FIGURE 7.1

Day 280, Twigs

(Lorraine Loots, 2013)

chapter seven

TECHNIFICATION

7.1 PREFACE

The aim of the final chapter is to develop a continuous reinterpretation of the conceptual and design intentions and translate them into technical resolutions. The **technical concept** that has been informed by the dissertation's fundamental objectives will be discussed to support all tectonic decision-making. **Material selection** and application, the **structural properties** of the building and **system applications** related to **permaculture and services** will be dealt with accordingly. Finally the applications of **passive environmental systems and technologies** will be discussed to ensure that regenerative and sustainable practices are accomplished on every scale.

7.2 TECHNICAL CONCEPT

The technological investigation examines the concept of **transition** from a state of **disconnection** to one of **reconciliation** between the natural and human conditions. It is crucial that the tectonic language not only visually articulates these two states separately, but also introduces a new condition where they are reconciled as a **nexus of reciprocity.**

The **material palette** will be the fundamental device to indicate the transition between states. **Natural** as well as **synthetic** building materials will be implemented and celebrated separately for their unique properties. These materials will then be **reconciled sensitively** with one another at certain nexus points in the building to indicate the advantages and beauty of their **reciprocal condition.**

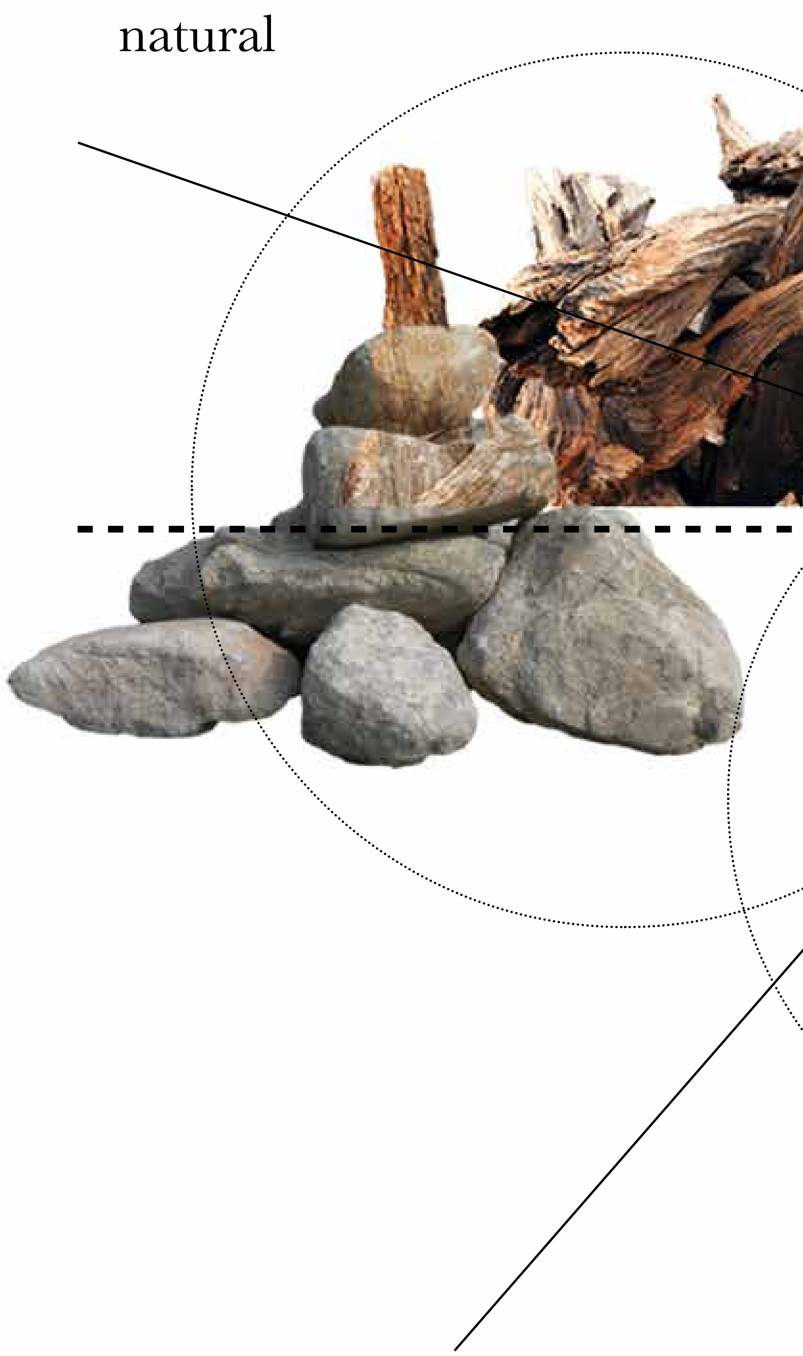
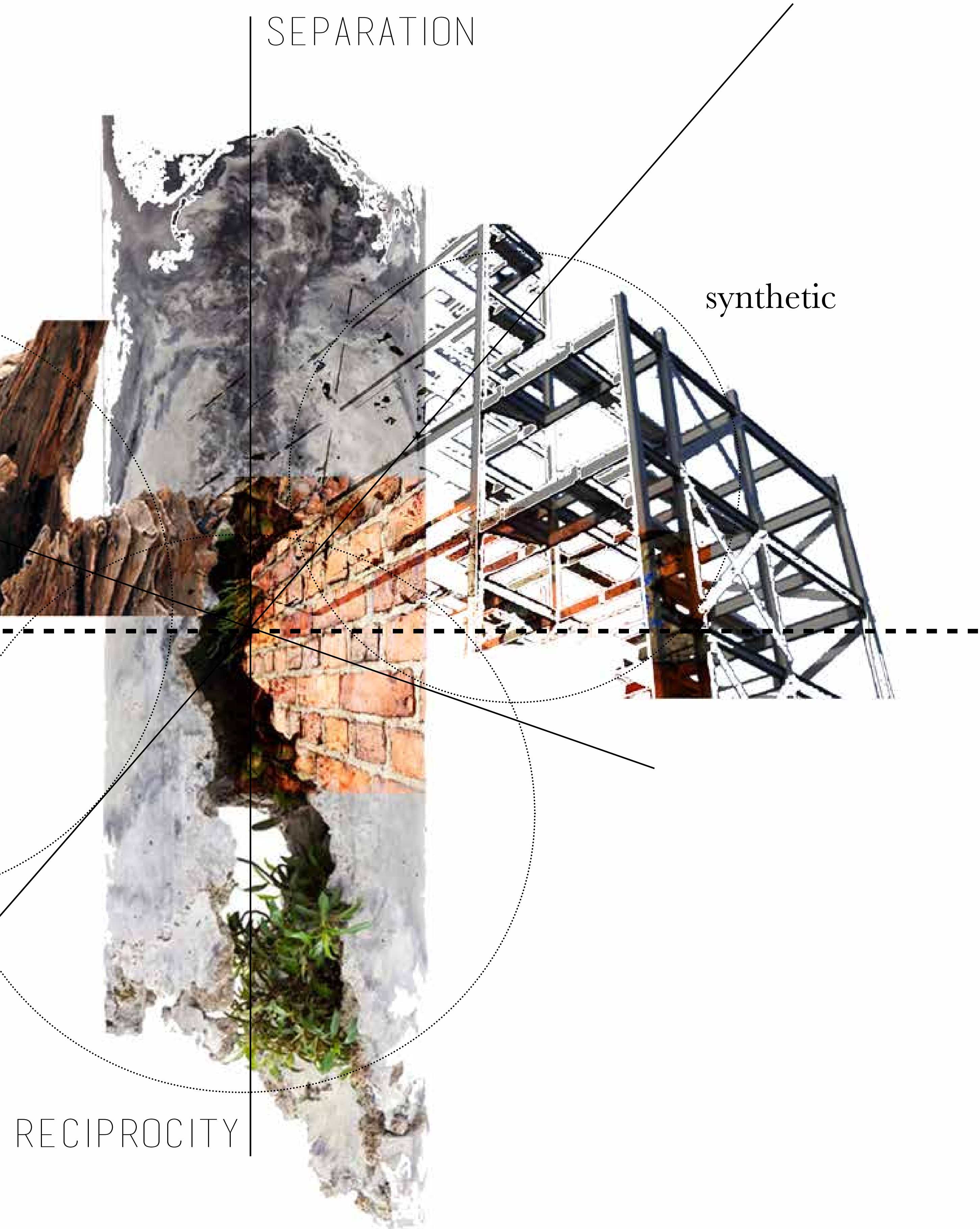


FIGURE 7.2

Diagram explaining tectonic concept (Author, 2016)


SEPARATION
synthetic
RECIPROCITY

7.3 MATERIALITY

As mentioned, the material selection is dependent on three categories in order to express the tectonic intentions, namely **natural materials**, **man-made/synthetic materials**, and **hybrid materials** and joining methods. The application and structural properties of these will be elaborated on when the building's structural configuration is dealt with. It is also important to note that the materiality of the building should be an expression of natural processes in order to support biophilia and thus allow for *sensory variability*, *demonstrate the age, change and the patina of time*, and celebrate *complementary contrasts.*

7.3.1 NATURAL MATERIALS

STONE

The **stereotomic** and **retaining** characteristics of natural stone will be utilized to enable direct associations with nature as well as provide inherent mass as a thermal design strategy.

ON-SITE CLAY AND SOIL

On-site soil that will be excavated on site during the construction of the building will be utilized where additional **compaction soil** is needed.

TIMBER

Pine plywood will be used in multiple ways in **interior spaces** in order to express its haptic qualities and affiliation with nature.

VEGETATION

Facade greening and productive green walls will be employed as fundamental tools to establish a **physical link with nature**.

FIGURE 7.3

Natural material palette

(Author, 2016)

7.3.2 SYNTHETIC / MAN-MADE MATERIALS

STEEL

The tectonic qualities of steel as a **tension device** will be implemented to create surface contrast with the stereotomic natural materials. The steel members will be acid-washed and painted to eventually undergo processes of weathering to indicate the *patina of time.*

POLYCARBONATE SHEETING

Wall and roof sheets made of polycarbonate will be applied to **enable light to be diffused** on entering the building while simultaneously **insulating internal spaces** against heat gain. In this way, energy savings will be achieved and the need for additional supporting structures reduced, as the material has a low unit weight with a long life span.

CONCRETE

Concrete is a **low-maintenance and robust materia**l that will be applied in floor slabs, roof and beam structures, foundations and retaining substructures.

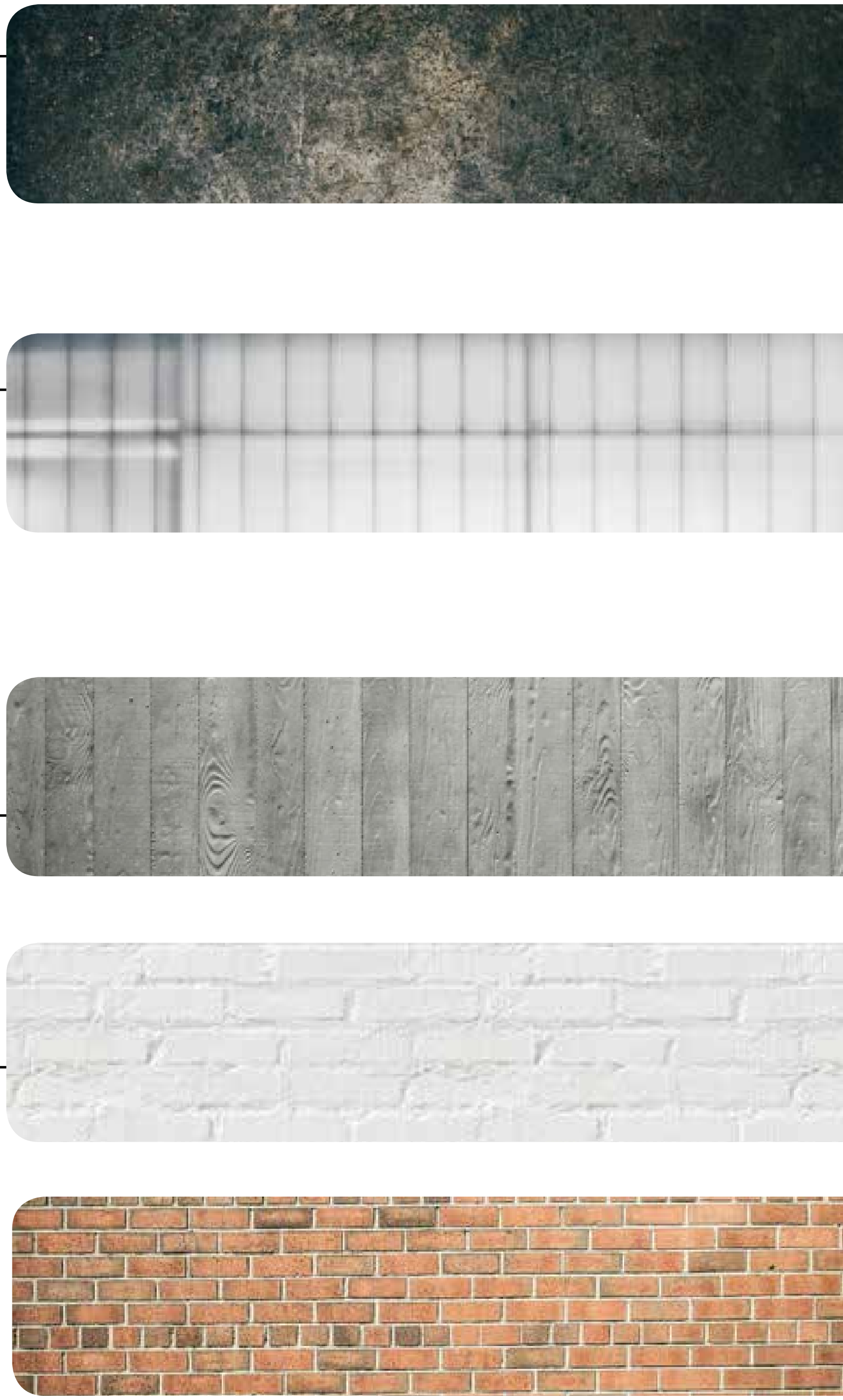
BRICK

Bricks will be implemented for wall structures throughout the building and will be given a **vernacular off-white bagged finish** in order to create a *complementary contrast* with the stonewalls. In some internal spaces the warm natural colour and properties of the brick will be exposed.

FIGURE 7.4

Synthetic/man-made material palette

(Author, 2016)



7.3.3 HYBRID MATERIALS AND RECIPROCAL POSSIBILITIES

PERMEABLE PAVEMENT

Permeable concrete paving will be implemented for **external surfaces**, including parking, roads and pedestrian routes in order to provide a hard surface to support vehicular and pedestrian traffic while simultaneously allowing for vegetation and grasses to grow in between the pavers. It will facilitate the process of **filtering storm water runoff** by trapping suspended solids as well as minimizing the effects of erosion.

BIO-CONCRETE

Bio-concrete supports the natural and enhanced growth of pigmented organisms such as fungi, microalgae and mosses, allowing the development of a beautiful, **living patina**. The material absorbs and reduces atmospheric CO2 regulates internal thermal conductivity, and has notable aesthetic and environmental properties (Brownell, 2013).

Bio-concrete is composed of a structural concrete layer that is made of conventional carbonated concrete together with magnesium phosphate cement and then waterproofed to protect this layer from possible water damage. To the contrary, the **biological layer** has the capacity to capture and retain rainwater by having an intermittent coating layer with a reverse waterproofing purpose that allows water and moisture to gather on it and e**nable biological growth of organisms** (Brownell, 2013).

It is important to note that bio-concrete will only be applied programmatically, where healing of urban diseases has already occurred, and nowhere near the clinic, as biological organisms such as moss and fungi can aggravate allergies for people struggling with environmental allergies and asthma.

FIGURE 7.5

Hybrid material palette

(Author, 2016)

7.4 THE STRUCTURE

The technical concept and its influences on the material selection reveal the inherent possibilities for how the structure will be constructed. The **primary structure** of the building will consist of the combination of soil, stone, steel, brick and concrete for foundations, floors and roof slabs. The **secondary structure** will consist of the use of steel supporting structures, permeable concrete and brick paving. The **tertiary structure** will become the skin of the building and includes polycarbonate sheeting and vertically growing creepers and vegetation supported by the application of steel mesh and cables. Finally, timber cladding will be applied in some internal spaces for acoustical and aesthetic purposes.

7.4.1 THE PRIMARY STRUCTURE

THE SUBSTRUCTURE

The **substructure** walls below natural ground level will be made of **reinforced concrete** and **brickwork** that is waterproofed in combination with a **geotextile Kay-tech Flo-drain pipe** with a 160mm diameter. The geopipes sloping to a minimum of 2 degrees will be connected to underground sumps that feed water into water treatment and storage tanks and chambers.

The specified **stone is 'autumn quartzite'** and is supplied by Bedrock Stone South Africa. The thickness of the stone walls will range between 450mm and 1000mm, and will be loose-packed infill walls further supported by steel columns with lateral bracing within the walls. Concrete rubble will also be used as infill to create thicker walls.

The **steel columns** and horizontal beams that support the superstructure as well as the vertical creepers will be 203 x 203 x 52 kg/m hot-rolled H-columns and will be spaced along a 5-10m grid that has been informed by the existing column grid spacing of the Gautrain platform. In order to have a rusted appearance, all steel columns/ beams and supports will be **acid-washed** and then finished with a **Glisten PC Paint-Over-Rust**, a high performance clear coat sealant, and finally with a clear intumescent paint for fireproofing.

Masonry walls will be applied in various thicknesses ranging between 115mm, 230mm and 425mm, depending on thermal properties and bearing loads. These external and internal walls, as indicated on sections and elevations will be **cement bagged** directly onto/over flush jointed selected stock bricks with a mixture to consist of 1 volume cement to 1 volume washed plaster sand, finished to a reasonably even surface and painted as per paint specification.

All **reinforced concrete floors** will be cast in situ at a thickness of 255mm with an iron-oxide additive and to be diamond-polished in order to provide a durable surface. A strip of brick pavement will be applied at all expansion joints to reduce the risk of cracking and to create aesthetic floor patterns.

The **reinforced concrete roof slabs** will be cast in situ in a custom-made timber shuttering that creates a tapered off-shutter form and finish. The concrete roofs will vary in thickness between 170mm and 425mm (including beams), depending on the internal spans and **green roof** application. Some roofs will also be given a **layer of gravel**, as it presents a fifth elevation viewable from the raised Gautrain platform. Roofs will be supported by **reinforced concrete beams** in accordance with the span and loads respectively.

7.4.2 THE SECONDARY STRUCTURE

125 x 65 x 20 x 3mm cold-rolled lipped channels will be implemented as **secondary supporting purlins** for light-weight fixtures such as the polycarbonate sheeting and steel mesh. 50 x 50mm steel angle slats will be applied as **steel louvered screens**. All **steel supports** will also be **acid-washed** and treated accordingly.

7.4.3 THE TERTIARY STRUCTURE

10 mm thick "Lexan Thermoclear" twin wall **Polycarbonate sheeting** will be applied at a slope of 2 degrees and be fixed to the 125 x 65 x 20 x 3mm cold-rolled lipped channel purlins by means of **"Posi-drive" self tapping screws and sealing washers** as per maunfacturer's specification.

Besides the applications of vertical farming and permaculture, which will be discussed later in the chapter, **planted creepers and climbers,** which are proficient in growing over the provided **steel structures** and **mesh screens**, will exist in a constantly changing state of growth. These plants are diverse in their requirements, colours and effects, and will illustrate different seasonal changes (Mucina & Rutherford 2010: 464). The following creepers will be employed:

FIGURE 7.6

Planting palette (Author, 2016)

JASMINUM POLYANTHUM (Pink Jasmine)

Minimal water requirements
Attracts multiple insects
Semi-deciduous
Requires semi-shade to full sun.

THUNBERGIA ALATA (Yellow Black-Eyed Susan)

Self-seeding creeper
Evergreen
Requires semi-sun

SENECIO TAMOIDES (Canary Creeper)

Semi- deciduous
Requires shade

CLEMATIS BRACHIATA (Traveller's Joy)

Evergreen
Requires full sun

COMBRETUM BRACTEOSUM (Hiccup Nut)

Produces fruit that attracts birds
Evergreen
Requires full sun

TRACHELOSPERMUM JASMINOIDES (Star Jasmine)

Ever-green climber
Minimal water requirements
Requires shade

7.5 SYSTEMIC IMPLEMENTATIONS OF PERMACULTURE

The implementation of **services and systems** will be directed to serve the **users of the building** and the **natural habitat** in which the building is embedded on equal terms. The implementation of the permaculture activities will serve as an educational and curative device for the health and well-being of its human occupants, while simultaneously remediating the condition of the soil on the site. For **water** and **waste treatment** the design will seek to create **closed feedback loops** within the multiple operations that the building requires. These will be discussed accordingly.

7.5.1 WATER HARVESTING AND TREATMENT

Due to the requirements of permaculture and food production practices, water is an essential element in the functioning of the building. The water harvested and used on site will constantly circulate in a **semi-closed systemic loop** that is linked to the Apies River running adjacent to the site. Wastewater will be treated according to the description that follows, after which it will be channeled for use inside and outside the building.

FIGURE 7.7

Water yield, demand and budget calculations (Author, 2016)

A WATER RESOURCE INFORMATION (YIELD, m³)

A1 RAIN WATER HARVESTING DATA

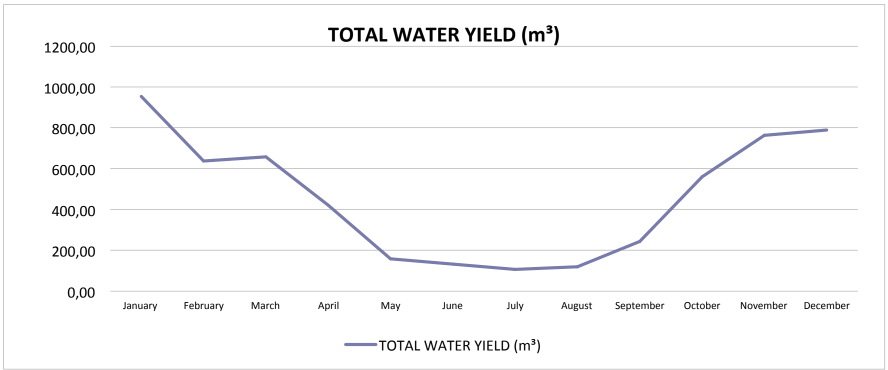
DESCRIPTION	AREA (m²)	RUNOFF COEFF. (C)
Roof catchment	4637	0,9
Concrete Pavement runoff	11955	0,2
		0
Other		0
TOTAL AREA (A)	16592,00	
WEIGHTED C		0,40

A2 RECYCLED / ALTERNATIVE WATER SOURCE

MONTH	Apies River Connection		ave of 285 litres aquired a day		TOTAL / MONTH (m³)
	WEEKLY YIELD (m³)	MONTHLY YIELD (m³)	WEEKLY YIELD (m³)	MONTHLY YIELD (m³)	
January	20	80,00	0	0,00	80,00
February	20	80,00	0	0,00	80,00
March	20	80,00	0	0,00	80,00
April	20	80,00	0	0,00	80,00
May	20	80,00	0	0,00	80,00
June	20	80,00	0	0,00	80,00
July	20	80,00	0	0,00	80,00
August	20	80,00	0	0,00	80,00
September	20	80,00	0	0,00	80,00
October	20	80,00	0	0,00	80,00
November	20	80,00	0	0,00	80,00
December	20	80,00	0	0,00	80,00
ANNUAL AVE.		960,00		0,00	960,00

A3 TOTAL WATER YIELD

MONTH	AVE RAINFALL , P (m)	CATCHMENT YIELD (m³) (Yield = PxAxC)	ALTERNATIVE WATER SOURCE (m³)	TOTAL WATER YIELD (m³)
January	0,13	873,05	80,00	953,05
February	0,09	557,97	80,00	637,97
March	0,09	577,66	80,00	657,66
April	0,05	341,34	80,00	421,34
May	0,01	78,77	80,00	158,77
June	0,01	52,51	80,00	132,51
July	0,00	26,26	80,00	106,26
August	0,01	39,39	80,00	119,39
September	0,03	164,11	80,00	244,11
October	0,07	479,19	80,00	559,19
November	0,10	682,69	80,00	762,69
December	0,11	708,94	80,00	788,94
ANNUAL AVE.	0,70	4581,88	960,00	5541,88



B WATER DEMAND

B1 LANDSCAPE IRRIGATION DEMAND (m³)

DESCRIPTION:	LAWN (m²):	2231	AGRI (m²):	1461	PLANTING (m²):	431	
MONTH	WEEKLY IRR. (m)	MONTHLY DEMAND (m³)	WEEKLY IRR. (m)	MONTHLY DEMAND (m³)	WEEKLY IRR. (m)	MONTHLY DEMAND (m³)	TOTAL MONTHLY IRR. DEMAND (m³)
January	0,02	178,48	0,025	146,1	0,005	8,62	333,2
February	0,02	178,48	0,025	146,1	0,005	8,62	333,2
March	0,02	178,48	0,025	146,1	0,002	3,448	328,028
April	0,02	178,48	0,025	146,1	0,002	3,448	328,028
May	0,01	89,24	0,025	146,1	0,002	3,448	238,788
June	0,01	89,24	0,025	146,1	0	0	235,34
July	0,01	89,24	0,025	146,1	0	0	235,34
August	0,02	178,48	0,025	146,1	0	0	324,58
September	0,02	178,48	0,025	146,1	0,005	8,62	333,2
October	0,02	178,48	0,025	146,1	0,005	8,62	333,2
November	0,02	178,48	0,025	146,1	0,005	8,62	333,2
December	0,02	178,48	0,025	146,1	0,005	8,62	333,2
ANNUAL TOTAL		1874,04		1753,2		62,064	3689,304

B2 DOMESTIC DEMAND

MONTH	PERSONS	WATER/ CAPITA/ DAY (l)	DOMESTIC DEMAND (m³/month)
January	80	4	9,92
February	80	4	8,96
March	80	4	9,92
April	80	4	9,6
May	80	4	9,92
June	80	4	9,6
July	80	4	9,92
August	80	4	9,92
September	80	4	9,6
October	80	4	9,92
November	80	4	9,6
December	80	4	9,92
ANNUAL TOTAL			116,8

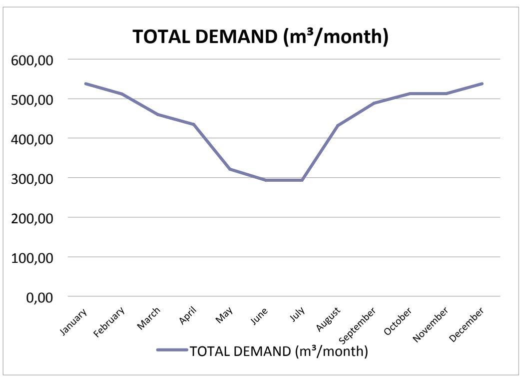
TOTAL WATER LOSS & DEMAND

MONTH	TOTAL DEMAND (m³/month)
January	537,36
February	512,12
March	459,35
April	434,75
May	321,55
June	293,50
July	293,82
August	431,62
September	488,48
October	513,08
November	512,76
December	537,36
ANNUAL TOTAL	5335,744

B3 EVAPORATION LOSS (For 'open' reservoirs)

AREA OF RESERVOIR (m²): 1214

MONTH	EVAPORATION RATE (m/week)	EVAPORATION RATE (m/month)	TOTAL LOSS (m³/month)
January	0,04	0,16	194,24
February	0,035	0,14	169,96
March	0,025	0,1	121,4
April	0,02	0,08	97,12
May	0,015	0,06	72,84
June	0,01	0,04	48,56
July	0,01	0,04	48,56
August	0,02	0,08	97,12
September	0,03	0,12	145,68
October	0,035	0,14	169,96
November	0,035	0,14	169,96
December	0,04	0,16	194,24
ANNUAL TOTAL	0,32	1,26	1529,64



C WATER BUDGET

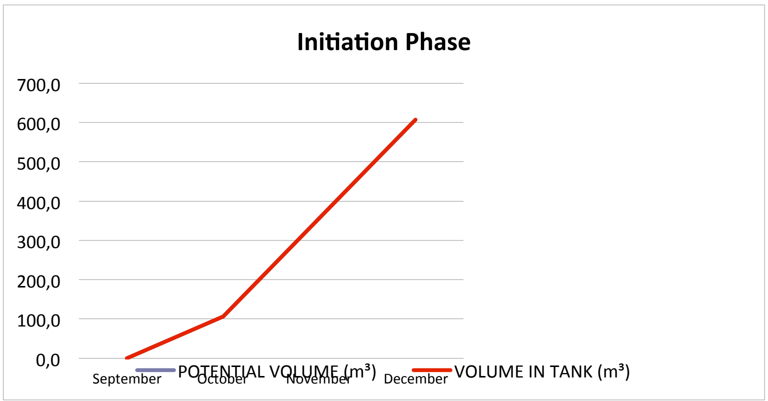
TANK CAPACITY (m^3): 953
MIN VOLUME (m^3): 106

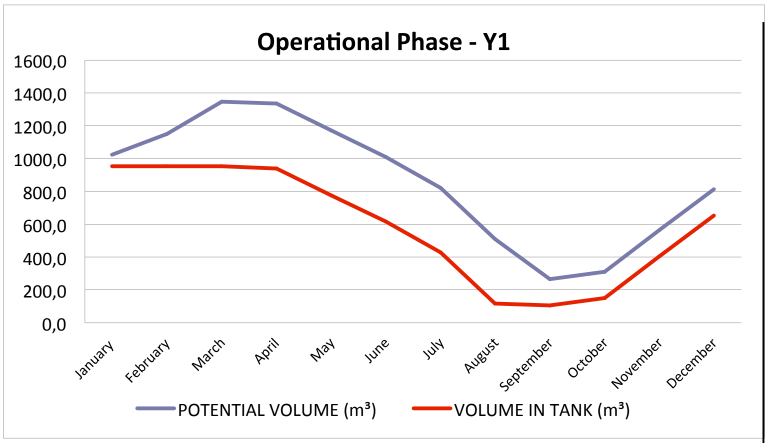
C1 WATER BUDGET — INNITIATION PHASE

MONTH	YIELD (m^3/month)	DEMAND (m^3/month)	MONTHLY BALANCE	POTENTIAL VOLUME (m^3)	VOLUME IN TANK (m^3)
September	244,1	488,5	-244,4	0,0	0,0
October	559,2	513,1	46,1	106,0	106,0
November	762,7	512,8	249,9	355,9	355,9
December	788,9	537,4	251,6	607,5	607,5
	2354,9	2051,7	303,3		

C2 WATER BUDGET — YEAR 1

MONTH	YIELD (m^3/month)	DEMAND (m^3/month)	MONTHLY BALANCE	POTENTIAL VOLUME (m^3)	VOLUME IN TANK (m^3)
January	953,1	537,4	415,7	1023,2	953,0
February	638,0	512,1	125,8	1149,0	953,0
March	657,7	459,3	198,3	1347,4	953,0
April	421,3	434,7	-13,4	1334,0	939,6
May	158,8	321,5	-162,8	1171,2	776,8
June	132,5	293,5	-161,0	1010,2	615,8
July	106,3	293,8	-187,6	822,6	428,3
August	119,4	431,6	-312,2	510,4	116,0
September	244,1	488,5	-244,4	266,0	106,0
October	559,2	513,1	46,1	312,1	152,1
November	762,7	512,8	249,9	562,1	402,0
December	788,9	537,4	251,6	813,6	653,6
ANNUAL AVE.	5541,9	5335,7	206,1		





THE ROUTE OF SANITARY AND STORM WATER

Water is harvested from roofs as well as external hard surfaces, filtered through a grid to remove floating debris, and then directed towards temporary galvanized steel water tanks, for purposes of further treatment.

Wastewater and grey water accumulated from the three kitchens and washing basins are directly taken through a fat trap and then directed towards the temporary galvanized steel water tanks, for purposes of further treatment.

Black water is directed towards the municipal sewerage connection and not dealt with in this scheme.

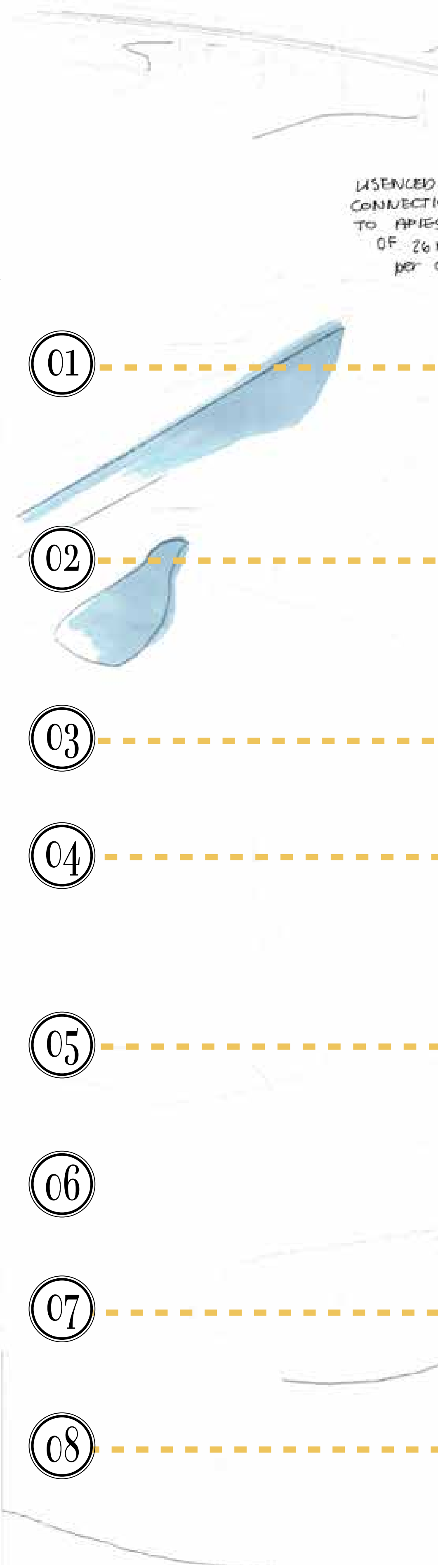
The water that has been stored in temporary water tanks is then directed towards multiple treatment chambers beneath the central water tower and taken through an oil trap and sedimentation filter.

Water required for irrigation is stored in the retention pond and wetland-based biological system and will retain dissolved minerals that are beneficial for plants.

Water used for domestic purposes is treated further in a different treatment chamber to remove harmful pathogens.

Water is then pumped up during the night into a storage tank 20m above ground within the water tower, in order to achieve a sufficient water pressure of 2bar.

An additional average of 285 litres of water will be acquired a month to support urban agricultural requirements with the site and urban precinct. It will be argued that the rights to a percentage of water will be acquired from the Apies River through a sump and channeling system that will feed water into the retention wetland.



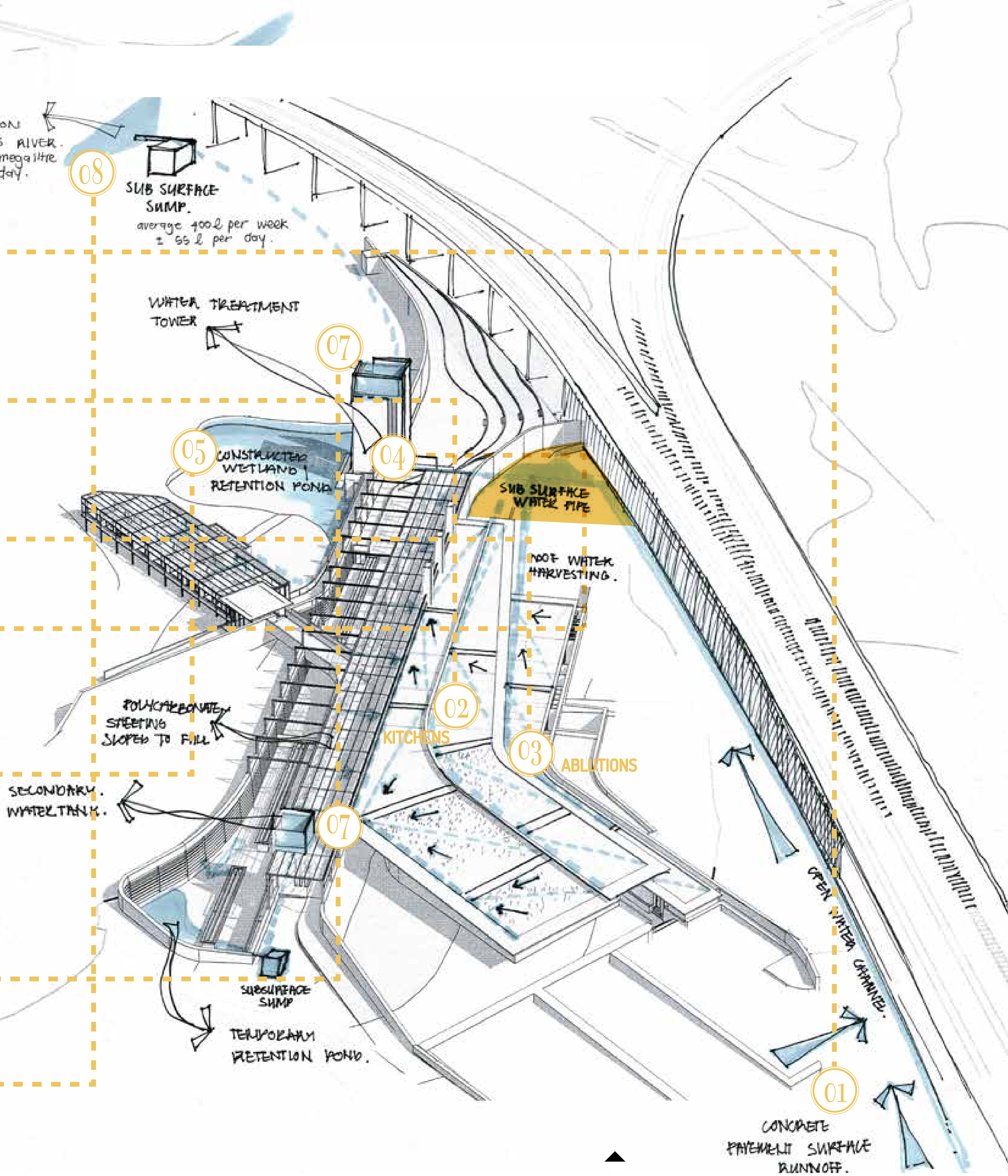


FIGURE 7.8

Diagram illustrating water harvesting, treatment and storage routes (Author, 2016)

7.5.1 WATER HARVESTING AND TREATMENT

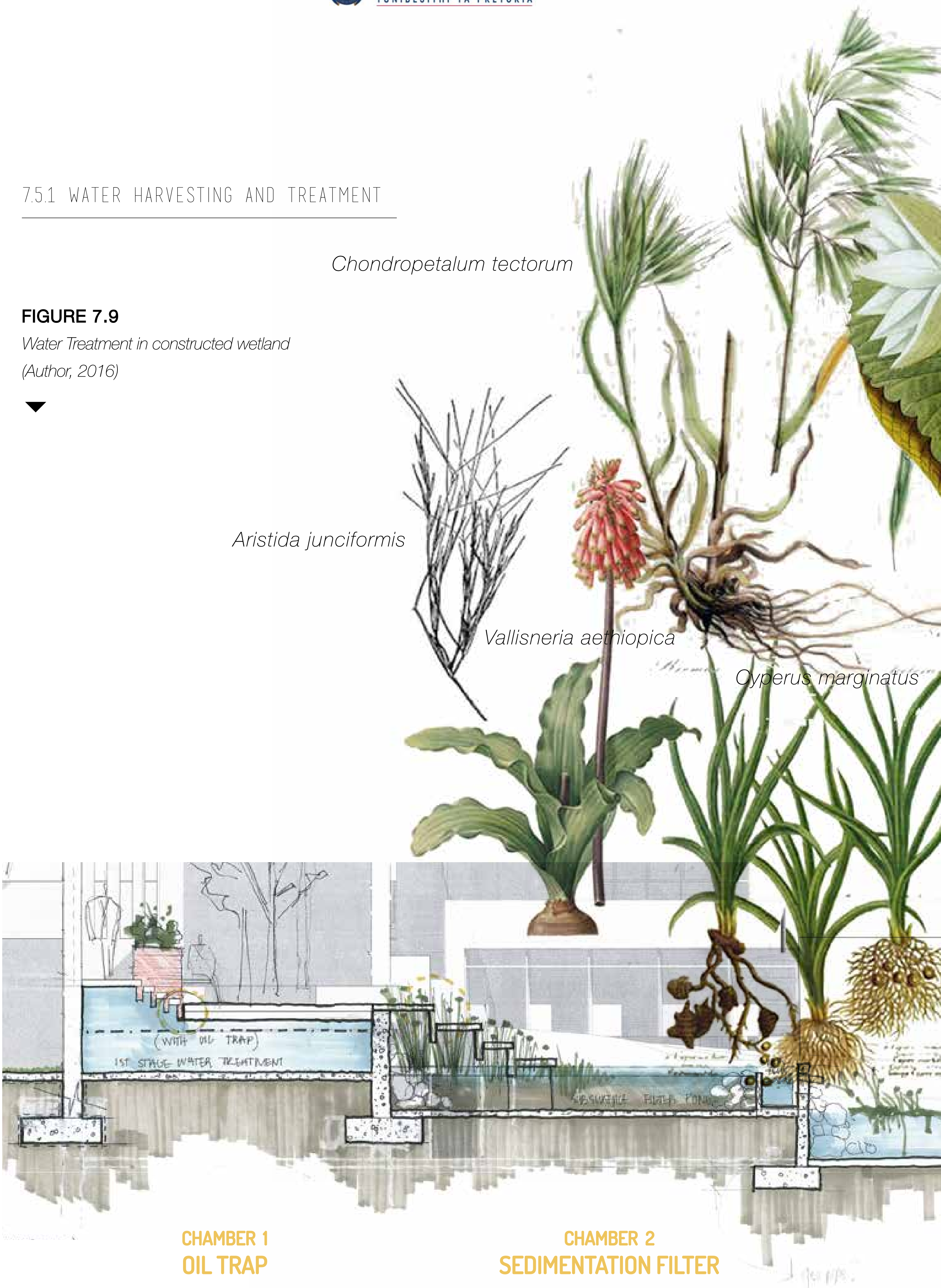
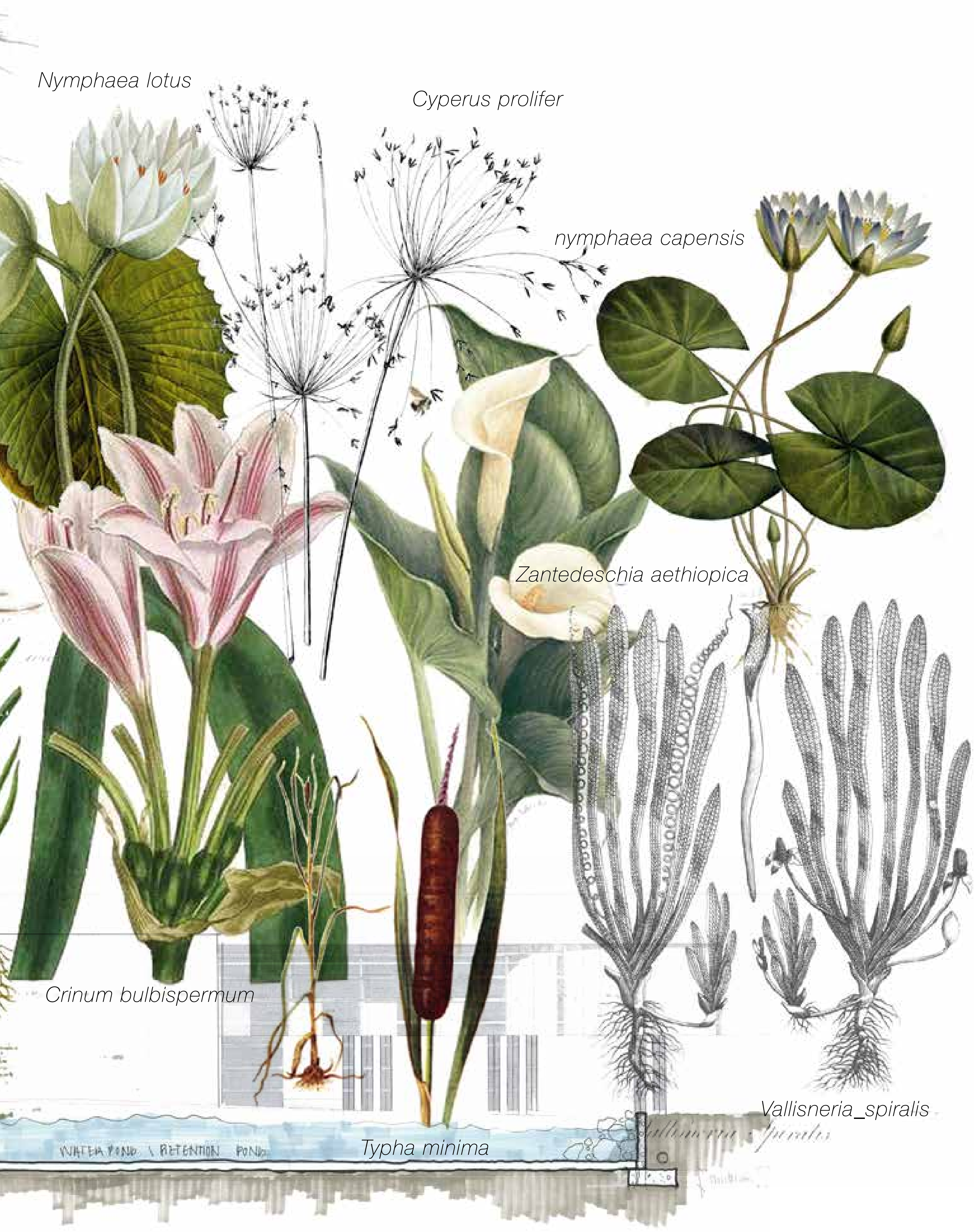


FIGURE 7.9

Water Treatment in constructed wetland (Author, 2016)



RETENTION POND

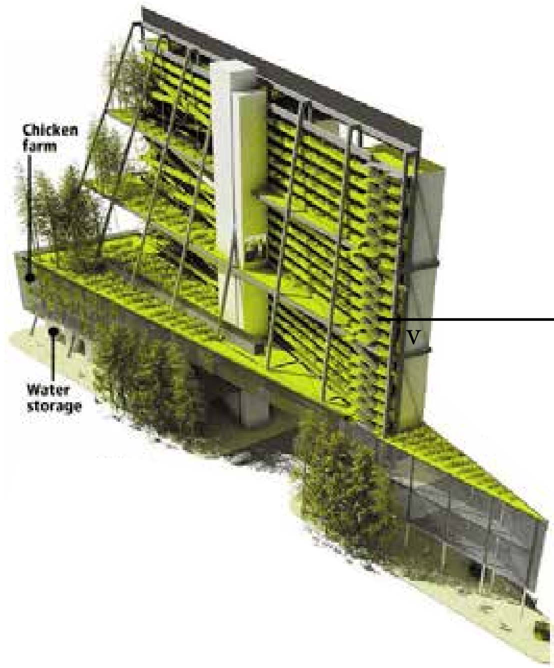
7.5.2 COMPOSTING AND WASTE FEEDBACK LOOPS

Organic waste accumulated on site through permaculture activities and that is of a low embodied energy will be stored in **composting pits** located at the back of house of the building, where it will be treated to produce decomposed organic matter, and be used as **plant fertilizer.**

Organic waste that has higher embodied energies, commonly present in kitchen waste, will feed directly into a **bio-digester**, and will be discussed as part of the technological implementations.

7.5.3 PERMACULTURE PRACTICES AND TECHNOLOGIES

Permaculture entails an ecological design approach that aligns natural systems with human needs and processes (Holmgren, 2002: 8). It is thus not limited to a specific method of natural production, but is rather a **site-specific and locally adaptive approach**. The technical application of permaculture within and around the building will predominantly be **small-scale vertical farming** that ensures controlled planting conditions and production that secures proper water management and input control demands. The approaches and technologies related to vertical farming will be discussed within appropriate diagrams.



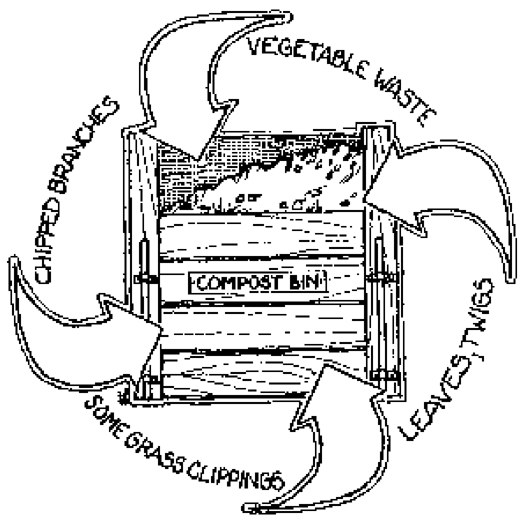
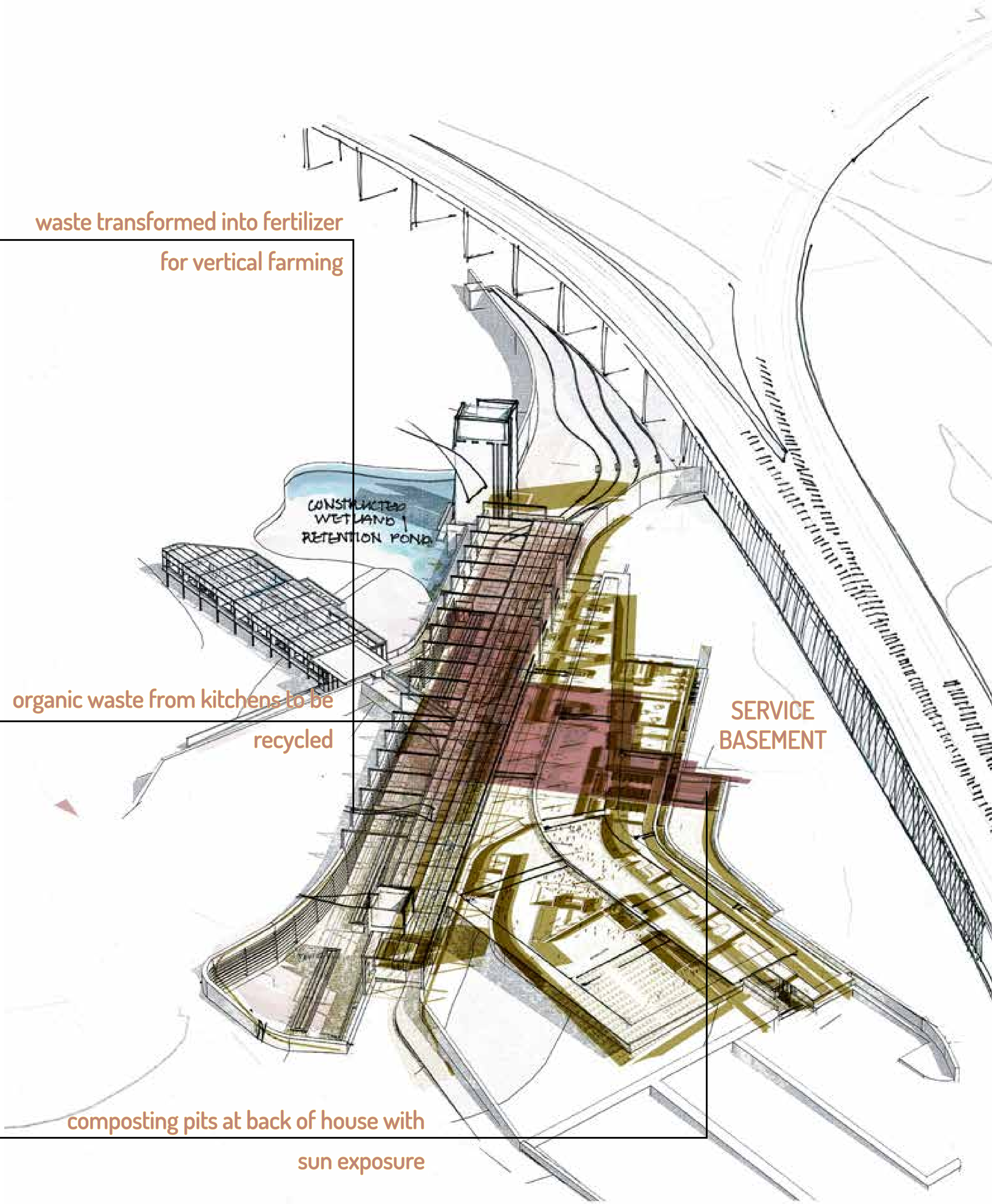


FIGURE 7.10

Waste management strategies (Author, 2016)


waste transformed into fertilizer for vertical farming
CONSTRUCTED WETLAND / RETENTION POND
organic waste from kitchens to be recycled
SERVICE BASEMENT
composting pits at back of house with sun exposure

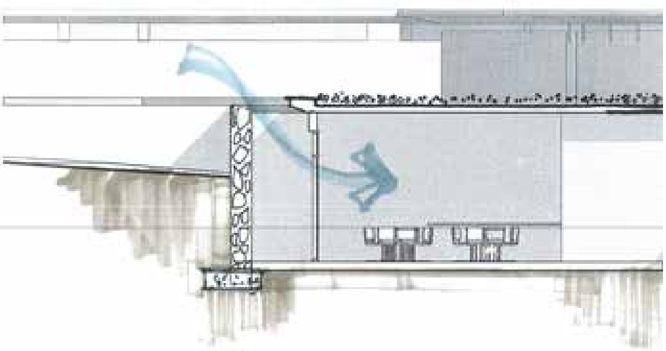
7.6 ENVIRONMENTAL SYSTEMS & SUSTAINABILITY

7.6.1 PASSIVE CLIMATE CONTROL

Stone and thick-skin bagged brick walls that have a **high thermal mass** are used predominantly for northern and western facades to reduce internal heat gain and control internal comfort. The planted facades and vertical farming together with misting and drip irrigation are placed adjacent to the main movement route and also assist to create a cooler, more comfortable temperature due to **evaporative cooling**. This is also achieved by the wetland located on the north-eastern side of the building.

Northern facades are accompanied by **overhead louvers** to reduce unwanted heat gain in the summer, but allow for deep penetration of light and heat in the winter.

The main building axes are perpendicular to the **north-eastern direction** of the **prevailing wind** and can thus make use of the opportunity for **cross ventilation**, as internal spaces are also narrow in nature.

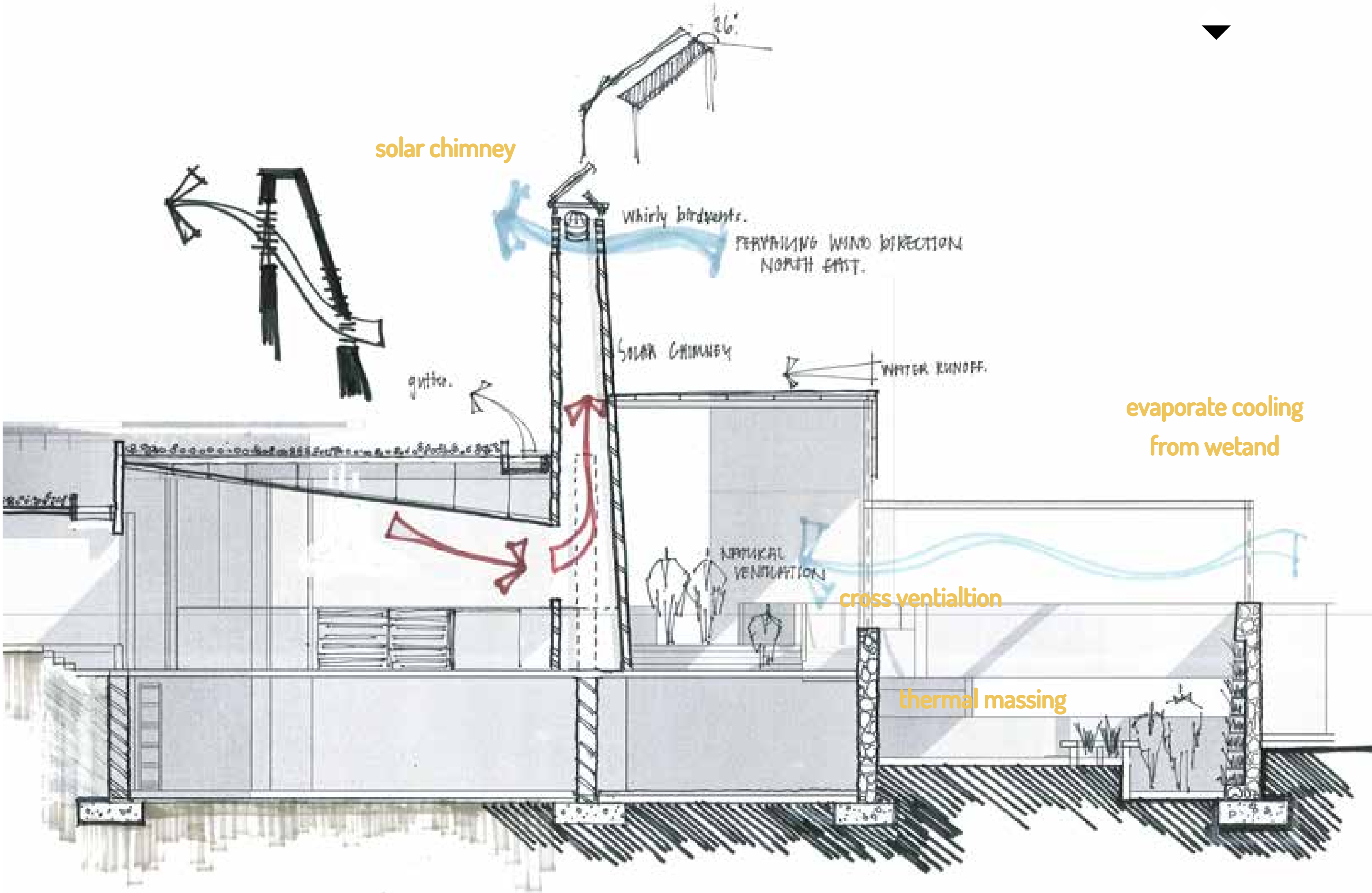


In the kitchens, where cooking and frying activities cause warm air to be trapped, it becomes crucial to provide a **central stack system**. Three central solar chimneys will be integrated to increase ventilation and thermal comfort in the kitchen spaces where latent heat is generated. The kitchens will be provided with a **sloped, suspended ceiling** to direct heated air to the chimney. As the heated air rises, fresh air is drawn into the building with the assistance of **whirlybirds and louvered side-panels**. A **trombe-assisted stack** will also be installed at a 26-degree angle to facilitate the process more effectively.

FIGURE 7.11

Ventilation & cooling strategies

(Author, 2016)



7.6.2 DAYLIGHTING

As mentioned, the building is predominantly angled in two directions namely north and north-east. All northern facades have deep edges and **light shelves.** Southern light will be maximised by taking advantage of the terraced nature of the roof, creating the opportunity for **clerestories** to facilitate natural light entering internal spaces. All the main public spaces such as the hot-desk meeting rooms, ablutions and library are provided with a **narrow open courtyard** to allow for the filtering of light as well as a brief visual connection with nature.

The material properties of polycarbonate sheeting are fully utilized as it **reduces glare** on the north-eastern side of the building by **diffusing the quality of light**. The open steel pergola structure above the production core that will support creeper plants will also create a dynamic casting of light and shadow, mimicking how light would filter through tree branches and leaves.

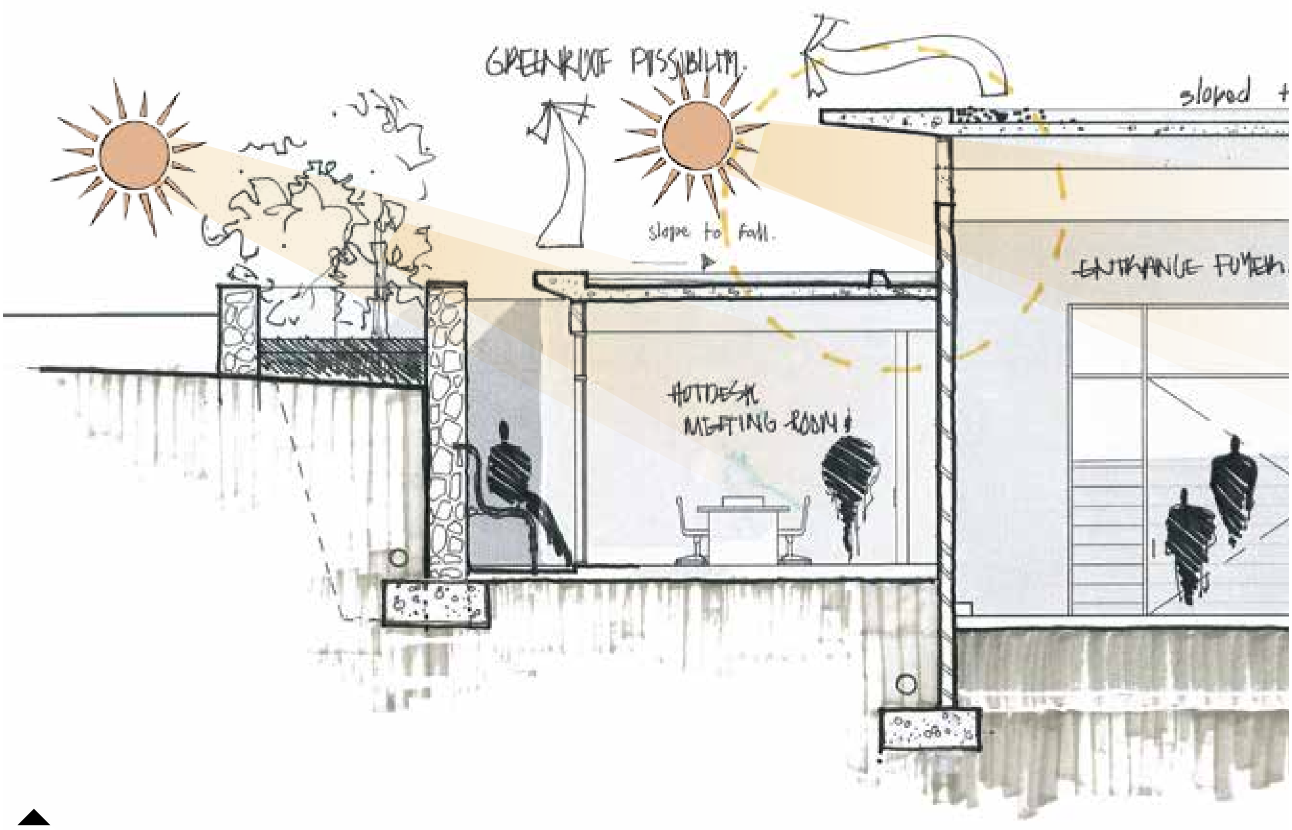
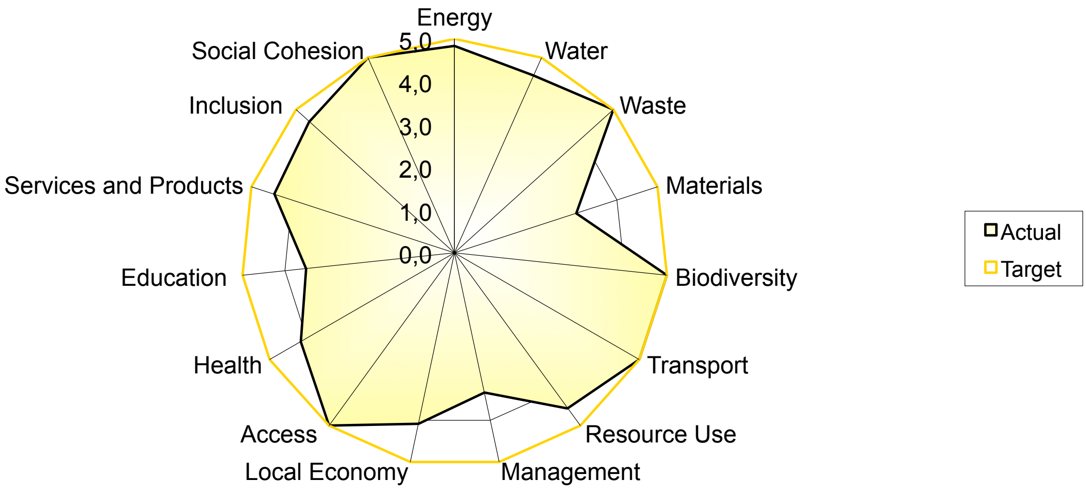


FIGURE 7.12

Diagrams of daylighting strategies (Author, 2016)

SB SBAT REPORT

SB1	**Project**
	Restoring Reciprocity_A wellness Centre for Urban Diseases
SB2	**Address**
	South Berea 609, Corner of Nelson Mandela Boulevard (R21) and Thabo Sehume Street Fountains,
SB3	**SBAT Graph**



SB4 Environmental, Social and Economic Performance	Score
Environmental	4,5
Economic	4,4
Social	4,3
SBAT Rating	4,4

SB5 EF and HDI Factors	Score
EF Factor	4,5
HDI Factor	4,1

SB6 Targets	Percentage
Environmental	90
Economic	88
Social	87

7.6.3 SBAT RATING

FIGURE 7.13

SBAT rating diagram (Author, 2016)

7.7 TECHNOLOGIES

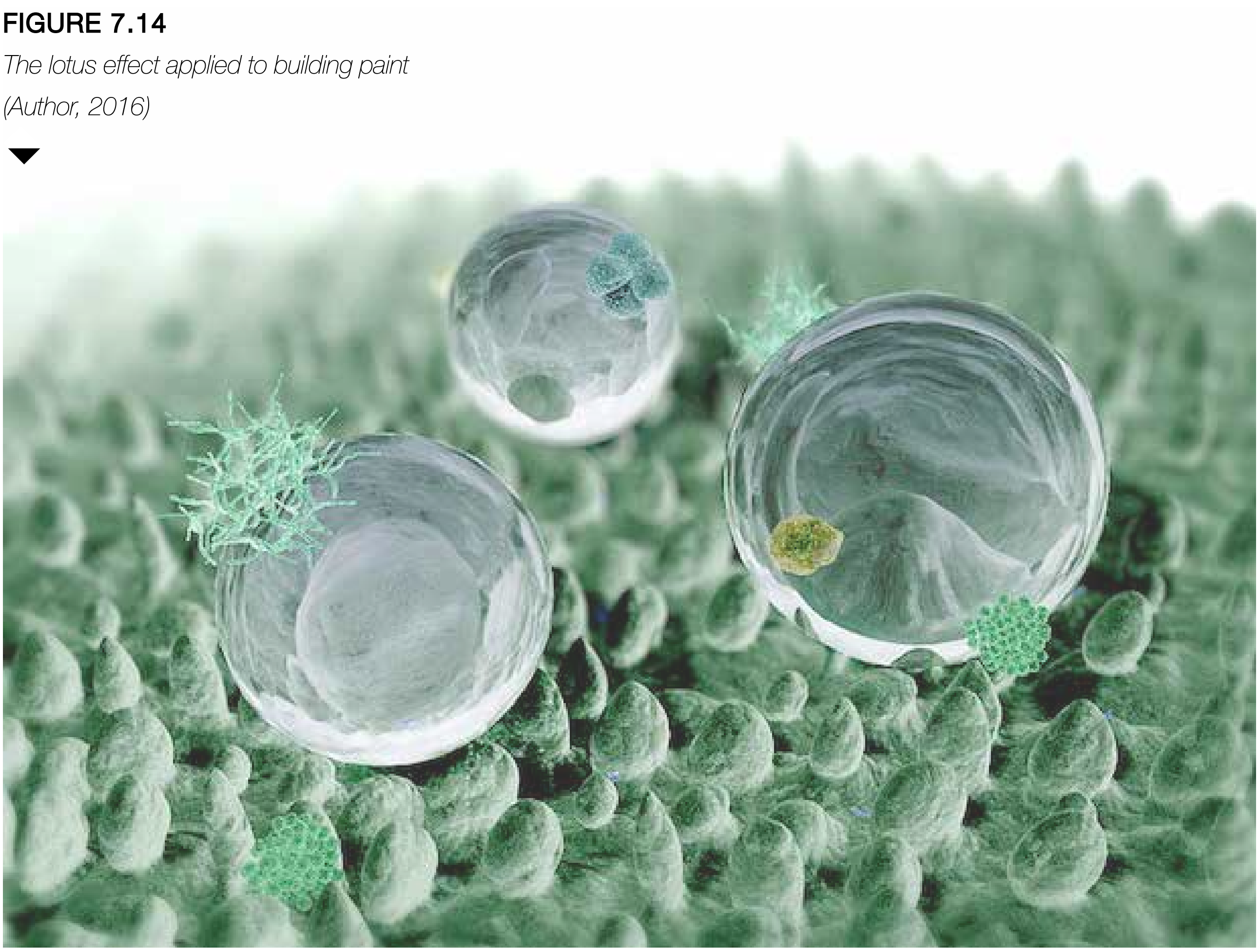
7.7.1 THE IMPLEMENTATION OF BIOMIMICRY TECHNOLOGY

The lotus plant has **self-cleansing capabilities** due to microscopic bumps and hairs on its waxy leaves. It is an excellent example of what biomimicry entails. This phenomenon is known as the 'lotus effect' and has inspired an entire industry of self-cleansing paints, textiles and domestic surfaces (Benyus, 2002: 35). *Lotusan* is an **exterior paint** that was developed by a German company, ISPO. By mimicking the microstructure found on the leaves of a lotus plant, the paint is able to minimize the contact area for water and dirt. This technology is an ideal application for the exterior bagged brick walls to ensure that the white walls are self-cleansing, to not only **reduce building maintenance**, but to also provide an **inherent connection to nature** on the smallest possible scale.

FIGURE 7.14

The lotus effect applied to building paint

(Author, 2016)



7.7.2 BIOGAS DIGESTING OF METHANE GAS

Organic waste that is generated by the operations in the **kitchens and restaurant** will be directed to a **central biodigester**, located in the **service basement** of the building. The biodigester uses anaerobic bacterial processes to convert organic waste products into **methane gas** as well as a by-product of **nutrient sludge.** The sludge can be directed to and treated in the proposed composting pits and be used as fertilizer. The methane gas that is produced will be redirected through a flame trap that is connected to the burner ovens in the kitchens.

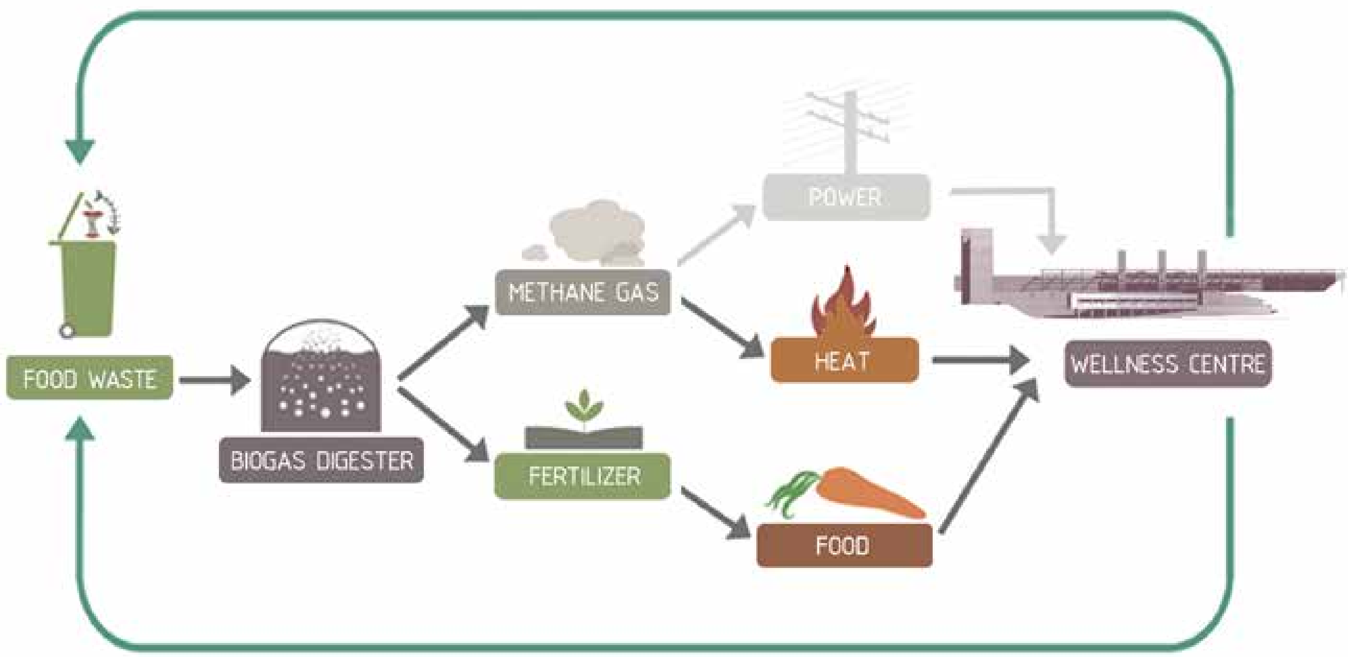


FIGURE 7.15

Diagram illustrating process of biodigester producing methane gas (Author, 2016)

7.9 SUMMARY

The fundamental aspects that this chapter outlines are mainly directed towards **environmental and systemic applications** to support all permaculture, treatment and public activities in and around the building. Biophilic design that enables people to affiliate with nature through architecture was predominantly achieved through **material selection** and application. **Detail resolution** was thus dependent on the properties that the different materials presented, and in some cases the solutions were simplistic whereas in other cases, such as the joining of these different materials, were more innovative.

It can thus be concluded that the technical outcome was predominantly directed to achieve a **sustainable environment** that operates on different **feedback loops** and scales to support **ecological regeneration** and **user awareness** in order to support the **reconciliation and realignment** of human and natural activities.