8

TECHNE

TECHNICAL DEVELOPMENT

Constructing the "Device"

Chapter 8 Techne: Chapter nine introduces the major influences to the structural and other systems, and technology of the building. The technological concept is introduced, which is followed by the structural concept. The technology and materiality of the device is described through its spatial, programmatic and functional arrangements. The water and ventilation systems of the building are presented along with a planting palette of floral species.

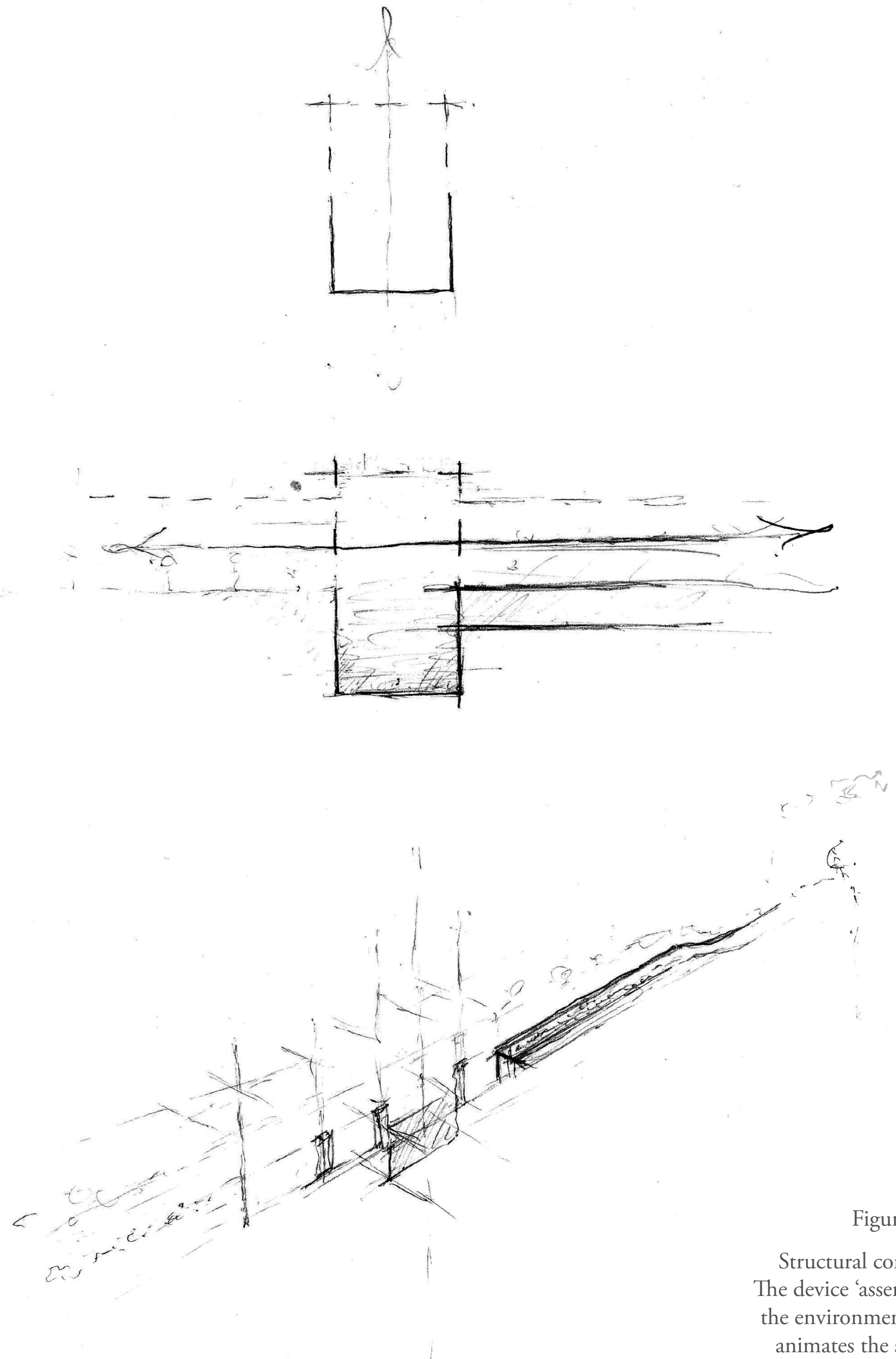


Figure 8.1

Structural concept. The device ‘assembles’ the environment and animates the spaces therewith

(Author, 2015)

TECHNOLOGICAL CONCEPT

The conceptual approach to the technology of the device is an interchanging animation between architecture and the natural environment. The one thus becomes and extension of the other to illuminate its counterpart's poetics and to service one another. The architecture invites nature to service the spaces with passive design strategies while nature is allowed to aid in the articulation of the architecture. The architecture makes the environment 'visible' while also enfolding natural vegetation for safekeeping and production.

STRUCTURAL CONCEPT

The Loggia is the transition between the building and natural landscape, as is the oculus the metaphorical transition between the terrestrial and the atmosphere. The building, as threshold device, mimics it's transience through it's structure. The structure is stereotomic where it morphs the ground plane of the gardens, and becomes more tectonic as it ascends upwards. Another axial unfolding takes place: To the west, the device is completely morphed with the gardens through the stereotomic form that unfolds rhythmically to intercept the tectonic street edge through channelled stacks. Rhythm is created continually through an interplay between tectonic and stereotomic form.

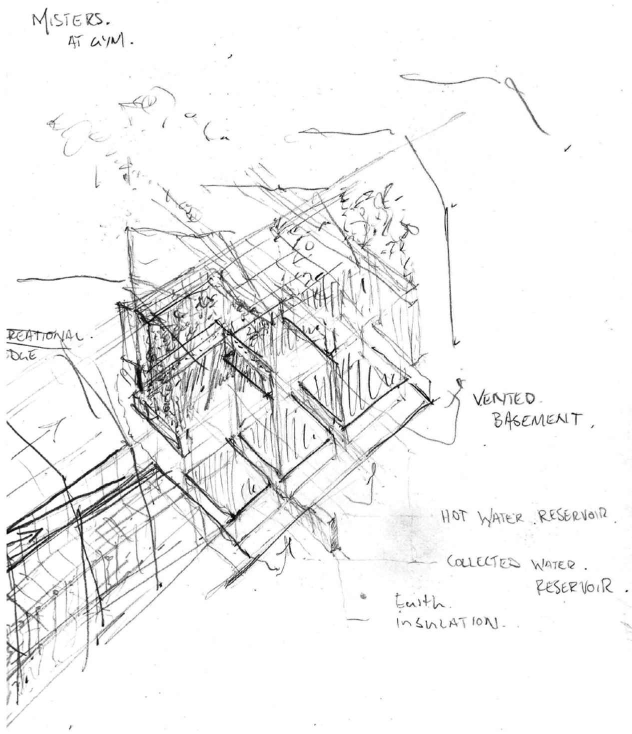


Figure 8.2

Conceptual sketch of the structure

(Author, 2015)

INTERCHANGING ANIMATION

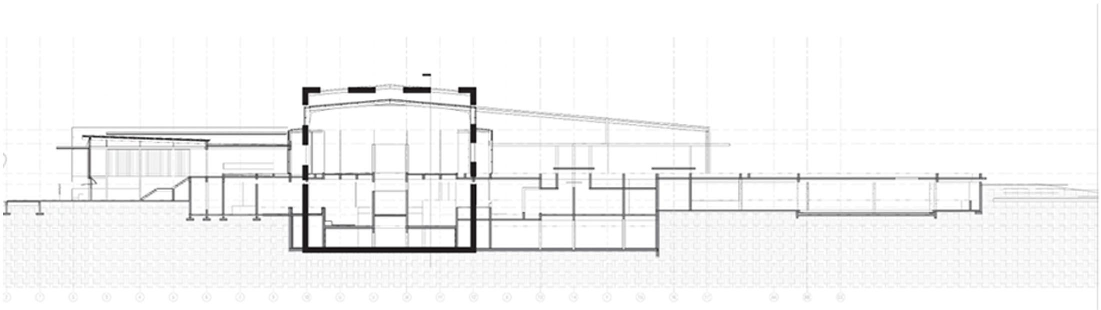
At the heart and spine of the intervention an interchanging animation is created in a volume between the water from the fountain, through the presencing in pools and facilities, and the natural environment, in a greenhouse conservatory, with a portal frame structure. The greenhouse's spine envelops double volume spaces in and around the pools; it unfolds rhythmically to the west to envelop double volume spaces over the length of the lap pool and foyer to the recreational facilities. The structure is stereotomic where it morphs the ground plane of the gardens, and becomes more tectonic as it ascends upwards. It extends onto the street edge to the north to frame the multi-purpose hall.

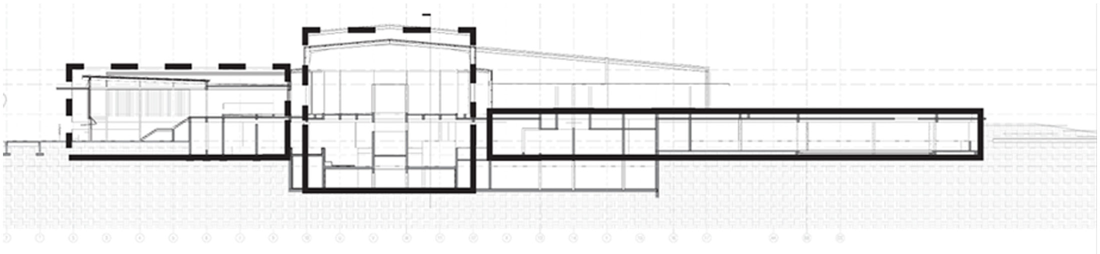
'ASSEMBLING' THE ENVIRONMENT

The architecture "assembles" and invites the natural environment from the west towards the nucleus and central spine. The gardens and the properties of the fountain to the west are 'gathered' by a stereotomic structure that morphs into the ground plane. This structural mass retracts and unfolds geometrically and through levels to form the pools and spaces along the nucleus and central axis of the intervention while the roof becomes the ground plane of the gardens. This level unfolds and retracts underneath the greenhouse to accomplish double volume spaces in and around the baths and a second level within the greenhouse. This level relates here to the upward ascent of the building, becoming more tectonic.

ANIMATING THE ENVIRONMENT

Concrete planters extend from the western edge of the building through to the eastern edge. These serve as spatial and physical conduits to animate and service the spaces with the properties of the environment. Within the semi-enclosed gym, these planters serve as drip trays to the misters. Inside the greenhouse a stainless steel mesh, supported by the tectonic steel structure of the greenhouse, extends upward for climbing plants and serve as divisions between public and private. To the east, these planters expand into evaporative cooling stacks that rhythmically intercept the tectonic street edge with stereotomic form. These retract their form and open to water channels with chilled water for post-cut flowers or planters that serve the Loggia. The eastern edge fronts the urbanity with tectonic double volume spaces interrupted rhythmically by stereotomic stacks.





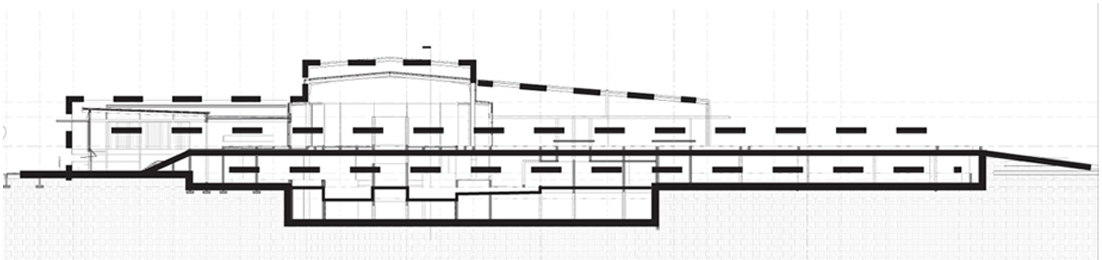


Figure 8.3 (top)

The Heart and Spine

(Author, 2015)

Figure 8.4 (middle)

'Assembling' the environment

(Author, 2015)

Figure 8.5 (bottom)

Interchanging Animation

(Author, 2015)

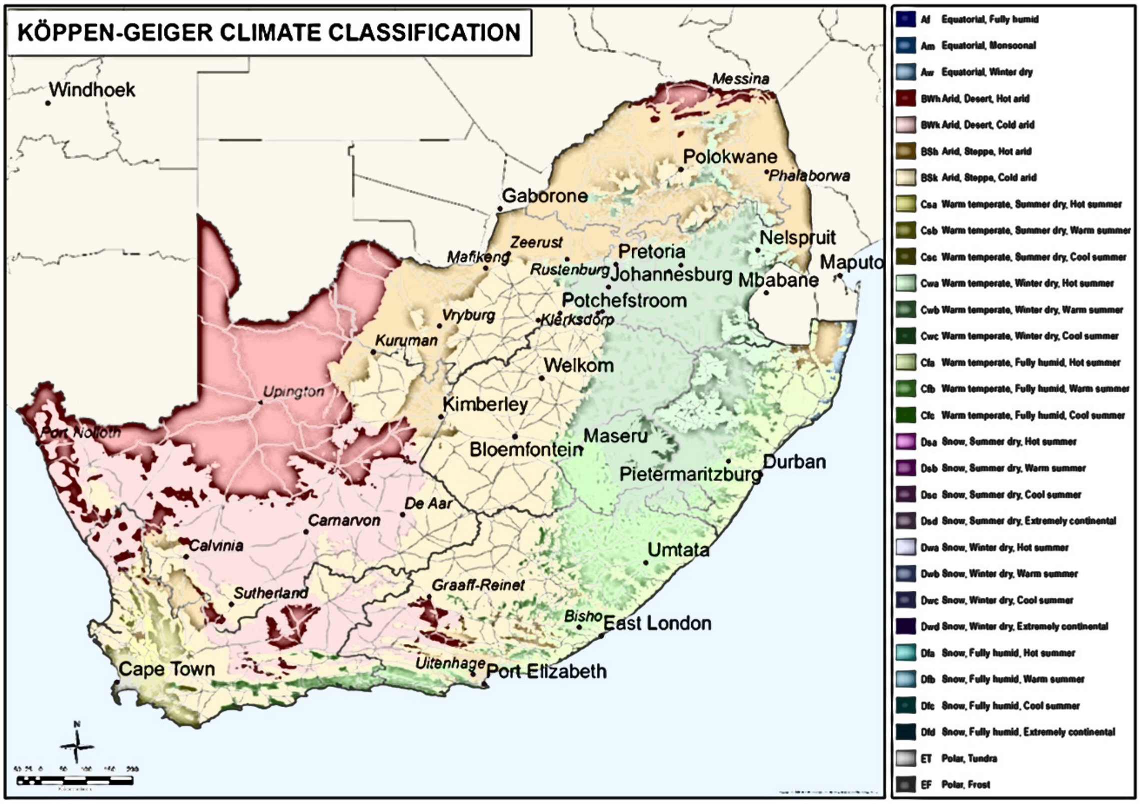


Figure 8. 6

CSIR Köppen-Geiger map

(Conradie et al, 2015)

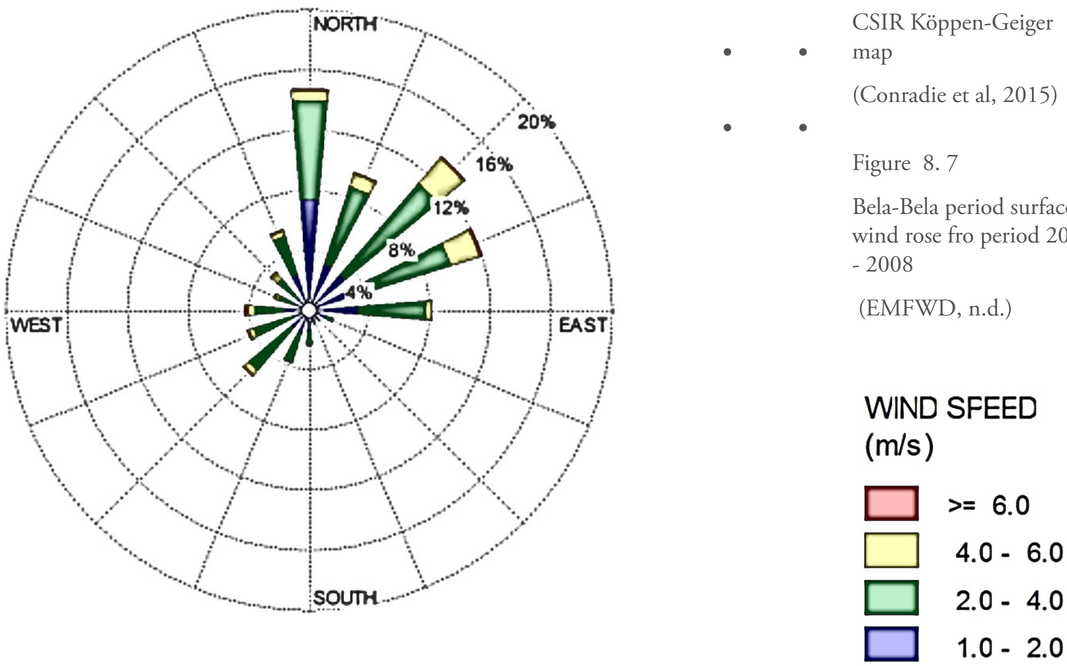


Figure 8. 7

Bela-Bela period surface wind rose fro period 2004 - 2008

(EMFWD, n.d.)

CLIMATE RESPONSE

CLIMATE

According to the CSIR Köppen-Geiger map (based on 1985 to 2005 Agricultural Research Council data on a fine 1 km x 1 km grid), Bela-Bela is classified as BSh Arid, Steppe, or hot semi-arid (Conradie and Kumirai, 2012: 5). Conradie et al. (2012: 6) propose passive solar heating, thermal mass, exposed mass and night purge ventilation, natural ventilation, direct evaporative cooling, and indirect evaporative cooling all as passive design strategies that could be employed in building designs within this region. The climate is defined by air with low levels of humidly, high irradiation levels, and hot summers and mild winters with cold evenings. The wind in Bela-Bela originates from the north, north-east and east-north-east and is considered slow to moderate apart from during the day time when speeds increase and faster winds of above 6 m/s are frequently seen (EMFWD, 79)

PASSIVE DESIGN STRATEGIES

The design is proposed to adapt climatically and provide ideal conditions for programmatic requirements by making use of passive, mechanically aided ventilation systems. The design necessitates that hot, dry air be kept outside or saturated, so as to increases the relative humidity and decrease air temperature. It furthermore necessitates that spaces be protected from high levels of solar irradiation, while insulating the spaces during cold winter nights. Spaces need to be well ventilated with the cool air of higher relative humidity and then circulated to provide the necessary air changes.

In hot, dry conditions, passive downdraft cooling or passive downdraft evaporative cooling (PDEC) is a passive cooling strategy proposed for such regions (Ford, Schiano-Phan and Francis, 2010: 13) as Bela-Bela's. The design proposes direct evaporative cooling strategies for spaces, in conjunction with passive and mechanically aided passive ventilation techniques. The Loggias and the florist are serviced with passive downdraft tower channels where the drip trays are planters by the Loggia or water circulation basins for fresh cut flowers in the florist's shop. Earth tubes are meant to provide air at desired temperatures to some spaces, while the humidification of air through misters is proposed for the greenhouse, gym and restaurant.

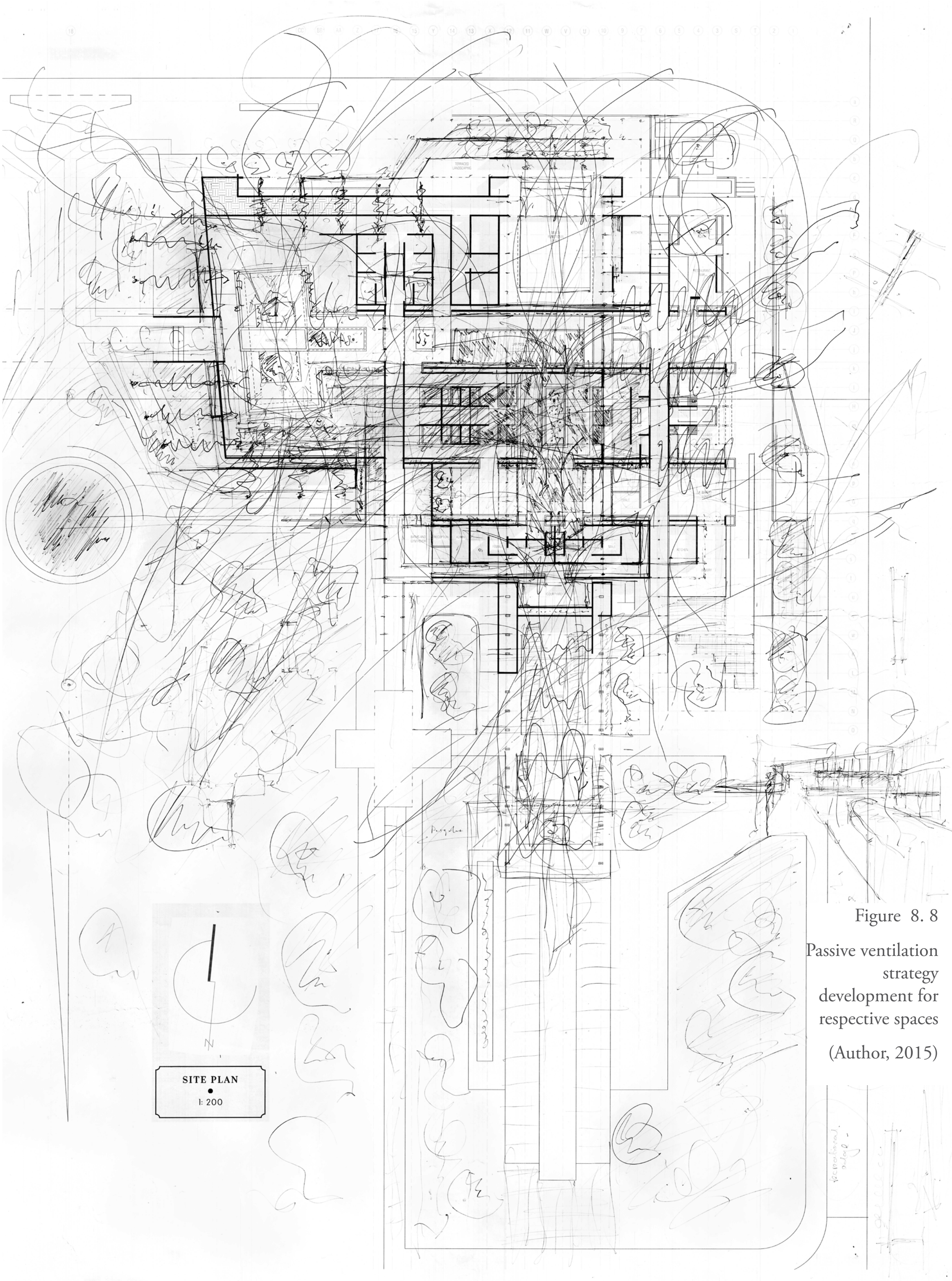


Figure 8. 8

Passive ventilation strategy development for respective spaces

(Author, 2015)

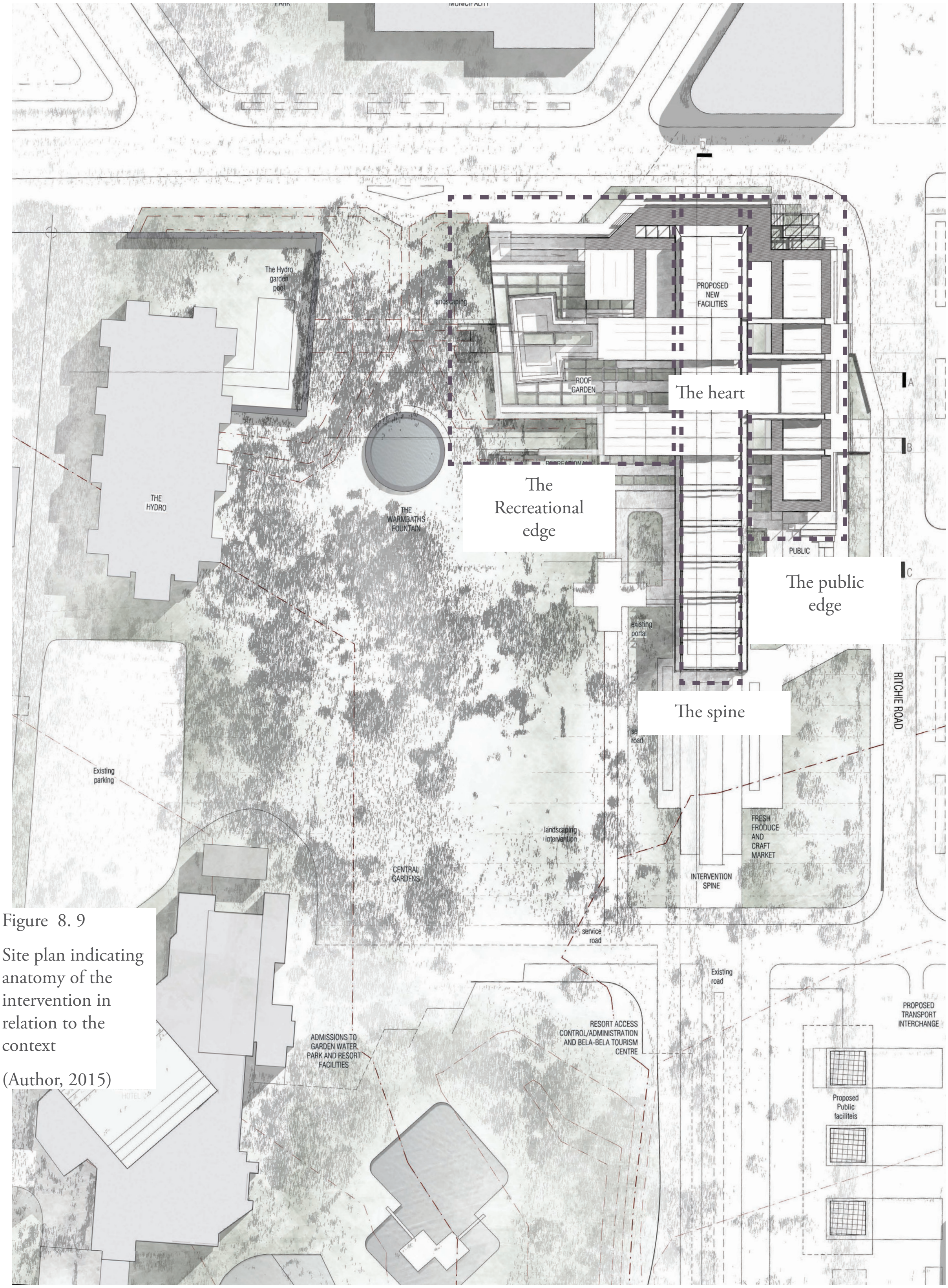


Figure 8. 9

Site plan indicating anatomy of the intervention in relation to the context

(Author, 2015)

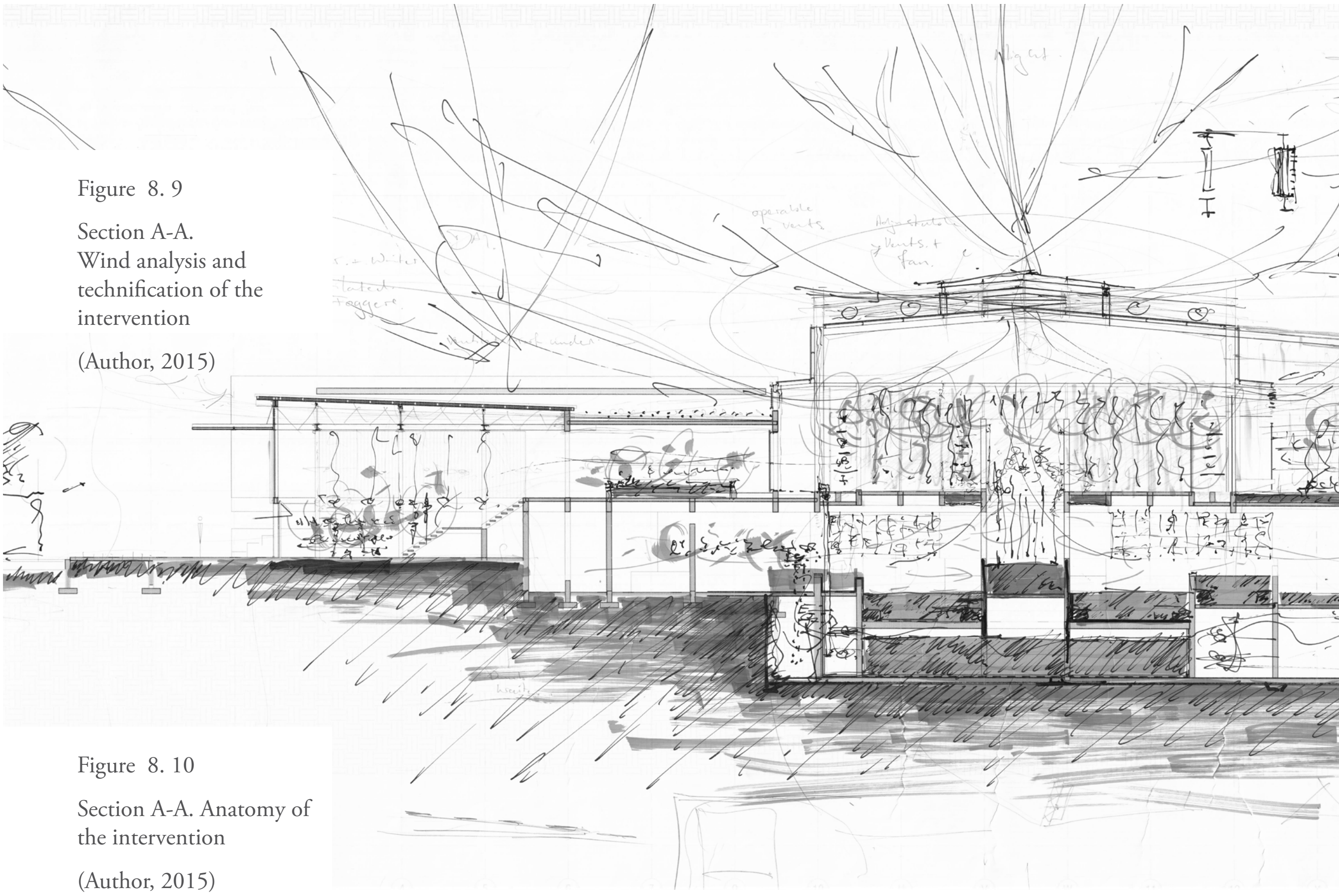


Figure 8. 9

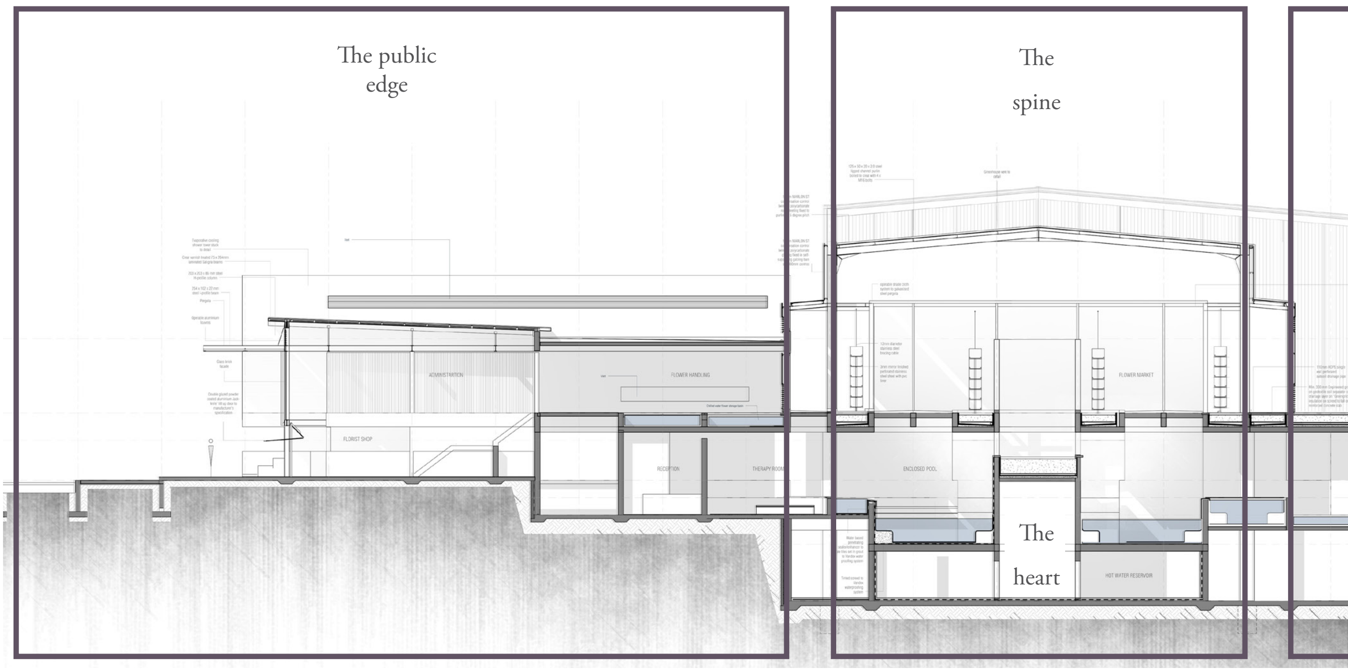
Section A-A.
Wind analysis and technification of the intervention

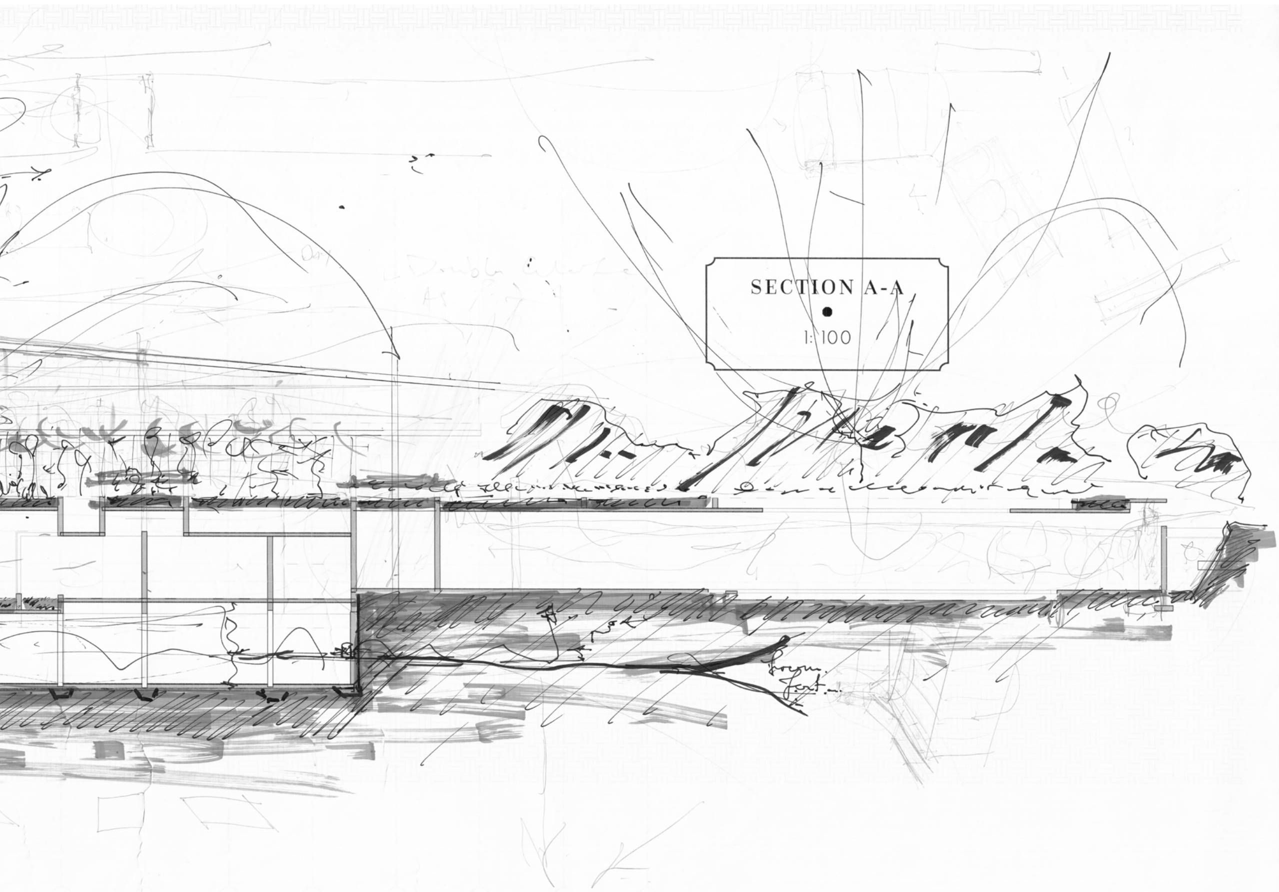
(Author, 2015)

Figure 8. 10

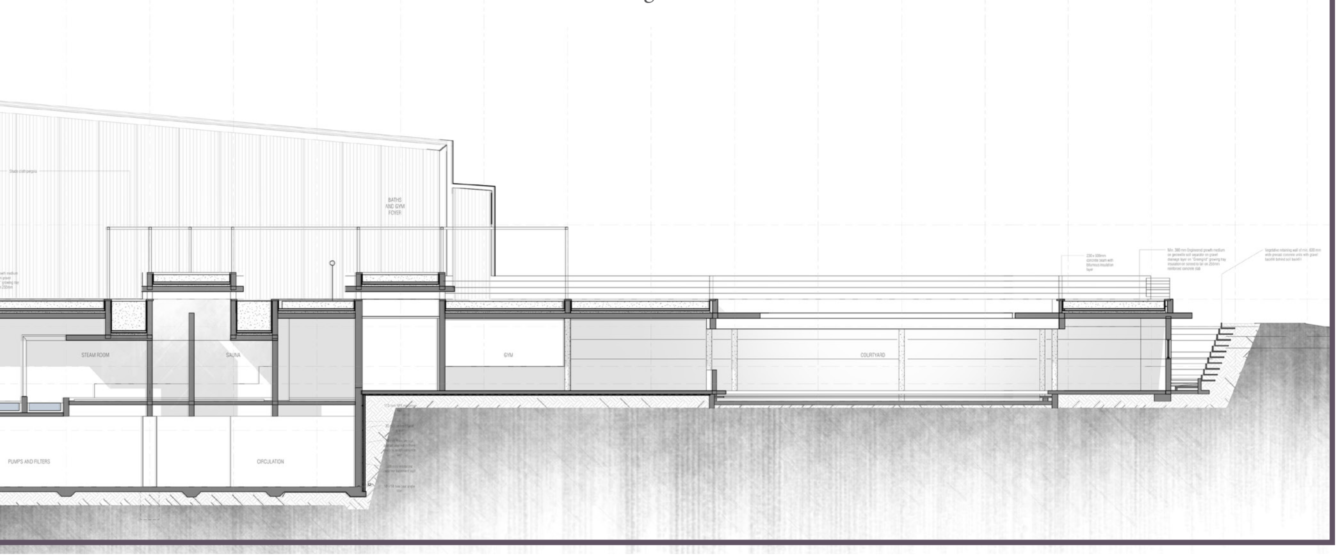
Section A-A. Anatomy of the intervention

(Author, 2015)





The
Recreational
edge



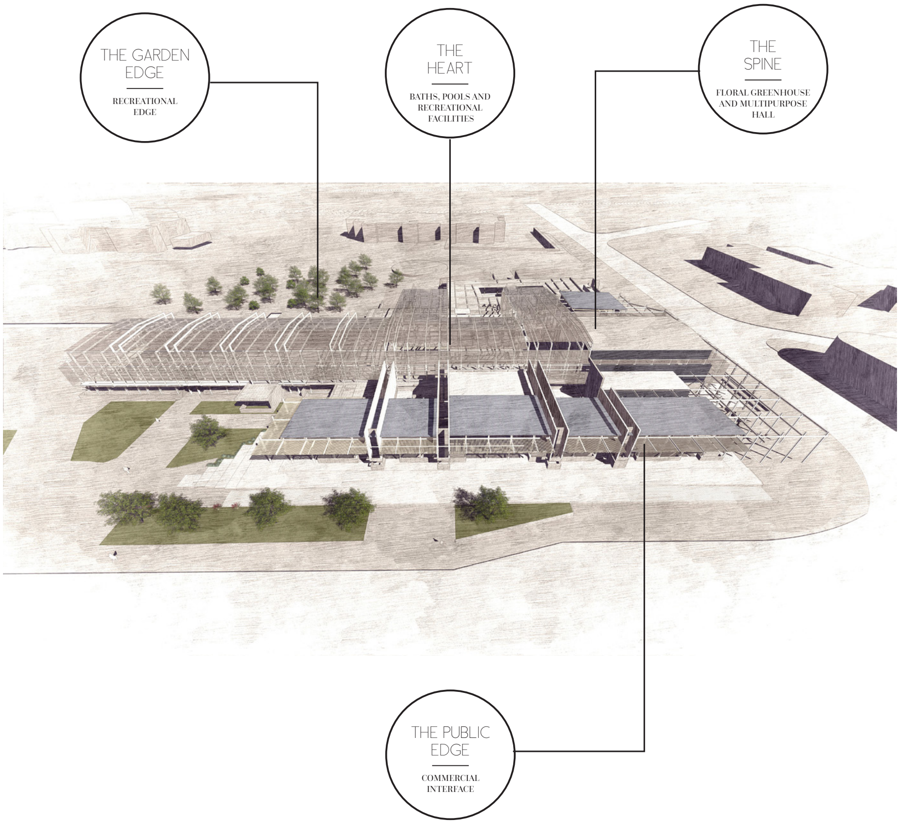


Figure 8.11

Anatomy of the intervention

(Author, 2015)

THE HEART AND SPINE

THE BATHS

Materials

The pools are treated with a darker pigmented screed to create the effect of a more natural pool. Circulation around the pool is of light coloured concrete tiles edged with slip resistant tiles where it meets the pool. A shadow line is created in the form of a drainage channel where it meets the enclosing concrete planters. The deeper spaces around the pool are of slate tiles, where shutter concrete slabs enclose it. The first floor is a slab and beam-system supported by columns with brick infill. The beam-frame edges planters and water bodies on the first level, where smooth soffit frames the enclosed spaces. At the nucleus, the soffit of the slab moves between the top and the bottom of the beam-system, creating planters on this level and a coffered rhythm enclosing the pools. An opening for an Oculus or light shaft above the nucleus - a planter box ringed by the water - is also created.

Figure 8. 12

Section A-A detail. The inherent conditions of the greenhouse volume serve a motoric engine to the ventilation of adjacent spaces. The pools surrounding the central pool are designed as infinity pools which overflow into the central body. Edges to the floral market are lined with stainless steel display boxes and planters to diffuse views onto the pools. (Author, 2015)

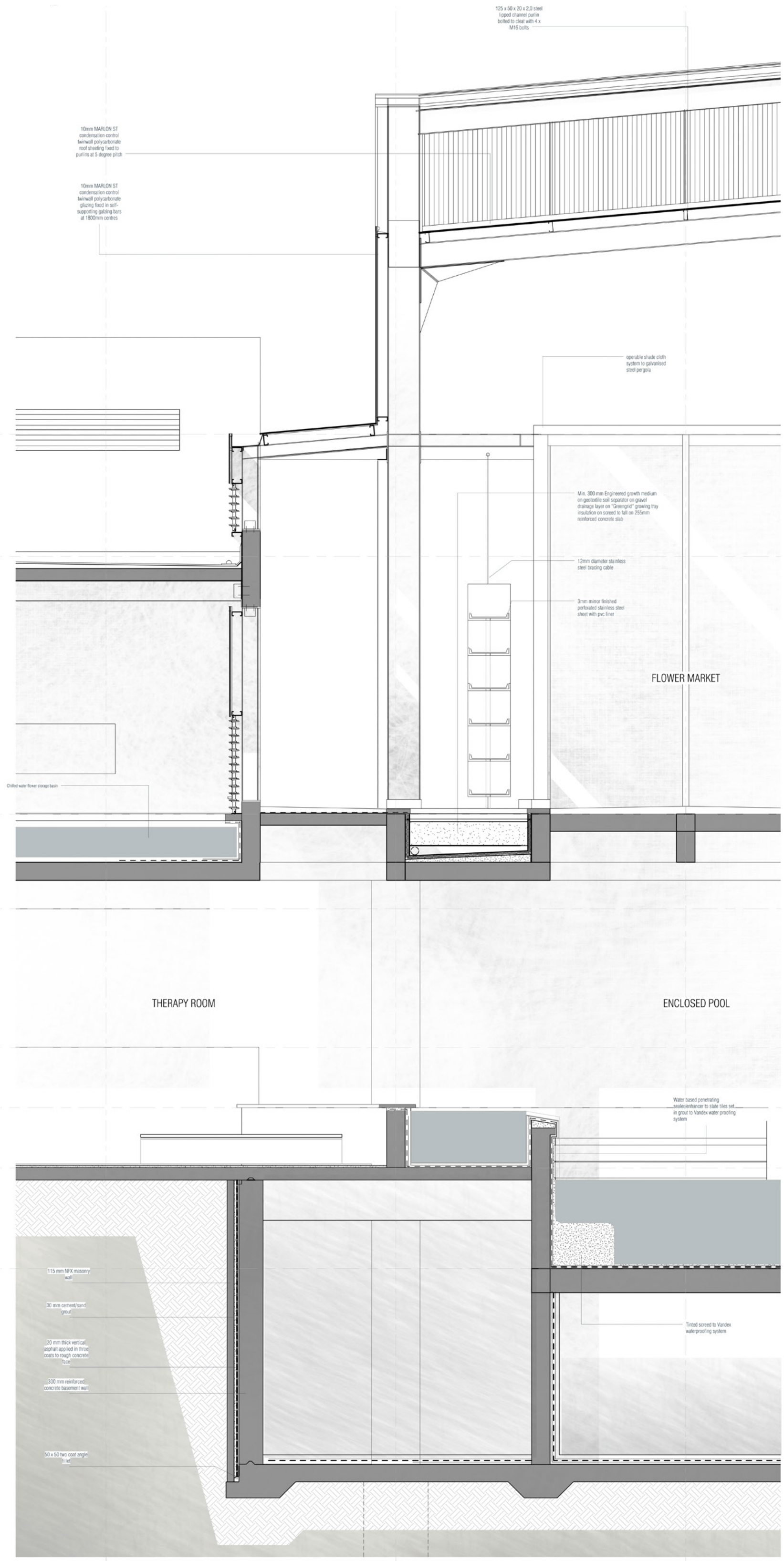
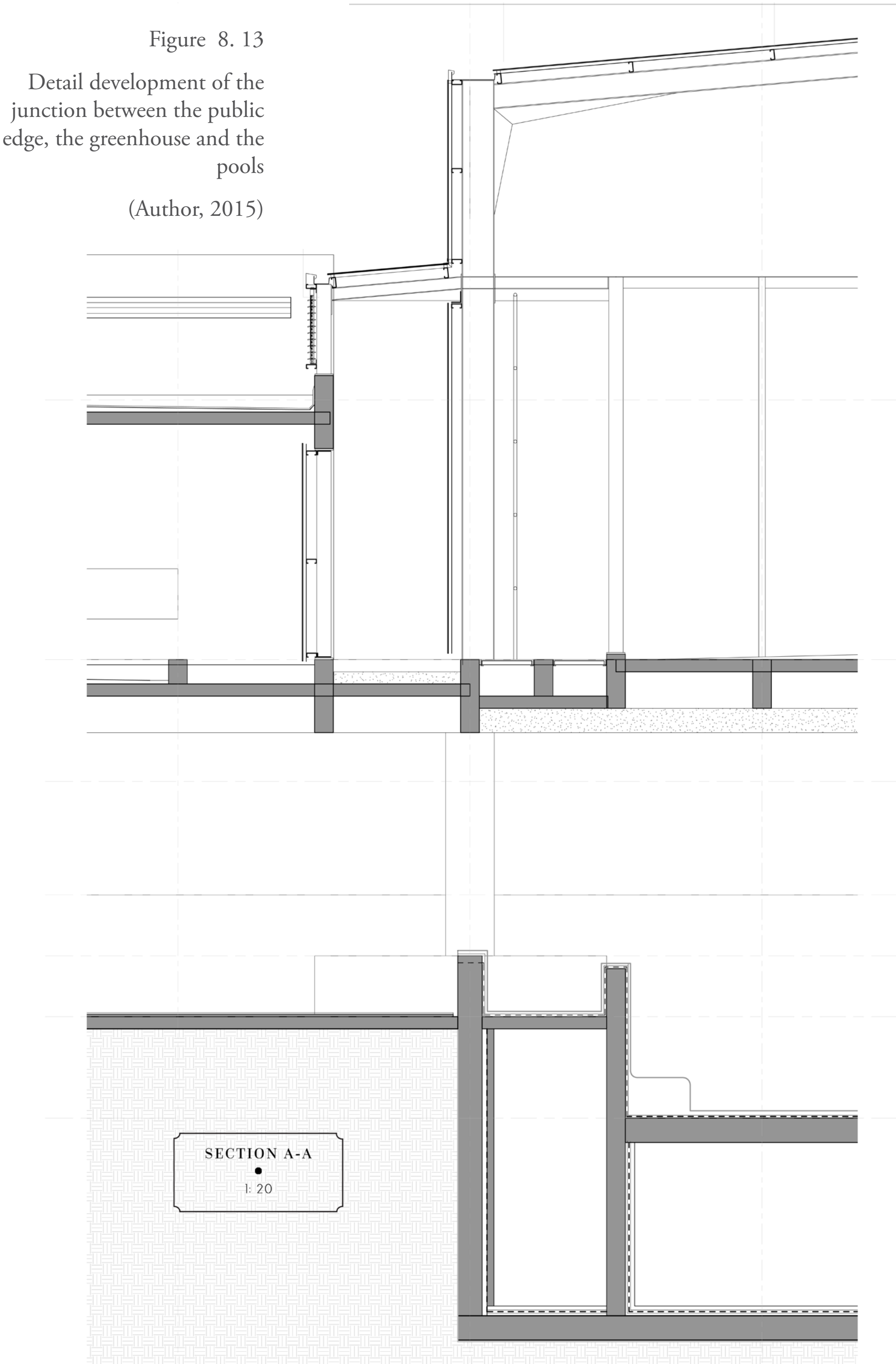

125 x 50 x 20 x 2,0 steel lipped channel purlin bolted to cleat with 4 x M16 bolts
10mm MARLON ST condensation control twinwall polycarbonate roof sheeting fixed to purlins at 5 degree pitch
10mm MARLON ST condensation control twinwall polycarbonate glazing fixed in self-supporting galzing bars at 1800mm centres
operable shade cloth system to galvanised steel pergola
Min. 300 mm Engineered growth medium on geotextile soil separator on gravel drainage layer on "Greengrid" growing tray insulation on screed to fall on 255mm reinforced concrete slab
12mm diameter stainless steel bracing cable
3mm mirror finished perforated stainless steel sheet with pvc liner
FLOWER MARKET
Chilled water flower storage basin
THERAPY ROOM
ENCLOSED POOL
Water based penetrating sealer/enhancer to slate tiles set in grout to Vandex water proofing system
115 mm NFX masonry wall
30 mm cement/sand grout
20 mm thick vertical asphalt applied in three coats to rough concrete face
300 mm reinforced concrete basement wall
50 x 50 two coat angle fillet
Tinted screed to Vandex waterproofing system

Figure 8. 13

Detail development of the junction between the public edge, the greenhouse and the pools

(Author, 2015)



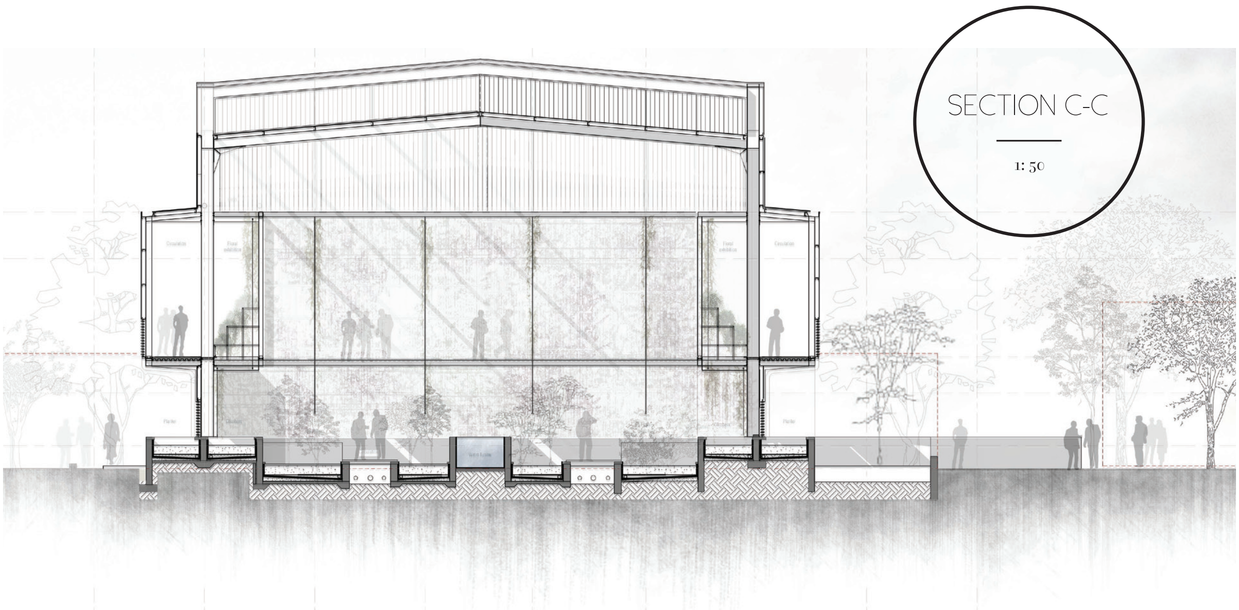
Orientation

The climatic elements to be considered for open-air and protected cultivation (and conservation) of flowers and plants are solar radiation, temperature, precipitation, humidity evaporation and evapotranspiration, and wind velocity (Von Zabeltitz, 2011: 5). In arid regions, such as Bela-Bela, Von Zabiltitz proposes that greenhouses have to protect crops from excessively high irradiation, have efficient ventilators that can be closed during the evenings, and, in the case of low humidity and high temperatures, evaporation cooling should be considered. In the southern hemisphere, and below 40 degrees north latitude, the ridge of single greenhouses should be oriented from north to south, since the angle of the sun is much higher (Ponce-Cruz et al., n.d: 45). This greenhouse is also to serve as tourist attraction and conservatory and thus the focus is not only on crop production but also on the exhibition of indigenous flora.

Figure 8. 14

Section C-C. The greenhouse structure.

(Author, 2015)



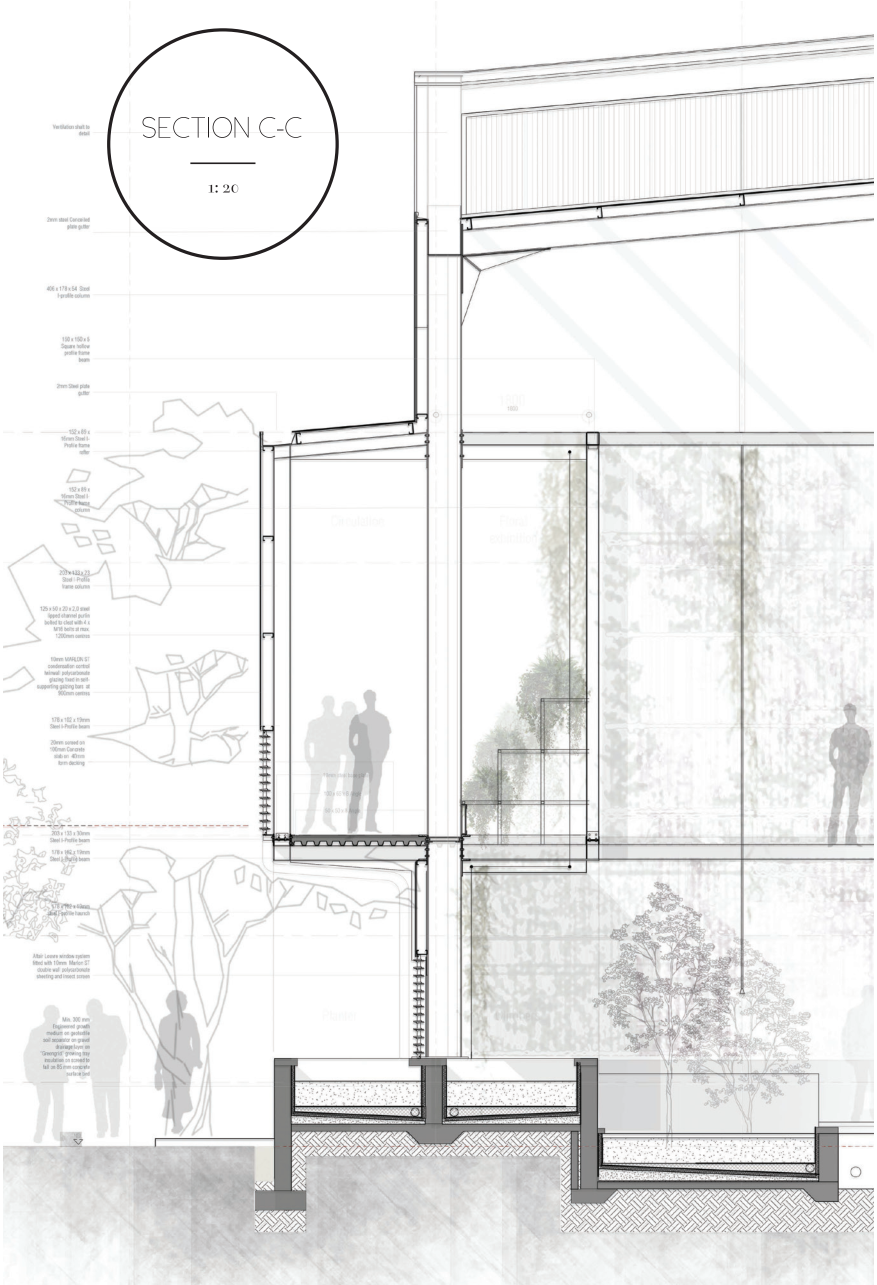

SECTION C-C
1: 20
Ventilation shaft to detail
2mm steel Conceiled plate gutter
406 x 178 x 54 Steel I-profile column
150 x 150 x 5 Square hollow profile frame beam
2mm Steel plate gutter
152 x 89 x 16mm Steel I-Profile frame rafter
152 x 89 x 16mm Steel I-Profile frame column
203 x 133 x 23 Steel I-Profile frame column
125 x 50 x 20 x 2,0 steel lipped channel purlin bolted to cleat with 4 x M16 bolts at max. 1200mm centres
10mm MARLON ST condensation control twinwall polycarbonate glazing fixed in self-supporting galzing bars at 900mm centres
178 x 102 x 19mm Steel I-Profile beam
20mm screed on 100mm Concrete slab on 40mm form decking
203 x 133 x 30mm Steel I-Profile beam
178 x 102 x 19mm Steel I-Profile beam
178 x 102 x 19mm Steel I-profile haunch
Altair Louvre window system fitted with 10mm Marlon ST double wall polycarbonate sheeting and insect screen
Min. 300 mm Engineered growth medium on geotextile soil separator on gravel drainage layer on "Greengrid" growing tray insulation on screed to fall on 85 mm concrete surface bed

Figure 8. 15

Section C-C. Detail. The portal is expanded on first level to form pedestrian circulation on the exterior and floral display on the interior. The display is alternated with climbers

(Author, 2015)

Wind and Ventilation

The moderate speed of the wind necessitate that it be considered when passively ventilating the building. The greenhouse is orientated north-south but the prevailing wind originates from the north. The portal frame is doubled over the walls of the planters where it divides spaces. The frame becomes a shaft that protrudes past the roof of the greenhouse and extends along the fall of the chapel structure. It is covered by translucent sheathing to the north and opens to the south through louvered installation. A negative pressure arising from winds that transverses the shaft stimulates draft which is drawn from the eastern and western sides. Though, the wind is primarily strong during the day, it might not prove sufficient and thus the addition of mechanically aided ventilation through fans along the top of this shaft is proposed. These fans can be operated in times where necessary. The induced draft draws air from cool pockets along the loggias of the building.*Figure 3*: Period surface wind roses for Bela-Bela during the period 2004 - 2008. Environmental Management Framework for the Waterberg District Status Quo Report (EMFWD). (n.d.).

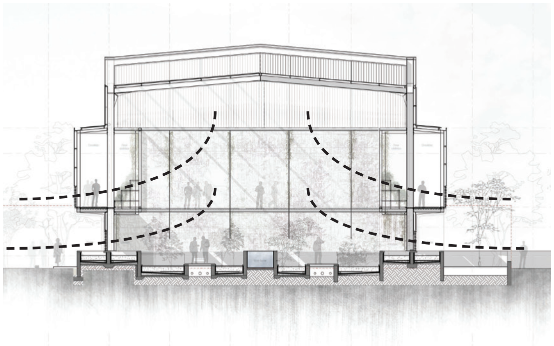


Figure 8.16

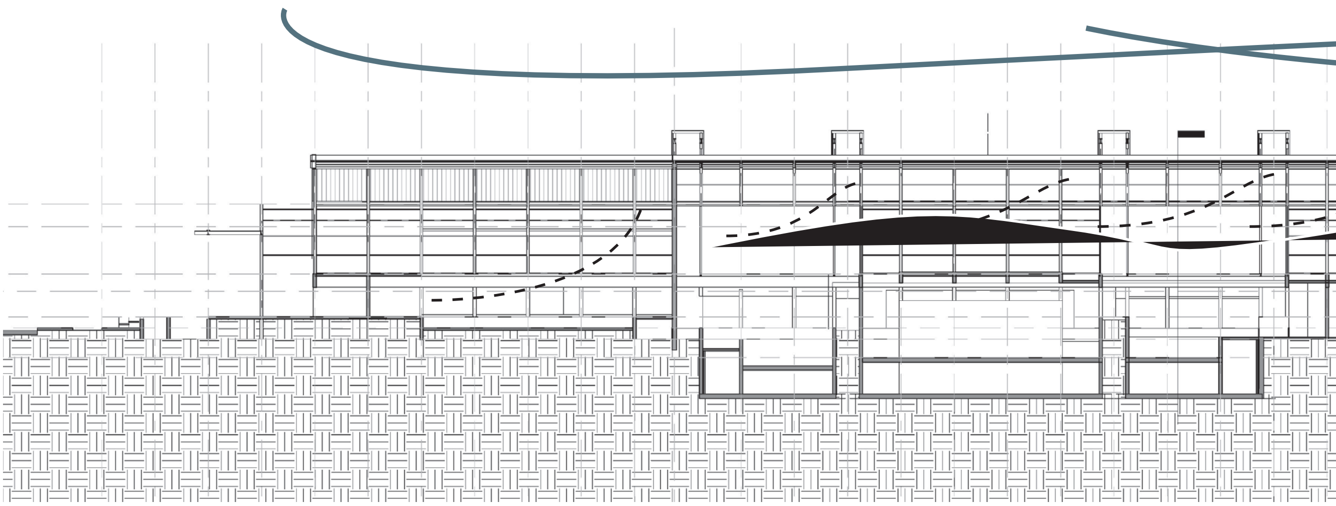
Ventilation strategy with prevailing winds from originating in the north

(Author, 2015)

Figure 8.17

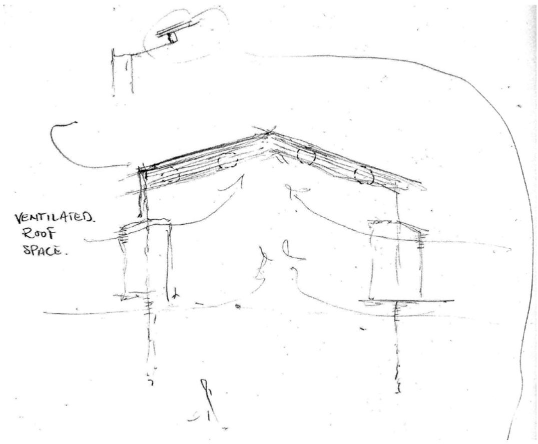
The double skin condensation control polycarbonate sheeting and ventilation system

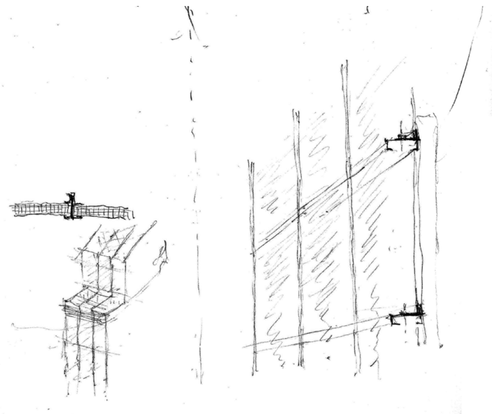
(Author, 2015)

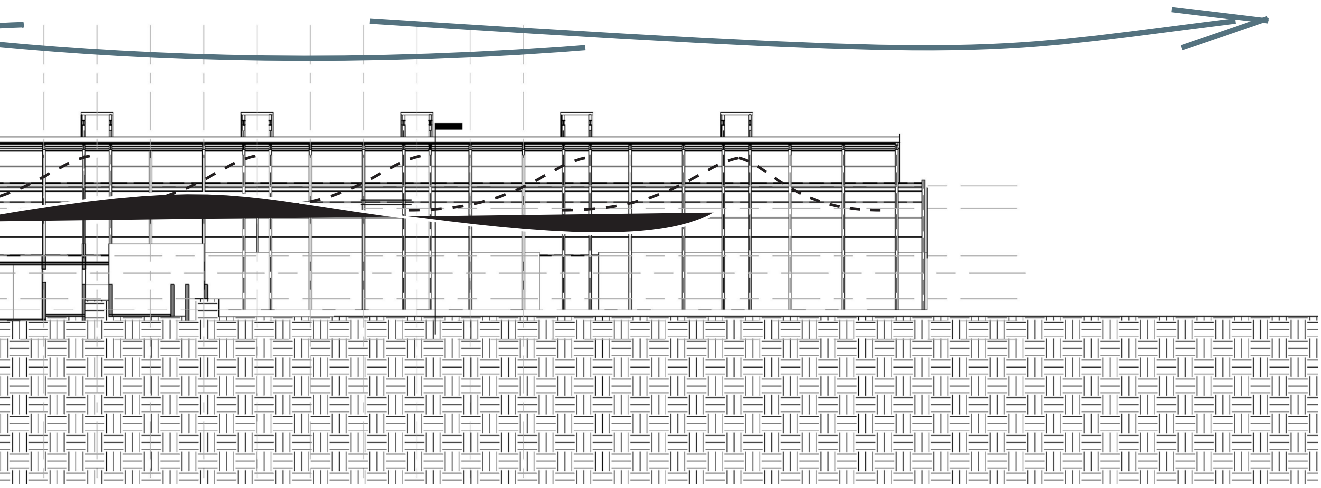


The Skin

The cladding of a greenhouse determines the amount of sunlight reaching the crops, as well as the heat-loss and heat-gain of the structure. A 10mm Marlon ST double wall condensation control polycarbonate sheeting is proposed, as the product achieves the high levels of photosynthetic light transmission necessary for healthy plant growth, and promises high impact resistance, condensation control, and UV protection (brettmartin.com, 2015).







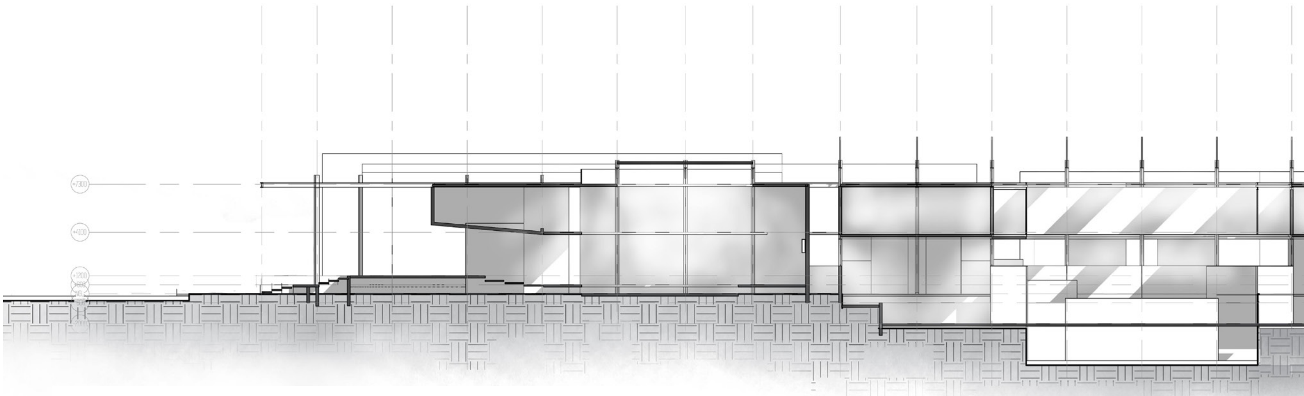
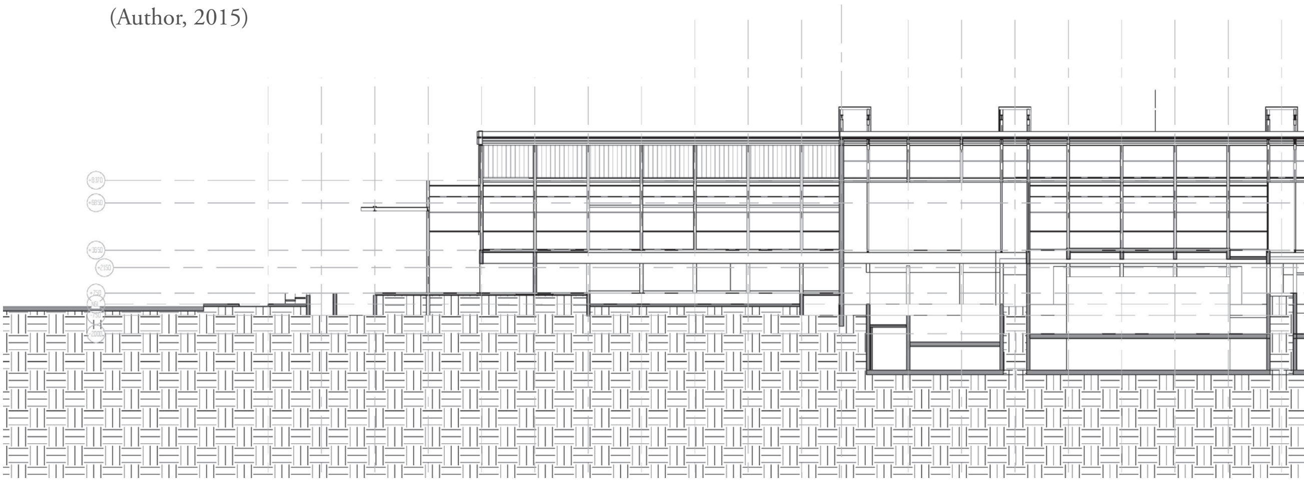
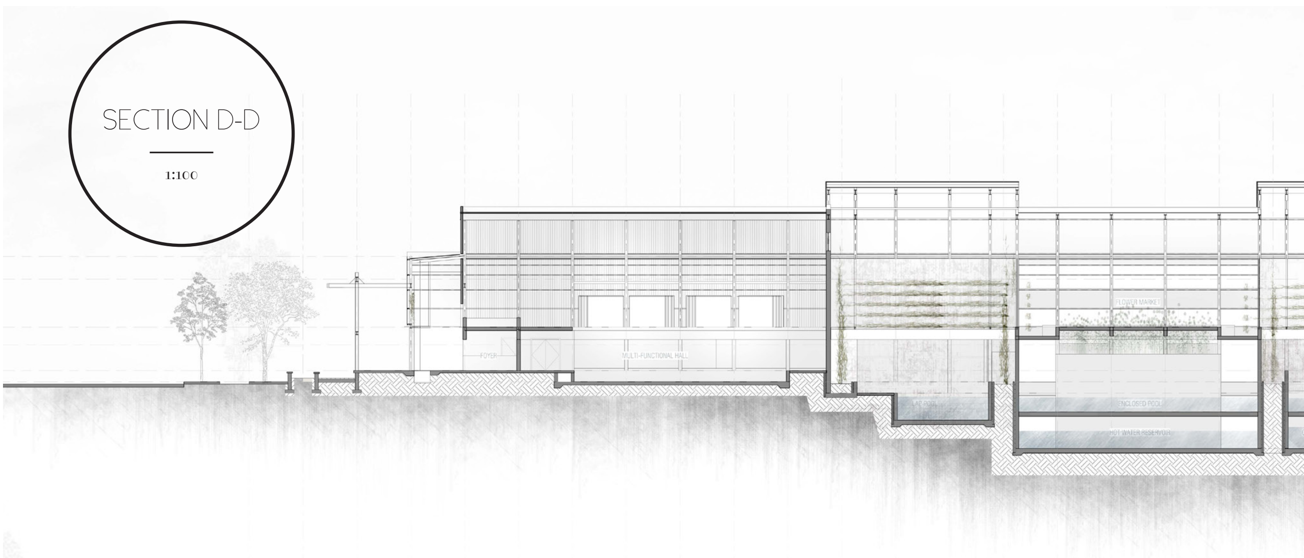


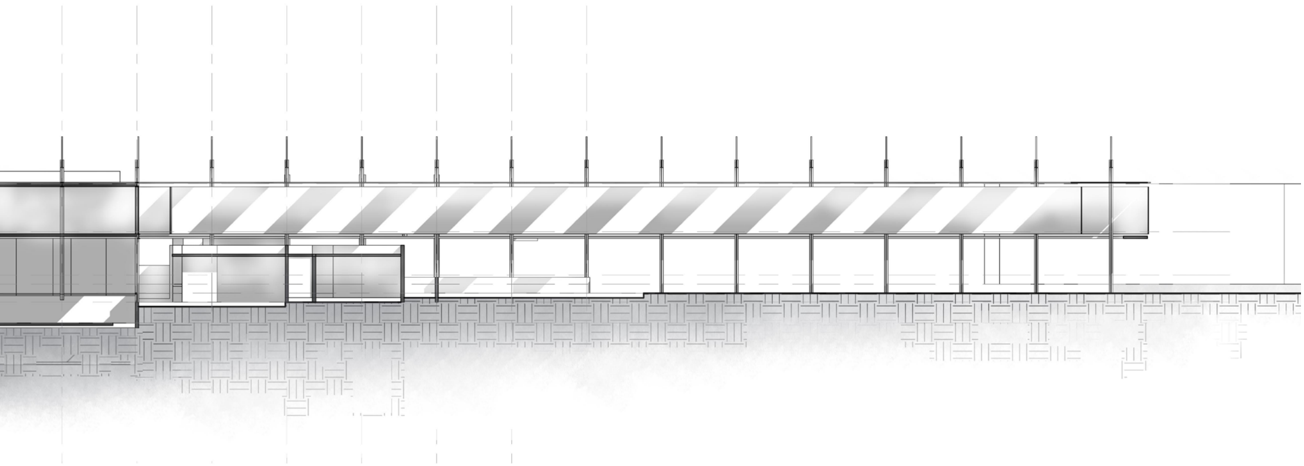
Figure 8.18

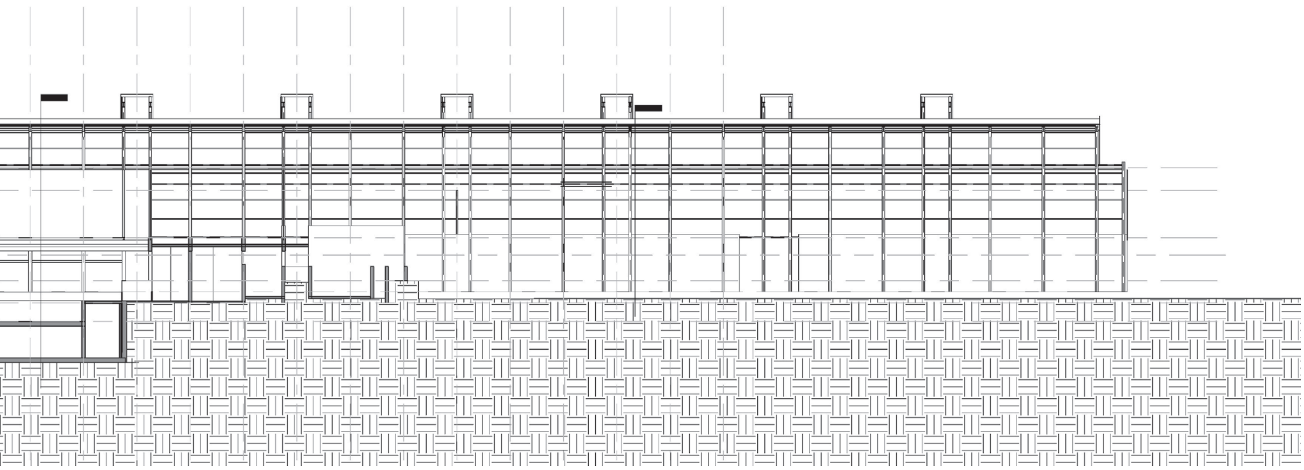
Section D-D development.

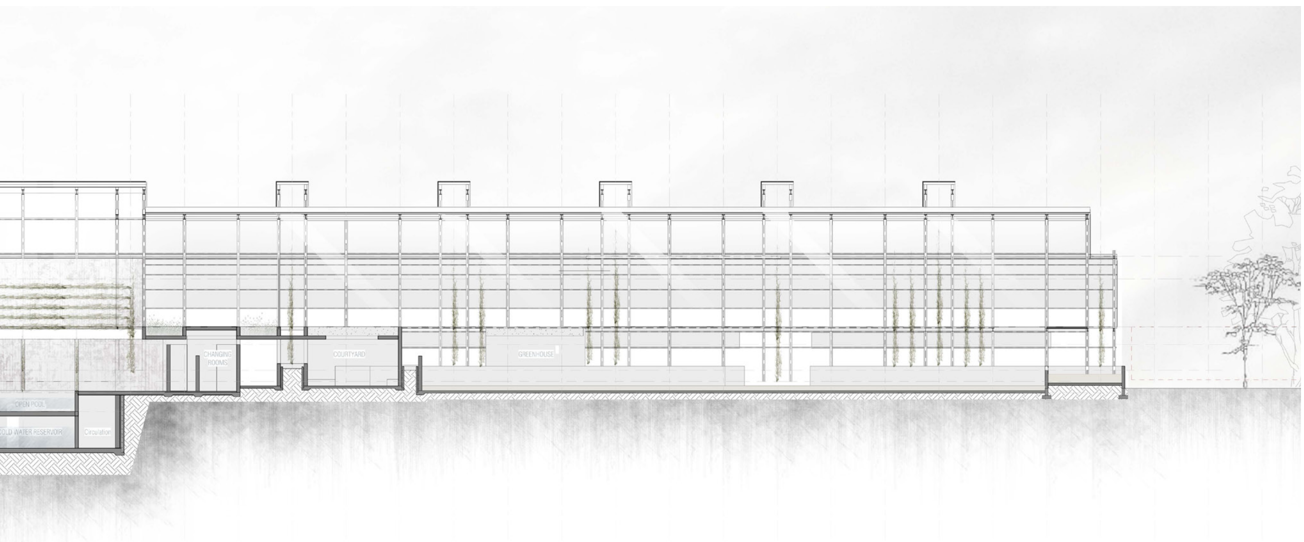
(Author, 2015)










CHANGING ROOMS
COURTYARD
GREENHOUSE
OPEN POOL
COLD WATER RESERVOIR
Circulation

Planting

Planters line the edges of the space to create privacy around the pools. Planter boxes are integral to the floor structure or located on the ground floor from where planters climb. Suspended off these edges is a 3mm Stainless Steel net secured in between 12mm edge cables. The proposed climbers are the *Jasminum* species along the north-south axis and the *Clemantis* species along the east-west axis, as their colours articulate the intersecting lines of the channels. Misters along these edges, along with the ventilation system, ensure a regular distribution of moisture throughout the space.

The intervention furthermore hosts a conservatory for indigenous plants of South Africa and the Waterberg region. The first level hosts this exhibition where the first floor structure interchanges between down stand beams (to articulate overhead surfaces) and upstand beams to form planter boxes for the conservatory and nursery.

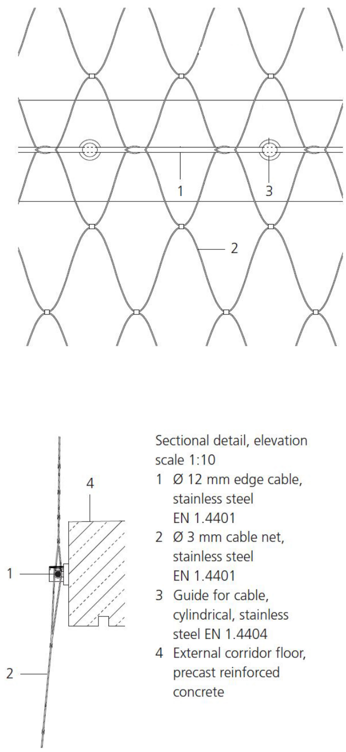


Figure 8. 19

Climbers support detail

(Author, 2015)

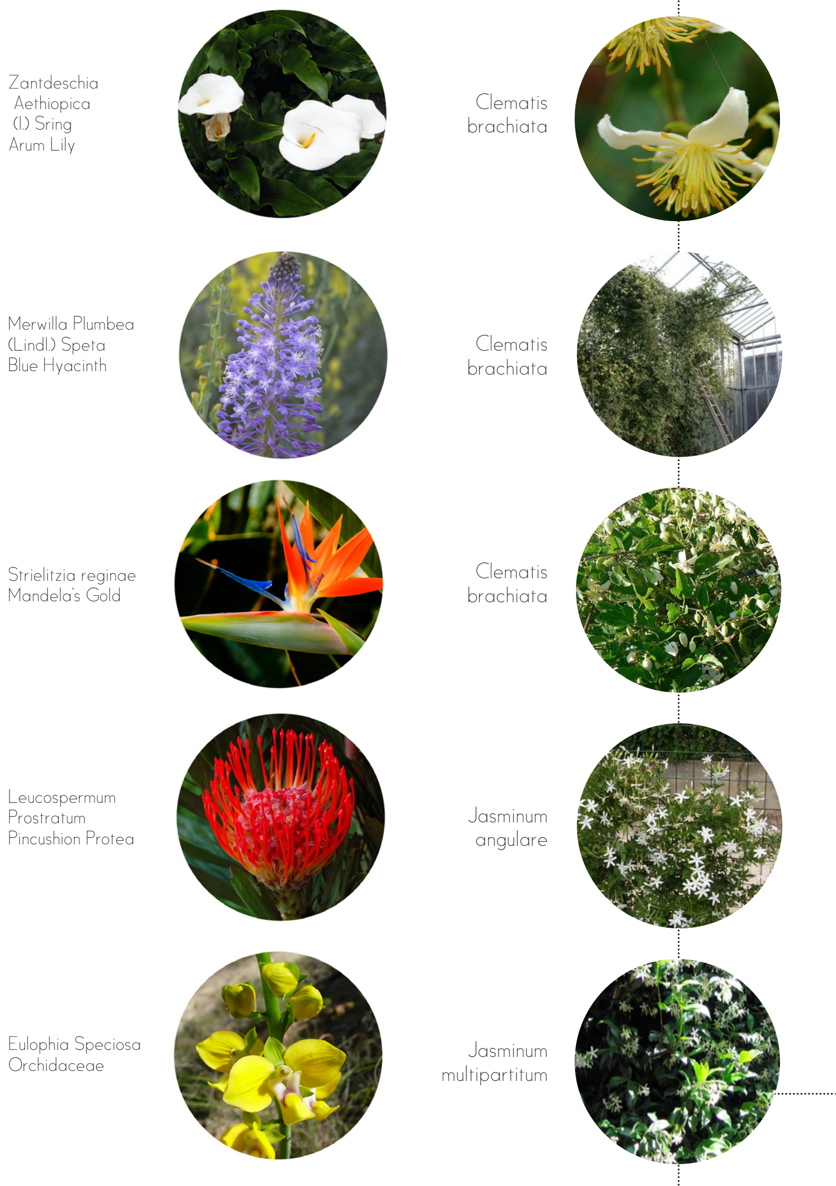


Figure 8. 20

Specification of climbers and indigenous planting

(Author, 2015)

THE HALL

The structure of the greenhouse extends into the hall and becomes its structure too. The circulation level becomes galleries that ring and live out onto the hall, with the eastern gallery extending into the greenhouse. A suspended ceiling, along with the provision of earth tubes, aid in converting the structure into a habitable space. The ventilation strategy yields a negative pressure to occur in the southern wall of the hall. This pressure draws air from earth tubes that surface at the north of the hall to ventilate the hall. It also draws air from the north through the ceiling cavity to ventilate and cool the void.

THE RECREATIONAL EDGE

Materials

The gym, as an extension to the recreational facilities, adopts its materiality. The roof is off shutter concrete where the upstand beams are used to frame soil for planters. A beam system is proposed that minimises columns in the gym surrounding the courtyard.

Passive Systems

The planters that line the internal edges of the gym are equipped with misters to be used for the cooling of the direct environment. The thick soil mass of the planters between beams insulates the space. The enclosing edges of the internal space are lined with earth tubes that draws air at desired temperature into the space as heat rises towards the courtyard and the wind from the north transverses it.

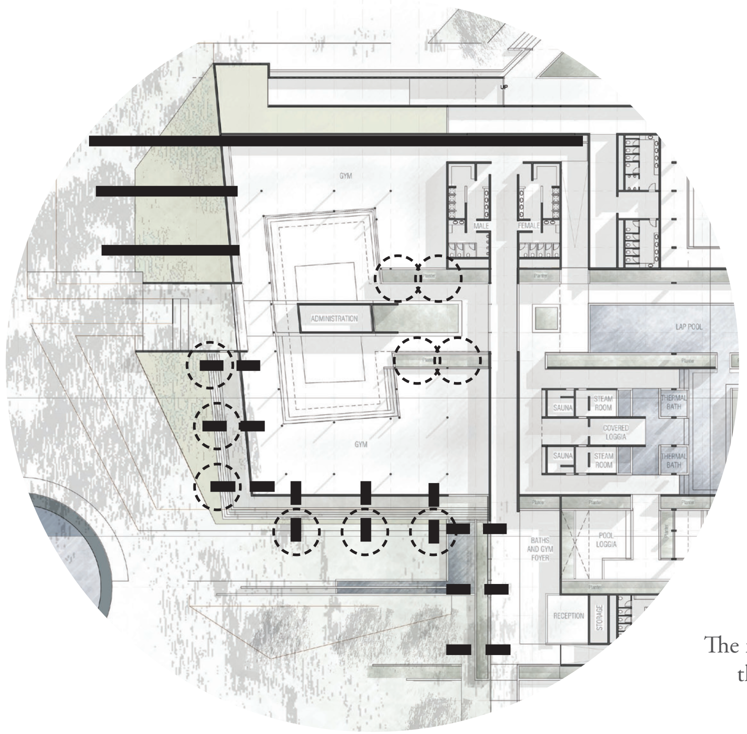


Figure 8. 21

The recreational edge and the passive ventilation strategy

(Author, 2015)

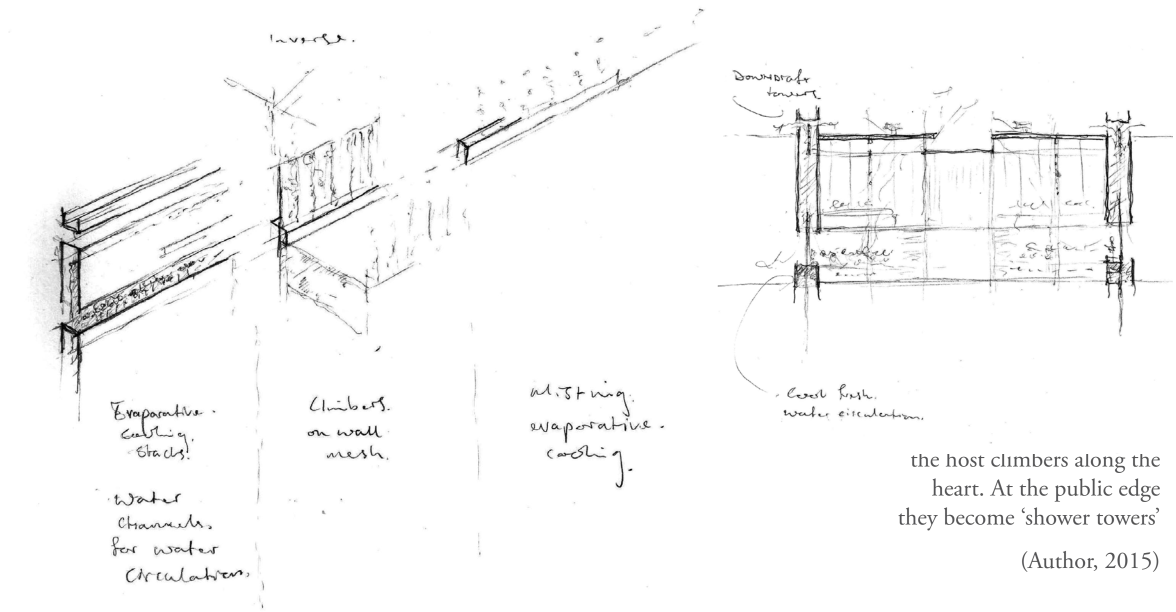
THE PUBLIC EDGE

Materials

The street edge to the east is composed of tectonic double volume spaces, intercepted rhythmically by the stereotomic stacks that run west-to-east. The stacks are bagged and painted so as to appear as a monolithic structure with openings along the length. The roof over the double volume has a double composite structure, with the steel beam frame erected as primary support. This structure supports a mono-pitched laminated saligna beam that spans from the east, and slopes to the west to drain water towards the reservoir. The primary steel frame supports form decking and concrete over the extension between the greenhouse and the florist to insulate the space.

Passive downdraft stacks

The stacks are extended past the roof structure to intercept and channel the prevailing wind from the north into the shaft past the misters to aid in a downdraft. The stack opens at ground level where it serves as conduit for the circulation of cold water that, in return, serves as a drip tray to the misters. These openings service the spaces with cool, moist air. The street edge of the stacks are planted walls, while a shading device is implemented, fronting the glazed façade, to shade spaces from a low sun angle from the east.



the host climbers along the heart. At the public edge they become 'shower towers'

(Author, 2015)

Iteration

The theme of the Oculus inspired a coffered roof system over double volume spaces with polycarbonate as roof sheeting. This design entails detailed steel spaceframe constructions that provide a homogeneous condition for the uninterrupted flow of space and a direct relationship between sky and earth. However, this design entails concealed gutters at each grid line and an intricate and skilled assembly, and thus it was decided to simplify the roof construction while retaining a depth in the structure and coffer articulation.

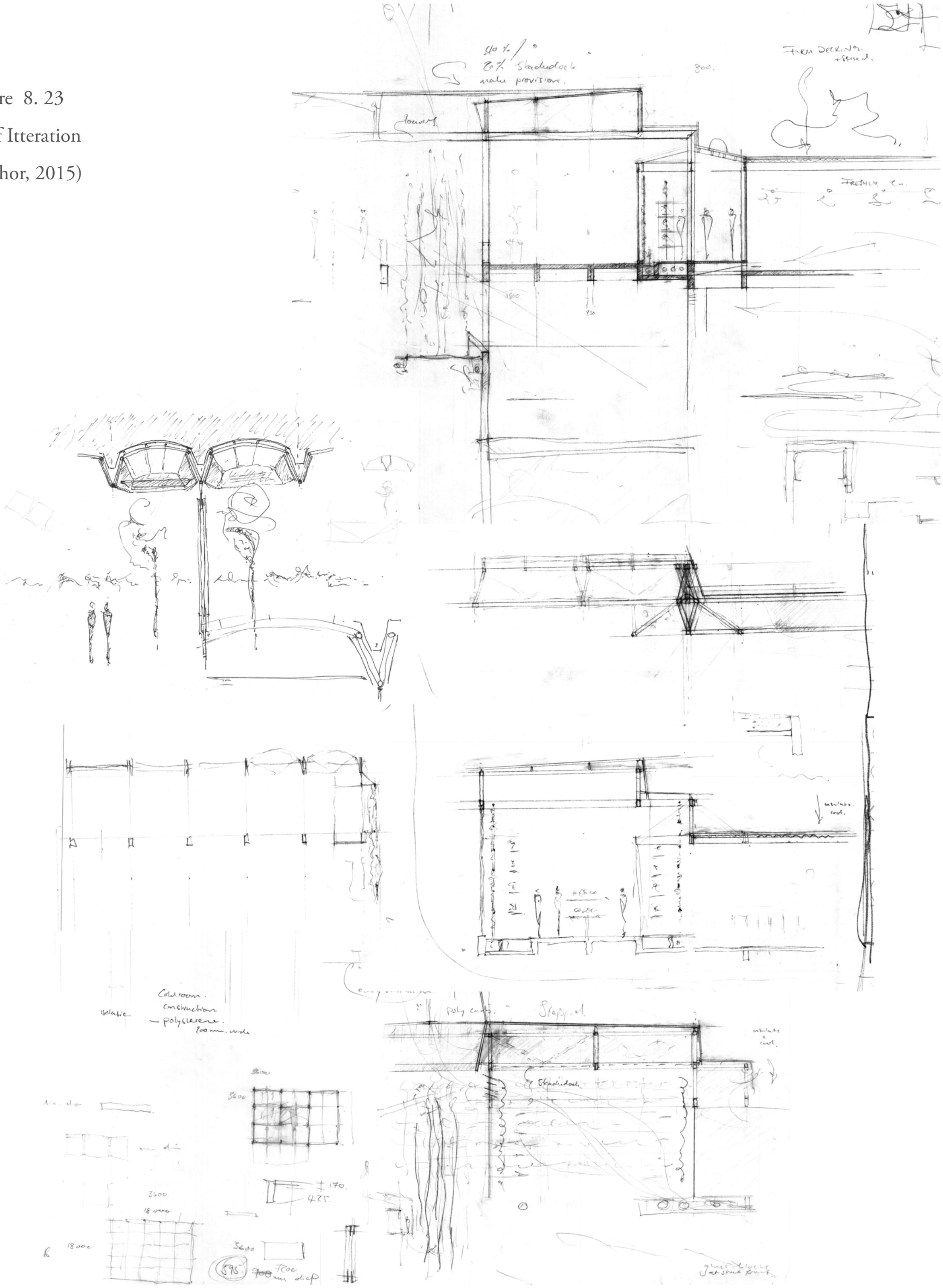


Figure 8. 23
Roof Itteration
(Author, 2015)

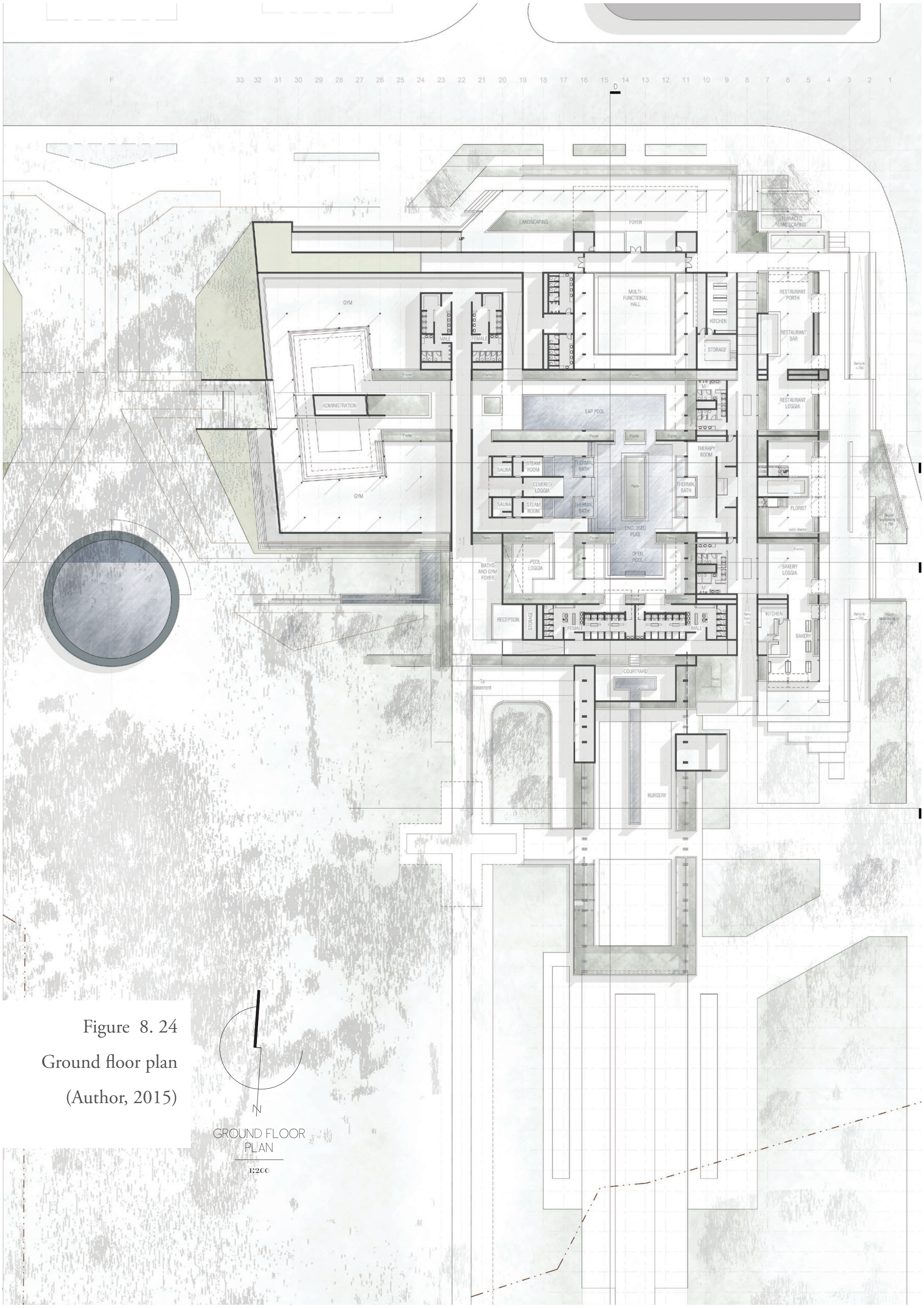


Figure 8. 24

Ground floor plan

(Author, 2015)

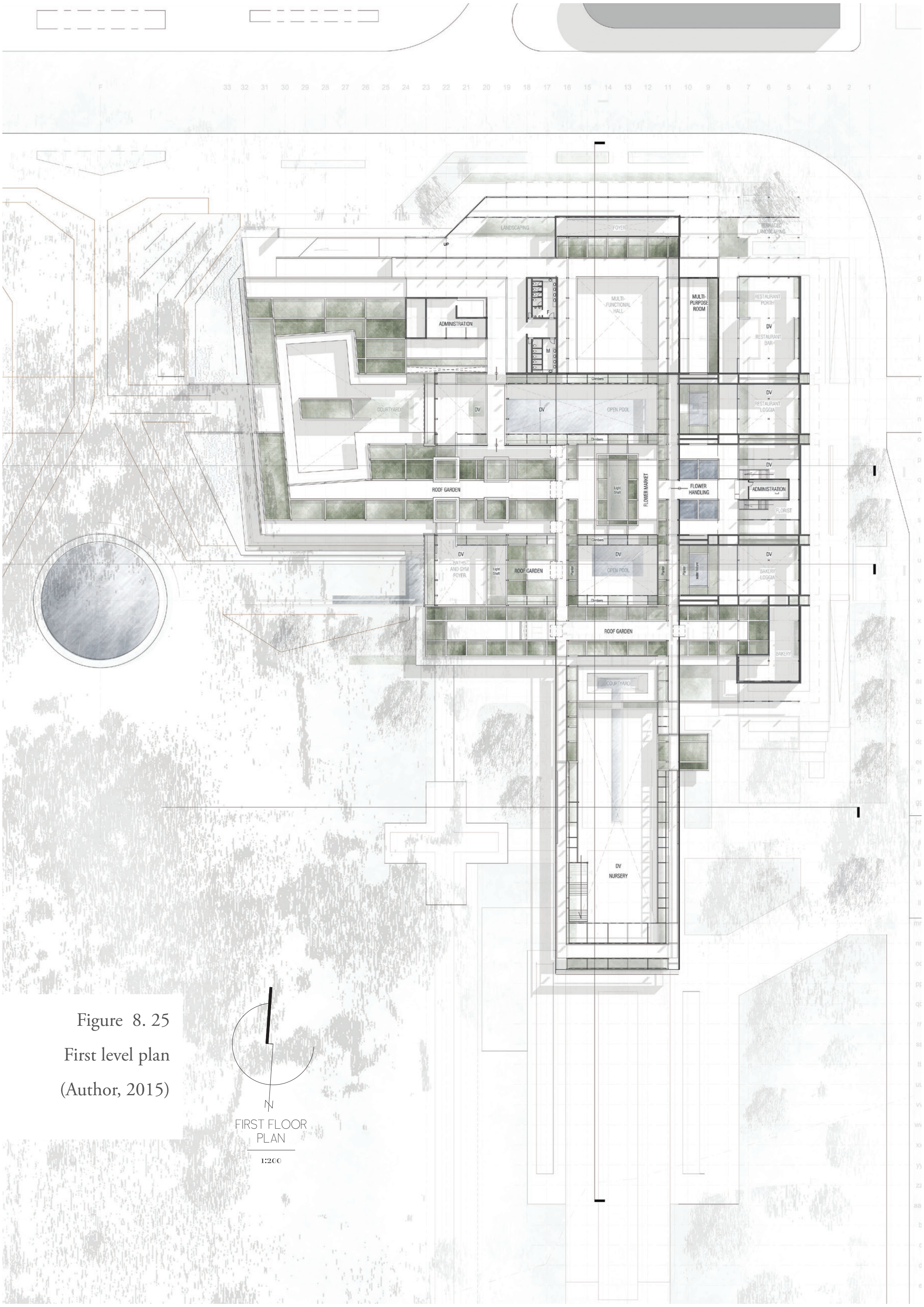
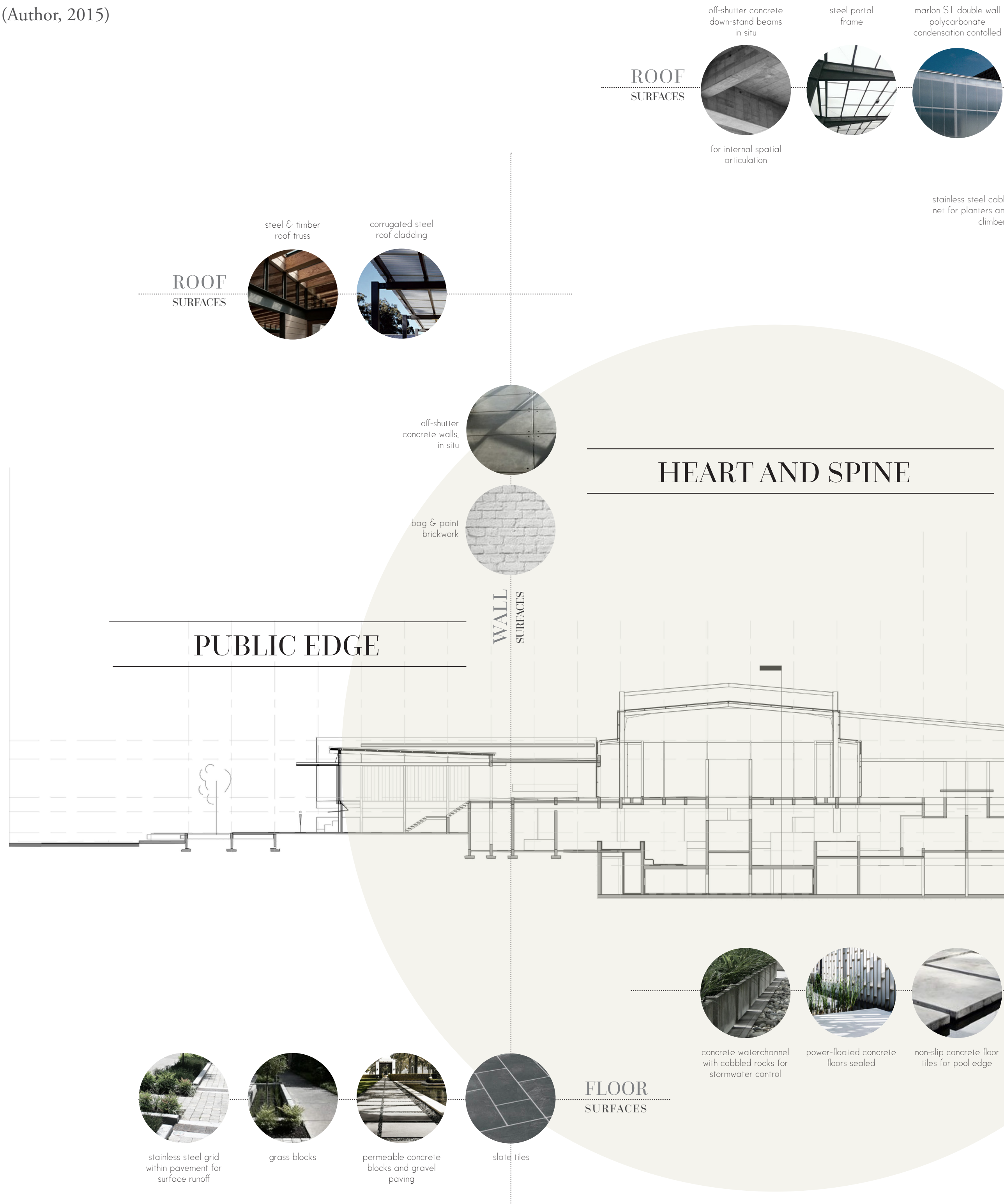
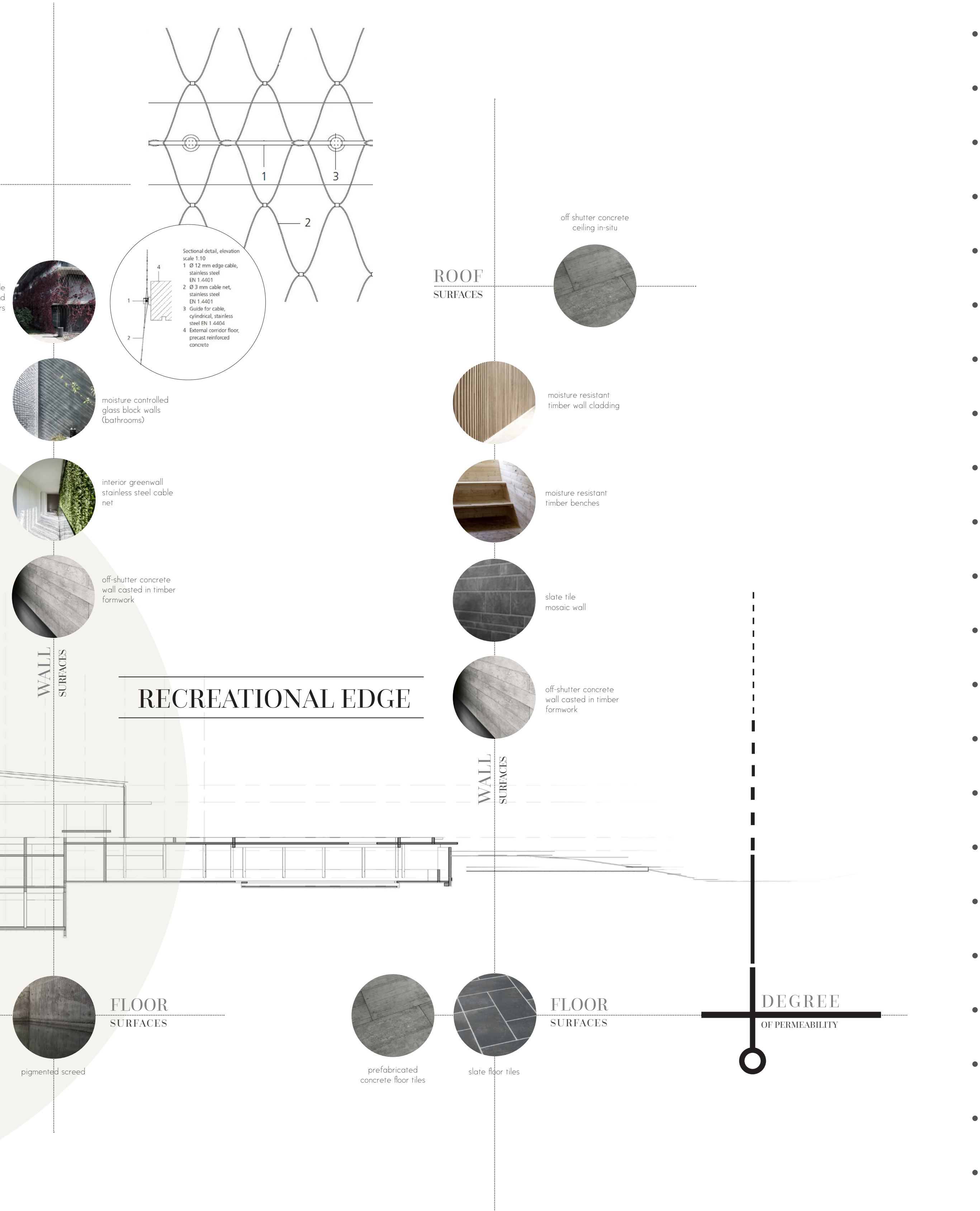


Figure 8. 25
First level plan
(Author, 2015)

Figure 8. 26
Material palette
(Author, 2015)




1
3
2
Sectional detail, elevation scale 1:10
1 Ø 12 mm edge cable, stainless steel EN 1.4401
2 Ø 3 mm cable net, stainless steel EN 1.4401
3 Guide for cable, cylindrical, stainless steel EN 1.4404
4 External corridor floor, precast reinforced concrete
moisture controlled glass block walls (bathrooms)
interior greenwall stainless steel cable net
off-shutter concrete wall casted in timber formwork
WALL SURFACES
RECREATIONAL EDGE
FLOOR SURFACES
pigmented screed
off shutter concrete ceiling in-situ
ROOF SURFACES
moisture resistant timber wall cladding
moisture resistant timber benches
slate tile mosaic wall
off-shutter concrete wall casted in timber formwork
WALL SURFACES
prefabricated concrete floor tiles
slate floor tiles
FLOOR SURFACES
DEGREE OF PERMEABILITY

WATER SYSTEMS

There exists two sources that supply water to the resort. Mineral-rich water is supplied via the Warmbaths fountain and potable water from a local borehole. The fountain has ample capacity to responsibly supply additional facilities with water, while the spare capacity on the borehole is estimated 20 000 l/h (Basson. Personal communication, 201e). The facilities treat the water with chlorine gas and an aluminium sulphate binding agent for dirt particles. The small quantity of chlorine gas, one to two parts per million, ensures clear water that supports biodiversity, aquatic life, and irrigation from the water flushed subsequently from the pools and baths (Basson, W. 2015: Personal communication).

HOT WATER

Water is pumped from the fountain into a central reservoir within the new facilities' basement. Here, the water is treated by the same method as the Hydro Spa. The treated water is circulated through the interconnected baths by a pump, and through a series of sand filters which provided a circulation for the baths. Heat exchangers are implemented that connect with the facilities' boiler and intercepts the supply to regain higher temperatures after an initial cool down.

POTABLE WATER

A reservoir edges the hot water reservoir to the south. It receives rainwater collected from the roof runoff and also greywater from the changing facilities. This body is connected with the borehole to provide additional capacity when necessary and is equipped with an overflow to drain into the resort's existing water drainage filtration system. The water is treated by circulating it through a course sand filter, a sand-granular activated carbon filter (GAC), an ultraviolet filter (UV) and a chlorinator (Cl). The water is then circulated through the wetlands on-site and also supplies the conservatory and greenhouse with water for irrigation. The water is circulated through the flower basins that host fresh cut flowers within the florist. Above these basin channels, water from the same source services the evaporative cooling system and irrigation system. At recreational edge, the water also serves the gym's flash evaporative cooling system.

DRAINAGE

The drainage from the pools and storm water collected from ground surfaces flow into the existing natural filtration system of the resort, as with the existing water facilities. Drainage from greenhouse irrigation, planters and flower basins also flows into this system. Black water drains into the municipal sewer.

Figure 8. 28

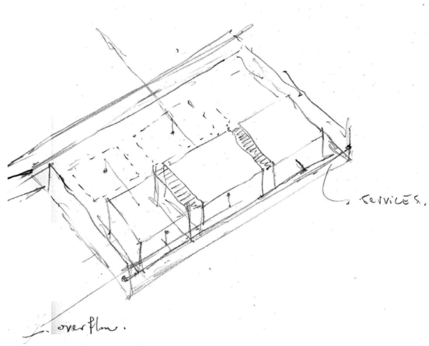
Water storage and filtration system. The opening of the basement edges allows ventilation to cross over cold water storage and for access to service pipes

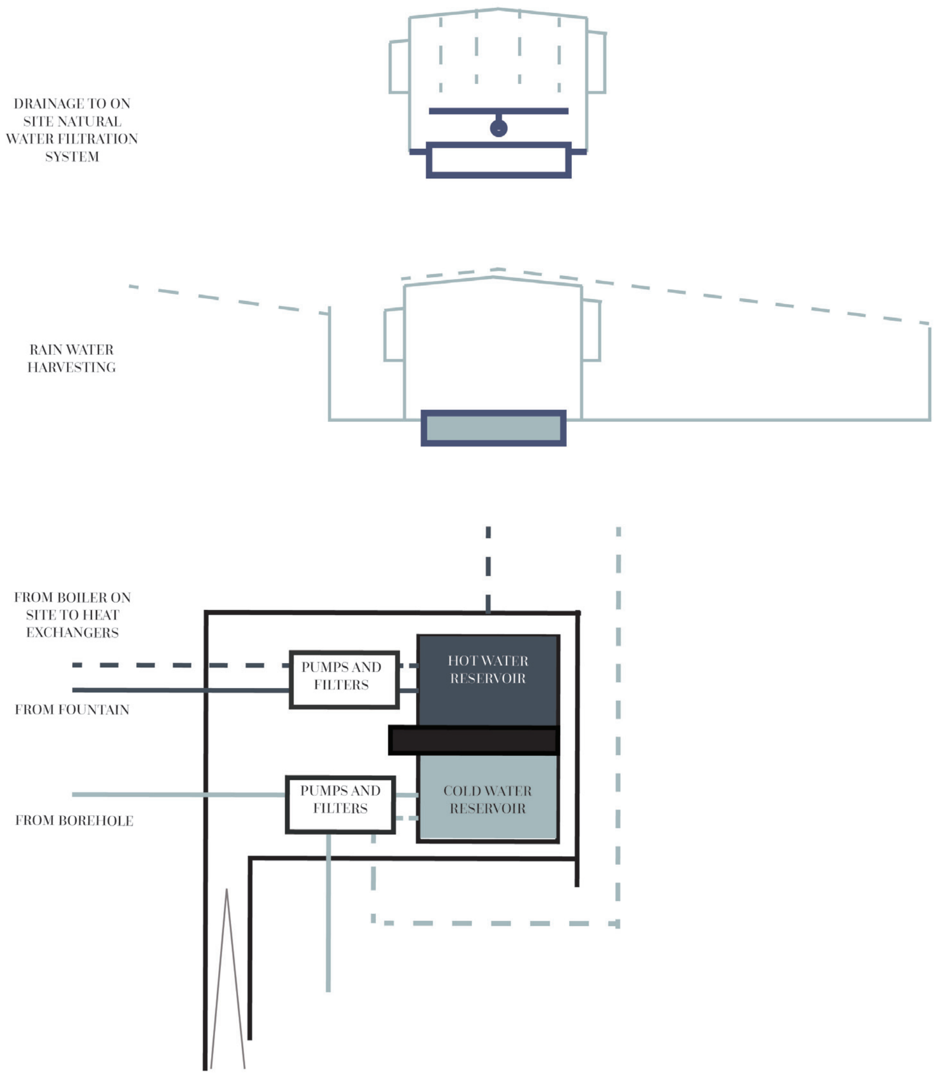
(Author, 2015)

Figure 8. 27

Basement and water reservoir construction. The hot and cold water reservoirs are seperated by soil infill between skins

(Author, 2015)





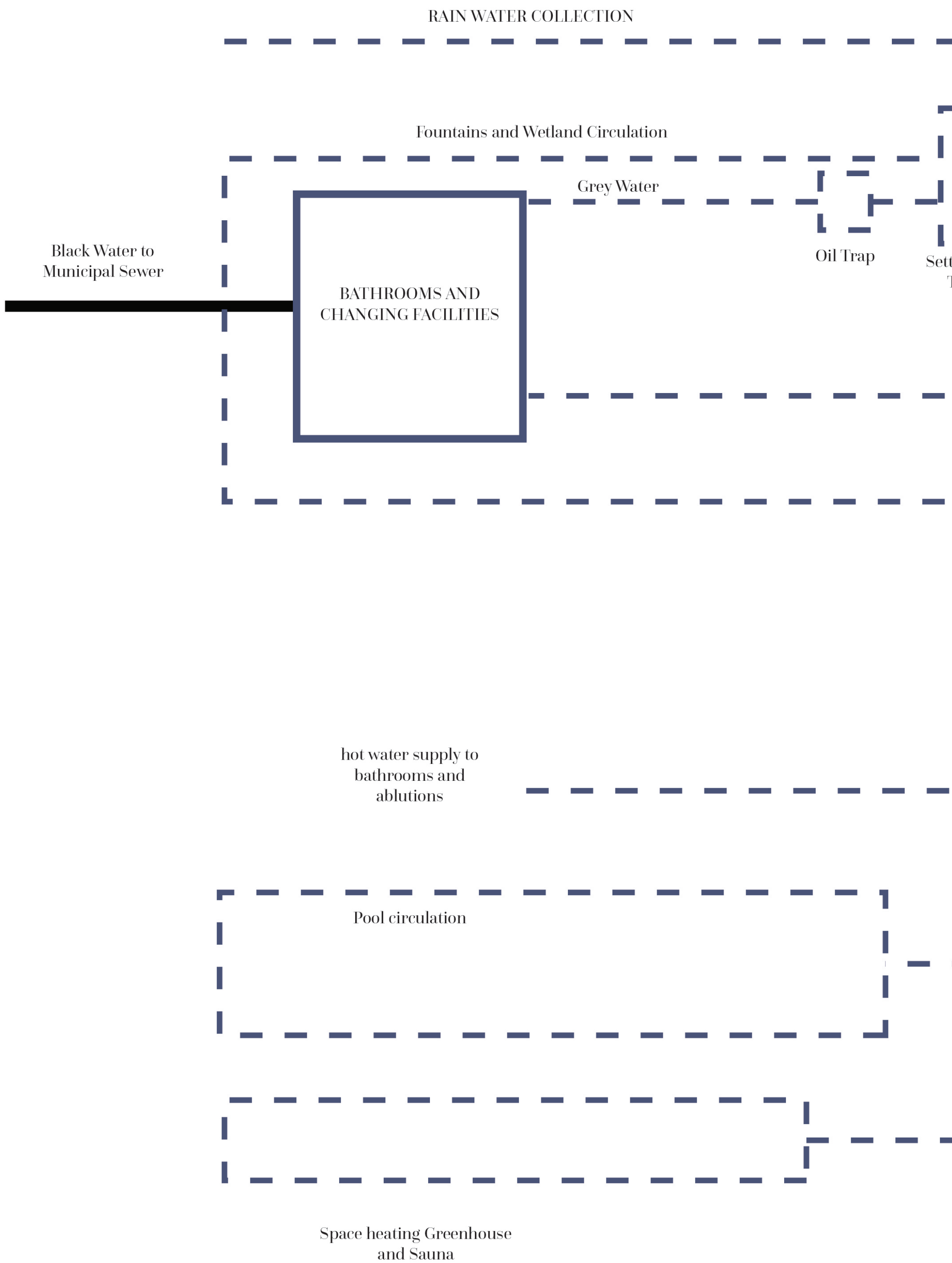

RAIN WATER COLLECTION
Fountains and Wetland Circulation
Grey Water
Oil Trap
Black Water to
Municipal Sewer
BATHROOMS AND
CHANGING FACILITIES
hot water supply to
bathrooms and
ablutions
Pool circulation
Space heating Greenhouse
and Sauna

Figure 8. 29

Water system

(Author, 2015)

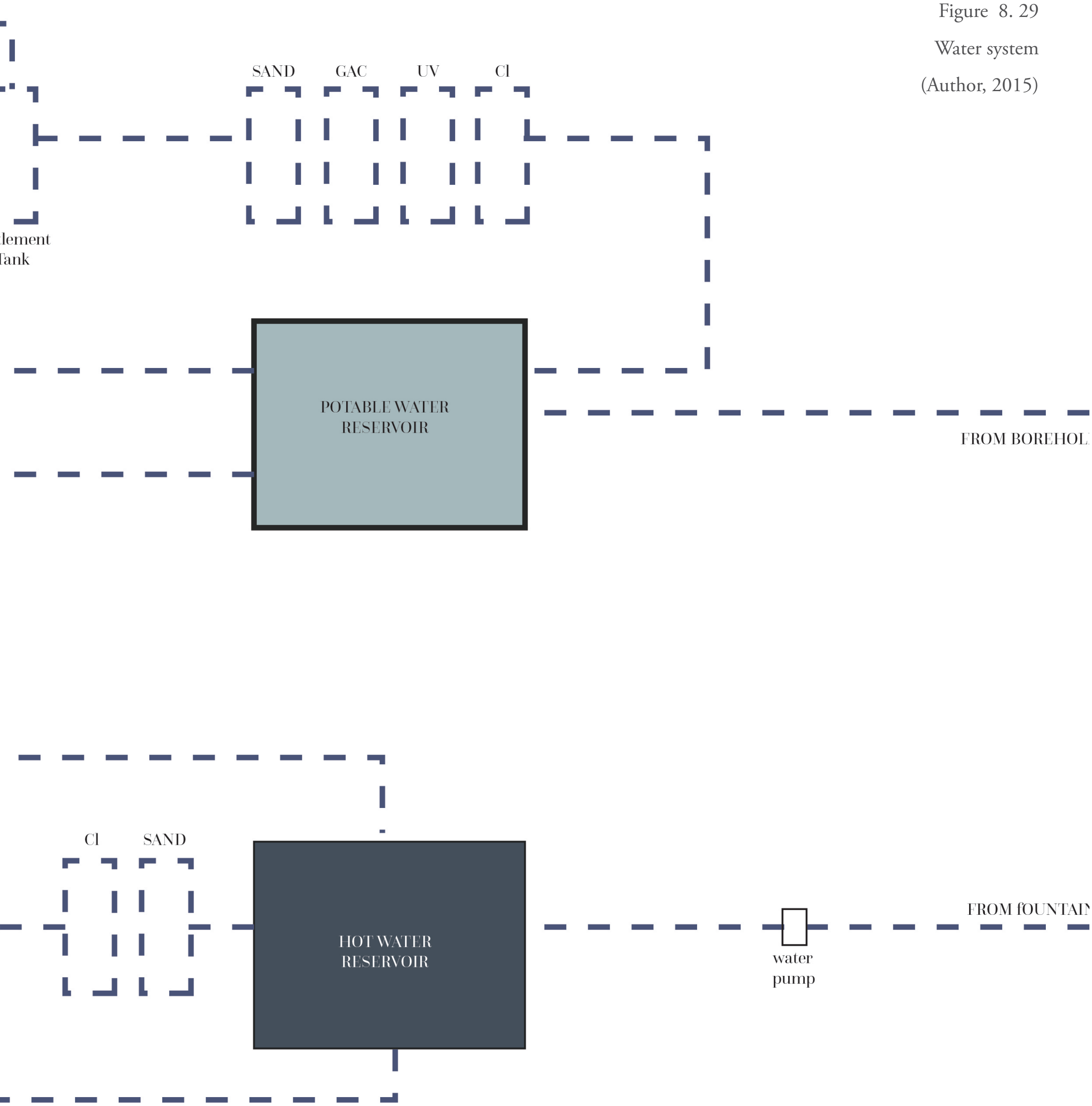
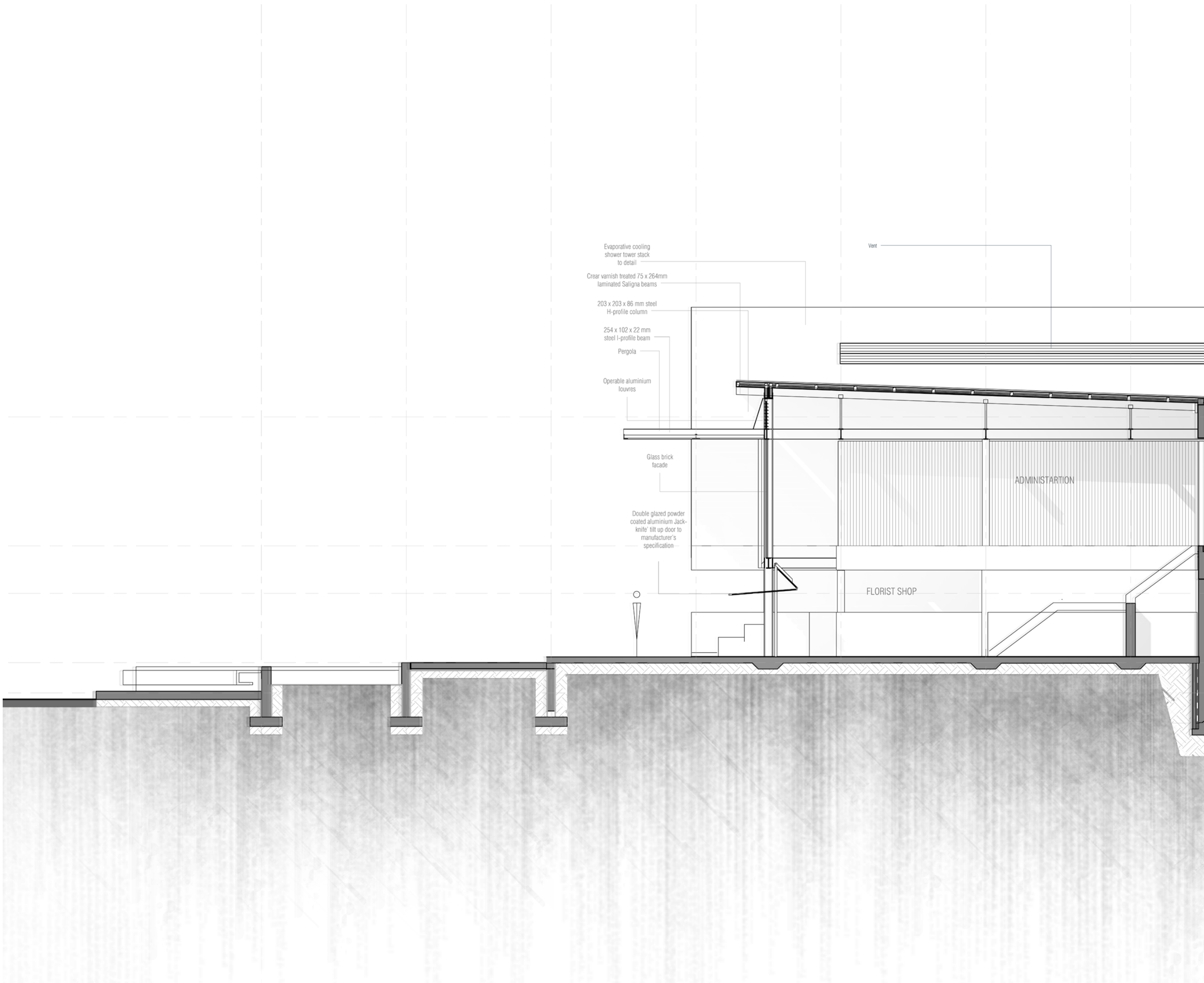
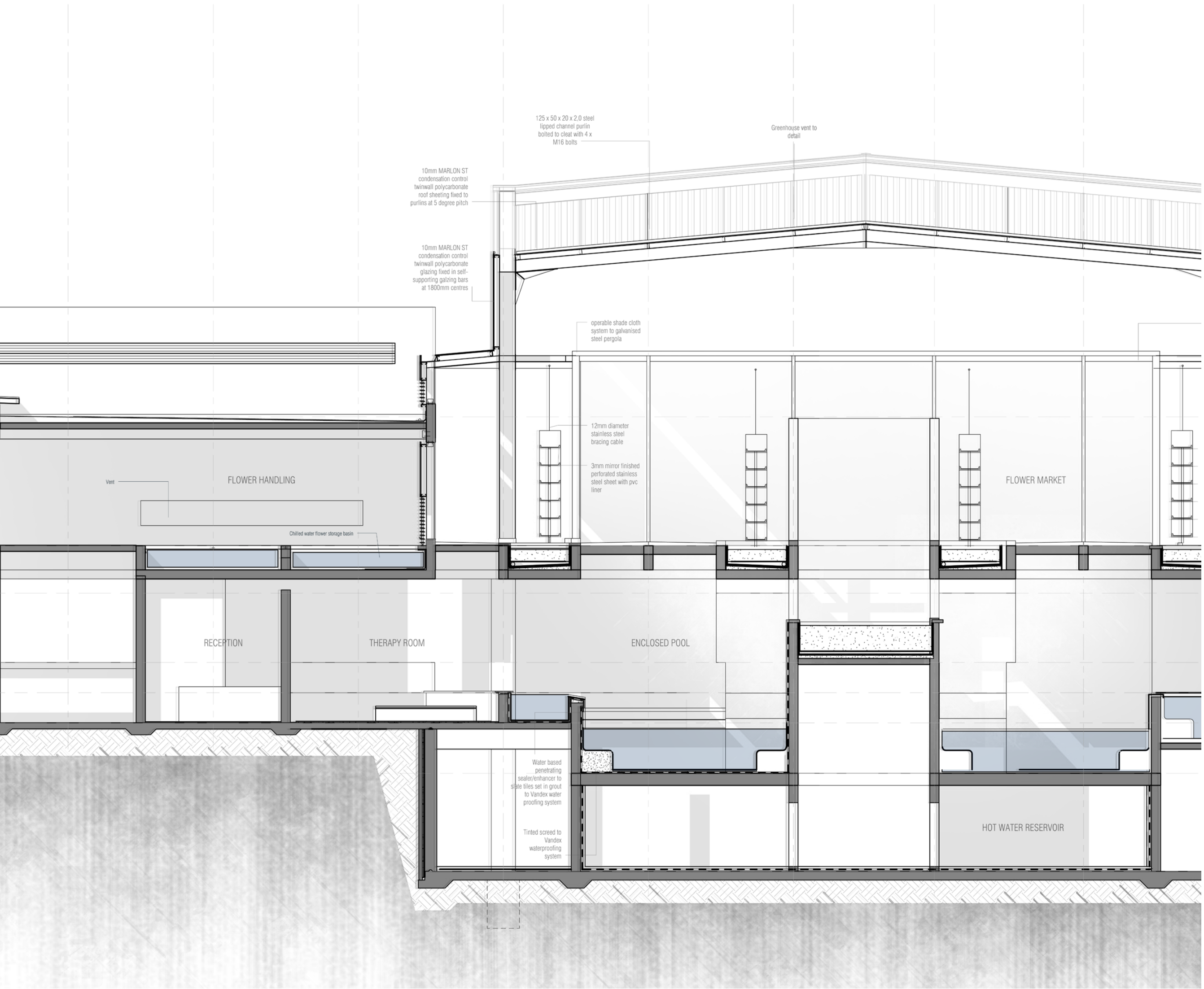


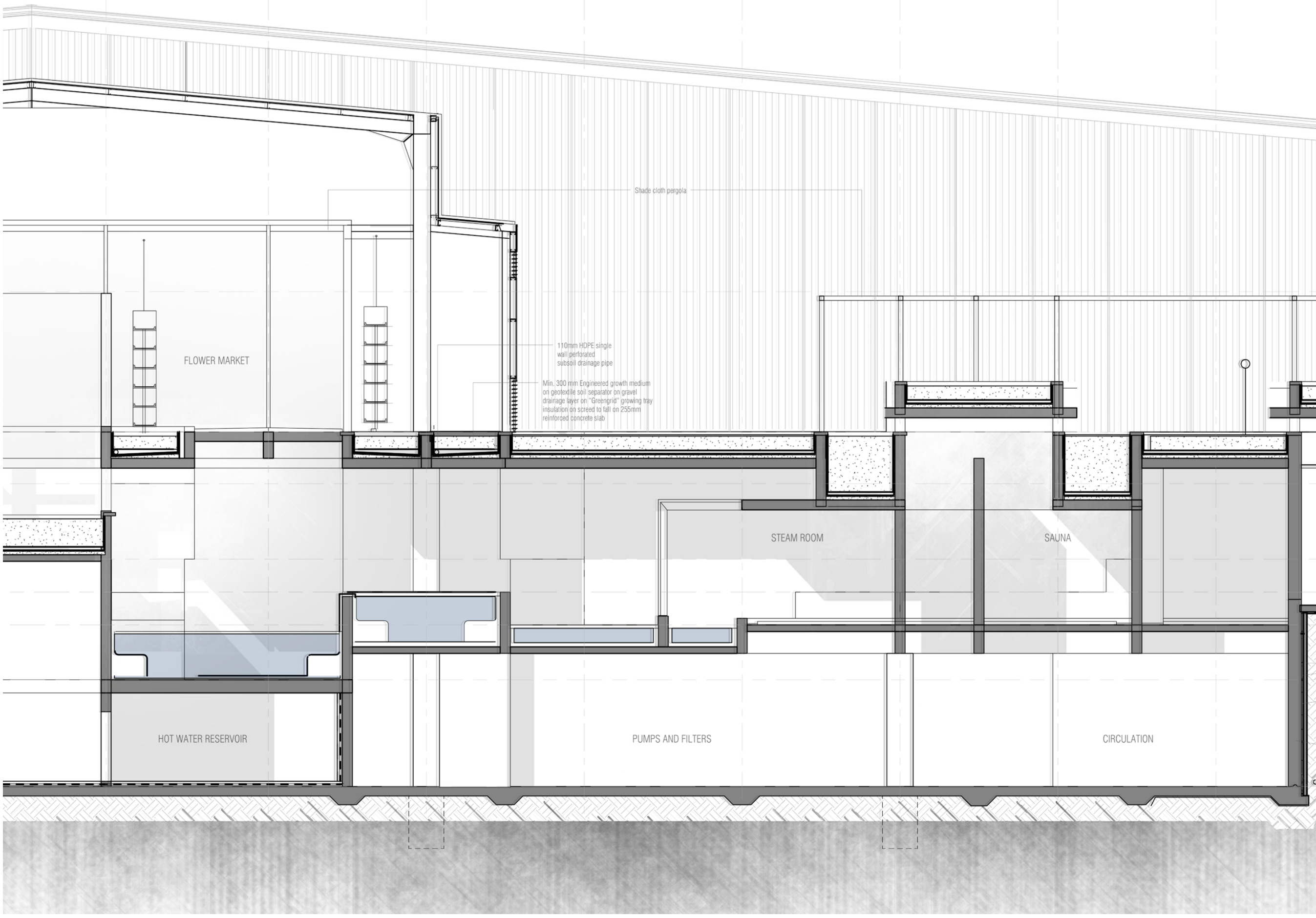
Figure 8. 30

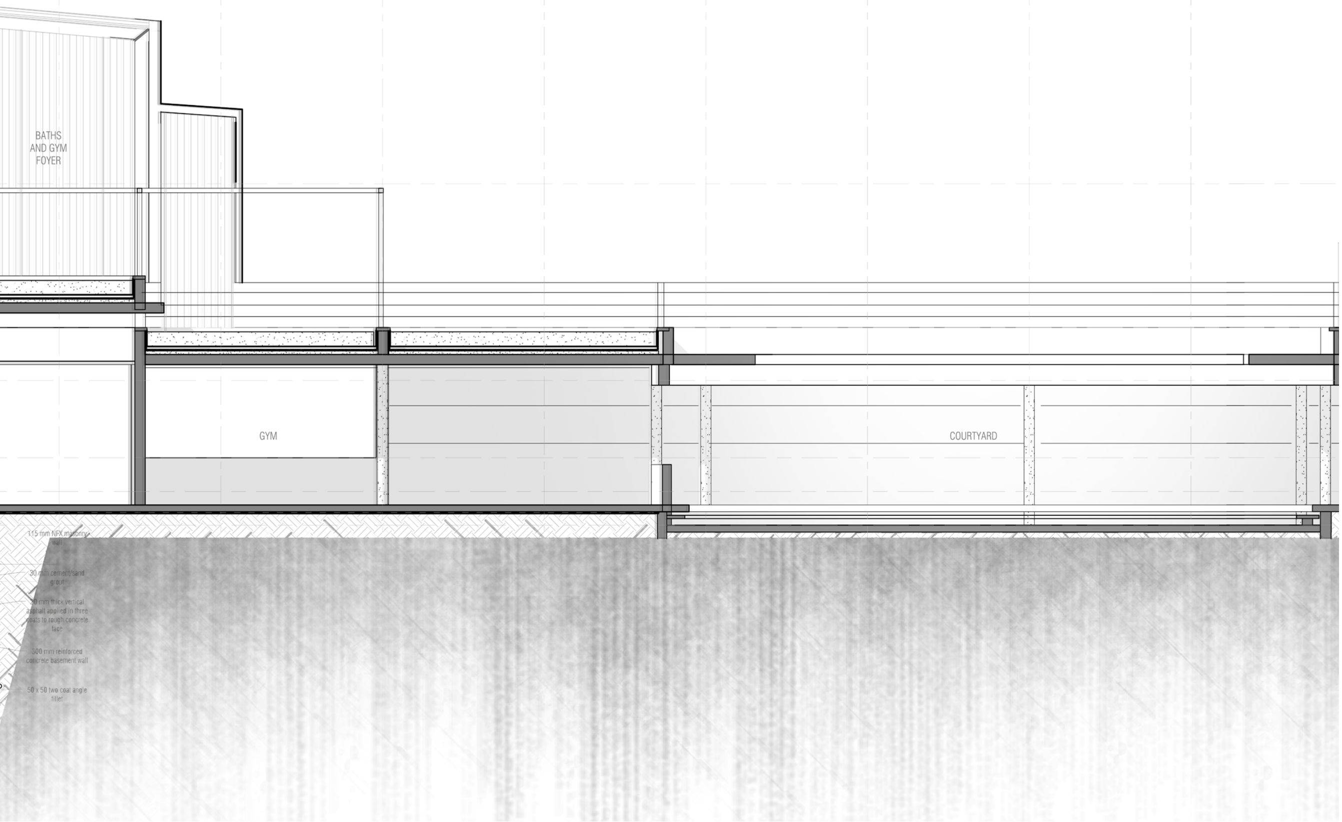
Section A-A detail

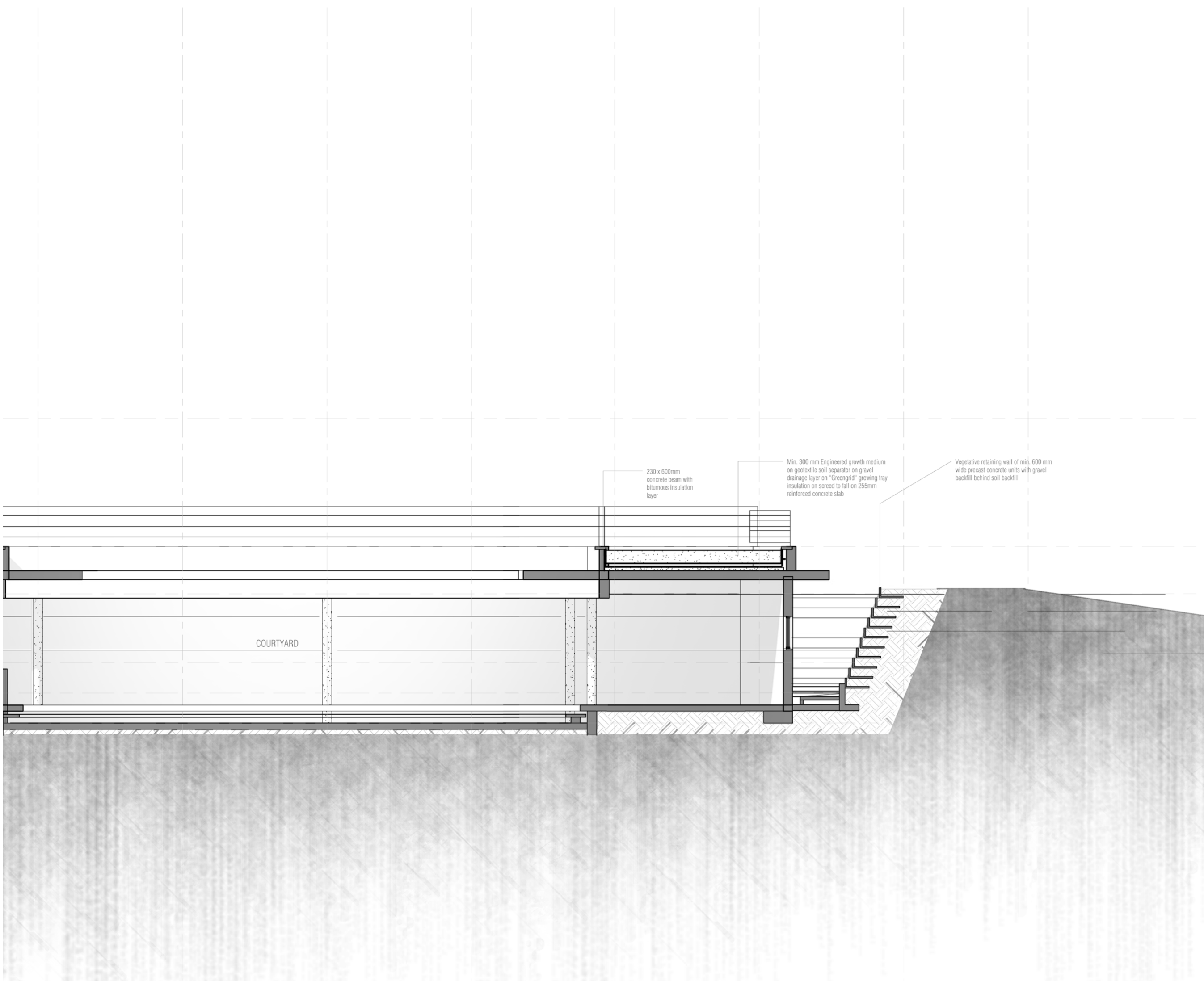
(Author, 2015)




125 x 50 x 20 x 2,0 steel lipped channel purlin bolted to cleat with 4 x M16 bolts
Greenhouse vent to detail
10mm MARLON ST condensation control twinwall polycarbonate roof sheeting fixed to purlins at 5 degree pitch
10mm MARLON ST condensation control twinwall polycarbonate glazing fixed in self-supporting galzing bars at 1800mm centres
operable shade cloth system to galvanised steel pergola
12mm diameter stainless steel bracing cable
3mm mirror finished perforated stainless steel sheet with pvc liner
Vent
FLOWER HANDLING
Chilled water flower storage basin
FLOWER MARKET
RECEPTION
THERAPY ROOM
ENCLOSED POOL
Water based penetrating sealer/enhancer to slate tiles set in grout to Vandex water proofing system
Tinted screed to Vandex waterproofing system
HOT WATER RESERVOIR


Shade cloth pergola
FLOWER MARKET
110mm HDPE single
wall perforated
subsoil drainage pipe
Min. 300 mm Engineered growth medium
on geotextile soil separator on gravel
drainage layer on "Greengrid" growing tray
insulation on screed to fall on 255mm
reinforced concrete slab
STEAM ROOM
SAUNA
HOT WATER RESERVOIR
PUMPS AND FILTERS
CIRCULATION


BATHS AND GYM FOYER
GYM
COURTYARD
115 mm NFX masonry wall
30 mm cement/sand grout
20 mm thick vertical asphalt applied in three coats to rough concrete face
300 mm reinforced concrete basement wall
50 x 50 two coat angle fillet


230 x 600mm concrete beam with bitumous insulation layer
Min. 300 mm Engineered growth medium on geotextile soil separator on gravel drainage layer on "Greengrid" growing tray insulation on screed to fall on 255mm reinforced concrete slab
Vegetative retaining wall of min. 600 mm wide precast concrete units with gravel backfill behind soil backfill
COURTYARD


SECTION A-A
1:50
THE
WARMBATHS
FOUNTAIN