Irrigation areas

Figure 143 sets out the irrigation areas and table 9 the corresponding need. The manicured lawn will be irrigated with 25mm per week during summer and 6,25mm during winter. The lawn mix will receive no water during summer and 10mm per week during winter (the lawn mix areas area part of the groundwater infiltration scheme). The formalised planting and restio mix will be watered 10mm per week during summer and 5mm per week during winter.

All of the irrigation needs are met by the rain and runoff harvesting system.

Table 10 describe the anticipated building use, classification and water use per day. Tables 11 (next page) sets out the summary of the water budget along with a estimated water related cost saving of 30,71% per annum.

Month	Months	Weeks	Lawn	need	m^3 need	no mow lawn	need	m^3 need	Planting	need	m^3 need
				m / m^2	/week	mix	m / m^2	/month		m / m^2	/week
January	1	4.43	1609	0.025	178.20	1266	0	0	1725	0.01	76.42
February	1	4.14	1609	0.025	166.53	1266	0	0	1725	0.01	71.42
March	1	4.43	1609	0.025	178.20	1266	0	0	1725	0.01	76.42
April	1	4.3	1609	0.00625	43.24	1266	0.01	12.66	1725	0.005	37.09
May	1	4.43	1609	0.00625	44.55	1266	0.01	12.66	1725	0.005	38.21
June	1	4.3	1609	0.00625	43.24	1266	0.01	12.66	1725	0.005	37.09
July	1	4.43	1609	0.00625	44.55	1266	0.01	12.66	1725	0.005	38.21
August	1	4.43	1609	0.00625	44.55	1266	0.01	12.66	1725	0.005	38.21
September	1	4.3	1609	0.00625	43.24	1266	0.01	12.66	1725	0.005	37.09
October	1	4.43	1609	0.025	178.20	1266	0	0	1725	0.01	76.42
November	1	4.3	1609	0.025	172.97	1266	0	0	1725	0.01	74.18
December	1	4.43	1609	0.025	178.20	1266	0	0	1725	0.01	76.42
					1315.66			**75.96**			**677.15**
Year total											**2068.77**

Table 9- Total irrigation need

Use	*SABS*	*description*	*floors*	*area*	*occupants*	*water /person*	*per day*	*total*
				m^2		*PP10.4*		
Offices	G1	rain garden	2.6	639.6	42.64	90	3837.6	
		block	3	738	49.2	90	4428	8265.6
Education	A3	education centre	1	246	49.2	90	4428	4428
Restaurants	A1	rain garden	1	246	246	20	4920	
		north facing	1	246	246	20	4920	
		old bmw	1.3	319.8	319.8	20	6396	
		café	2	492	492	20	9840	26076
Shops	F2		1	246	24.6	9	221.4	221.4
Public toilets			1	1	650	9	5850	5850

Table 10- Building use, occupation and water need

Month	Days	Offices	Education	Restaurants	Shops	Public toilets	Total month
		8265.6	4428	26076	221.4	5850	
January	31	256233.6	137268	808356	6863.4	181350	1390071
February	29	239702.4	128412	756204	6420.6	169650	1300389
March	31	256233.6	137268	808356	6863.4	181350	1390071
April	30	247968	132840	782280	6642	175500	1345230
May	31	256233.6	137268	808356	6863.4	181350	1390071
June	30	247968	132840	782280	6642	175500	1345230
July	31	256233.6	137268	808356	6863.4	181350	1390071
August	31	256233.6	137268	808356	6863.4	181350	1390071
September	30	247968	132840	782280	6642	175500	1345230
October	31	256233.6	137268	808356	6863.4	181350	1390071
November	30	247968	132840	782280	6642	175500	1345230
December	31	256233.6	137268	808356	6863.4	181350	1390071
							16411806
Total in m^3							16411.806

Grey water (estimated at 10% of effluent)	1641.1806

Total harvested:	Irrigation need:	Buildings need:	with 10% water saving devices
5134.46	2068.77	16411.806	
Total water need		**18480.57**	**16632.52**

Cost of 1 m^3 water	R 9.02
Yearly cost without harvesting	*R 150 025.30*
Yearly cost with harvesting	R 103 712.51
Yearly saving of harvesting	**R 46 312.79**
% saving per year	***30.87***

Table 11 - Water balance and saving per annum

This leads to

- using no potable water for irrigation
- using less water for sanitation
- reducing the impact on down stream systems by reducing site runoff
- saving money

(the author notes that the buildings on site needs more water than the landscape)

The rain meter maze system

The second on site water system addresses rainwater. Rainwater from one of the on site buildings is harvested and displayed in a rain-meter garden.

Water from roof B2 (see table 12) is used for the rain meter maze system. A first-flush device intercepts the first dirty water where after it drizzles down a rain-curtain into a rain meter system (see figure 144).

From the first rain meter tank, underground pipes with openings on the same level, controls the water level in all the tanks, thus all the tanks are equally full (figure 146).

Each tank has an overflow slot that lets water from rain events of more that 90mm drain into the temporary wet-land.

After each rain event, the water is kept in the tanks until the next event. Solar powered pumps circulate the water and UV light reduces algae growth.

A rain sensor triggers the drainage system as a shower approaches so that the new event can be captured and celebrated. Figures 144 to 147 explains the phases of the rain meter maze system.

The rain-meters are large bullet resistant glass tank-like containers, calibrated to show how many millimetres of rain have fallen during the shower.

A rain sensor drains the water into the temporary wet-land and lets it percolate into the underground storage tank.

Section OO and PP (figure 149 and 151) illustrates the system further.

Table 12 - Water from B2 and rain meter tank capacity

From roof B2

meter capacity (m^3)	**area of meters (m^2)**	**height (m)**
from roofs - first-flush		
29.82	20.39	1.46

calibration

Calibration

10mm rainfall event:	height / 9 (for 10mm intervals)	0.16

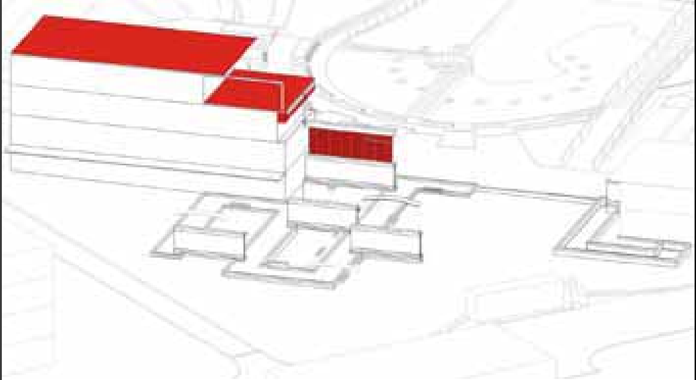


FIGURE 144. CATCH AND CONVEY

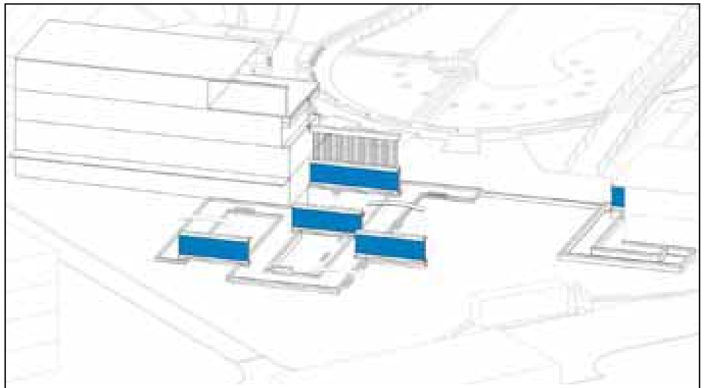


FIGURE 146. DISPLAY

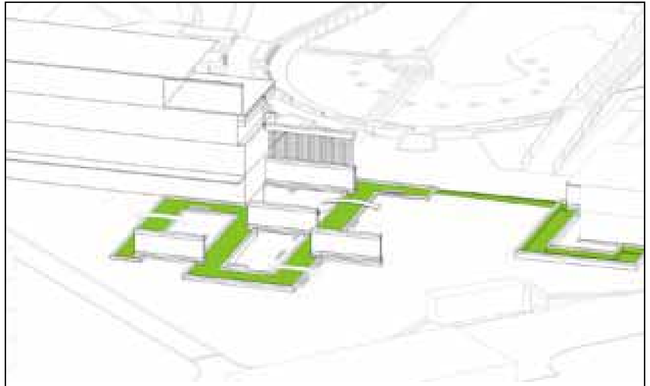


FIGURE 148. FILTER

FIGURE 145. DRAIN TO STORAGE

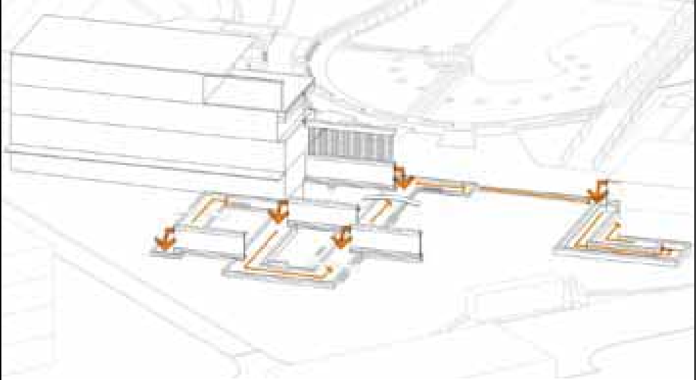


FIGURE 147. FLUSH AND PREPARE FOR NEXT SHOWER

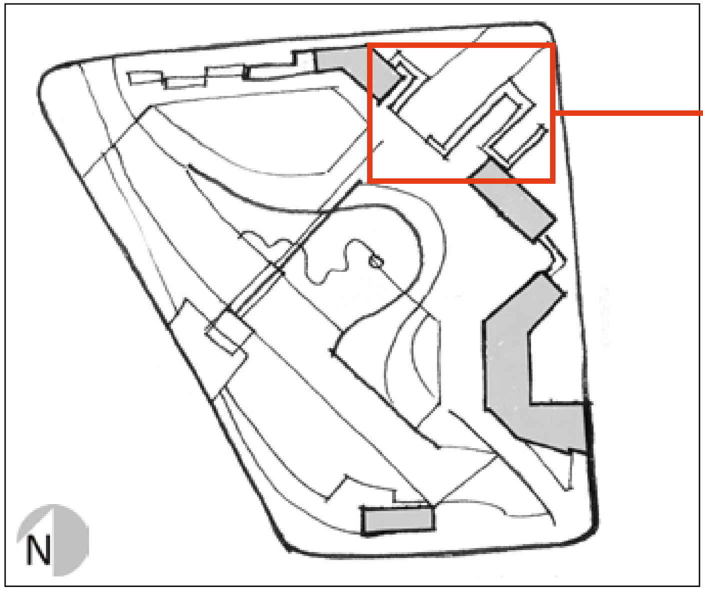


FIGURE 148. SECTION LINES OO & PP SCALE 1:200

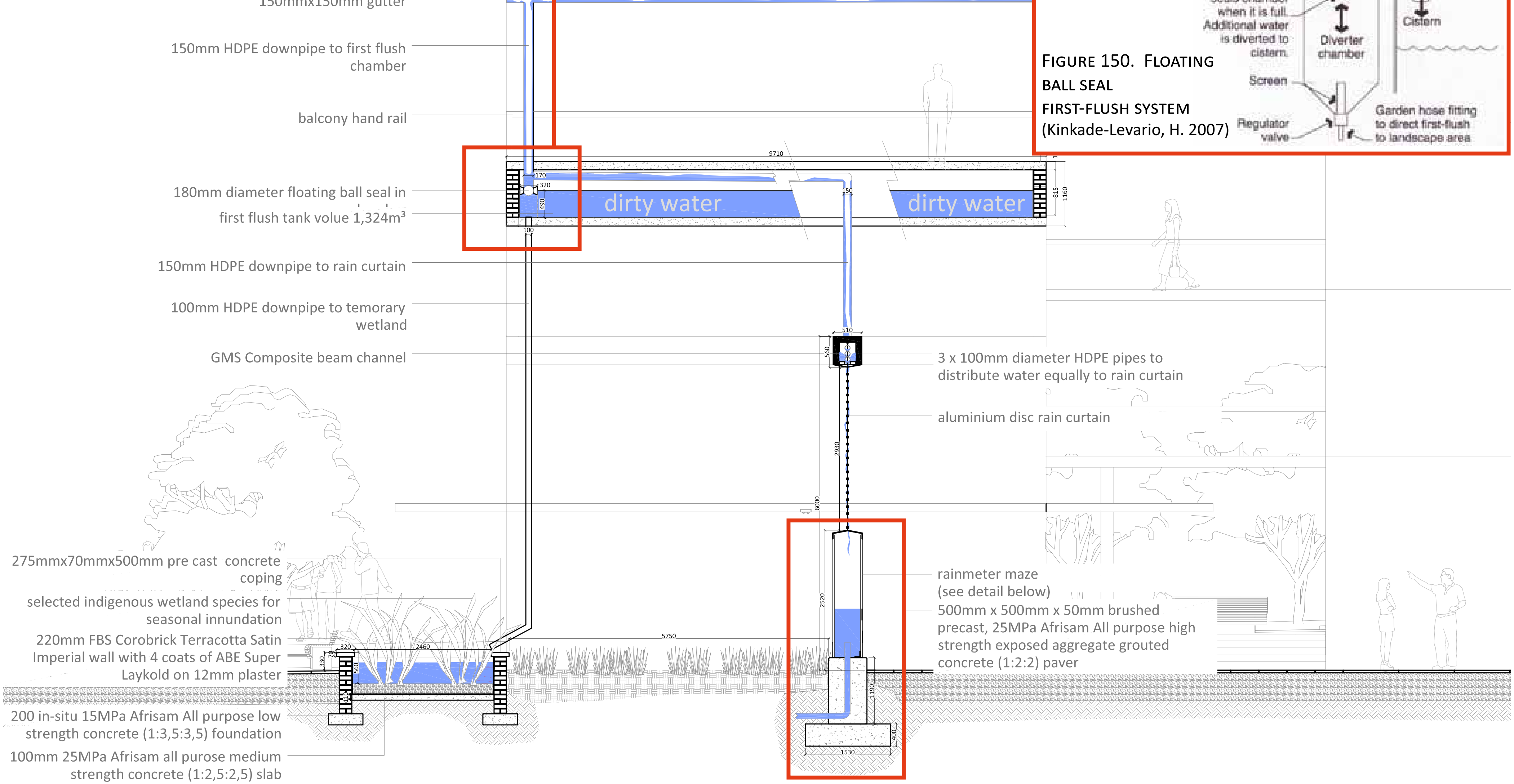


Figure 149. Section OO - Rain display system
Scale 1:100

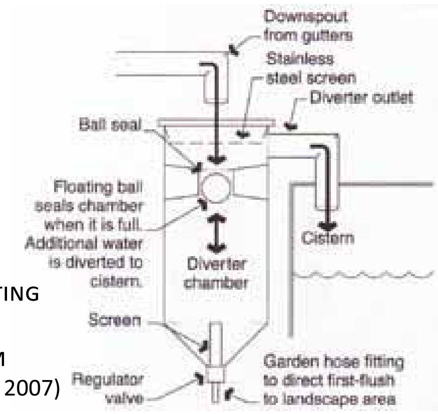


Figure 150. Floating ball seal first-flush system (Kinkade-Levario, H. 2007)

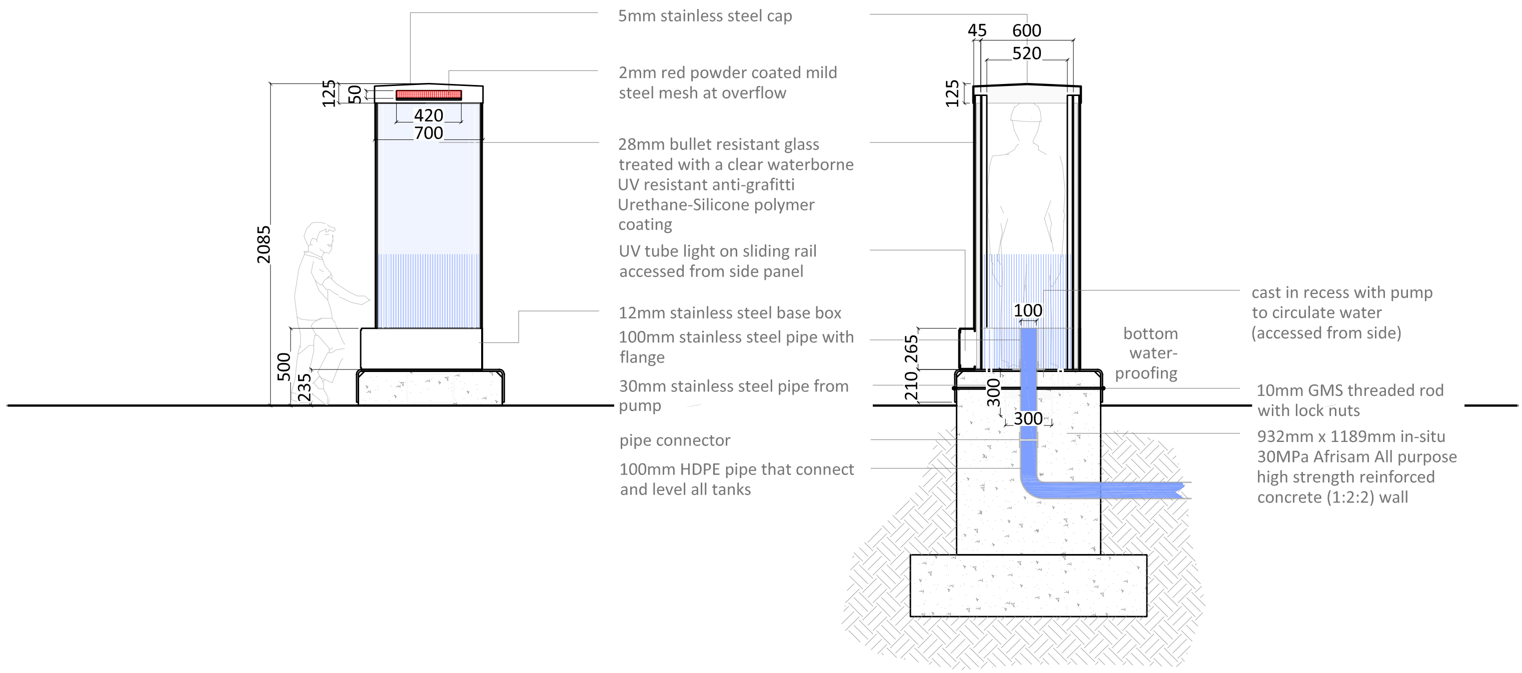


Figure 149 -1. Rain meter detail section and elevation
Scale 1:50

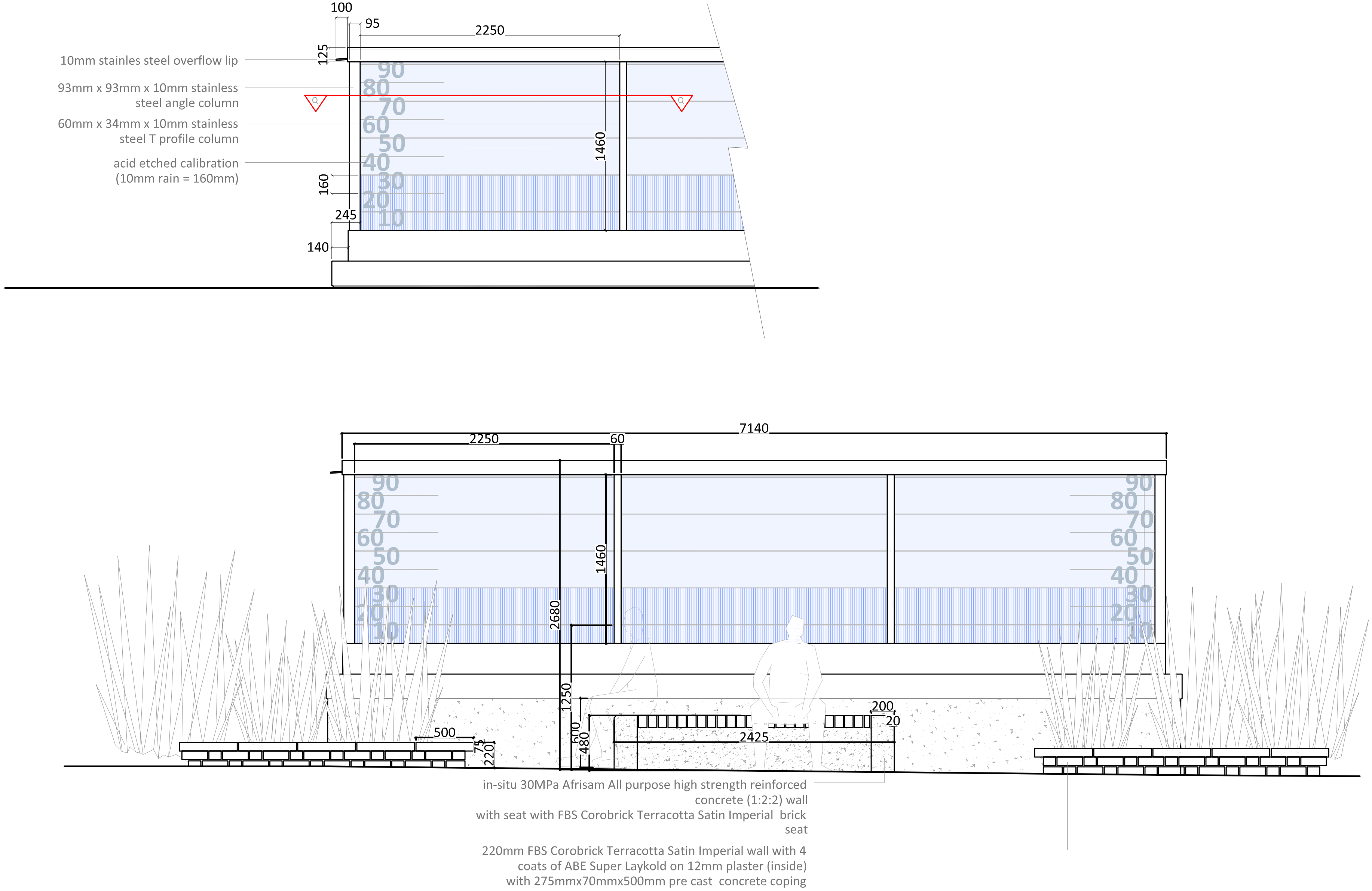


FIGURE 149 - 2. RAIN METER SIDE ELEVATION AND RAIN METER WITH BENCH INTEGRATION
SCALE 1:50

The grey water system

The third on site water system treats grey water from buildings through a stepped constructed wetland and displays the cleaned water in a jubilant motion activated display at one of the pedestrian entrances.

Water from all the taps and basins in the buildings are treated through the grey water wetland. For the biological processes in the wetland to be effective, the water needs to be in the system for a minimum of two days, thus 3283 litres over 2 days gives a flow rate of Q=0,019 (see table 13).

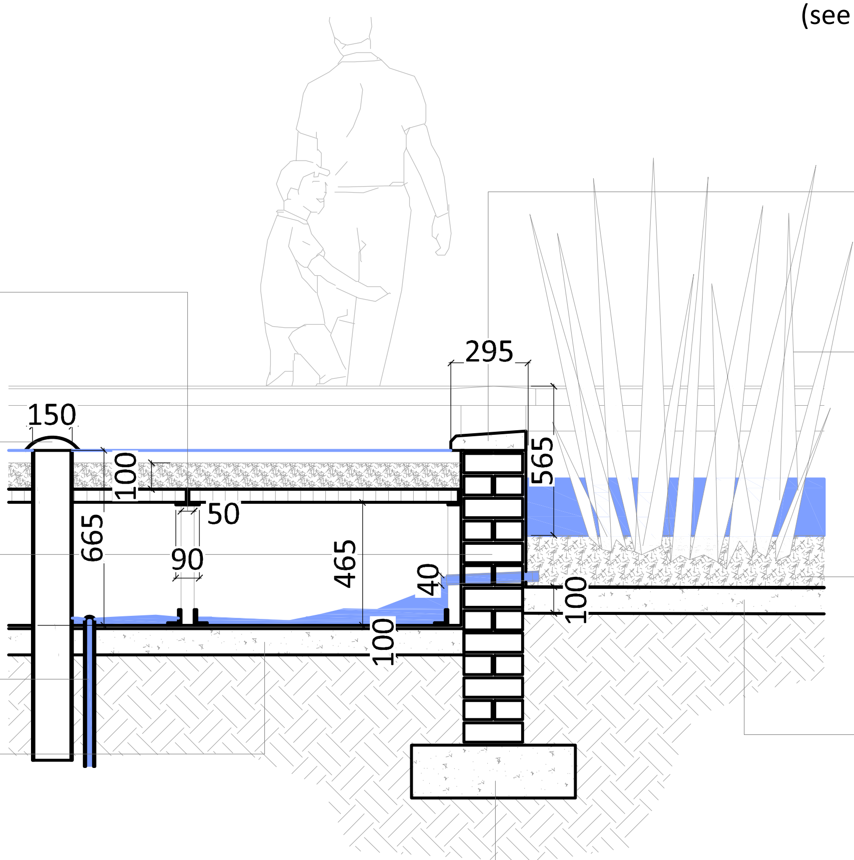
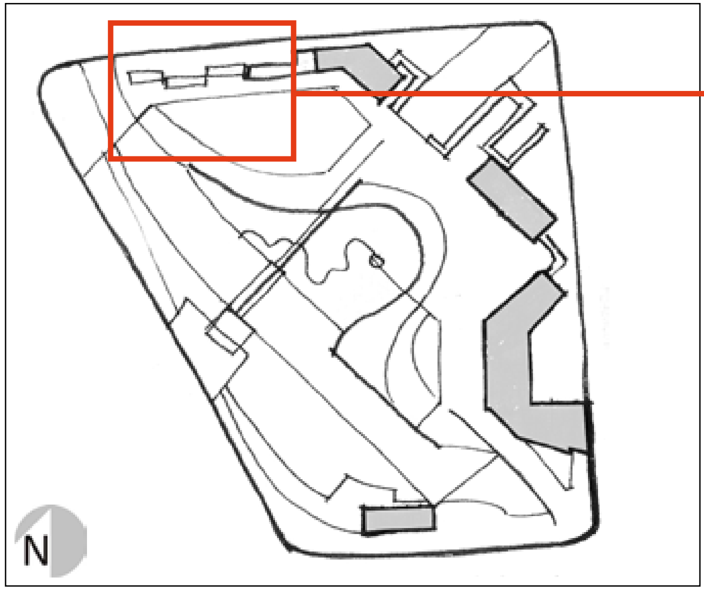


Figure 151. Section PP - Overflow into storage tank
Scale 1:50

grey water wetland							
component	channel width	*Q*	*A*	*P*	*n*	*S*	*y*
	0.775	*0.019*	*0.04263*	*0.522*	0.021	*0.0025*	*0.055*

Table 13 - Grey water wetland channel size calculation



Water from the rain-meter system; the grey water system and harvested surface runoff all contributes towards meeting the water needs of irrigation and buildings.

Figure 152. Section lines QQ & RR
Scale 1:200

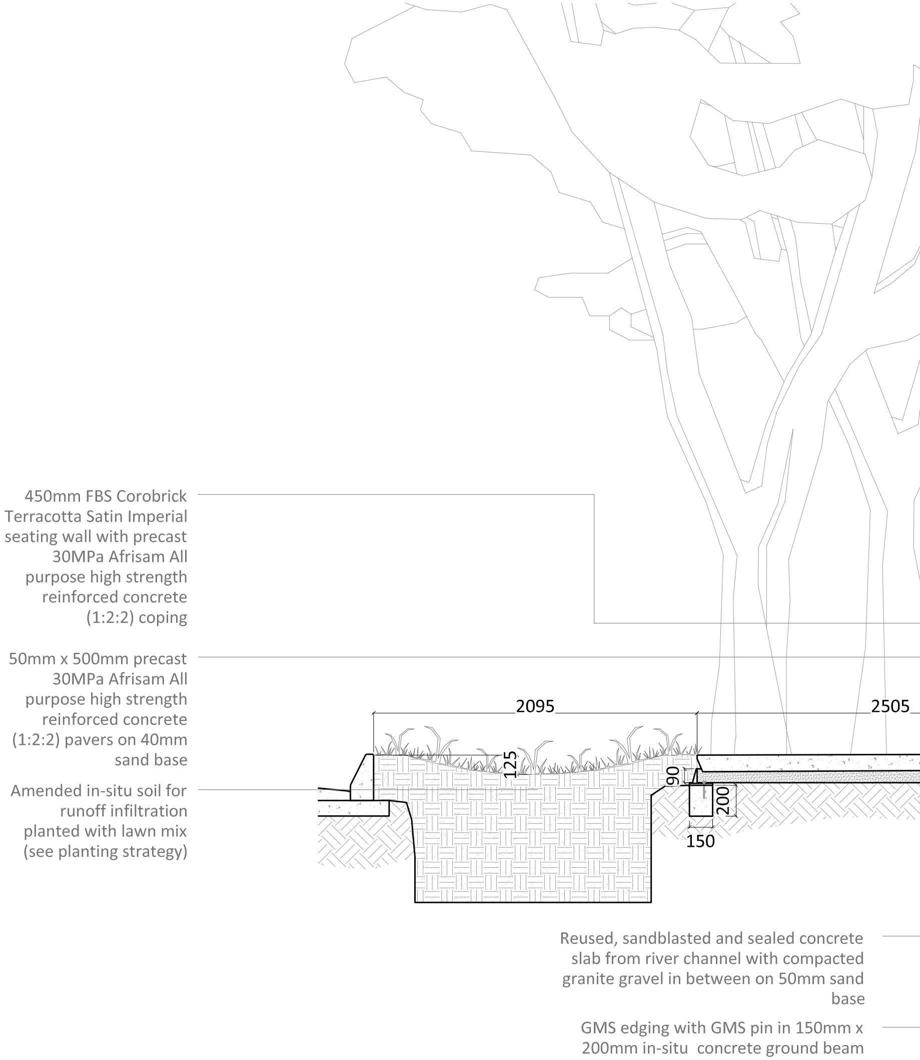
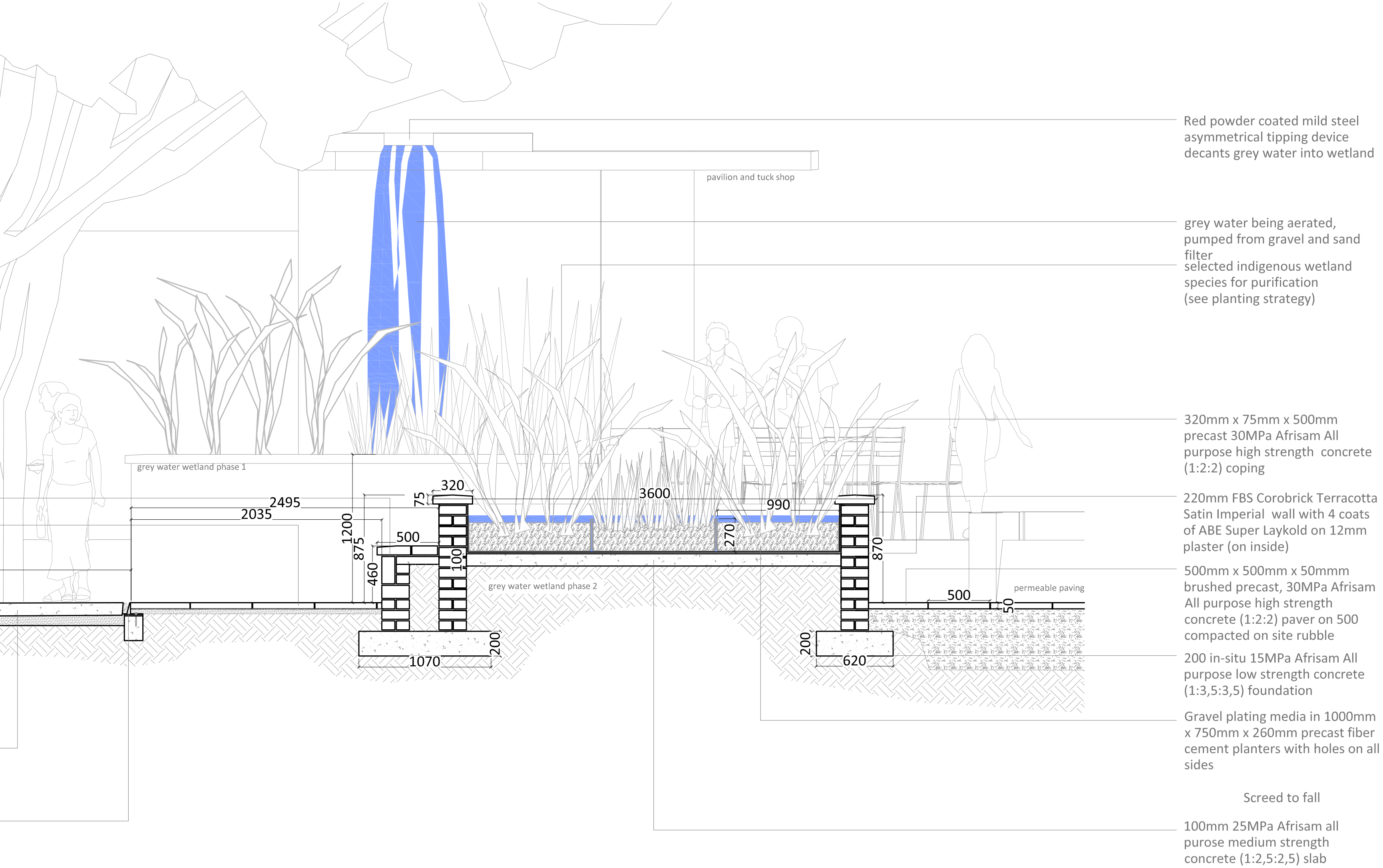


Figure 153. Section QQ - Grey water wetland
Scale 1:50


pavilion and tuck shop
grey water wetland phase 1
grey water wetland phase 2
permeable paving
2495
2035
1200
875
460
500
320
75
100
3600
990
270
870
500
50
1070
200
200
620
Red powder coated mild steel asymmetrical tipping device decants grey water into wetland
grey water being aerated, pumped from gravel and sand filter
selected indigenous wetland species for purification (see planting strategy)
320mm x 75mm x 500mm precast 30MPa Afrisam All purpose high strength concrete (1:2:2) coping
220mm FBS Corobrick Terracotta Satin Imperial wall with 4 coats of ABE Super Laykold on 12mm plaster (on inside)
500mm x 500mm x 50mmm brushed precast, 30MPa Afrisam All purpose high strength concrete (1:2:2) paver on 500 compacted on site rubble
200 in-situ 15MPa Afrisam All purpose low strength concrete (1:3,5:3,5) foundation
Gravel plating media in 1000mm x 750mm x 260mm precast fiber cement planters with holes on all sides
Screed to fall
100mm 25MPa Afrisam all purose medium strength concrete (1:2,5:2,5) slab

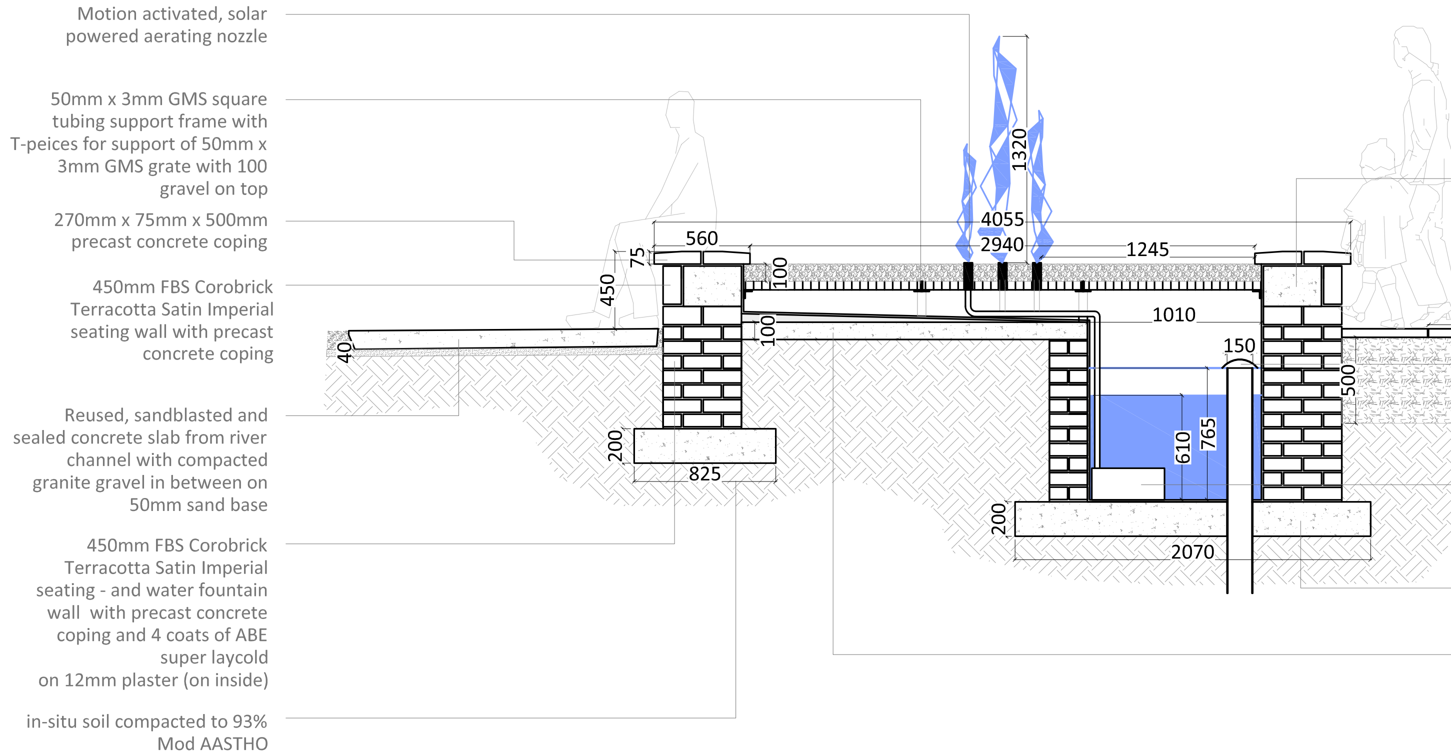
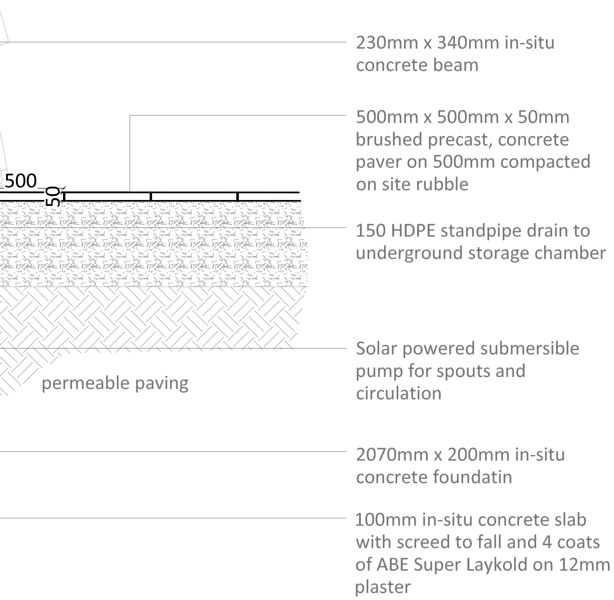


FIGURE 154. SECTION RR- GREY WATER FOUNTAIN
SCALE 1:50


230mm x 340mm in-situ concrete beam
500mm x 500mm x 50mm brushed precast, concrete paver on 500mm compacted on site rubble
500
50
150 HDPE standpipe drain to underground storage chamber
Solar powered submersible pump for spouts and circulation
permeable paving
2070mm x 200mm in-situ concrete foundatin
100mm in-situ concrete slab with screed to fall and 4 coats of ABE Super Laykold on 12mm plaster

Planting approach

Ecological intent

From the design goals and objectives (chapter 5), the following ecological objectives was identified

- Introduce constructed systems that supports components of ecology by focussing on water as a critical building block
- Incorporate the prominent themes from the ecosystem service analysis
  - Conserving water sources and the systems they support while optimising the use of on-site water and reducing the use of potable water
  - Introducing and preserving existing natural and on site region appropriate biomass

Appropriate biomass

From the historical analysis of the Apies River (see chapter 5), the following appropriate tree and plant species have been identified

- Bushwillows *(Combretum sp)*
- Wild olives *(Olea europaea subsp. africana)*
- White stinkwood *(Celtis africana)*
- Wild currant *(Rhus pyroides)*
- Ferns (Asplenium aethiopicum, Blechum australe and Cyathea dregei are appropriate according to van Jaarsveld (2000 p. 126 - 131)
- *Zantedescia sp.*

According to *Vegetation of South Africa, Lesotho and Swaziland* (Low & Rebelo, 1998 p. 39) the site is classified in the Rocky Highveld Grassland as part of the Grassland Biome.

Vegetation is dominated by grass species, forbs and trees. The use of veld grass in urban applications are limited due to the accumulation of biomass, the seasonal fire hazard and sensitivity towards trampling. A few species will be planted in manageable areas to serve as a reminder of what we have lost.

Selected forbs identified in *Vegetation of South Africa, Lesotho and Swaziland* will be used where appropriate.

All other plants selected are listed in 'Waterbesparende Inheemse Tuinmaak - 'n streeksgids tot inheemse tuinmaak in Suid-Afrika' by Ernst van Jaarsveld. In his publication van Jaarsveld addresses gardening in South Africa by grouping indigenous plants together that are appropriate for each region of South Africa. The groupings are based on suitability regarding climate and water conserving for each region. The site is located in his classification of the *highveld garden*.

On site biomass

All of the Jacaranda trees on site will be utilised and some will be moved to form a continuous edge along the streets. Restricting the use of Jacaranda trees to the street edge not only defines the edge but also maintains and enhances the historical value of Jacaranda trees as part of the heritage of the city.

Indigenous groundcovers will be replanted on site while exotic groundcovers will be used in the on site composting system.

Planting design as a system

Vegetation depends on soil, water and light. The soil on site mostly lies bare, compacted and polluted by rubble. An extensive soil rehabilitation plan needs to be drawn up (it is not within the scope of this thesis to do so). Part of the problem can be addressed by the proposed on site composting facility in that forms part of the service yard behind the shops.

Appropriate water strategies have been devised and covered earlier in chapter 9. Further water saving can be achieved by mulching. Using rocks or gravel as a mulch not only retains moisture in the soil but also reduces the presence of weeds and invasive species and stabilises the soil as well.

Planting groups

Manicured lawn

Cynodon transvaalensis 'florida'

Formalised planting

A selection of the following groundcovers

- *Sphenostylis angustifolia* (Low & Rebelo, 1998 p. 39)
- *Geranium incanum*

Some of the following perennials

- *Asparagus virgatus*
- *Barleria obtusa*
- *Diascia integerrima*
- *Europs tysonii*
- *Haplocarpa scaposa*
- *Plectranthus grallatus*
- *Senecio seminiveus*

(van Jaarsveld, 2000 p. 126 - 131)

Lawn mix

LM or *Dactyloctenium australe* (average height of LM lawn is around 200mm high) used as a continuous surface that will not be regularly mowed. Some of the following bulbs and forbs will be scattered throughout.

When needed, a brush cutter can be used in between emerging plants. These scattered bulbs and forbs will include some of the following

- *Senecio venosus*
- *Xerophyta retinervis* (monkey tail)
- *Crassula lanceolata*
- *Scilla nervosa*

  Above mentioned are specific to Rocky Highveld Grassland vegetation (Low & Rebelo, 1998 p. 39)
- *Boophane disticha*
- *Chlorophytum krookianum*
- *Crocosmia aurea*
- *Dierama adelphicum*
- *Eucomis autumnalis*
- *Eucomis bicolor*
- *Gladiolus dalenii*
- *Haemanthus sp.*
- *Hypoxis hemerocallidea*
- *Moraea huttonii*
- *Nerine bowdenii*
- *Scadoxus puniceus*
- *Watsonia pillansii*

(van Jaarsveld, 2000 p. 126 - 131)

Wetland species

Herbaceous species with roots in water

- *Crinum bulbispermum*
- *Cyperus latifolus*
- *Cyperus papyrus*
- *Echinochloa cabana*
- *Phragmites australis*
- *Scilla natalensis*
- *Typha capensis*
- *Zantedescia sp.*

Herbaceous species on edge of wetland

- Juncus kraussli
- Juncus effuses
- Hermarthria altissima
- Cynodon dactylon
- Kniphofia uvaria

(Wyatt, 1997 p. 3 - 11)

Veld grass mix

Rock or gravel mulching will contribute to control and space the following grass species

- *Cymbopogon valdis*
- *Hyparrhenia hirta*
- *Melinis nerviglumis*
- *Themeda trianrda*

(van Jaarsveld, 2000 p. 126 - 131)


Plectranthus sp


Geranium incanum


Diascia sp


Typha capensis


Zantedescia aethiopica


Sphenostylis angustifolia


Cyperus papyrus


Juncus effusus


Asparagus viragtus


Celtis africana


Combretum erythrophyllum


Xerophyta retinervis


Scilla nervosa


Melinis sp


Eucomis autumnalis


Crocosmia aurea


Cyathea dregei

Materials

Red face brick relates to the history of the Kirkness brickworks in Groenkloof, Pretoria.

Wooden decking (Ecucalyptus diversicolor 'karri') is widely associated with waterside activities and will strengthen emotive link with the river.

The extensive use of concrete connects with the river channel and the finishes hints at the erosive quality of water. The concrete will be brushed, sandblasted or off shutter while the aggregate will be exposed in some applications. Square concrete flagstones used throughout links with the rigid grid of the city.

Bullet proof glass will be used for the rain meter tanks along with stainless steel and powder coated black and red mild steel.

Handrails will be stainless steel.

exposed aggregate concrete

bullet resistant glass

wood


red face brick


wooden seating


off shutter concrete wall


red brick paving


Eucalyptus saligna decking


sandblasted concrete