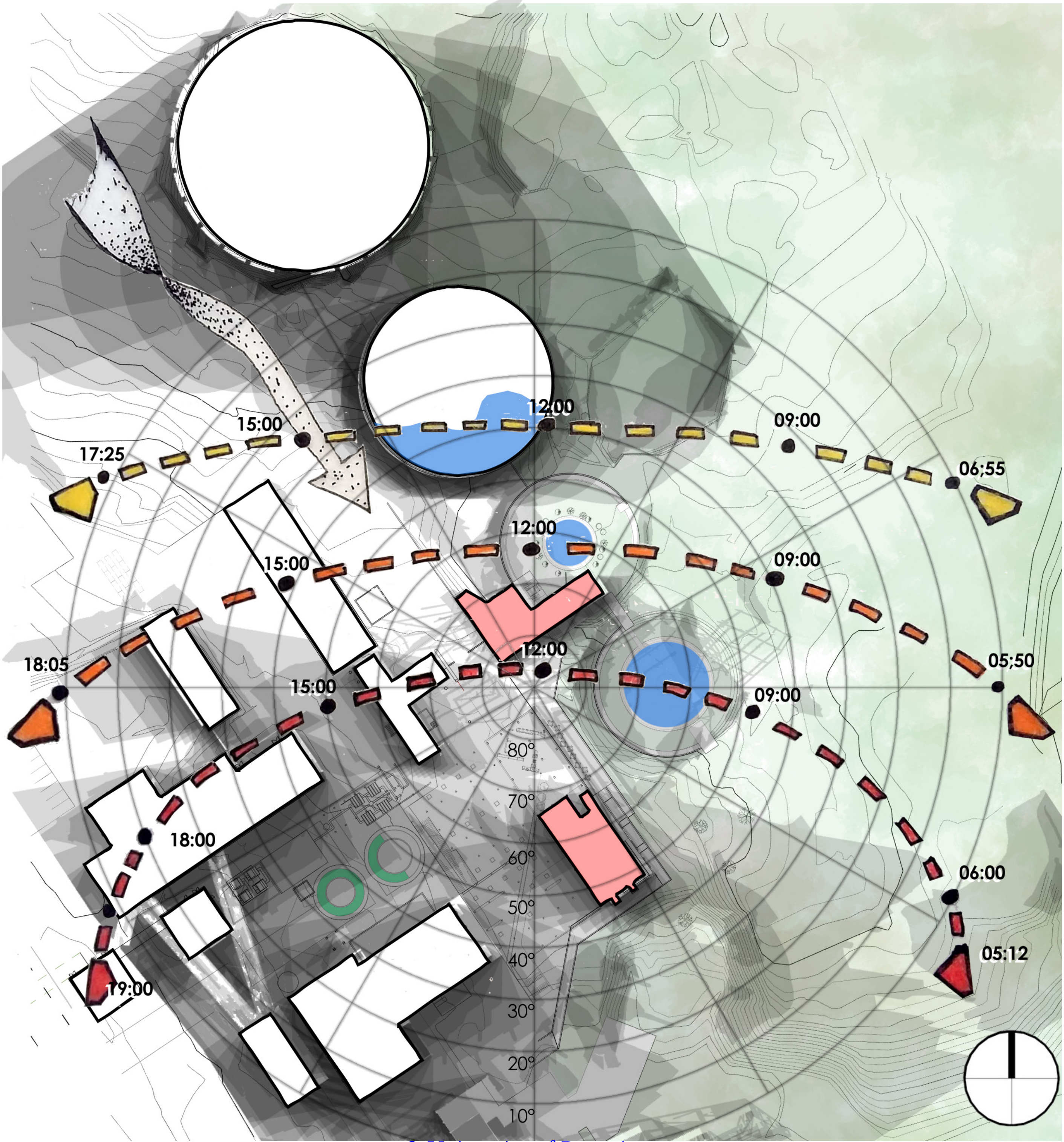


Figure 129 Winter solstice shadow paths

Below: **Figure 130** Climatic analysis with September solstice shadow paths



Right: **Figure 131** Structural system of Building 1 (Author, 2017)
Below: **Figure 132** Reference plan for building 1 (Author, 2017)

8.3.1 Structural system Building 1

Structural system

For Building 1, it was decided that the structural system should follow the same spacing as the purification plant ruins, which are spaced 5,3m apart longitudinally. Structural steel is employed for the primary and secondary structure and brick as skin in order to employ the same construction method as used in the Retort buildings.

Permanent shuttering floor

Bond-dek permanent shuttering is used in the construction of the first floor and roof slabs. This is an economical options since this product can span 3m unsupported under wet concrete (saving on props) and it eliminates the need for reinforcing.

Primary structure

Secondary structure

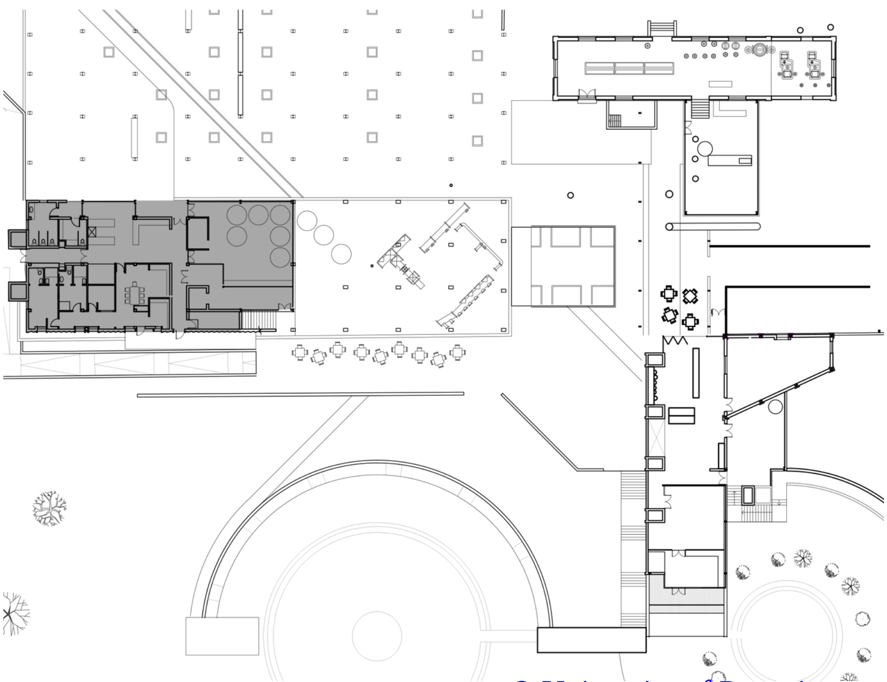
Floors and Roofs

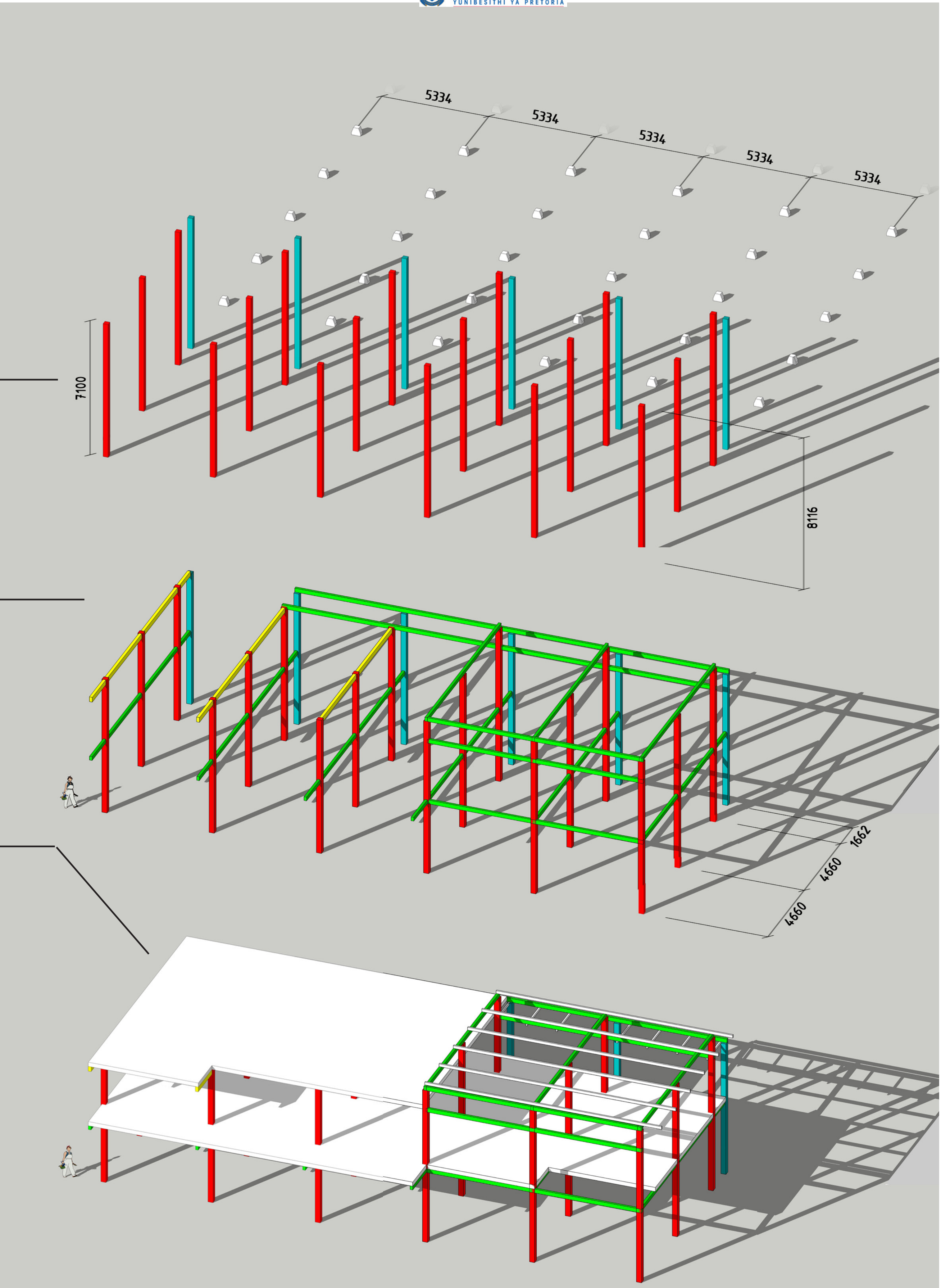
254x254 steel H-columns

203x203 steel H-columns

203x133 steel I-sections

254x146 steel I-sections




5334
5334
5334
5334
5334
7100
8116
1662
4660
4660

Right: **Figure 133** Structural system of Building 2(Author, 2017)
Below: **Figure 134** Reference plan for building 2(Author, 2017)

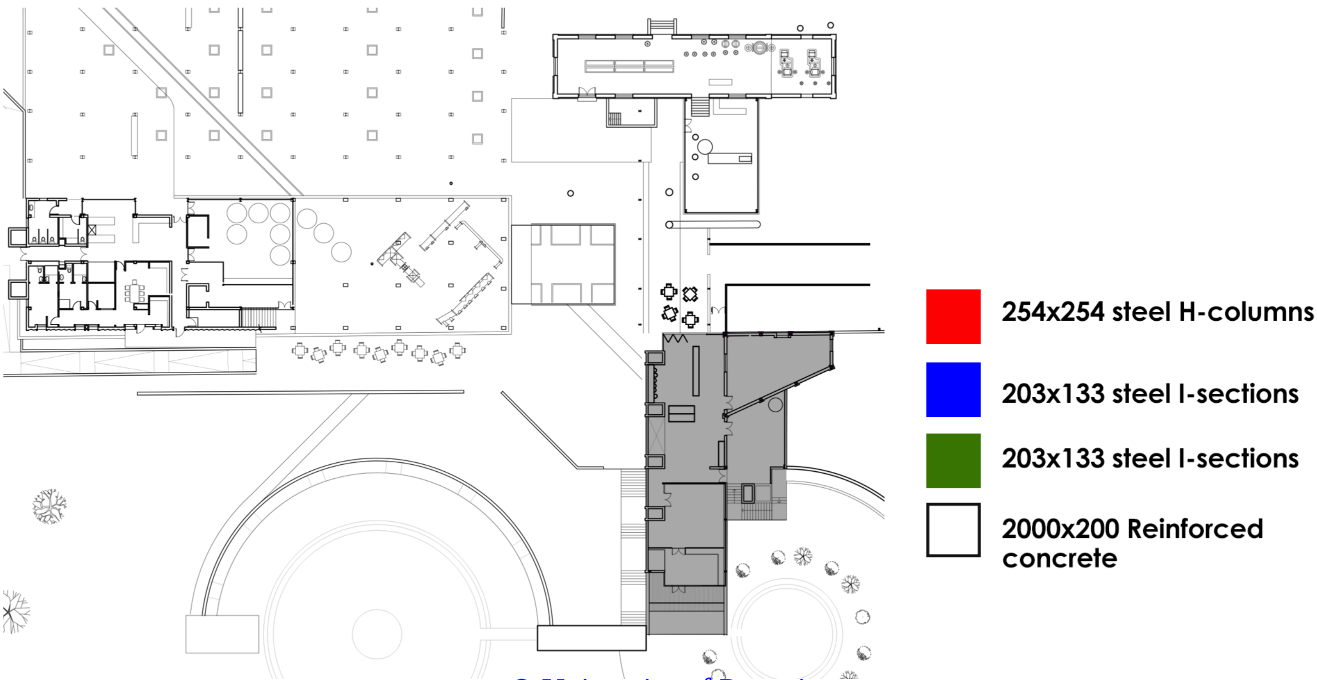
8.3.2 Structural system Building 2

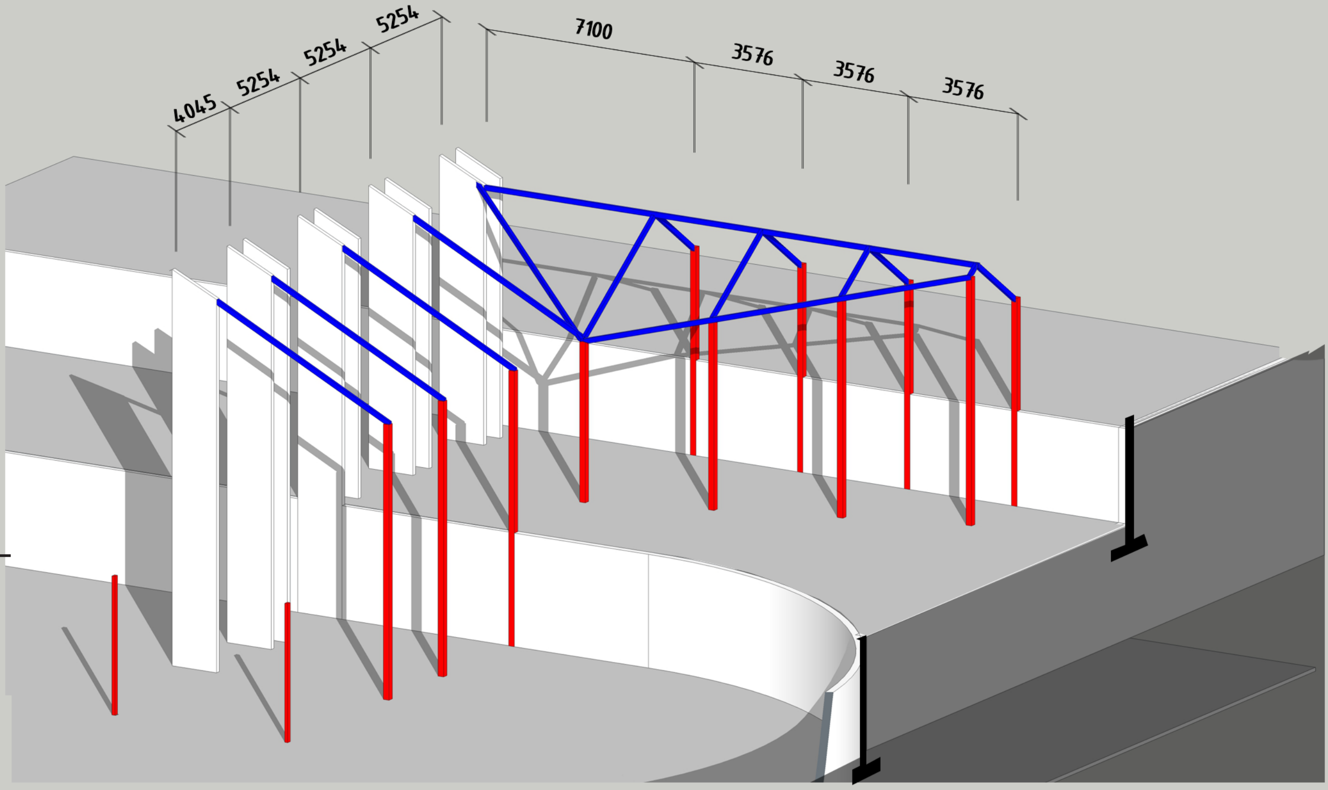
Structural system

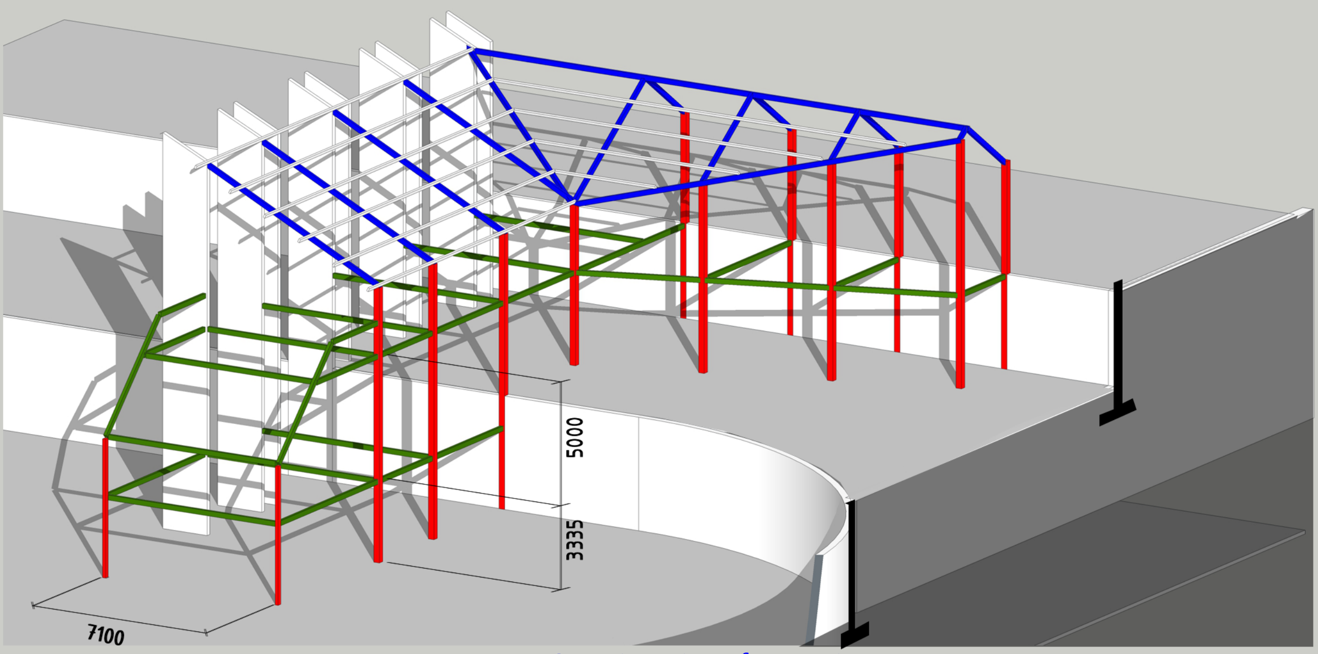
Building 2's structural system is a series of portal frames supported in some instances by 2000x200mm concrete columns, which form part of the passive ventilation strategy explained later. Steel construction also enables the building to be lifted from the ground where the building overlaps with the gas tank hole within which it partially sits. The building also makes use of permanent shuttering for reasons mentioned in Building 1's explanation.

Primary structure

Secondary structure



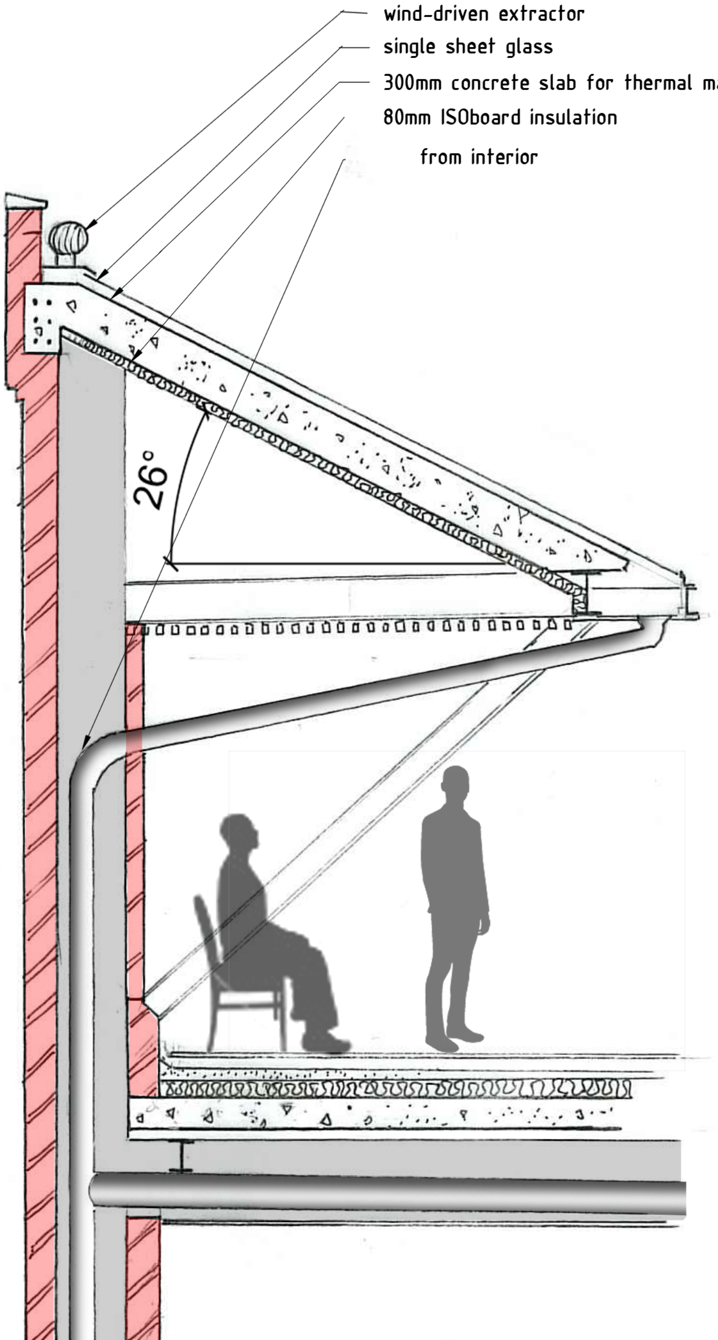

4045
5254
5254
5254
7100
3576
3576
3576


5000
3335
7100

Below: **Figure 135** Trombe wall detail at scale 1 to 50.

Right: **Figure 136** North-eastern elevation showing continuity between Trombe wall and external stair in elevation at scales 1 to 200 and 1 to 100

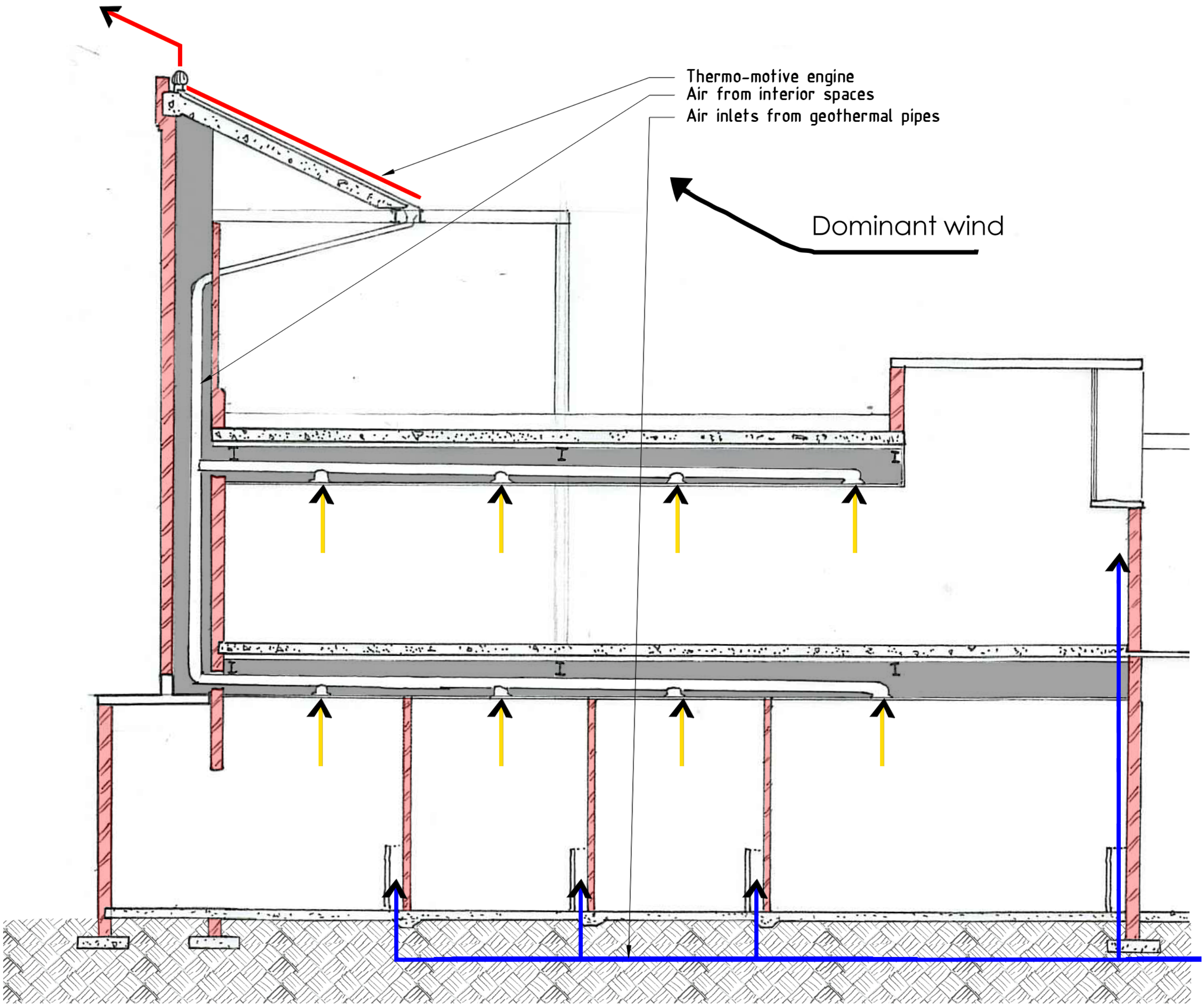
8.4.1 Passive ventilation Building 1



Trombe assisted stack

As can be seen in Figure 136, the Trombe assisted stack fulfills the practical role of drawing stale air out of the building and the aesthetic purpose of continuing and ending the diagonal geometry initiated by the stair. This aesthetic aim is especially successful when employed at a sufficient height to form an overhang for a bench as can be seen in Figure 135

The Trombe wall is slanted to an angle of 26° since solar radiation would be optimized if the system is tilted to the same angle as the latitude of the location of the building. Geothermal pipes installed under the building will supply the interior space with air at a moderate temperature.

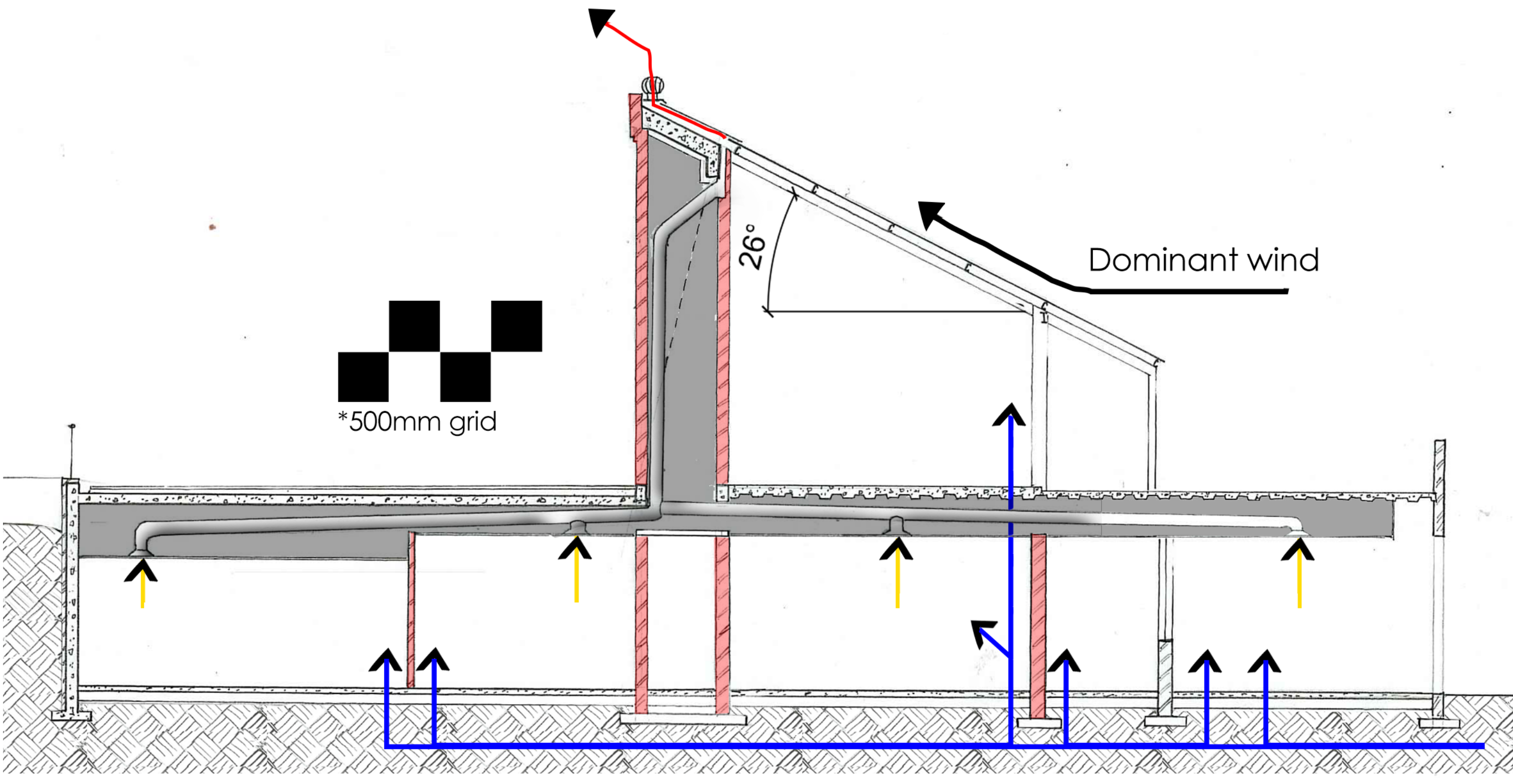

Thermo-motive engine
Air from interior spaces
Air inlets from geothermal pipes
Dominant wind

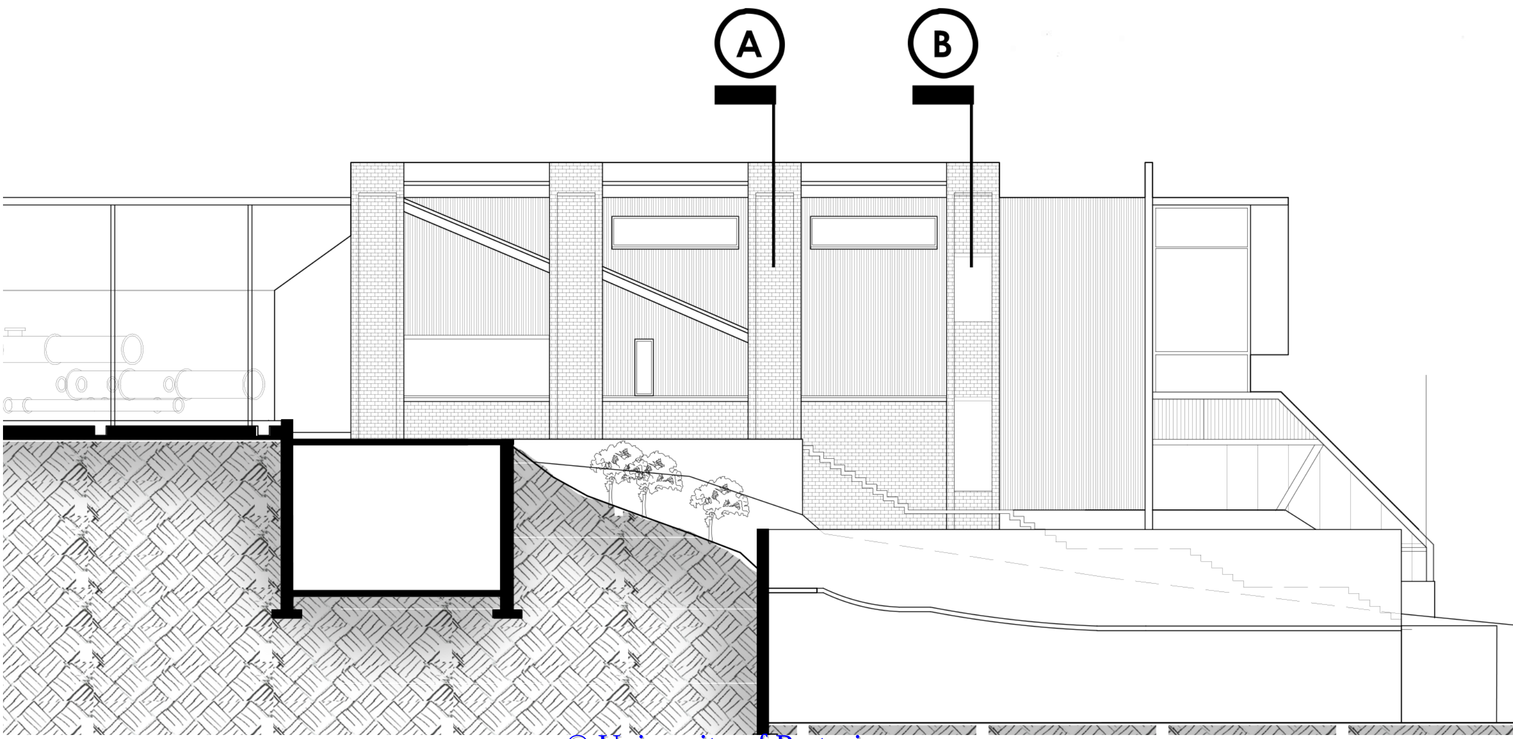
Below: **Figure 137** Building 2 cross section showing passive ventilation strategy at scale 1 to 100

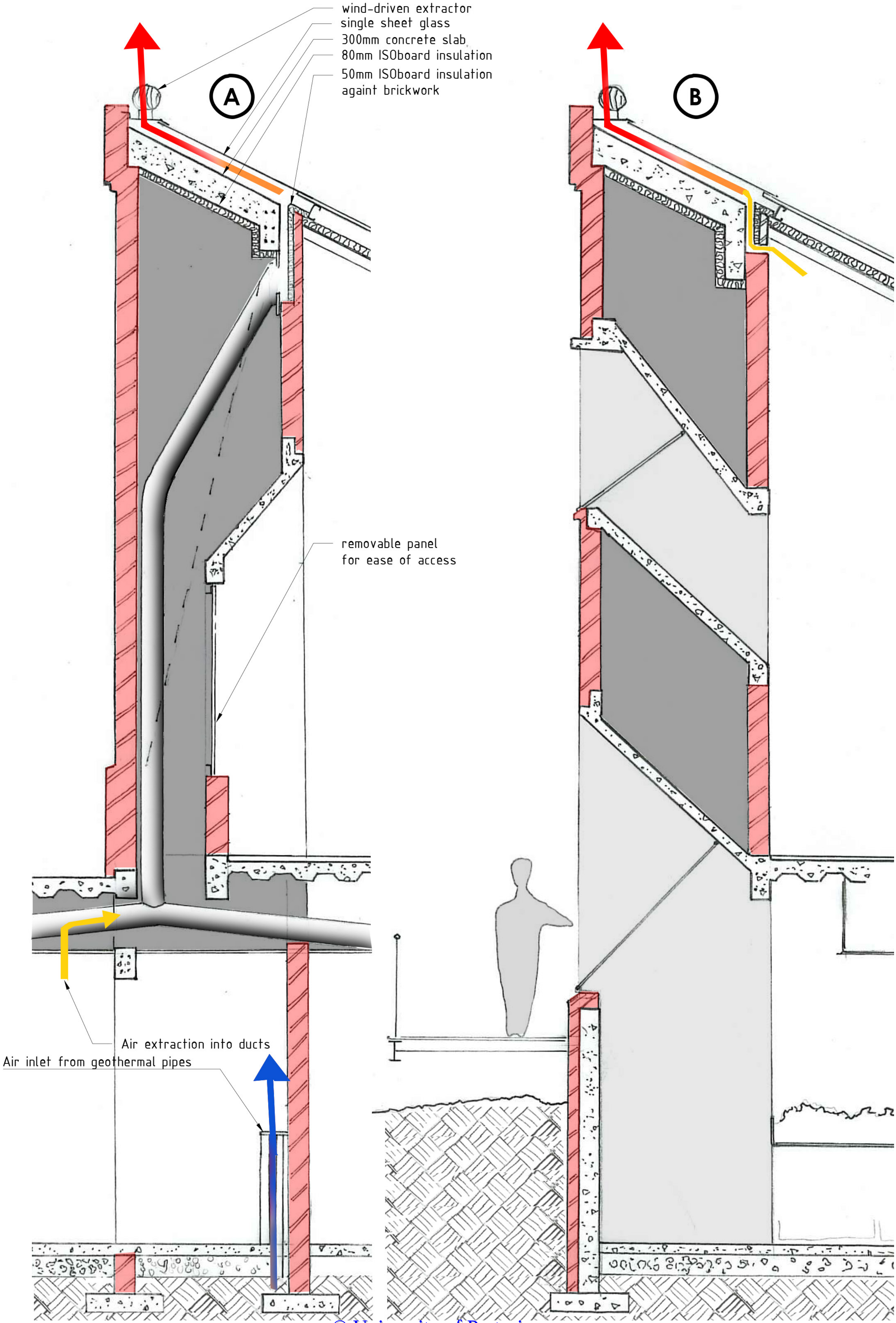
Bottom: **Figure 138** South-eastern elevation of building 2 showing Trombe wall system as implemented in the facade

Right: **Figure 139** Trombe wall detail at scale 1 to 50 showing possibilities of implementation at either level.

8.4.2 Passive ventilation Building 2






wind-driven extractor
single sheet glass
300mm concrete slab
80mm ISOboard insulation
50mm ISOboard insulation
againt brickwork
A
B
removable panel
for ease of access
Air extraction into ducts
Air inlet from geothermal pipes

8.4.3 Geothermal pipes and ventilation strategy

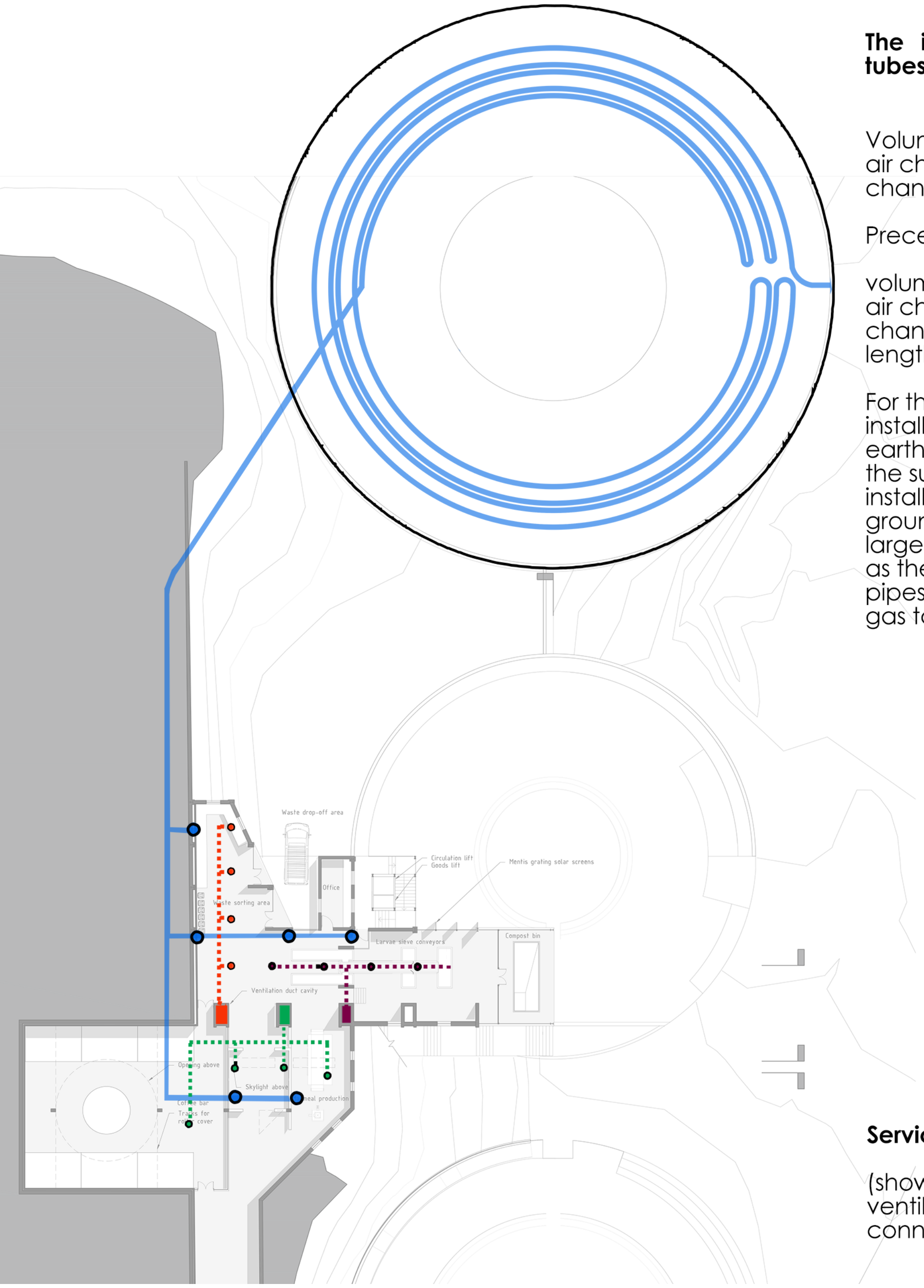
The implementation of geothermal earth tubes and Trombe assisted stack ventilation

Volume to ventilated: 1250 cubic meters
air change rate required: 15 air changes/hour (industrial)

Precedent study:

volume to be ventilated: 600 cubic meters
air change rate required: 8 air changes/hour
length of pipe installed: 180m

For this scheme it is proposed that there be installed 500 meters of geothermal earthtubes to assist with the ventilation of the submerged service level. Typically, the installation of the amount of pipes below ground require severe excavations over large surface areas. For a site as sensitive as the Gas Works it was decided to lay the pipes within the earth moud proposed for gas tank no. 3.

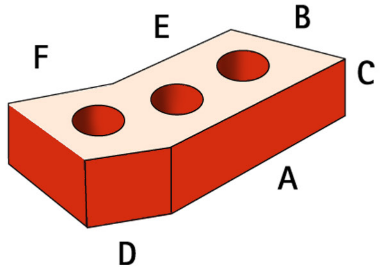


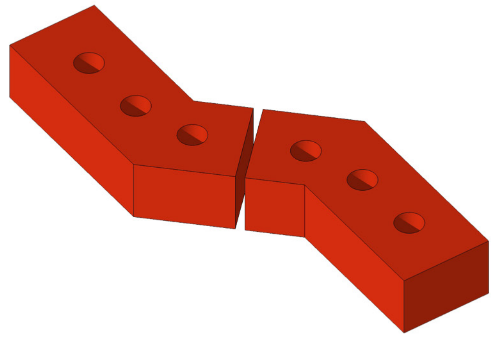
Service level plan. Scale 1:200

(showing geopipies path and overhead ventilation ducts
connected to Trombe assited solar stack)

Figure 140 The implementation of geothermal earth-tubes (Author, 2017)

A 222mm
B 106mm
C 73mm
D 106mm
E 178mm
F 57mm



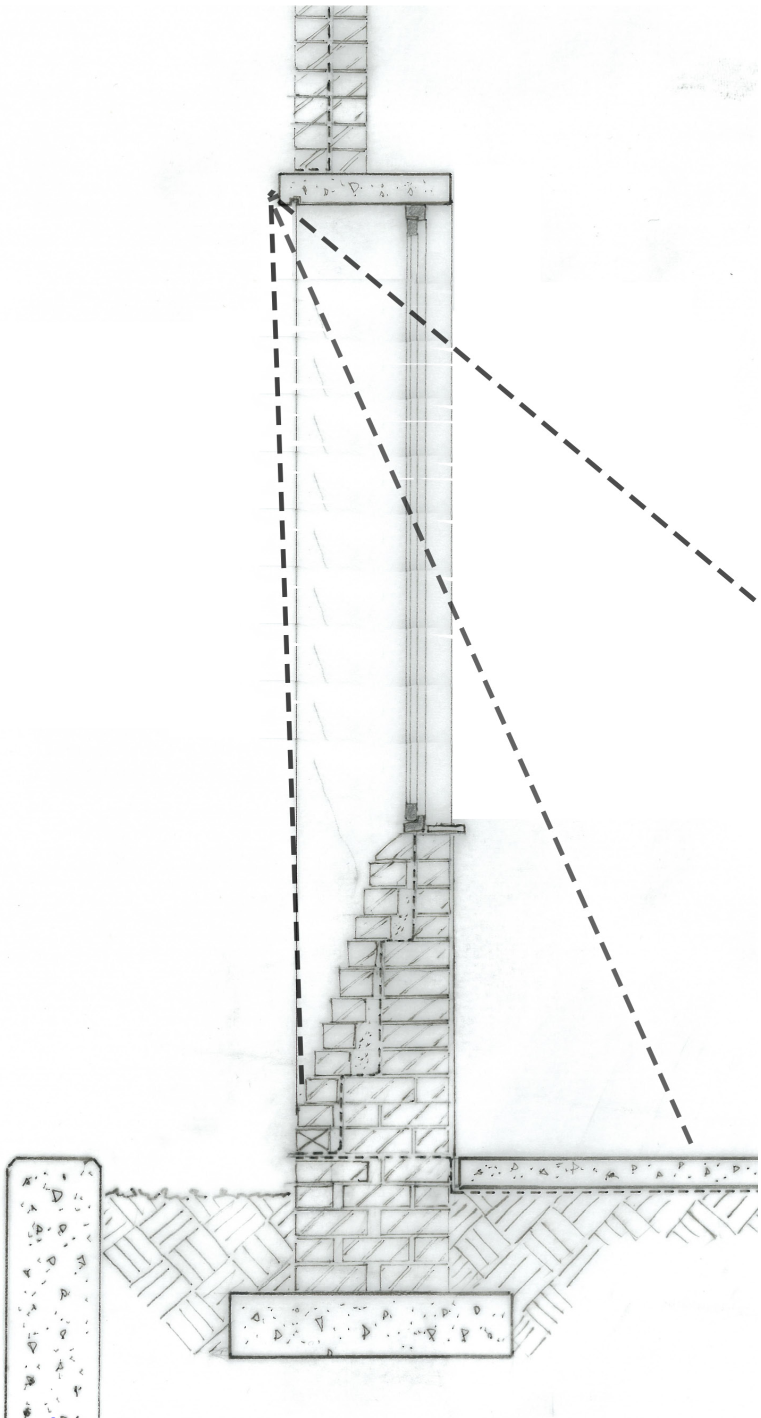


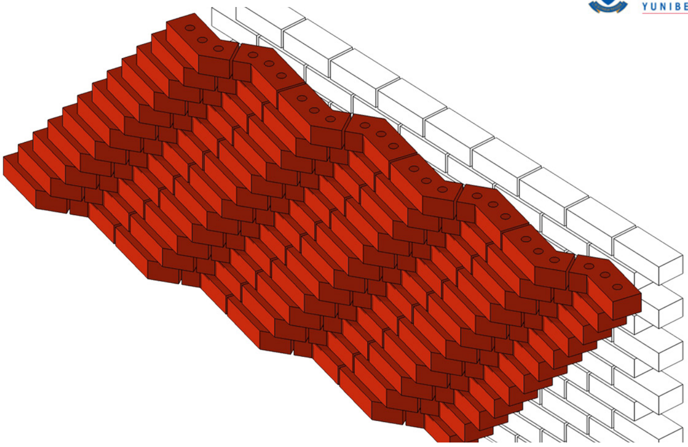
8.5 Construction detailing

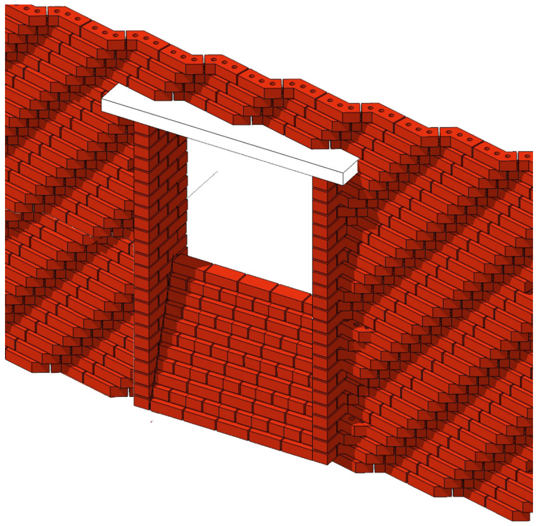
Utilizing brick in new ways

As mentioned on the previous page, using brick in a new way creates a distinction between the rigidity of the large scale brick facades constructed in stretcher bond and the new building. By using the external angle 45 brick on the north-eastern facade, not only can the front facade be read in conjunction with the front facade of Retort No. 2, but the diagonal protrusions created by repeating the brick will create different variations of shadow patterns on Building 1's facade throughout the day.

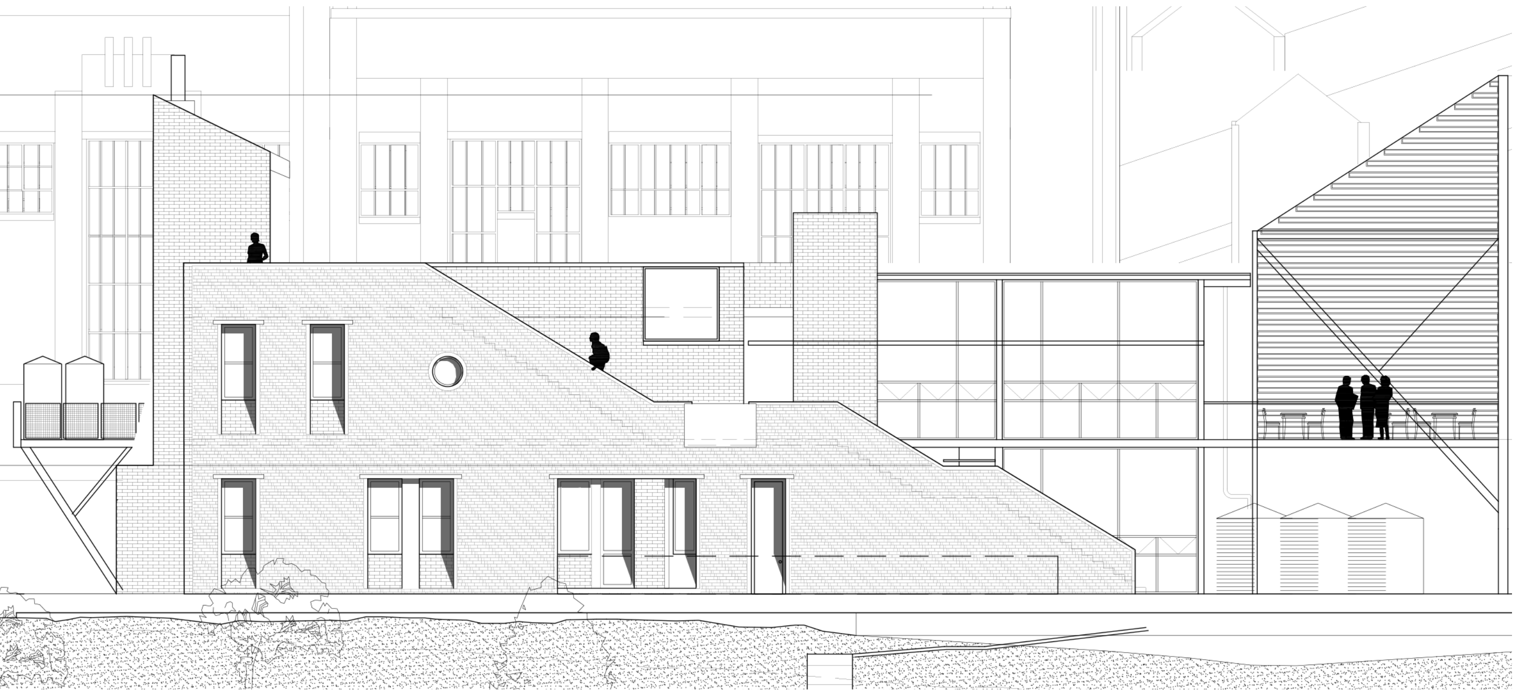
Although the existing brickwork on site is typically employed as a thin skin wrapped around the building structure, the facade of building 1 aims to realize more of the potential of the material than being a mere envelope. By creating more depth in the facade, the brickwork is also used a means of solar control.

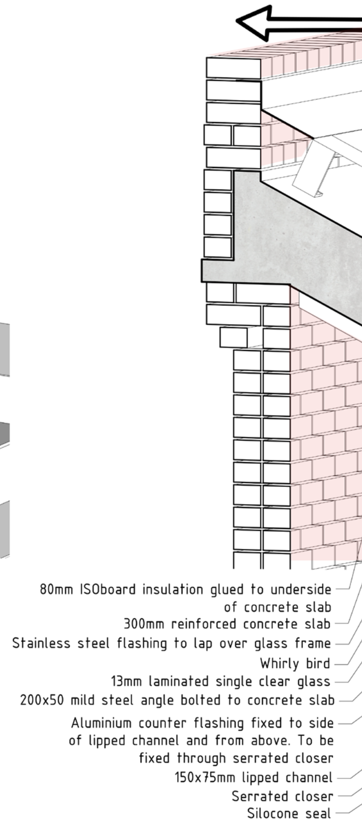




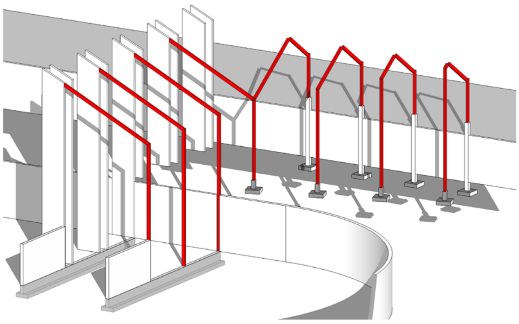


Top: **Figure 141** The implementation of Corobrik external angle 45 brick into building facade (Author, 2017)
Left: **Figure 142** Recessed brickwork as a means of solar control (Author, 2017)
Right: **Figure 143** Recessed brickwork and the effect on building 1's facade (Author, 2017)



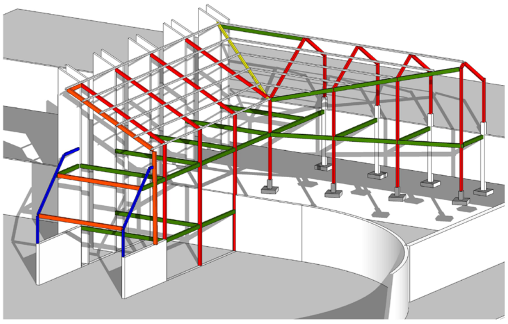


PRIMARY STRUCTURE

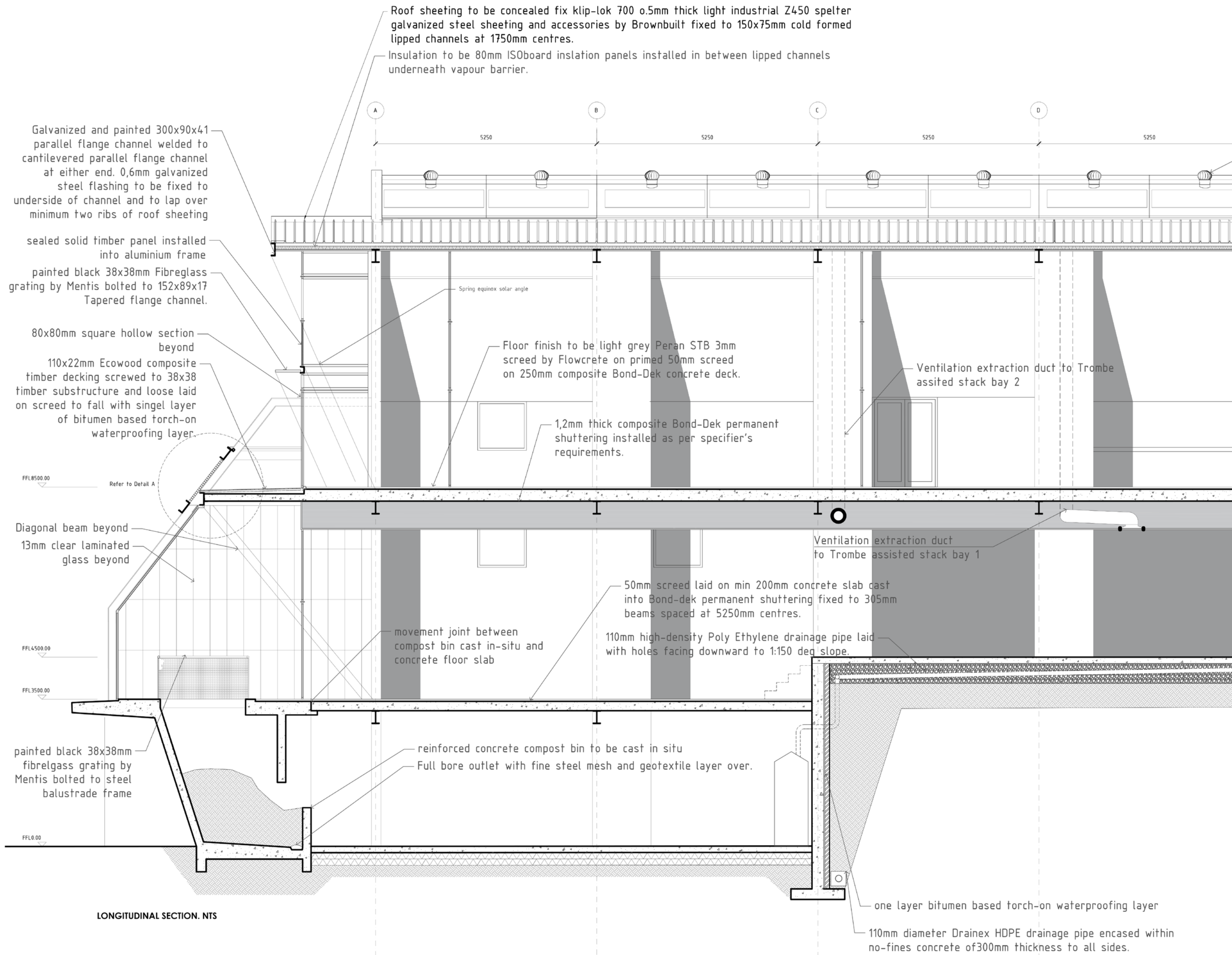


- 254x146x37 steel I section frames
- Reinforced concrete

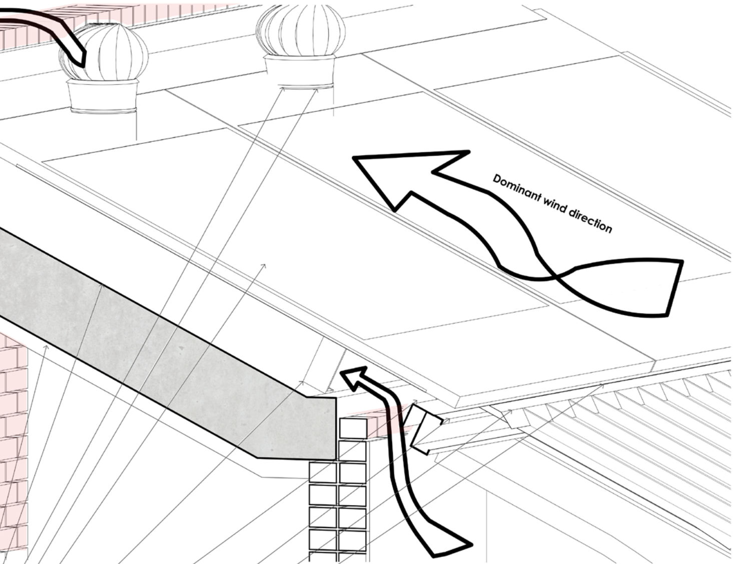
SECONDARY STRUCTURE



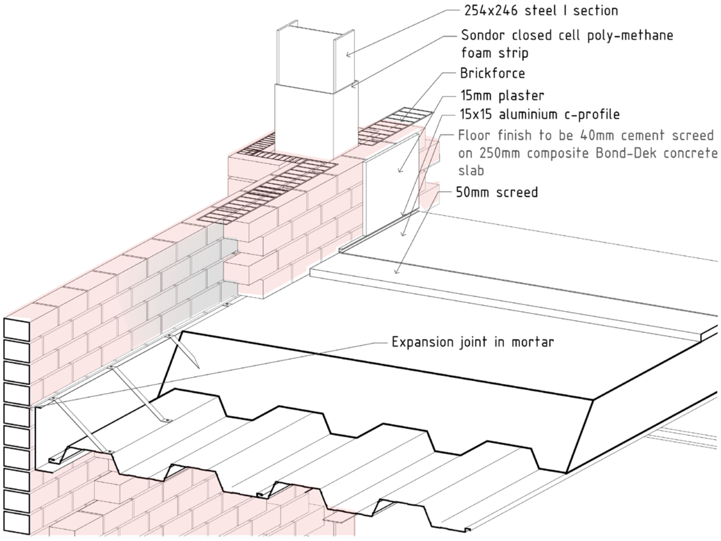
- 300x90x41 parallel flange channels
- 305x165x40 steel I-sections
- back to back 300x90x41 parallel flange channels
- 200x146 steel I section



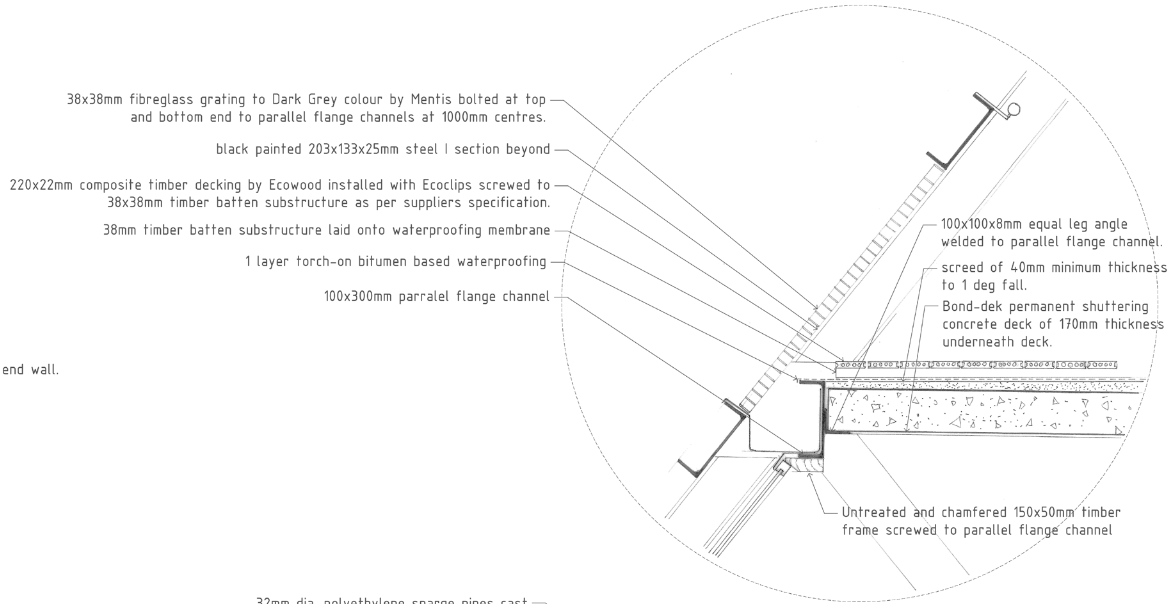
LONGITUDINAL SECTION. NTS



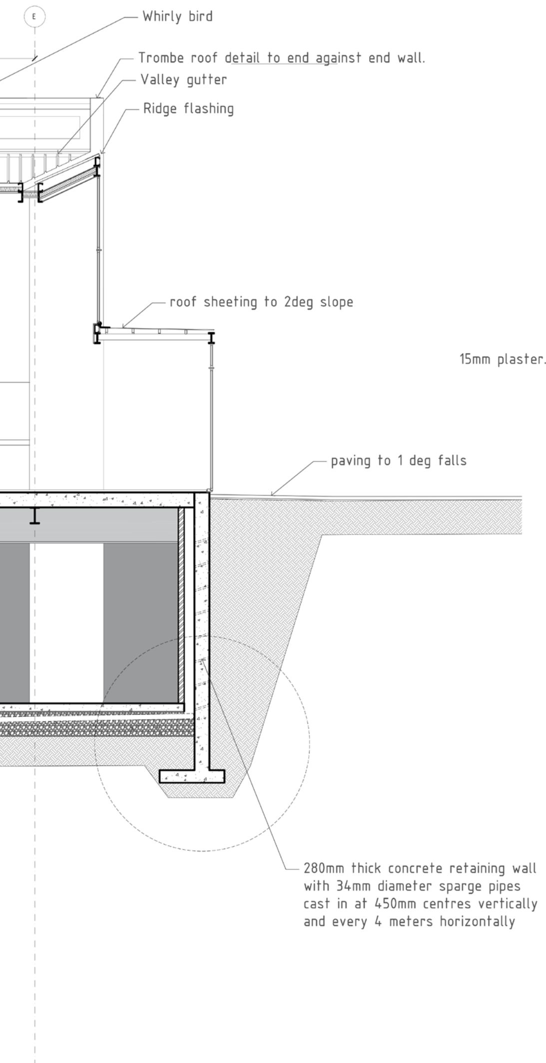
TROMBE ASSISTED SOLAR STACK DETAIL. NTS

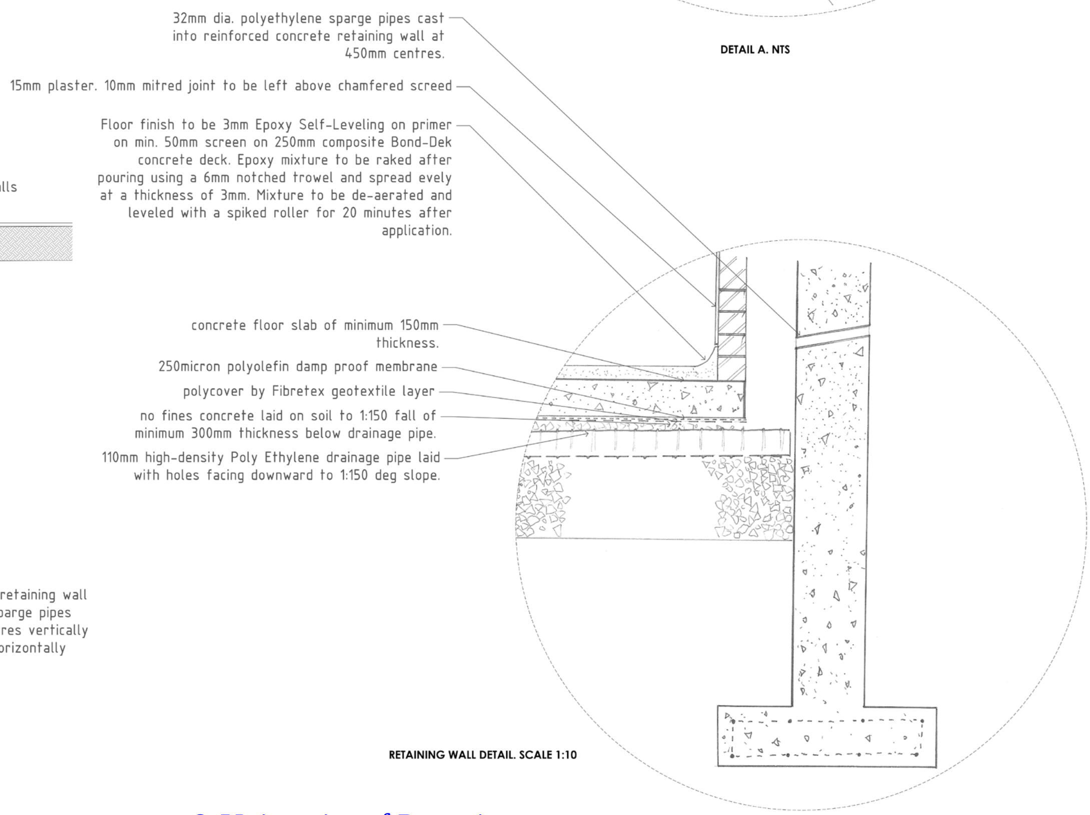


WALL TO FLOOR CONNECTION OF MUSEUM. NTS



DETAIL A. NTS





RETAINING WALL DETAIL. SCALE 1:10

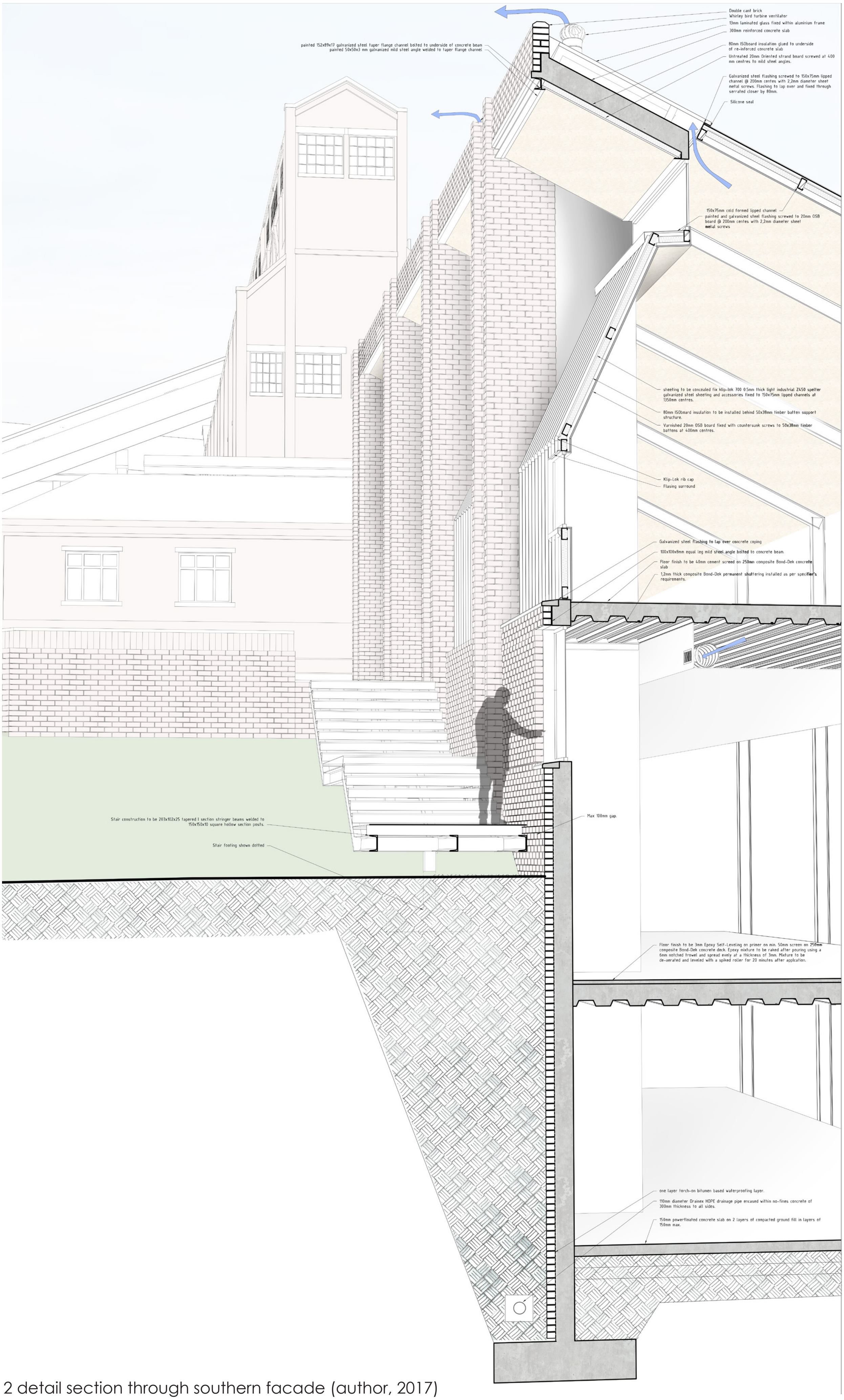
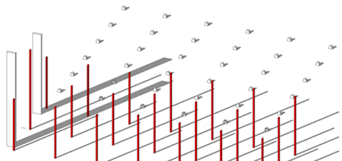
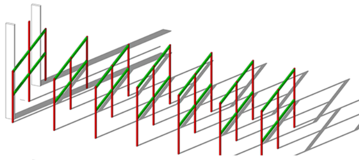


Figure 144 Building 2 detail section through southern facade (author, 2017)



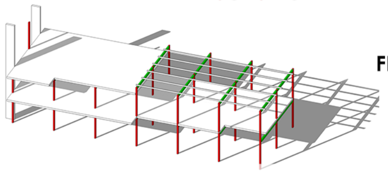
PRIMARY STRUCTURE

254x146x37 steel I section frames



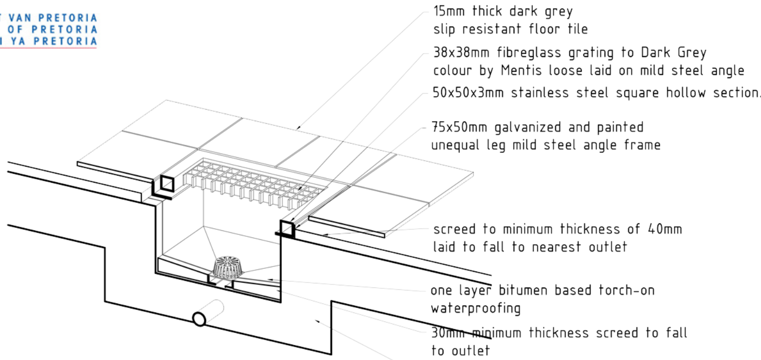
SECONDARY STRUCTURE

305x165x40 steel I-sections

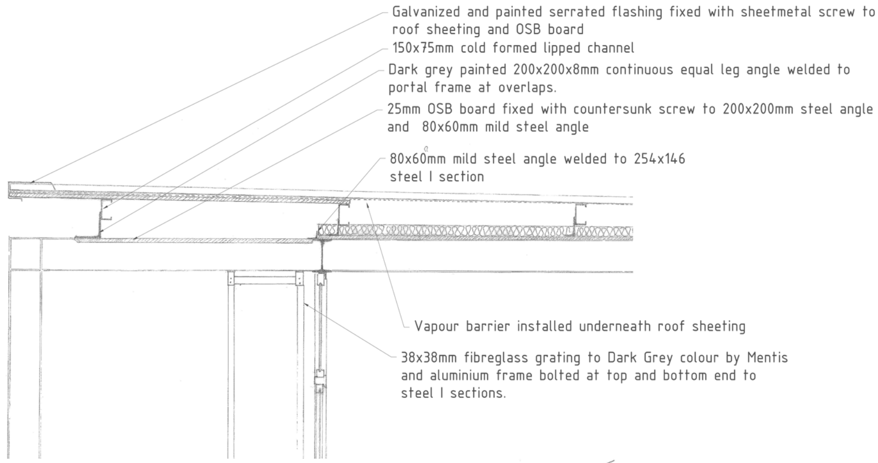


FLOOR AND TERTIARY STRUCTURE

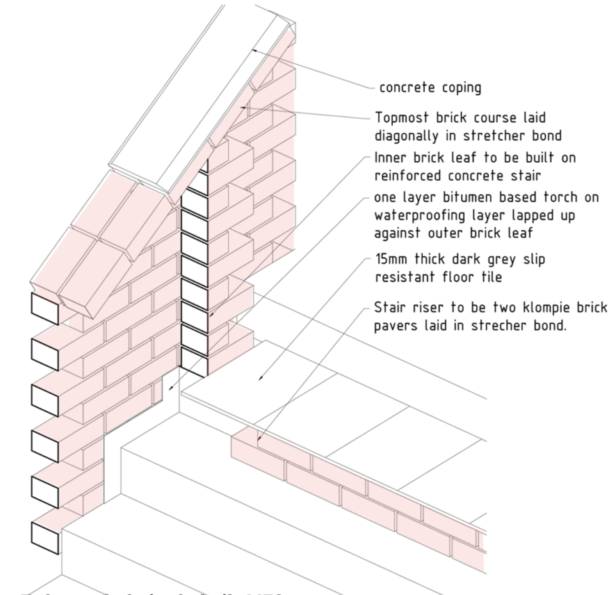
Floor: Bond-Dek composite concrete deck
Purlins: 150x75mm lipped channels



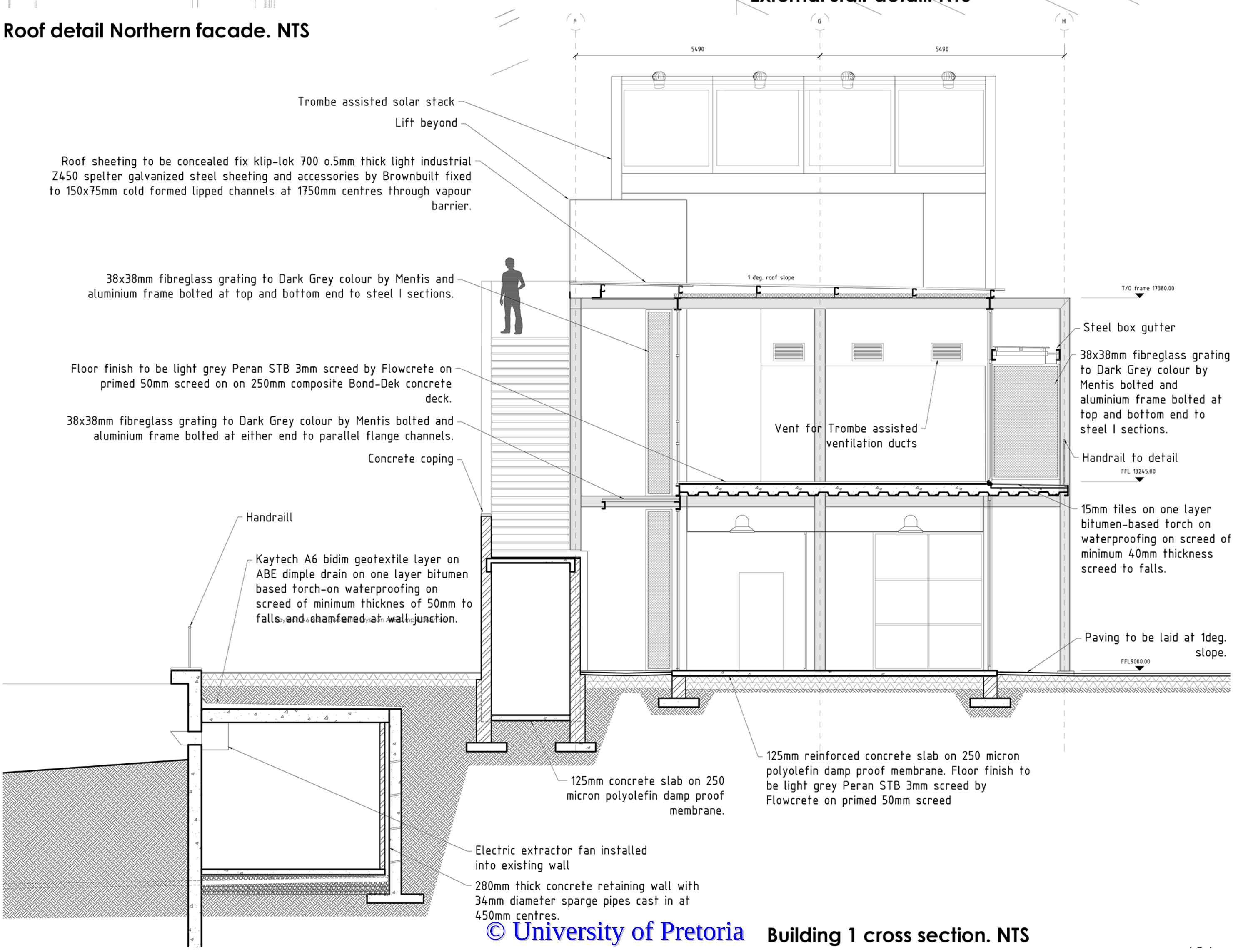
Water park recess detail. NTS



Roof detail Northern facade. NTS



External stair detail. NTS



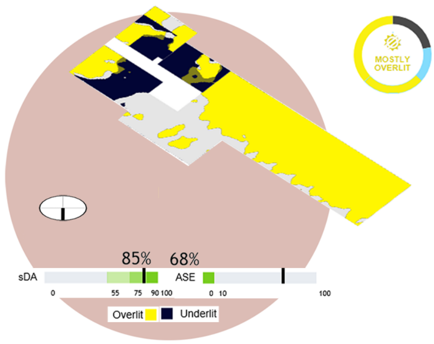
Building 1 cross section. NTS

8.6 Daylighting iterations

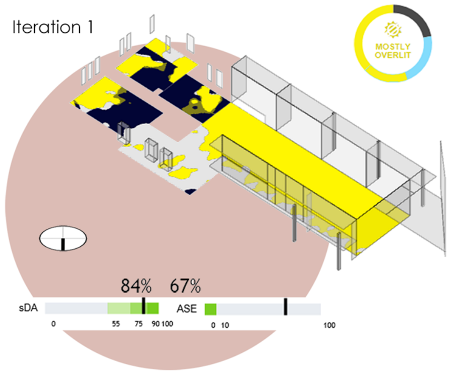
Building 1 Southwestern Elevation prior to iterations

Overlit/ Underlit areas study

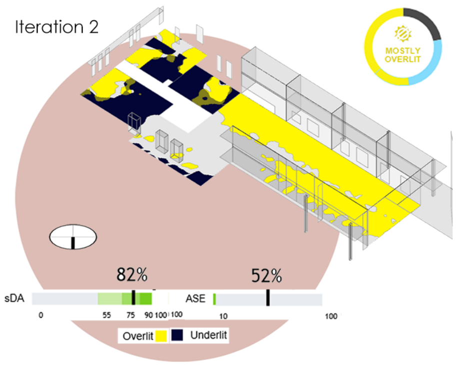
Baseline test on Building 1 ground floor



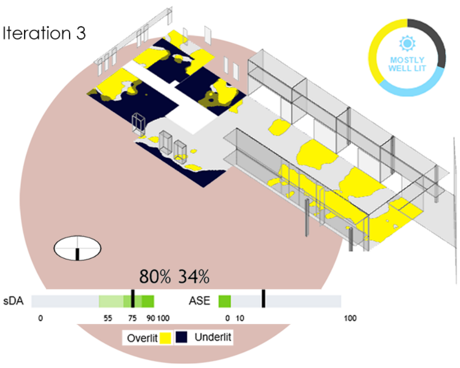
Iteration 1



Iteration 2



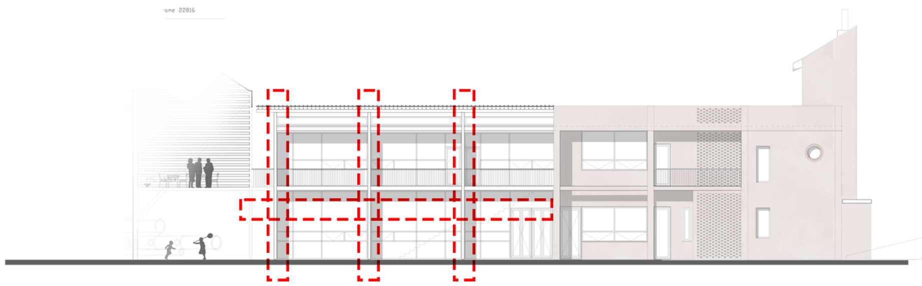
Iteration 3



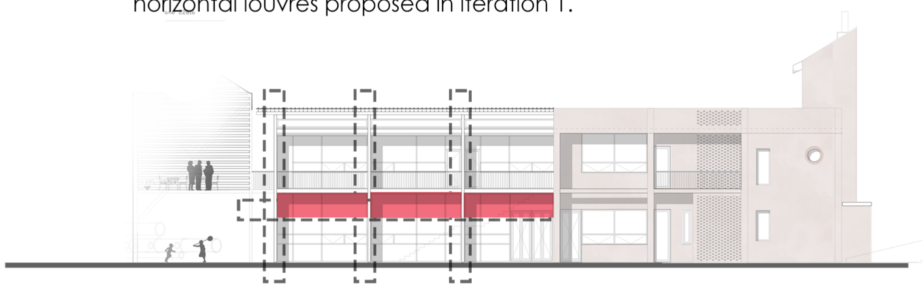
Findings

After a daylight analysis of building one was conducted, it was found that the steel and glass construction at the northern end of the building dealt poorly with overlighting in the ground floor aquaculture and first floor restaurant area. With almost the entire restaurant area being overlit, it was clear that numerous iterations would have to improve the situation.

Iteration one entailed the introduction of vertical and horizontal louvres on the Western facade between the structure and the skin of the building.



Iteration two entailed the implementation of solid infill panels in between the first floor slab and the horizontal louvres proposed in iteration 1.



Iteration three entailed installing three vertical shading screens that each filled half a bay in the western facade. These screens could either be part of the skin or as seperate entities part ofthe structure.

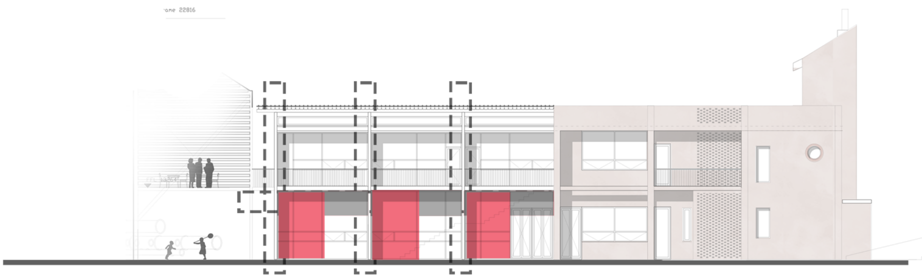
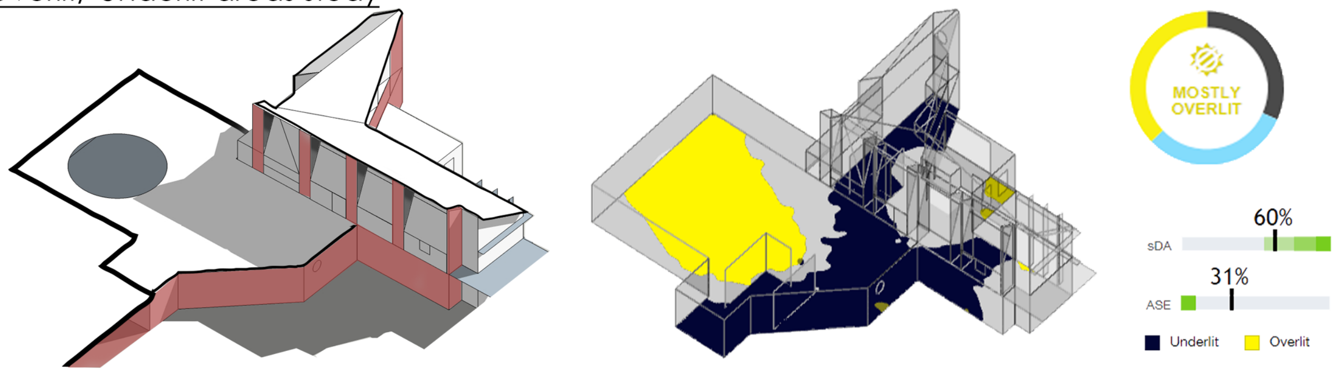
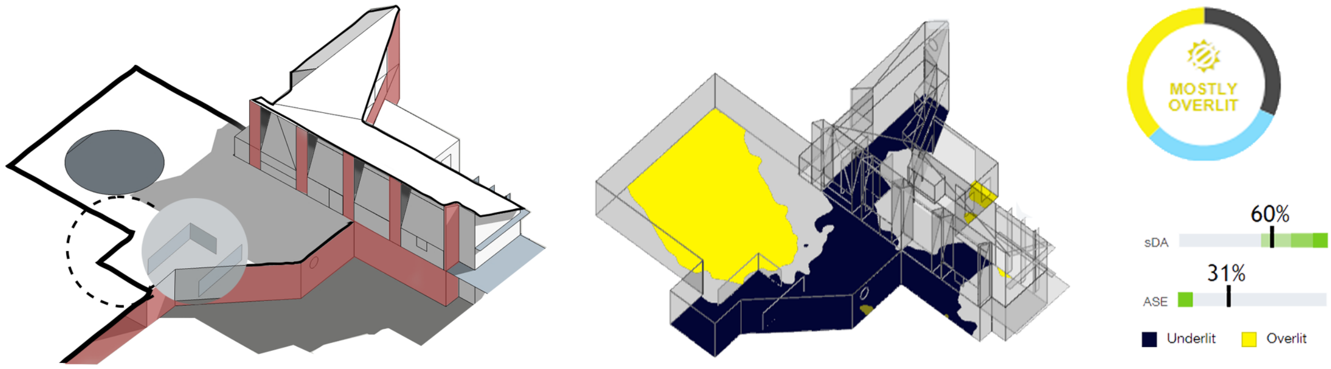


Figure 145 Building 1 baseline over/under-lit study (Sefaira, 2017 and edited by author)

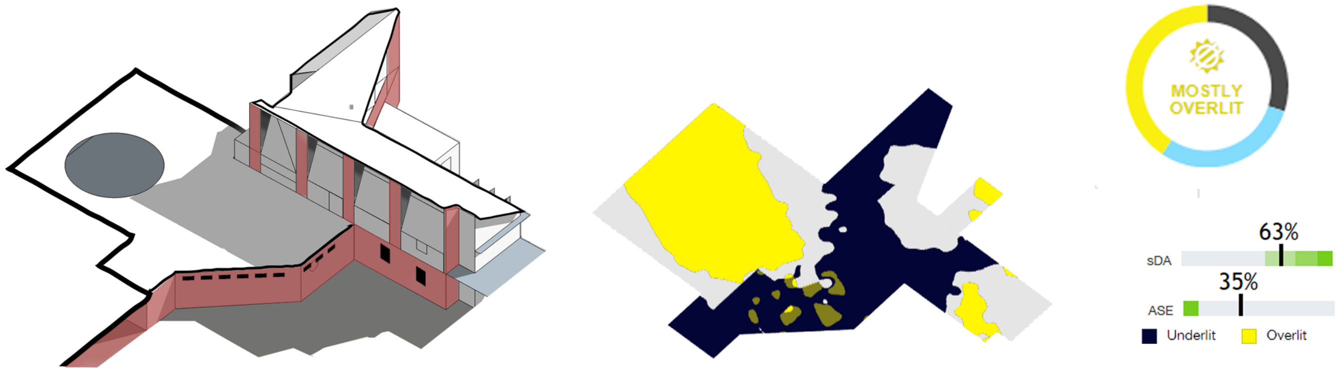
Building 2 Basement level prior to iterc
Overlit/ Underlit areas study



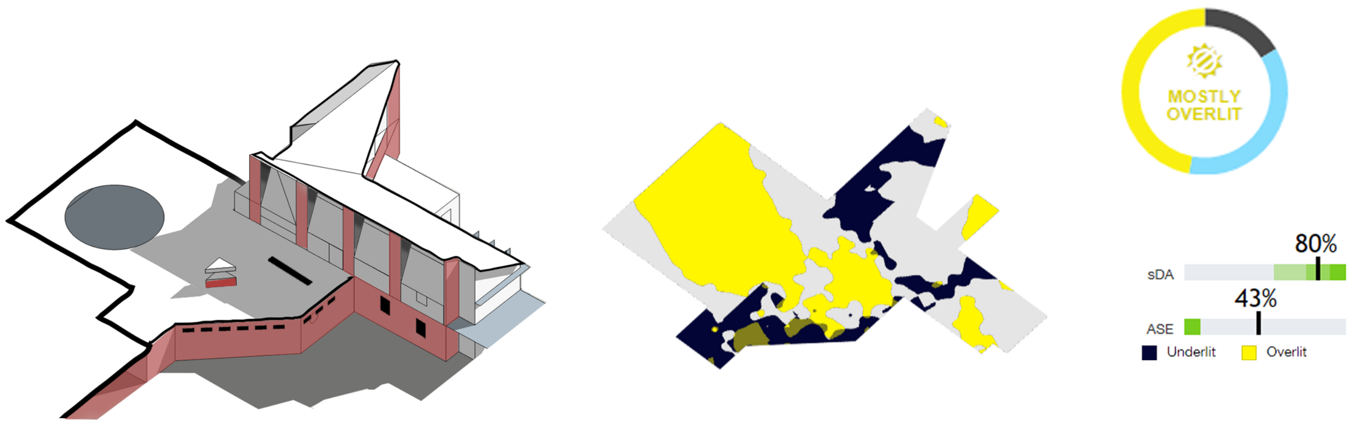
After a baseline test was conducted it was found that the basement service level was underlir. Therefore, a series of iterations sought to improve the daylighting of this floor



Iteration 1 - lower all internal non-load bearing walls



Iteration 2 - The addition of windows in the retaining wall



Iteration 3 - The addition of windows in the waste delivery area and longer linear skylights in the lookout point.

- Underlit (Less than 300lux for more than 50% of occupied hours)
- Overlit (Over 1000lux of direct light for more than 250 occupied hours per year)

Figure 146 Building 2 baseline over/under-lit study (Sefaira, 2017 and edited by author)

8.7 Rainwater harvesting calculations

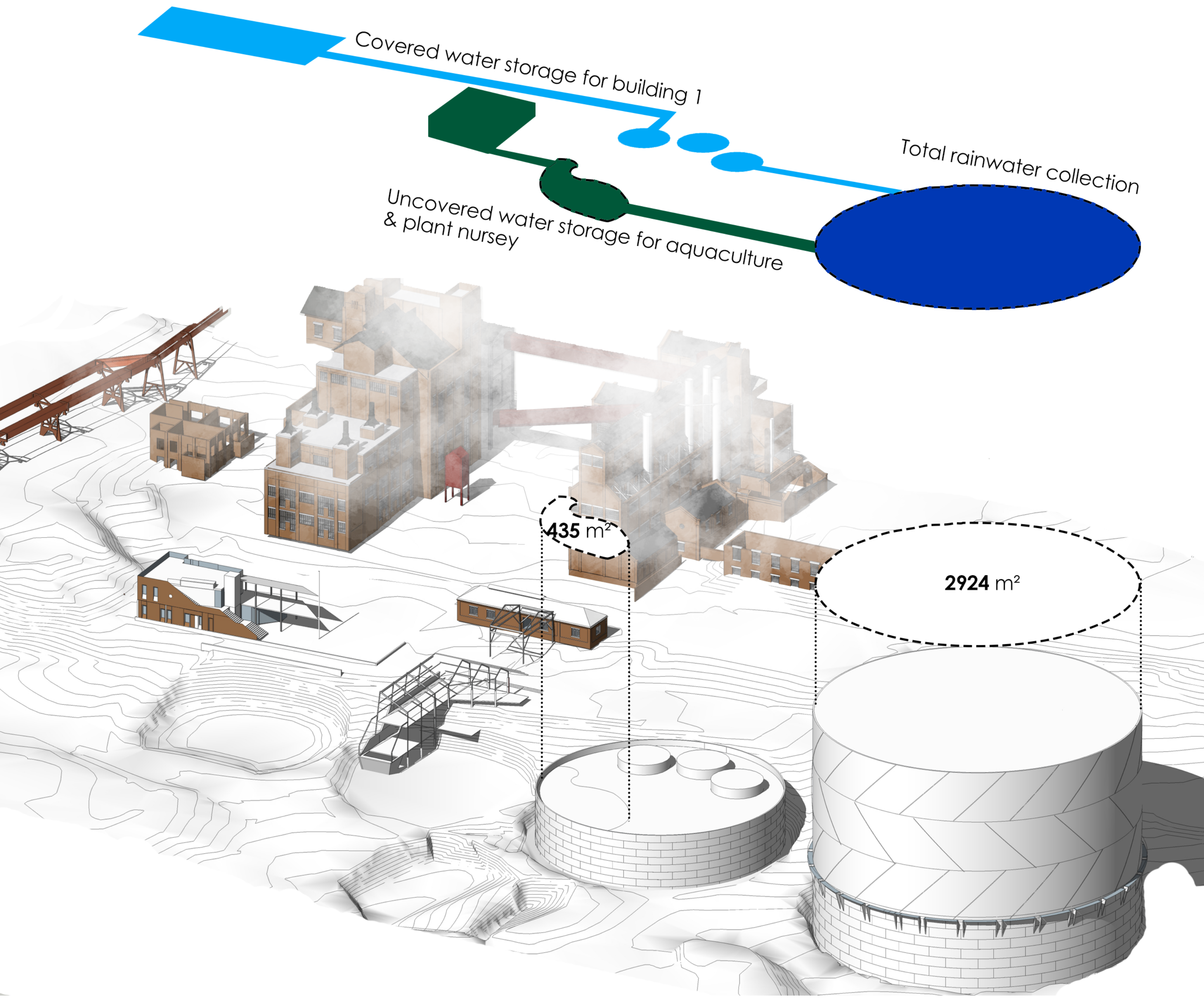


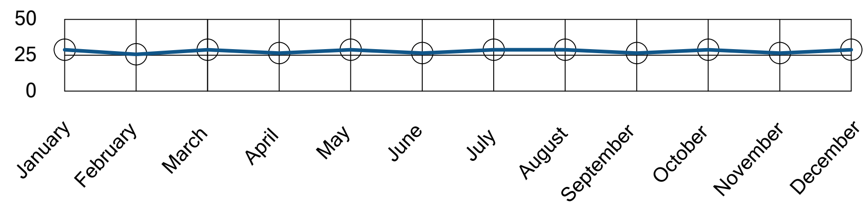
Figure 147 Rainwater harvesting strategy (Author,2017)

Table 1. Rainwater collection

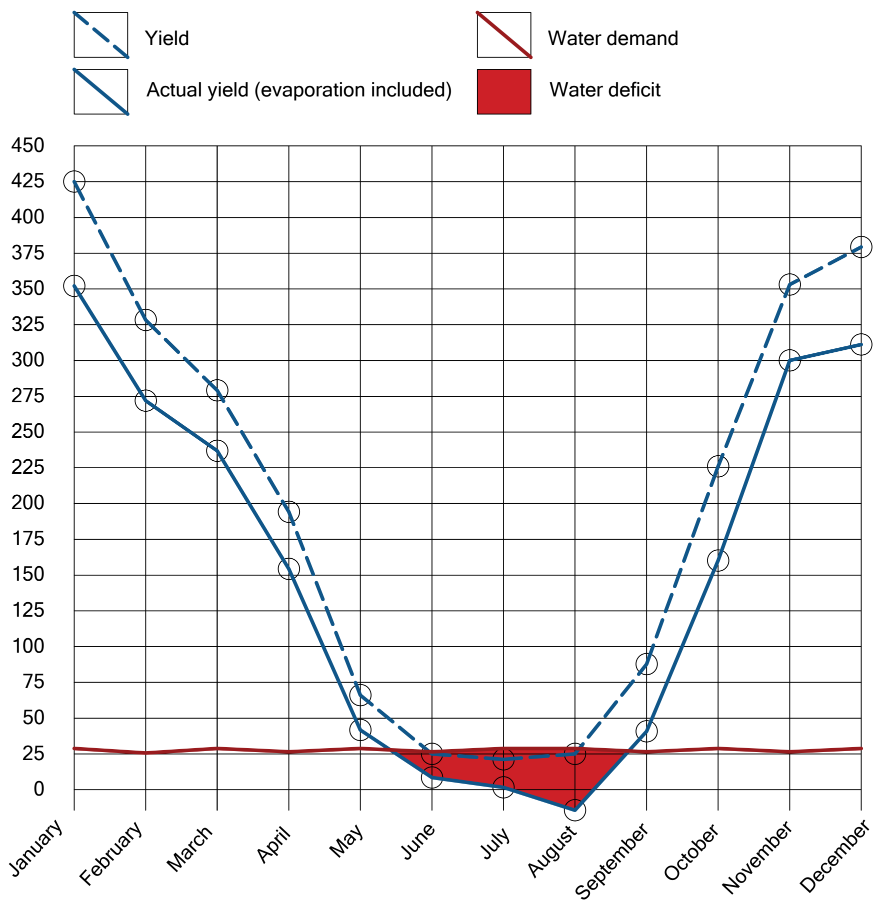
WATER DEMAND FOR APPLIANCES

Appliance	Quantity	flow rate l/minute	liter/use	Usage/day	liter/day	liter/week
public toilet	4	-	4	64	256	1536
staff toilet	2	-	4	10	40	240
Urinal	1	-	1	180	180	1080
handwash basin	6	12	1	100	100	600
shower	2	6	24	3	72	432
Dishwasher	1	-	180	1	180	1080
Kitchen basin	2	12	-	16	192	1152
TOTAL					1020	6120

WATER DEMAND (m^3)



RAINWATER YIELD AND DEFICIT CALCULATION



SURFACE	Area (m^2)	Runoff Coeff.
Roof	2924	0,9
Pond	434,8	1
	3358,8	0,91

MONTH	Ave. rainfall (mm)	Yield (m^3)
Jan	139	426,23
Feb	108	331,17
March	91	279,04
April	62	190,12
May	21	64,39
June	9	27,60
July	7	21,46
Aug	8	24,53
Sept	28	85,86
Oct	74	226,91
Nov	118	361,84
Dec	125	383,30
		2422,46

Storage volume required= $40m^3$ x 3 months = $120m^3$. Therefore, the dam proposed in the foundation of Gas tank 3 with an area of 434 m^2 and average depth of 1,5 m will suffice.

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