A

RESERVOIR URBAN LIVING ROOM

Increasing Water Relatedness In Marabastad

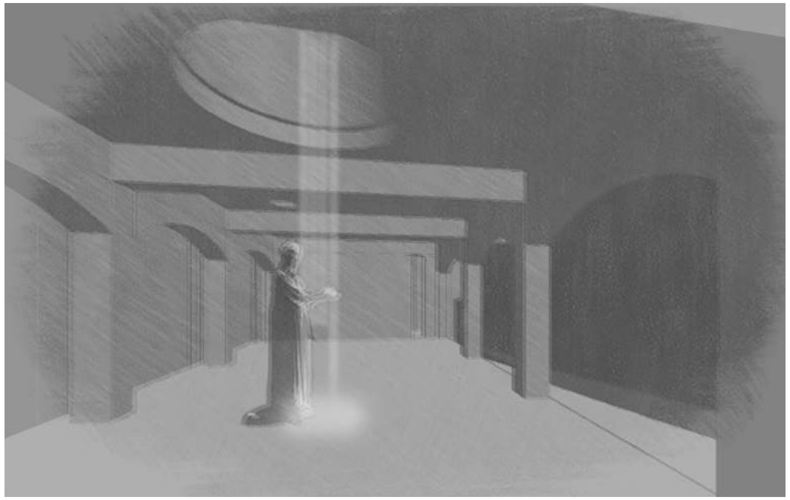
Mamofella Mphaka
u28185341

Edited by: C. Mukuka

Submitted in partial fulfillment of the requirements for the degree of:
Magister of Architecture (professional).
Faculty of Engineering, Built Environment and Information Technology.
University of Pretoria,
Department of Architecture
2020.

Year coordinator: Prof. Arthur Barker.
Study leader: Abre Crafford.
Research field: Environmental Potential.
Site address: 37 4th Street Marabastad (Asiatic Bazaar), Pretoria.
-25.742740, 28.174813.
Current usage of site: Empty lot with informal parking of taxis and buses and informal trade.
Proposed usage of site: Urban Living Room (including informal trade).

With special thanks to my family, without whom I would not have been able to achieve this.
Thank you to my friends, whose patience and support have been invaluable.



ABSTRACT

This dissertation aims to investigate how architecture can improve water literacy and, thus, water conservation and security, by bringing the user closer to the building's water processes and systems.

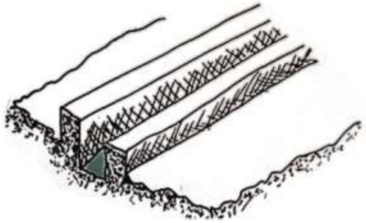
The programmatic function of the building is an urban living room. Here, the dwellers of the adjacent social housing development – about 3000 people – will be provided amenities for mostly recreational purposes. Furthermore, the tens of thousands of people who travel into Pretoria CBD daily for various government services, will be provided with a place to pause, linger, and perhaps have something to eat.

The architectural exploration aims to empower the user through the provision of basic water services and surrounding secondary services, whilst at the same time enhancing the everyday user's relationship with, and reverence of, water. The two main water resources that will be focused on are rain roof water and storm water.

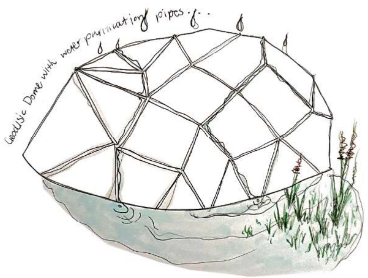
In an urban context where storm water runoff is currently treated as a destructive force and the water is discarded as quickly as possible from the city, the project will endeavor to harness this resource and utilise it to enhance the architecture. Similarly, roof rainwater will also be collected and utilised. The project will invite water into the building in various ways that enhance the climatic conditions within the building. Unlike in the traditional manner of waterproofing and keeping the water out of the building, these enhancing processes will be made visible to the users of the building in order to increase their understanding.

This dissertation endeavors to add to the large body of research into the global quest for water security, underpinning itself in the context of the Marabastad, Pretoria.

PROJECT SUMMARY



Dissertation title:
A **Reserv**oir urban living room- incrasin water relatedness in Marabstad.

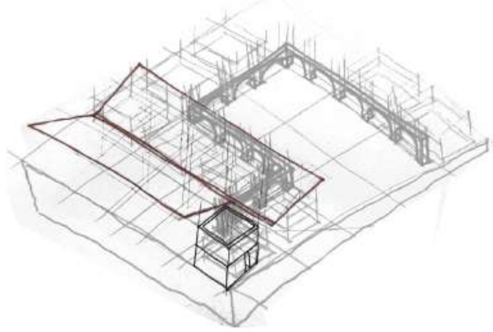


Type of building: Urban living room

Site address: 37 4th Street Marabastad (Asiatic Bazaar), Pretoria.
-25.742740, 28.174813.

Research field: Environmental Potential.

Client: City of Tshwane with Tshwane Housing Company and the Department of Human Settlement



Theoretical premise: Pragmatism

Key words: Water security, Nature relatedness, Water literacy

CONTENTS

TABLE OF IMAGES

TABLE OF IMAGES

TABLE OF IMAGES

TABLE OF IMAGES

TABLE OF IMAGES

TABLE OF IMAGES

CHAPTER 1: INTRODUCTION

Water is one of the most basic needs for human existence and is governed by the South African Constitution through the Water Services Act, 108, 1997 (The Constitution of South Africa, 1997, chapter 2). Due to climate change, access to water for survival is not always guaranteed in Sub-Saharan Africa, and its prevalence is declining (Davis-Reddy, C.L. and Vincent, K. 2017). Much in the way that the South African government has legislated for water security, the United Nations has set the quest for increased global water security, as one of its Sustainable Development Goals (United Nations, 2015), proving that it is undeniably a high priority issue at present.

Yet, urban dwellers have lost their sense of relatedness to water in terms of where it comes from, how it arrives at the tap, what different water quantities look like, and how heavy they are (Zylstra et. al., 2014; Geere et. al., 2010). Because of this, frequent campaigns for water conservation have little effect in reducing water consumption by urban dwellers (Addo et. al., 2019), and, consequently have little effect in influencing legislature to force industry to participate in water conservative production methods.

Architecture can influence people (Ragsdale, 2009). To avoid being caught like the proverbial frog in slowly boiling water, it is mandatory for architects to continue to participate more explicitly in the efforts to ensure water security through the way that we design buildings.

Problem Statement

People can benefit from a more explicit participation by architecture in South Africa and the global quest for water security. Locally, roof rainwater runoff and storm water runoff is typically channelled away from site and out of urban areas as quickly as possible. The benefit of these water resources are not being harnessed in the architecture and are thus not being witnessed by the building's inhabitants.

Hypothesis

By bringing water services and systems to the foreground of the user instead of keeping them hidden, architecture can increase the water relatedness of urban inhabitants of South Africa, thus increasing water conservation.

Overview of Structure and Rationale

The document will be set up into these three overarching headings with various relevant subheadings. This structure flows from one topic to the next, but the overarching headings keep the entire document argument succinct and maintain the main argument of the dissertation.

A. What are the current design conventions regarding water concerning South African urban buildings?

B. What are the influencing factors in people's behaviours towards water conservation?

C. How can water systems and processes be made more visible and interactive with the building's user?

CHAPTER 3: CONTEXT

Site Locality

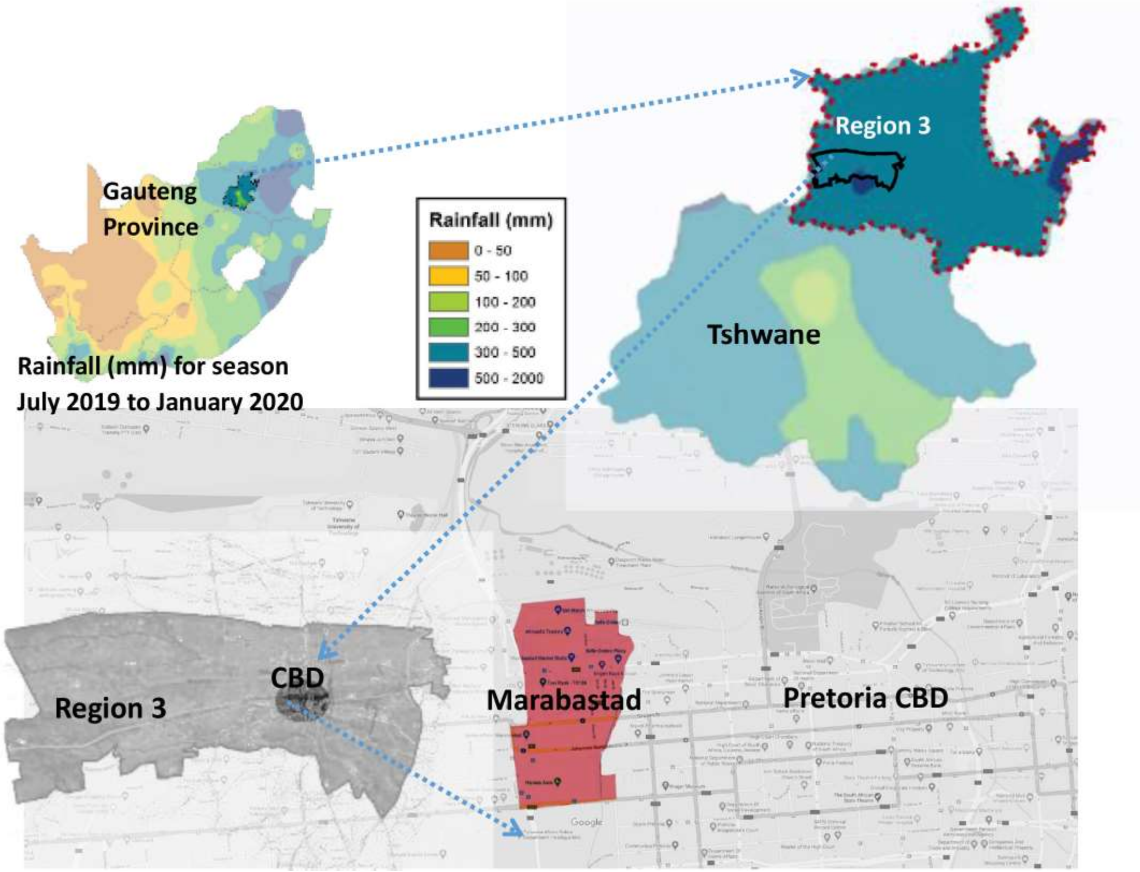


Figure 1: Site locality within South Africa's rainfall context. (Weather SA, 2020)

Figure 2: Site locality- Map showing Marabastad within the Pretoria CBD context (Adapted from Tshwane GIS, 2020))

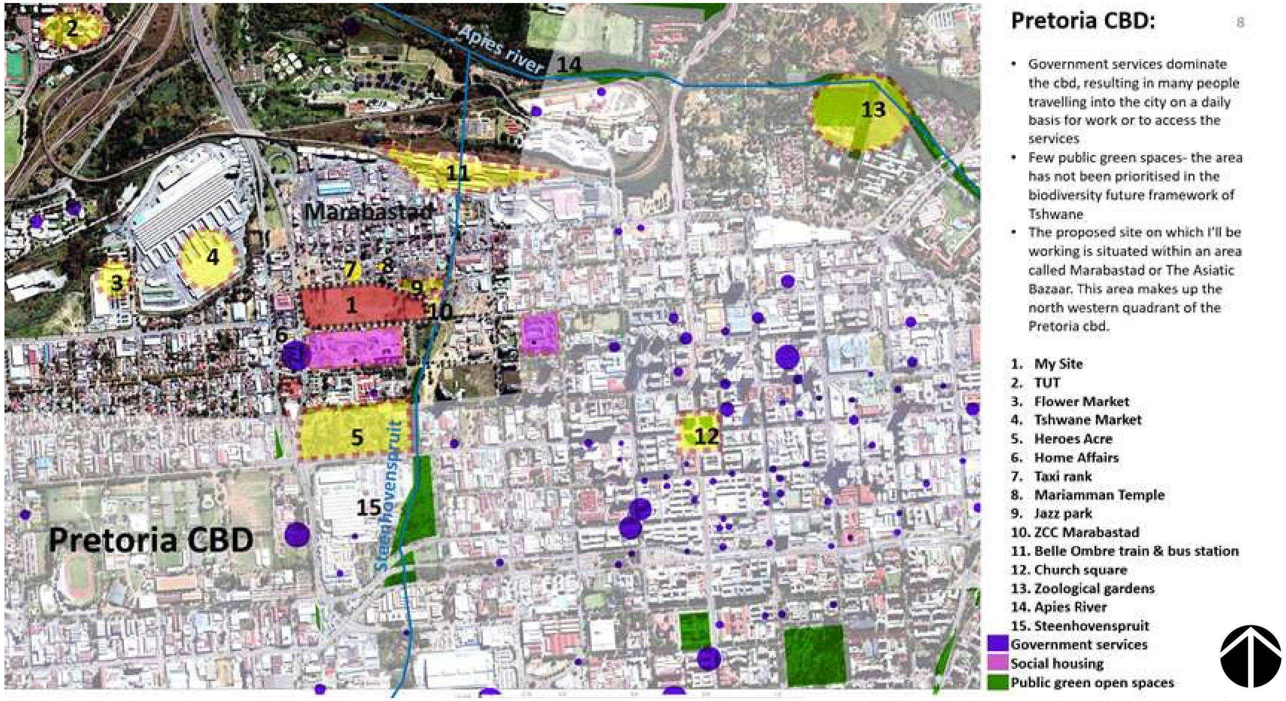


Figure 3: Places of interest in Tshwane CBD (Adapted from Tshwane GIS, 2020)

Pretoria City is one of South Africa's capitals and is located in Gauteng province and within area 3 of Tshwane Municipality. It is home to many government services, and most of its workforce lives outside of the CBD and in other areas of Tshwane. These factors contribute to a large number of "day visitors" who travel in and out of the city on a daily basis (Tayob partnership, 2002). This geographic layout is also a relic of South African apartheid planning and laws (Tayob partnership, 2002). In keeping with the legislated Spatial Planning and Land Use Management Act 16 of 2013, it is thus important to include features that will encourage inclusivity and spatial justice in the project design.

The proposed site is situated within Marabastad. Marabastad is in the north-western quadrant of the Pretoria CBD. Some notable landmarks in close proximity to the proposed site are Church Square to the east, Belle Ombre train station and bus depot to the north, Heroes Acre to the South, and the Pretoria flower and general markets to the west

Climatic conditions

The climatic conditions of Sub-Saharan Africa have been found to be trending towards an even drier direction, yet, during the rainy seasons, the same area is prone to flooding (Davis-Reddy, C.L. and Vincent, K. 2017). In urban areas, storm water floods cause damage to infrastructure and, in worse cases, displace people and cause death and disease (Davis-Reddy, C.L. and Vincent, K. 2017).

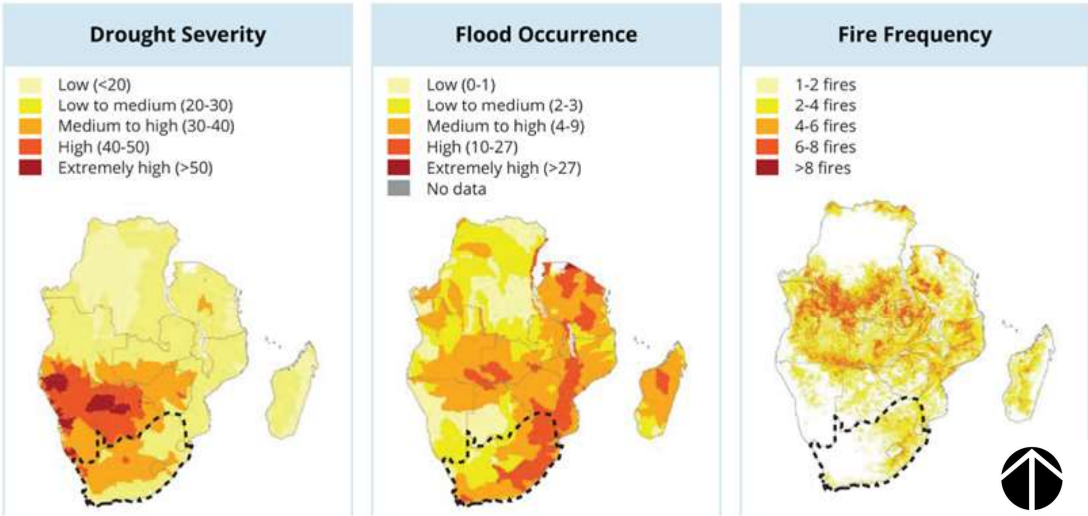


Figure 4: Climatic observation of Sub- Saharan Africa from 1980- 2012 (Adapted from Davis, Reddy & Vincent, 2017: 36).

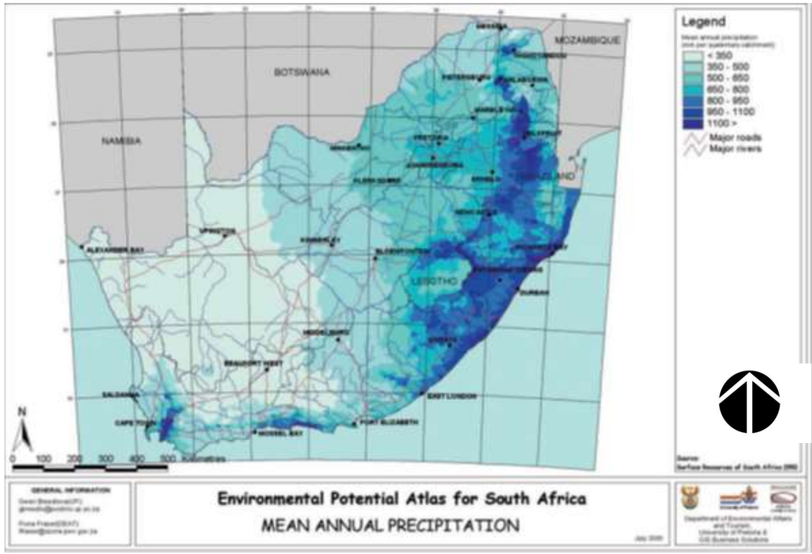


Figure 5: Pretoria may receive up to 800mm of rainfall, which due to the sealed surfaces in the city, causes flooding (Knight, J, & Rogerson, CM (eds) 2018: 93.

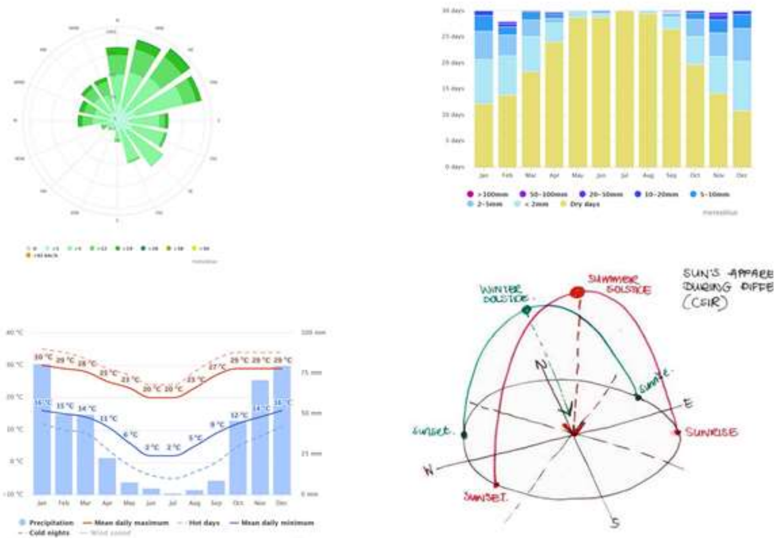


Figure 6: Pretoria's climate (Meteoblue, 2019)

Sub- Saharan Africa's climate is trending towards the direction of more arid areas of the world (Davis-Reddy, C.L. and Vincent, K. 2017). It would thus be advantageous to design buildings that borrow from these regions.

Marabastad's spatial conditions

Pretoria, as it is known presently, largely owes its existence due to settlers finding water in the area. Upon arrival the settlers were made aware of two ground water springs in the area which would serve as a reliable clean water source for the ensuing town, "the location of Pretoria was selected by General Marthinus Wessel Pretorius because of the existence of the two groundwater springs that discharge into the Apies River through the CBD" (Dippenaar, 2013). These springs are still in existence today and are situated in the Fountains Valley.

Until the 1920's, ground water from the springs at Fountains Valley, served as the only source of water for the town of Pretoria. Due to increases in population and development, "After dutifully serving as Pretoria's only source of water for 75 years, groundwater supply now required augmentation by alternative sources"- Dippenaar, 2013. Subsequently, in 1929 the Reitvlei Dam was constructed; and in correspondence with the inclusion of various other municipalities into that of Pretoria over the years, other dams such as, Roodeplaat and Bon Accord were added. Presently, Pretoria mostly relies on water imported from other metros, "at present, approximately 57 million litres of water per day is supplied to the City of Tshwane from groundwater sources, accounting for approximately 7.5% of the total (the remaining 742 million litres per day is supplied from dams or imported from water boards."- Dippenaar, 2013.

Our current water supply systems are stressed and alternatives need to be established in order to fulfil our daily demands (Sershen et. al., 2016). As our population continues to grow and climatic conditions cause more droughts, it is imperative for us to collect and utilise as much roof rain- water and storm water that falls in the narrow rainy seasons in our cities rather than discard it.

Marabastad's borders

As shown in Figure 7, Marabastad's northern border is the Apies River, and the area slopes down in this direction. The eastern border of Marabastad is a stream called Steenhovenspruit. The western border is currently Es'kia Mphahlele road, while the southern border is WF Nkomo Street. Marabastad is surrounded by natural water resources, however, they are currently not harnessed to complement and improve the economic potential of the area. Steenhovenspruit, channelized in 1923, no longer floods naturally to create urban green spaces for the area. Instead, the stream is polluted and acts as a barrier, rather than a feature that enhances the area.

Marabastad's commuters

Pedestrians play a very big role in the day-to-day operations of Marabastad. It is estimated that in 2002, about 75,000 people travelled through Marabastad on their way into Pretoria CBD (Tayob partnership, 2002). The main route used by pedestrians making their way into the CBD is Jerusalem Street. The ease of movement by pedestrians is encouraged by the fine-grain nature of Marabastad's blocks, each being 75m by 40m wide. Despite the large prevalence of pedestrians, there are few trees to shade people as they walk along the streets of Marabastad. Tayob partnership's 2002 SDF recommended that trees be planted along Jerusalem Street – this feature will be included in the final design. Another key recommendation by Tayob's partnership is the provision of public ablution facilities and informal trading stalls in all existing and future bus and taxi ranks in the area to serve shoppers and commuters. (Tayob Partnership, 2002: 213). These will also be included in the final design.

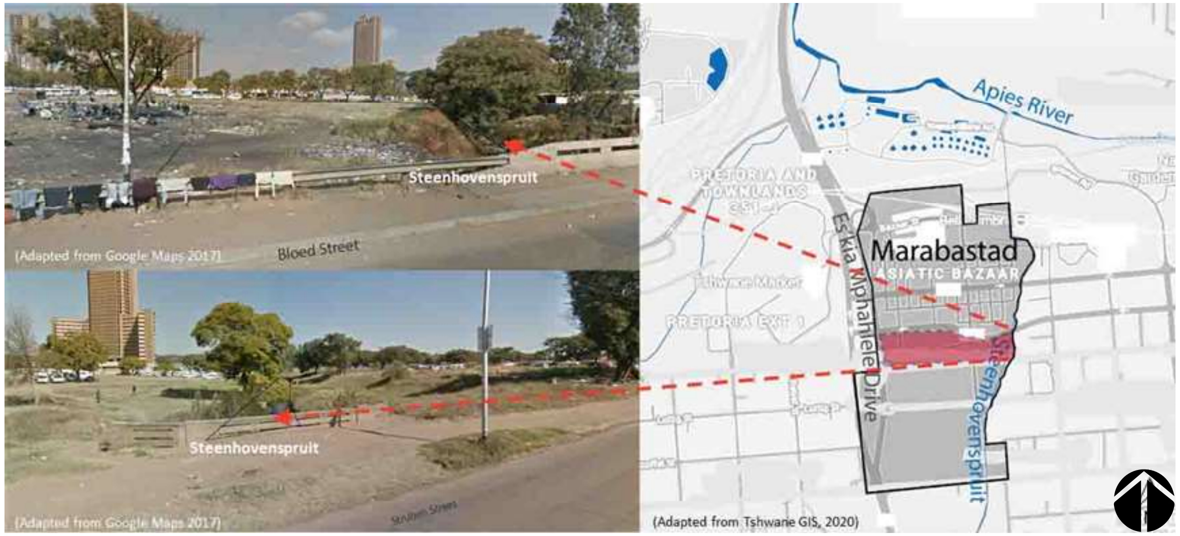


Figure 7: Present day boundaries of Marabastad. It is surrounded by unused and inaccessible water (Adapted from Google Maps, 2017 & Tshwane GIS, 2020).

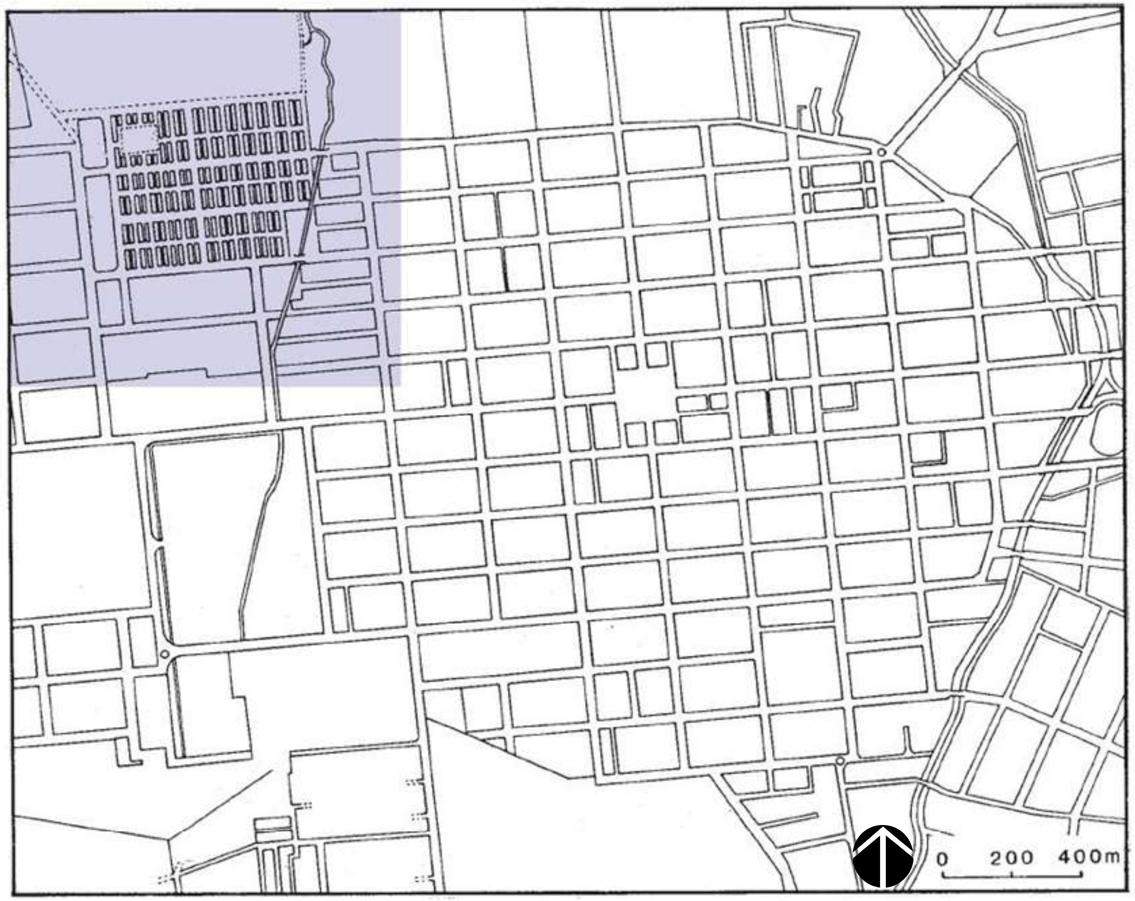


Figure 8: Marabastad's fine grain shown within larger context of Pretoria CBD (1950). (Tayob Partnership, 2002: 78)

Trade in Marabastad

Historically, the housing typology of Marabastad was one where the ground floor was occupied by shops and the 1st floor was residential space. Due to the social conditions and resultant from the varying cultures of people living in the small space together, trade was abundant in Marabastad. This area is currently zoned primarily for business activity, and has remained a shopping destination for people from all corners of Tshwane. The high foot traffic of people commuting into the city also aids trade in the area. "Trade in Marabastad depends to a large extent on the passage of commuters" (Tayob Partnership, 2002).

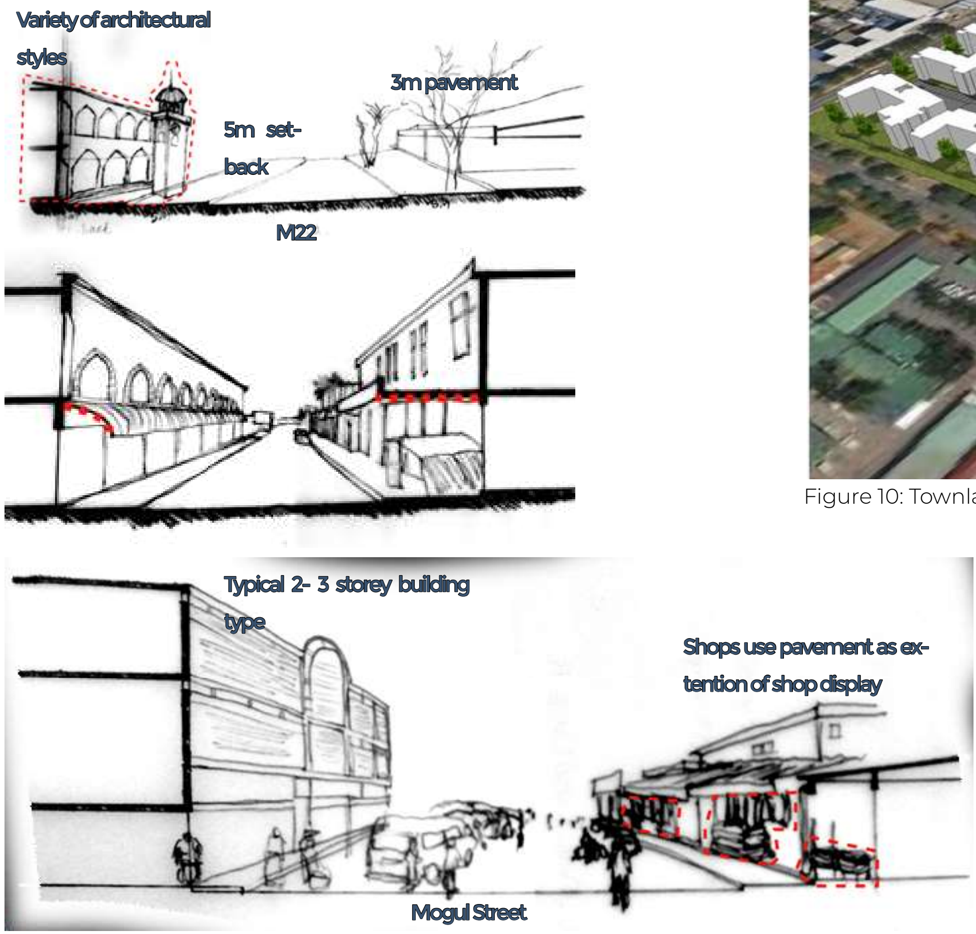


Figure 9: Section studies of existing buildings of Marabastad. (Author, 2020)

Figure 10: Townlands Social Housing Scheme (Adapted, CoArch, 2020)

Townlands Social Housing

In 2020, a social housing scheme was constructed to the south of my proposed site. This scheme will be completed in early 2021, and will house +/- 3000 people, increasing the foot traffic of the area. This is one of the factors that guided my choice in site location, as the new social housing scheme further prompts the need for public green open spaces in the area (Arch Active, 2020).

West Capital Phase 1 & 2 Design Guidelines

The West Capital Design Guidelines document was created by the City of Tshwane in 2014. It is the latest available document setting out guidelines for the development of the Marabastad area. The document states that the city wants Pretoria CBD to become denser with residential buildings. These buildings will be mixed use in nature, with the ground floors accommodating shops, the floors above these accommodating offices, while the top floors will accommodate residential spaces. Struben Street is described as being a Ceremonial Street as it allows a view of government buildings and activities further down in the east direction. Jerusalem Street is said to be a Pedestrian First street. The site which I have chosen for my project is to remain a Pedestrian First area.

Micro site conditions

Site location

Figure 11: Micro site locality (Adapted from Google Maps, 2017 by Author, 2020)

Existing zoning

Figure 12: The area within which I'm working is currently zoned as Business 1 (Tshwane GIS, Image adapted from Google Maps, 2017)

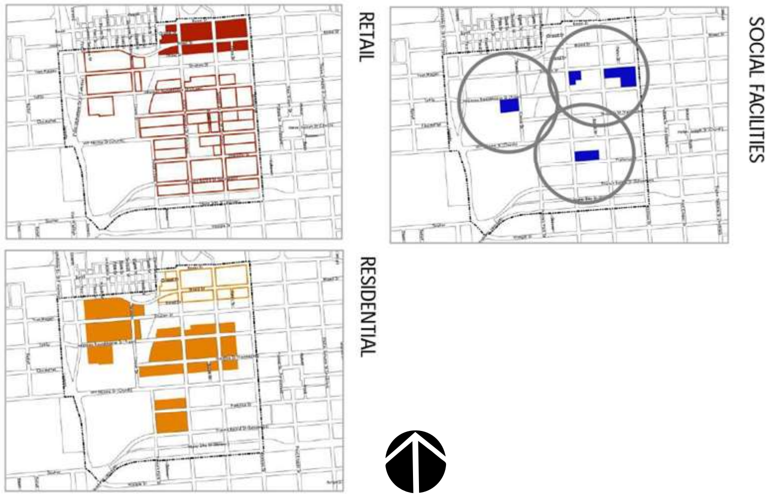


Figure 13: West Capital Multi- zoning (West Capital SDF, 2015)

Current land ownership

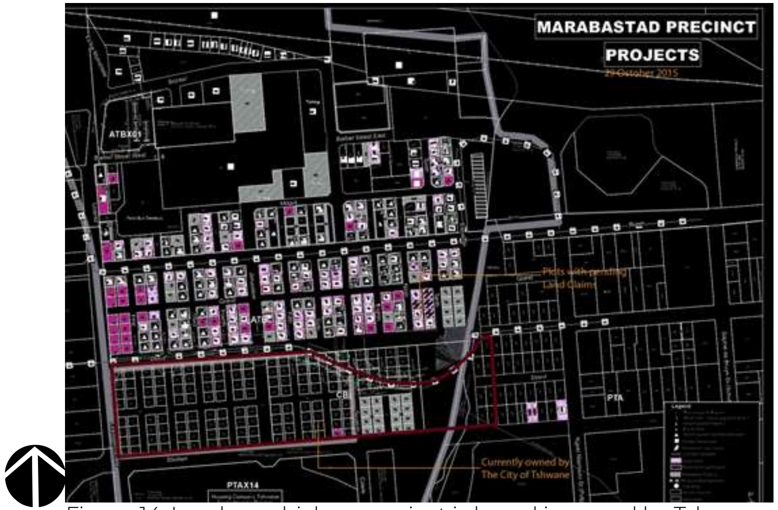


Figure 14: Land on which my project is based is owned by Tshwane City Council (Tshwane City Council, 2015)

Figure 15: Projected massing for the site (CoArch International for Tshwane City Council, 2014)

Guidelines on set-back ad street conditions

- Built- to- line
- 0m
- Where buildings front onto more than one street they must follow the built-to line on both frontages.
- Create a continuous street wall with building mass abutting a minimum of 75% of street frontage on both vertical and horizontal planes
- A maximum of 25% of the building may be set back 2m from the built-to lines preferably at building entrances or at corners
- Variations from the build-to line such as balconies, canopies, or colonnaded frontages / walkways may project up to 2m beyond the build-to line into the road reserve (sidewalk) provided the main street wall clearly follows the build-to line

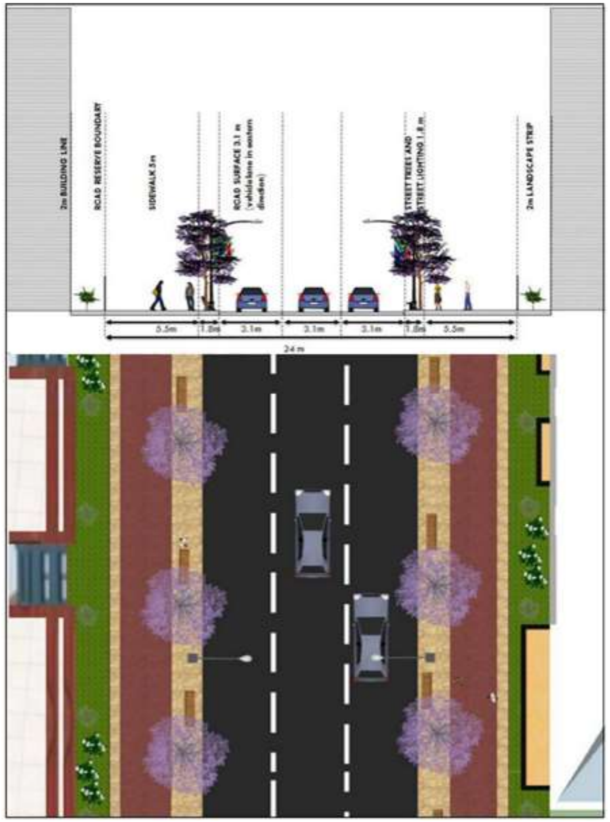


Figure 16: Set back guidelines along Struben Street (West Capital SDF, Tshwane City Council, 2014).

Pedestrian friendly area

Tayob partnership recommends and reiterates the ambition of the West capital Design Guidelines document, of keeping and enhancing Marabastad as a pedestrian friendly area. It is recommended that 7th street be widened to allow it to become an access route from east to west while Jerusalem Street becomes a “high- street” in the north- south direction. The proposal gives acknowledgement of the centrality and historical value of Jerusalem Street in the original grid of Marabastad. It is recommended that Jerusalem Street be allowed to extend right through the residential areas, which will be established on the south, thus drawing pedestrians into and through Marabastad- (Tayob Partnership, 2002).

Figure 17: Jerusalem Street as a north-south pedestrian artery leading to, from and through Marabastad (Tayob Partnership, 2002: 228).

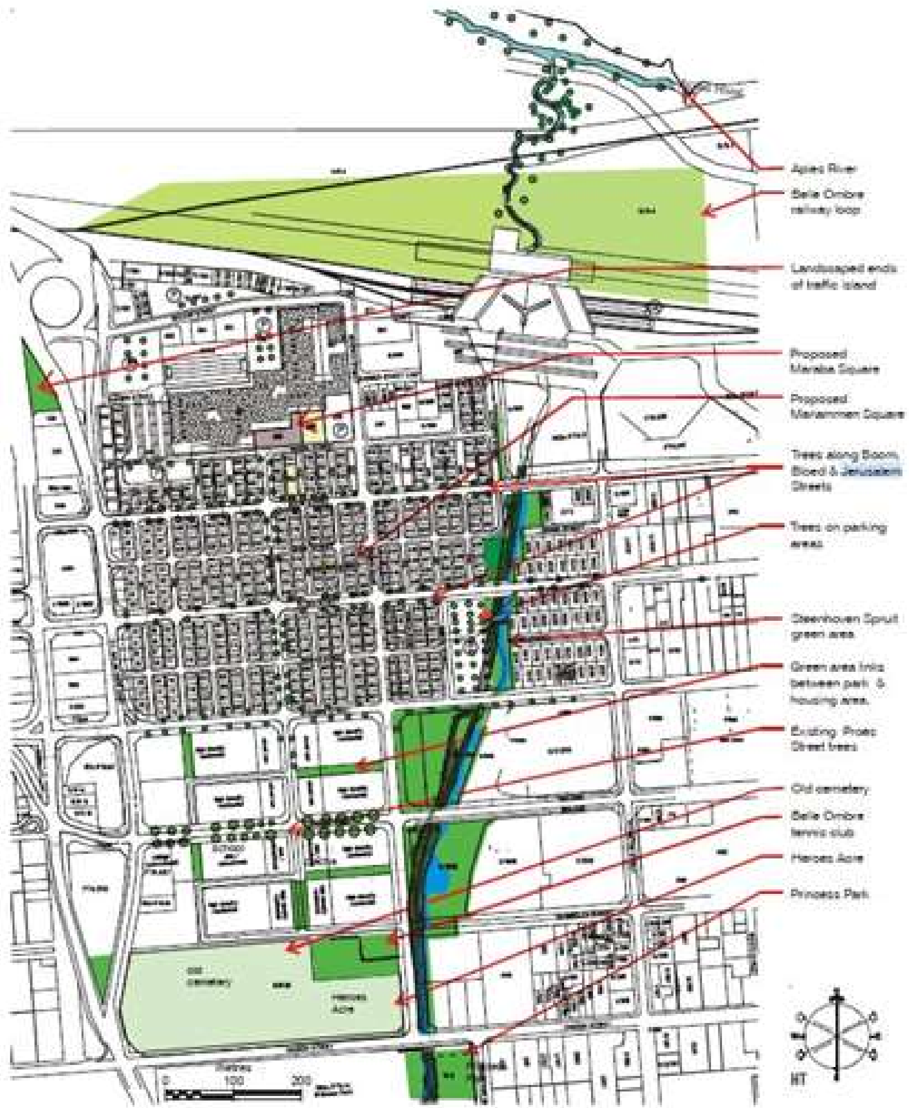


Figure 18: Proposal for introduction of green spaces and green corridors leading to Steenhovenspruit (Tayob Partnership, 2003: 234).

Existing site activities

The proposed site is currently a vacant plot of land belonging to the municipality. It has been subdivided into 142 sites that are each about 16m by 16m, this subdivision reflects the historical layout and the existing Marabastad, to the north. Each block on the precinct comprises 8 plots and is thus approximately 38m by 69m m in size. The larger site will be referred to as The Precinct and my specific proposed site will be referred to as The Site. The Precinct is bordered by Bloed Street on the north, Es'kia Mphahlele on the west, Steenhovenspruit on the East, and Struben Street on the South. There is currently a large social housing development under construction on the plot south of The Precinct, along Struben Street. The social housing scheme will comprise 1700 units upon completion and house approximately 3200 people (Arch Active, 2020). South- west of The Precinct, is the Marabastad Home Affairs office, and many people commute to this area on a daily basis to access the services. The Precinct is currently being used by taxi and bus drivers as a place to linger and park while they wait for the next peak commute period of the day. A couple of enterprisers have set up temporary automobile parts "shops" in the forms of stacked tyres and carefully arranged exhaust pipes stacks. Since construction of the social housing on the adjacent plot started, people coming to seek services at the Home Affairs Department have begun queuing and waiting in this area.

Figure 19: Various street trade activities currently take place on the proposed site (Adapted from Google Maps, 2017 and Author's photos)

CHAPTER 4: THEORY

Methodology

My research required both quantitative and qualitative research. Some of the information required was data such as water quantities for various household activities, while other information was around people's perceptions about water quantities and water issues. The interpretation of the data was not only objective but also required narrative inquiry. The objective data influenced the legislated spatial requirements of my building, and the subjectivist data influenced the sensory and haptic qualities of the architecture. The most appropriate paradigm to follow for research was Pragmatism (Dr C. Combrink, 2019).

Paradigm: Pragmatic

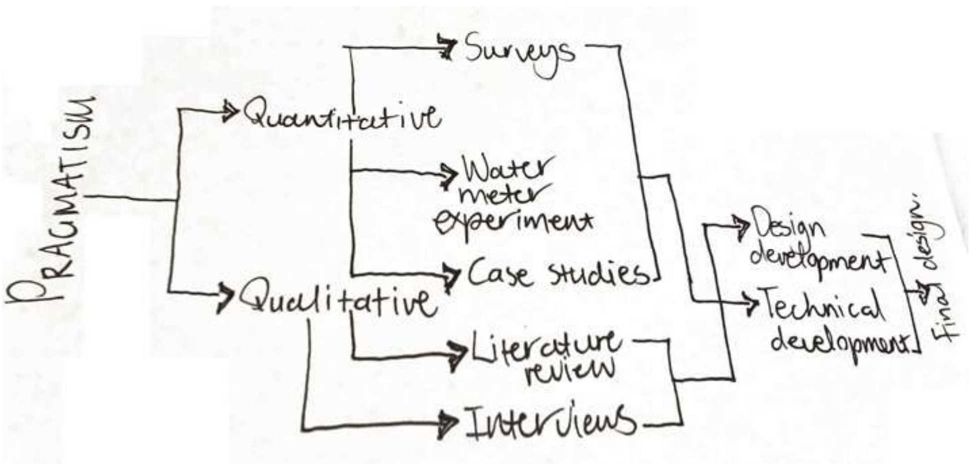


Figure 20: Research process followed. (Author- adapted from lecture by Dr C. Combrink, 2019)

Research Design:

1. Research was conducted to establish what the current conventional water systems and processes in urban South African settings are. A comparative study was conducted to identify the differences between architecture where water systems are hidden as compared to architecture where they are exposed. The merits of the exposed water systems were noted.

2. Desktop research was conducted on methods that have been found to influence people's behaviours for water conservation.

3. One experiment was conducted and it entailed reading water meter data of various households for a period of half a week, without the residents being made aware of their water usage. The second part of the experiment entailed collecting water meter readings for the second half of the week and making the residents of the house aware of their daily water consumption. The third part of the experiment was an interview with the household representative regarding perceptions, behavioural changes during the experimentation period and water relatedness of members of the household.

4. Various other interviews were conducted with members of the public to ascertain their relatedness to water; and their perceptions and attitudes towards water and conservation.

5. A survey was conducted utilising an online survey app called freeonlinesurvey.com. The nature of the survey questions were pragmatic. Participants were asked to indicate the quantities of water required to perform various day- to -day household activities. The purpose of the survey was to ascertain how many of the participants were aware of the amount of water that they likely consume on a daily basis.

Data Analysis:

1. A Comparative analysis: was applied to the desktop research where hidden water systems architecture was compared to visible water systems architecture. The benefit of this method was that it helped to identify key similarities and differences in the architecture types, and aspects of the architecture types helped to inform the design.

2. A case study analysis was conducted on various existing successful architectural precedents of key

concepts. These concepts would contribute to the design and technical resolution of the building.

3. Word frequency analysis: was conducted to ascertain perceptions of people that have been interviewed. This was done through manual analysis and with the help of an online word analysis tool (https://www.online-utility.org/text/analyzer.jsp).

1. Grounded theory analysis was conducted for the interviews.

Limitations:

1. Most of the research conducted this year was accessed from online platforms due to restrictions resulting from the 2020 COVID-19 pandemic. Because of this, journal articles were referenced much more than books, as many books were unavailable in online formats. Fortunately, this ensured that the latest research was obtained.

2. Most of the interviews were conducted telephonically. This affected the quality of sound of the interview recordings, however, notes were also taken during the interviews and this helped with clarifying information.

3. The water meter readings experiment was the most affected aspect of the research as the individual home-owners were now needing to record the meter readings themselves. On many occasions, they would forget to take a meter reading, and this resulted in some of the meter reading experiments lasting for a period of up to two weeks with a few days of data missing in between. For the purposes of this research, these gaps in the data didn't have a negative effect. However, due to the lack of access to the water meters, I had to assume that the water meter readings sent to me by the home-owners were indeed accurate.

4. The sample of people who participated in the experiment; interviewed or took the survey, composed mostly of middle class urban dwellers of South Africa. Because of this, the data may be skewed and may not be generalised to represent the general population of urban South Africans.

LITERATURE REVIEW

Abstract

Efforts have been made by the state to encourage South Africans to conserve water. These campaigns have mostly failed to yield permanent positive behavioural changes amongst the public. One of the reasons for this is the general low sense of water literacy among citizens. This article will explore the level of water literacy of urban South African dwellers. It will also show the connection between the low water literacy and people's inability to change their behaviour to become conservative in their every-day water usage.

Key- words

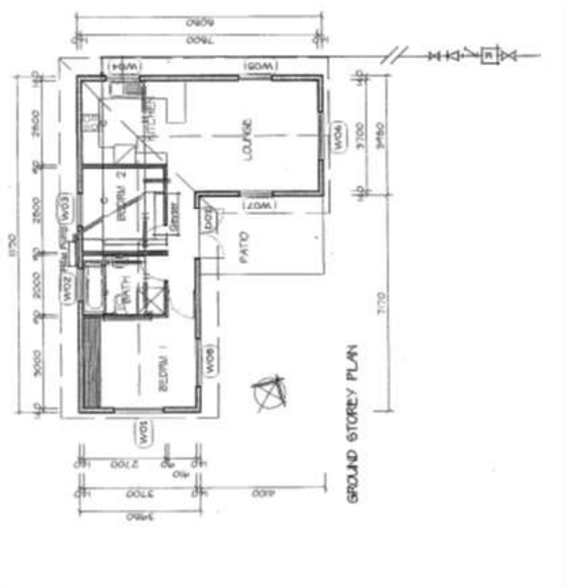
Water literacy; water conservation; water security; nature-connectedness

Introduction

Water security is a pressing issue in South Africa and the world at large at the moment. It is an issue that requires us to become more conservative in our use of water. One of the hindering factors to water conservation is people's belief in the abundance and ubiquity of water (Sershen et. al., 2016). These ideas are reinforced by the fact that urban South African dwellers receive their water via taps in their houses (Zylstra et. al., 2014). Unlike their rural counterparts there is a disconnection in understanding the water system as a whole and mentally connecting the source of water and the very water that comes out of the tap (Abson et. al., 2017, Zylstra et. al., 2014). In many rural areas of South Africa, people are compelled to fetch water in buckets for use in their homes thus fostering a sense of appreciation for the resource and an understanding of water quantities (Uehara et. al., 2019). Urban South Africans aren't often confronted with the opportunity to see water quantities such as a 20 litre bucket, in the same way that some South Africans in rural areas often have the opportunity to see and interact with (Geere et. al., 2010; Graham, Hirai & Kim, 2016).

Furthermore some rural South Africans often get to see the source of their water and thus the state it's in thus allowing them the opportunity to develop an innate and intimate knowledge about water, which is known as water literacy (Otaki, Sakura & Otaki, 2015; Geere et. al., 2010). Not receiving this opportunity as well as other factors makes it difficult for urban South Africans to take active measures to conserve water as part of their daily lifestyles (Starsh- en et. al., 2016). This article will explore the water literacy of urban South African dwellers, their daily water usage habits and how the low water literacy has a negative impact on water conservation efforts. The article is supplementary to a bigger exploration of how architecture can be used to aid urban South Africans practice water conservation in their daily lives.

South Africa's Existing Building Style Pertaining to Water Management



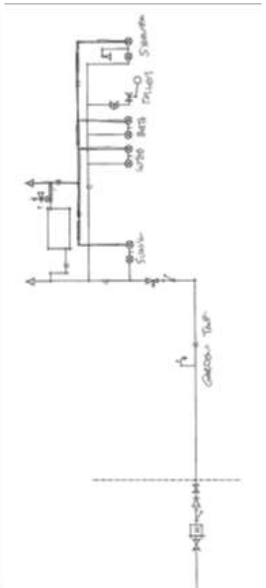


Figure 21: (Left) A typical floor plan layout of a building in urban South Africa- SANS 10252-1_Water supply in buildings calculations.
Figure 22: (Right) A typical accompanying schematic water layout- SANS 10252-1_Water supply in buildings calculations.

The water systems and services of the average building in South Africa, are hidden within the walls. The status quo and building standard is to build the water pipes of a building into the walls; hide the municipality water inlet and bury the waste water pipe out of sight underground (SANS 10400; SANS 10252-1) . By the time that a building is occupied by the users there are no traces of the water pipes and subsequently the water process.

The water systems and services of the average building in South Africa, are hidden within the walls. The status quo and building standard is to build the water pipes of a building into the walls; hide the municipality water inlet and bury the waste water pipe out of sight underground (SANS 10400; SANS 10252-1) . By the time that a building is occupied by the users there are no traces of the water pipes and subsequently the water process.

Many rural South African have to walk the distance back to their house from a water source with the bucket of water bearing its entire weight physically on them (Zylstra et. al., 2014). There is thus a mind and body connection developed between the quantity of the water e.g.: 20 litres, and what it really is physically (Zylstra et. al., 2014). When the bucket of water is sitting in the house one is able to see the physical depletion of the water and thus ration it out carefully to the various household functions. All of these factors, instil a sense of reverence for water, and an understanding of water systems and processes as well as water quantities (Zylstra et. al., 2014).

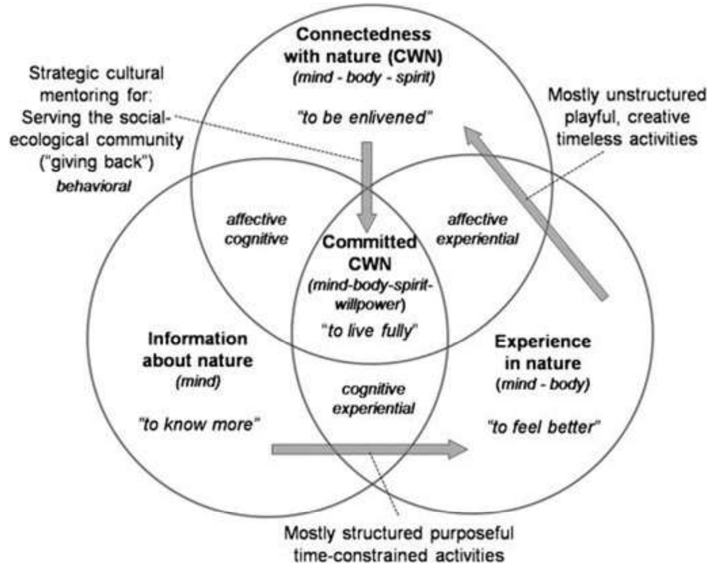


Figure 23: "Conceptual framework of key components comprising connectedness with nature"- Zylstra et. al., 2014.

Learning From Water Visible Architecture

Traditional Islamic Arabic architecture utilises water as a feature in the architecture, making it audible, visible and interactive for the occupants of a building (El Shakhs & Ezzat, 2018). Unlike South African buildings, traditional Islamic Arabic architecture embraces water as an active tool to achieve cooling in the building and for aesthetic purposes (El Shakhs & Ezzat, 2018). It can't be ignored that Islam as a religion compels it's observers to revere water too, however, this article is exploring the architectural factor of water visibility and utility (El Shakhs & Ezzat, 2018; Zarghami & Fatourehchi, 2015).

In this type of architecture water ducts are open and a building's occupants are able to see the water as it flows through the building. They are also mostly allowed an opportunity to see the water as it travels to its various distribution locations in the building. This creates a sense of hierarchy that favours usage of water for climate control (El Shakhs & Ezzat, 2018; Zarghami & Fatourehchi, 2015). In comparison the current norm in South African architecture favours external and ablution activities for water usage (Hoy & Stelli, 2016). Urban South Africans are unable to see this hierarchy because all the water systems are typically hidden from view. The result is usually that the quantity of water that is dedicated to external and ablution activities is the highest (Hoy & Stelli, 2016). We can benefit in our quest for water security if we borrow from Islamic Arabic architecture and change our current hierarchy of potable water usage.

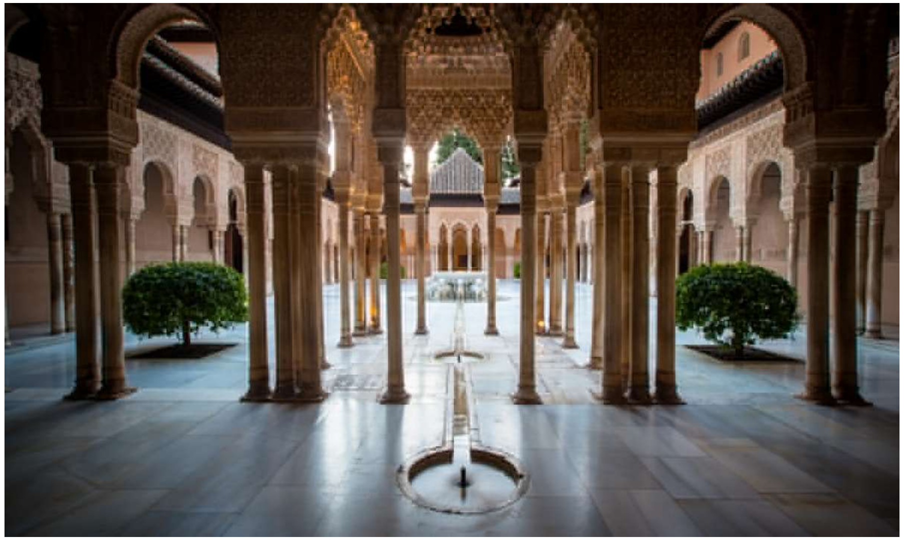


Figure 22: (Right) A typical accompanying schematic water layout- SANS 10252-1_Water supply in buildings calculations.

Figure 25: (Right) The Burj Kalifah in Dubai uses water that condensates off its facade for cooling and irrigation on site. (Skidmore, Owings & Merrill, 2020)

Water Conservation Information Campaigns

Arbour week is observed annually in South Africa. This observational holiday is marked on school diaries across the country. During Arbour week- schools plant trees as a supplementary part of the education that children receive regarding trees and general conservation (Department of Agriculture, Forestry and Fisheries, 2020). The message of these campaigns is targeted at encouraging people to observe general conservation and plant trees to aid global conservation. This message is accessible to citizens and they are able to conceive being able to plant a tree thus participating in the conservation effort (Addo, Thomas & Parson, 2019; Moglia, Cook, & Tapsuwan, 2018).

Water conservation on the other hand is a much less tangible effort and thus seems more like a conceptual idea to urban dwellers (Addo, Thomas & Parson, 2019). Unlike the aforementioned Abor day planting of trees effort, water conservation campaigns often comprise a message of wastage and a message of the need for conservation (Addo, Thomas & Parson, 2019; Moglia, Cook, & Tapsuwan, 2018). The message of wastage is communicated using water quantity references. The message may say, e.g.: "the average shower uses about 10 litres of water per minute", attempting to illustrate to the public that 10 litres is a large quantity of water. These messages are not grasped by the urban public as they are unable to conceive how much 10 litres of water actually is (Sammel & McMartin, 2014).

The second part of the message is then often a message urging people to e.g.: "reduce their shower times" to conserve water. Message framing suggests that the problem with the second part of the message is that it is not giving people a clear instructional solution like, e.g.: "Shower for 5 minutes to conserve water". Message framing recommends that information campaigns such as these should contain clear instructional and simple solutions to accompany the message about the issue that is being attempted to be solved (Otaki, Sakura & Otaki, 2015; Sammel & McMartin, 2014; Fielding et. al., 2015).

Fundamentally however, if the person that a message is intended for cannot accurately gauge the water quantity that they are utilising, they cannot correctly receive the information and act on it (Otaki, Sakura & Otaki, 2015).

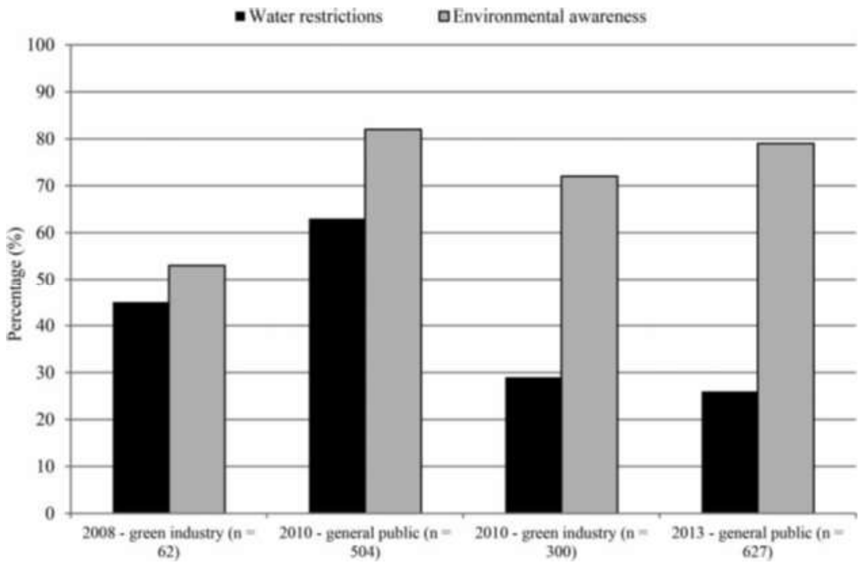


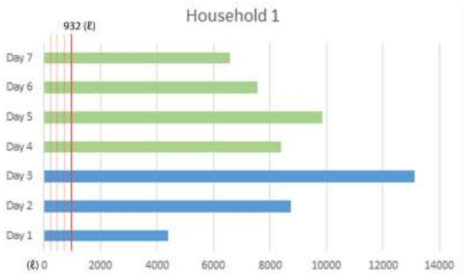
Figure 26: "The percentage of respondents from various sample groups that feel water restrictions and environmental awareness would encourage water conservation"- Hoy & Stelli, 2016

Water Experiment Findings and Discussion

The purpose of this experiment was to gauge and compare the daily water usage of the participants as compared to the South African average of +/- 233 litres per person per day (Makou, 2020; SANS 10252 part 4). The household's water meter readings were observed for one half of the experiment period without communication with the residents. In the second half of the experiment, the water meter readings were captured and in addition, the residents of the household were informed of the previous day's water consumption amount.

This experiment was designed in reference to Willis et. al., 2011 in their peer reviewed article titled, Quantifying the influence of environmental and water conservation attitudes on household end use water consumption. It was hypothesised that the participants would change their water consumption behaviours after being made aware of how much water they consumed.

Figure 27: Examples of typical water meter reading captured during the water experiment (Author, 2020)



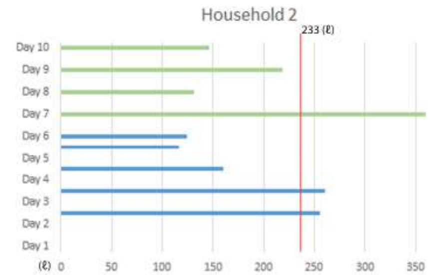
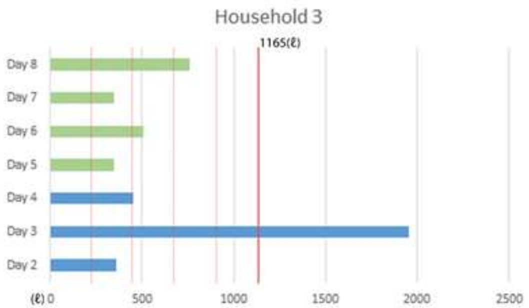


Figure 28: (Left) Household 1's daily water consumption relative to other 4 person households in South Africa (Author, 2020)

Figure 29: (Right) Household 2's daily water consumption relative to other 2 person households in South Africa (Author, 2020)



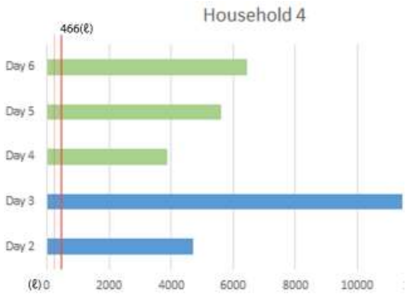


Figure 30: (Left) Household 3's daily water consumption relative to other 5 person households in South Africa (Author, 2020)

Figure 31: (Right) Household 4's daily water consumption relative to other 2 person households in South Africa (Author, 2020)

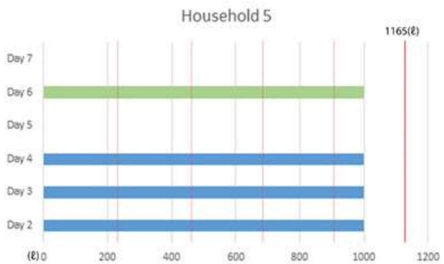


Figure 32: Household 5's daily water consumption relative to other 5 person households in South Africa (Author, 2020)

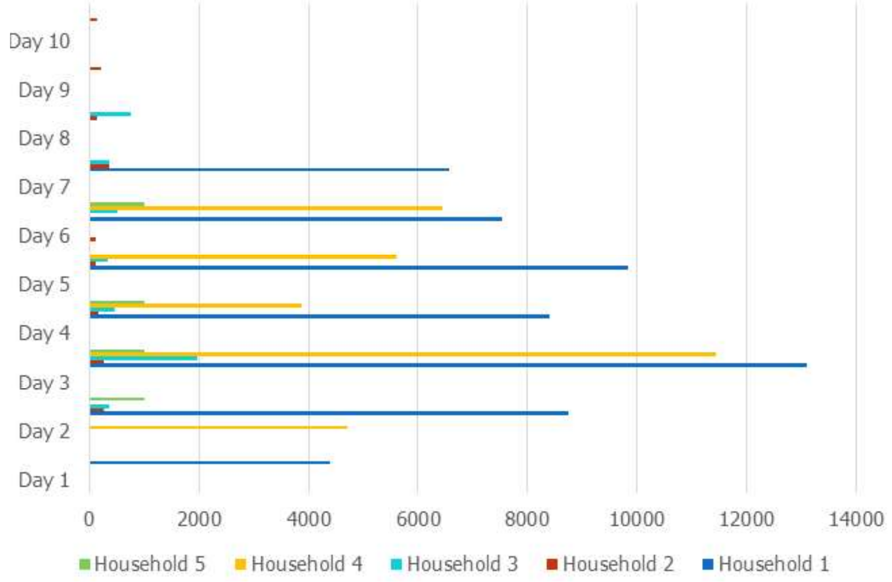


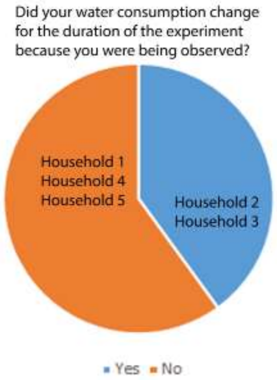
Figure 33: A chart showing the observed daily water consumption of all the participating households. (Author, 2020)

When the participants were interviewed, households 2 and 3 admitted that they had adjusted their behaviour to use water more sparingly for the duration of the experiment as shown in figure 34. They admitted that the knowledge of being observed caused them to adopt water conservation methods. When asked whether being informed about their water consumption quantities had caused them to change their water usage, households 4 and 5 said no as shown in figure 35. Households 4 and 5 said that they believed that they were doing as much as they were able to do already to utilise water sparingly, and that they couldn't change anything else in their daily behaviours.

When asked about the methods that they employ in the household to conserve water, the common method mentioned between them was that members of the household showered for less than 5 minutes on some days. Households 4 and 5 also indicated that they have a desire to adopt additional habits to conserve more water but that current recommended methods were too inconvenient. Collectively, all participants anticipated that they would not sustain the water conservative methods that they had adopted during the experiment. All the households also expressed that they believed that the house should be fitted with more tools to make it much easier for them to adopt a water conservative lifestyle.

A discrepancy was observed between the behavioural changes that the participants claimed to have made and their water consumption. Households 1, 2 and 3 believed that they had reduced their water consumption after they had been informed of the water quantities that they had used on the previous day, however the data collected showed that this was not the case as indicated in figures 28, 29 and 30 (the green portion of the graph indicates the days when participants were informed of their water consumption quantities). It was observed that no change occurred despite them having adopted methods to conserve water. This may be due to the fact that despite their best intentions, they had not actually changed their behaviour, or that the methods that they had adopted had not actually worked.

These findings are in keeping with those of Van der Vyver, 2016 and Graham et. al., 2016 and reveal that the residents require assistance from the architecture to make the water conservation actions as convenient as possible.



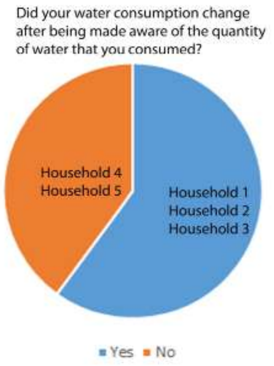


Figure 34: (Left) Participants conserved water more than usual throughout the experiment. (Author, 2020)

Figure 35: (Right) Two of the households didn't change their behavior after being made aware of their water consumption quantities. (Author, 2020).

Interviews findings and discussion

Six interviews were conducted and the findings are in alignment with the hypothesis. Half of the participants interviewed indicated that they didn't know where the water that supplied their home comes from. In figure 36, responses to question 6 indicate that most of the interviewees feel a sense of responsibility for water conservation. This indicates a willingness to participate in water conservation behaviours (Graham et. al., 2016).

6. How do you feel about water conservation?

	Actual Answer	Derived key words/ phrases	Interpreted perceptions
Interview 1	Maybe someone needs to figure out how to make sea water into drinking water	Someone needs to	Not responsible
Interview 2	Scared, guilty	Scared, guilty	Responsible
Interview 3	I should do it, it's pricey	I, pricey	Responsible
Interview 4	Affected	Affected	
Interview 5	Panicked & personally responsible	Panicked, responsible	Responsible
Interview 6	The feeling of a mother looking after its child	Mother looking after, child	Responsible

Figure 36: Most interviewees feel that they are personally responsible for water conservation (Author, 2020)

As shown in figure 38, questions 12, and 13 endeavor to find out how willing the participants have been to take actions to conserve water. When asked about changes that they have made to conserve water regarding their person, participants indicated that they had mostly reduced their shower times; turn off the tap when water is not in use during the shower and turn off the tap when brushing their teeth. Most of the interviewees indicated that they had not made any physical changes to their household to conserve water. In question 15, they indicate that they feel that the architect who designed their house did not include enough or any features to help them to conserve water. This again indicates that the architecture which people occupy should work to integrate water conservation methods into people's lives so as to cause little disruption and discomfort while conserving water.

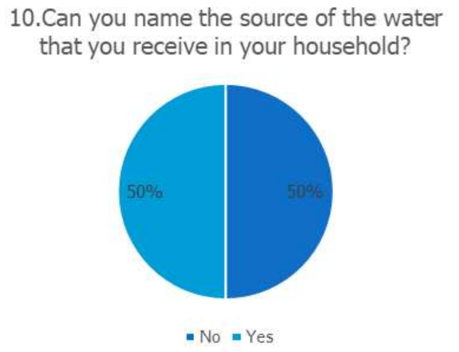


Figure 37: Half of the interviewees did not know where the water that is supplied to their home comes from (Author, 2020).

12. What has changed/ has anything changed about your water usage habits since the ongoing drought?	13. Are there any collective measures taken in the household as means to conserve water?	16. How many items on your property/ in your house, have you added/ removed in order to make your home a water conserving environment and or to ensure water security on the property?	15. Do you think that the architect who designed your house included any/ enough features that help the household to conserve water?
Nothing	No	None	No
Turning the water off when not in use in the shower	Showering with a bucket to collect excess water	None	No
Shower not bath Turn off running taps while showering, brushing teeth	No	None	Just the dual- flush system
Nothing, besides our usual conservation habits	Nothing besides our usual conservation habits	Rain- water harvesting	No
Reduced shower times from 20 minutes to 10 minutes. Washing dishes once a day. Washing dishes in a smaller container placed within the sink.	No but we already are a family that practices water conservation in general.	Water tanks & dishwasher	Rain-water harvesting that was meant for internal home use but is not connected properly and is being used for irrigation instead
Turning the tap off when not in usage e.g.: during brushing teeth. Removing automated sprinkler system.	Capturing the cold water that runs before the hot water come out the shower nozzle or bathtub tap, to use for irrigation or emergency storage later.	None	No

Figure 38: An indication of the participant's willingness to take action for water conservation (Author, 2020).

Survey findings and discussion

The survey was created using the online platform, FreeSurveyOnline.com. The survey was anonymous however the survey taker was required to indicate whether they were older than 18 years of age, and to give their consent for use of the information collected in this document. A total of 65 people took the survey but only 30 were viable as some were not complete and others were taken by minors, while others indicated that they didn't give consent for their responses to be used for this research.

The questions that were asked were pragmatic and didn't require interpretation for analysis. They served the purpose of indicating people's knowledge of water quantities and their relatedness to water (Zylstra et. al., 2014). The answers that the survey takers provided were compared to Voosloo's research which provide the more accurate water quantities for the activities mentioned in the survey:

Typical water usage for different domestic functions (Vosloo, 2013, University of Pretoria; SANS 10252 part 4):

Bath (250 l)
·Shower (120 l) or 10 l per minute (Water Wise SA, 2020)
·Hand wash (1 l)
·Toilet flushing (±4-11 l)
·Cooking and dishwashing (±20 l/person/day)

·Irrigation (0.16m/month in summer, 0.125m/month in winter)

Table 2 — Average water consumption (hot and cold) of appliances

1	2
Domestic and commercial appliances	L/operation
Bath	80 – 90
Bidet	6 – 8
Clothes washing machine	60 – 180
Dishwashing machine	3 – 70
Domestic waste disposal unit	10 – 15[a]
Shower	3 – 6[a]
Wash-hand basin	4 – 8
WC flushing valve (normal flush)	8 – 10
Domestic appliances	L/day/person served
Car washing and garden use	3 – 6
Drinking, food preparation and cooking	18 – 22
Laundry	10 – 15
Personal washing and bathing	20 – 30
Washing dishes	8 – 12
WC flushing	32 – 40
Office installation appliances	L/day/person served
Hand washing: normal taps	8 – 15
Hand washing: spray taps	3 – 7
Urinal flushing: 24 h day	10 – 18
Urinal flushing: 8 h day	4 – 6
WC flushing: no urinals provided	12 – 18
WC flushing: urinals provided	4 – 6
[a] Per minute.	

Figure 39: Average water consumption per appliances (SANS 10252 part 4, 2012).

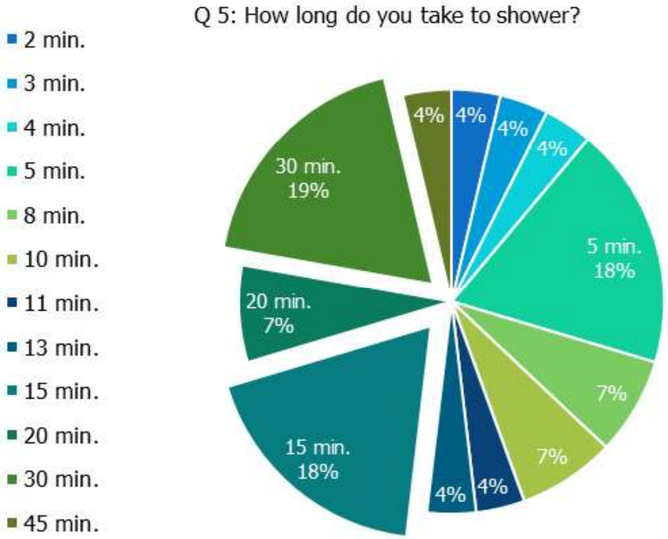


Figure 40: Many of the respondents indicated that they shower for 30 minutes (Author, 2020)

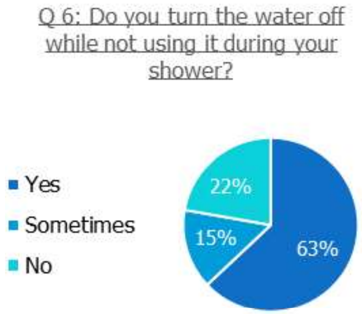


Figure 41: Most people turn off the tap when the water is not in use while they shower (Author, 2020).

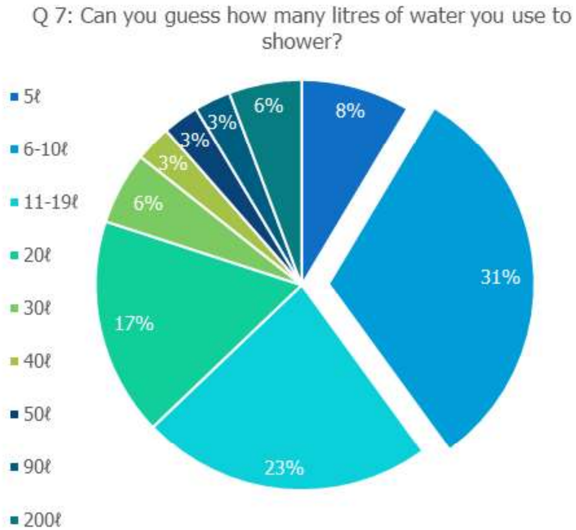


Figure 42: Most people estimated that they only utilise 31 litres of water when showering.

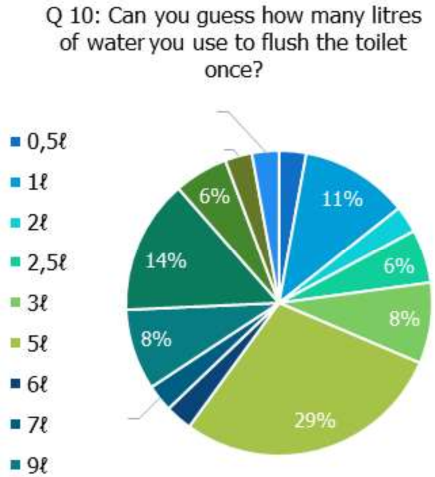


Figure 43: Most people estimated that they utilise 5 litres of water to flush the toilet.

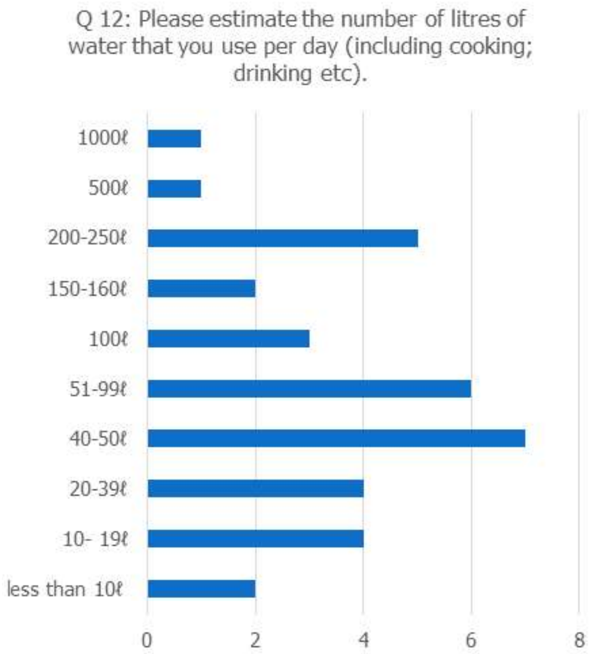


Figure 44: Most people estimated that they only utilise 40 - 50 litres of water for all daily activities.

The findings indicate that most of the people surveyed underestimated the amount of water that they consume for all daily activities mentioned in the questionnaire. Most notably, the majority of the participants indicated that they showered for 30 minutes (as shown in figure 39), which according to Vosloo's calculations would conservatively amount to +/- 120 litres, yet the majority of the people estimated that they consumed 6- 10 of water per shower (as shown in figure 41).

Another notable finding was that even though people assigned quantities that tallied up to more than 100 litres of water consumption per person per day while responding to each survey question, when they were asked to estimate their total quantity of water used per day in question 12, most of the survey takers indicated the amount to be 40 – 50 litres (as shown in figure 43). This number falls short of the estimated +/- 233 litres used per person per day by urban South African dwellers (Makou, 2020; Vosloo, 2013). These findings show that despite the best intentions, South African urban dwellers are unable to correctly gauge large quantities of water and thus are unable to affectively participate in water conservation efforts

Serious Games

The theory of Serious Games is based on the idea that when people experience something, they tend to learn better from it because they are presented with the opportunity to not only witness the event, but to also participate in it (Darwesh, 2016; Wein & Labiosa, 2013). Mogalia et. Al., 2018, found that people learn from exposure and that they gain better knowledge of a topic when they are exposed to information about it. Addo et. Al, 2019, further found that individuals already know about water scarcity and want to participate in water conservation but don't want to do anything that requires a lot of effort to achieve this. By interweaving serious games into people's everyday lived experiences pertaining to water, their water relatedness and water conservation will be increased (Darwesh, 2016; Wein & Labiosa, 2013).

Serious games concepts	Practical applications to water relatedness education
Scenario:	Making a water component that would usually be hidden, visible and accessible to users (e.g.: roof drainage)
User's traces:	Integrating a practical tasks with the water component
Scoring:	Each task should have a goal and tangible result
Learning:	Communicating issues such as the way that different water quantities look
Enthusiasm:	Making the tasks easily accessible to adults and children

Figure 45: Table illustrating examples of practical applications of Serious Games to architecture (Author, 2020).

By using these concepts to guide the design of water components of a building, the architect may be able to turn the building into a vessel for water literacy.

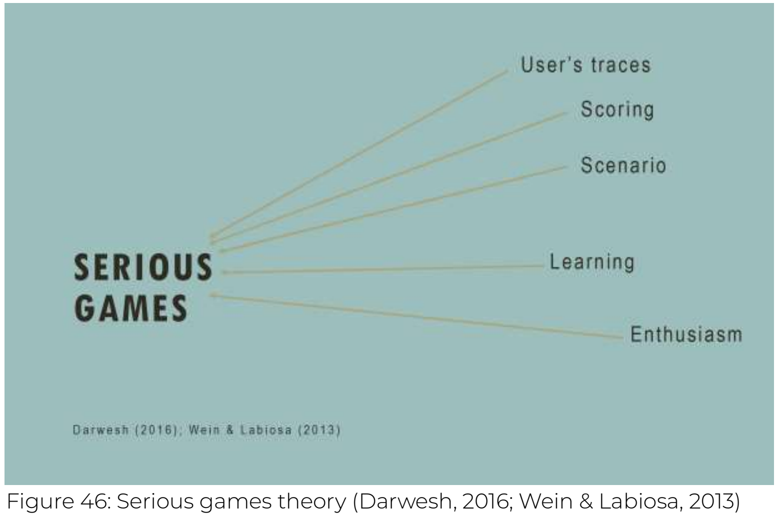


Figure 46: Serious games theory (Darwesh, 2016; Wein & Labiosa, 2013)

Conclusion

South Africa's climate is becoming more arid and requires for us to rethink our buildings' relationship with water (Davis-Reddy, C.L. and Vincent, K. 2017). Urban South African dwellers need to be aided by architecture to increase their water relatedness in order for us to effectively conserve water (Sershen et. al., 2016). Architecture can borrow from the Serious Games theory and bring water systems and processes of buildings to the foreground and not have them remain hidden as is conventionally practiced in South Africa (Fennemore et. al., 2014). As is practiced in traditional Islamic Middle Eastern architecture, the utilitarian nature of water and its aesthetic value can be combined, through the integration of low-tech design interventions that showcase water processes to the user (El Shakhs & Ezzat, 2018; Zarghami & Fatourehchi, 2015). Through the integration of these ideas and theories, South African architects can build on them and push a building's design even further by creating structures that showcase water. These buildings can subsequently be design to encourage interaction by the user through interesting educational components and harness water's aesthetic value while aiding the user with water conservation.

CHAPTER 5: PROGRAM CONSIDERATIONS

Identified stakeholders:

1. City of Tshwane- Property Owners

a. They already have plans to invest in the densification of the area as described in the West Capital SDF, 2014.

2. Tshwane Housing Company- Townlands social housing

a. Their investment can be protected if a development that aids the quality of living and value of Townlands is created opposite their building.

3. Marabastad Traders' Association-

a. Opportunities for informal and formal trade which the daily operational needs will require the investment of the traders' association.

4. Townlands community

a. The proposed site is opposite their residence and will affect their quality of life

Identified client:

City of Tshwane

Identified user profiles:

1. Day visitors of Pretoria CBD

Who they are:

· General public of all ages

o Non- inhabitants of the area

o Commuters into the city center

o Estimated to be +/- 75000 people (Tayob partnership, 2002)

Their identified needs:

· A place to wait for their next appointment

· A place to sit and eat their lunch.

· A place to temporarily rest before their next appointment

· Lockers for storing their goods for the afternoon while they attend to other business in the city.

· Ablution facilities

Identified stakeholders:

2. Townlands Social Housing Residents- (CoArch, 2020)

Resident group A

Who they are:

- Young adults and parents
- 25-40 yrs. old
- Formally employed

Their identified needs:

- A place to meet clients during work hours
- A place to spend time together after hours
- A place to spend time as a family at the weekends

Identified user profiles:

Resident group B

Who they are:

- Kids
- 5- 16 yrs. old
- School- going

Their identified needs:

- A place to socialize with peers
- A place to for group work with school mates after school hours
- A place to spend at weekends with family

Resident group C

Who they are:

Identified stakeholders:

Resident group C

Who they are:

- Elderly People
- 60 yrs. old +
- Retired

Their identified needs:

- A place to get away from the house to stretch their legs during the day
- A place to take grandchildren to when they come to visit.
- A place to play “bridge” with peers.
- A place to connect with other people.
- A place where basic groceries can be bought.

Identified user profiles:

Resident group D

Who they are:

- Students
- 18-27 yrs. old
- Studying

Their identified needs:

- A safe place to socialise late into the evening.
- A place to hang out away from house- mates.
- A place to do group work with other students.

Identified stakeholders:

3. Informal traders selling dry goods on a small scale (Clark et. al.,, 2018)

Their identified needs:

- A flat surface to sit and display their goods
- Ablution facilities

4. Informal trader selling food (Clark et. al.,, 2018)

Their identified needs:

- Potable water
- Clean work surface
- Means to discard of organic materials
- A place to securely lock their tools away overnight
- Ablution facilities

Identified user profiles:

5. Informal trader selling clothes, bags etc. on a medium scale (Clark et. al.,, 2018)

Their identified needs:

- Somewhere to hang their goods for display
- A flat surface to sit and display goods
- A place to securely lock their goods away overnight
- Ablution facilities

Program generators:

Meet clients Time together Spend time Socialize

Group work Family Stretch Grandchildren Connect

Groceries Hang out Place to wait sit and eat

Rest Lockers for the afternoon Lockers over-night

Food prep Goods display Ablution facilities Seating

Play

Programs to inform design

PRIMARY:

· An Ode To Water (Poetry in the form of a building structure) that will:

o Showcase the various forms of water, it's aesthetic and pragmatic uses, its properties, Pretoria's history with water etc.

o Provide opportunity for people to engage with water in a passive learning manner

o Allow people to witness a building's water systems in ways that they've never seen them presented before

SECONDARY:

· Urban Living Room

o Urban dwellers can use the space as a temporary waiting/ lingering space.

o Some urban dwellers who don't have living rooms at their apartments can use the space as a semi temporary lingering spot

o Facilities provided in the space may include: cell- phone charging ports, wash- up rooms, laundry rooms, study desks,

o The building may operate as an urban eco-system of all of the above amenities

TERTIARY:

· TRADE FACILITIES

o Informal and formal trade

o Lockers and storage facilities may be provided.

Program case study

Project name: Resuscitation of the Fez River, 2007

Location: Fez, Morocco

By: Aziza Chaouni

Figure 47: Children's play area at the Fez Medina (Chaouni, 2007).

After many years of neglect, like many rivers that run directly through a city/ urban area, the Fez Medina was polluted and few benefits were being derived from it by the local residents and business owners. After its rehabilitation the health of the river increased thus prompting an economic activity in the area as well as raising the quality of life of the local people (Chaouni, 2007).

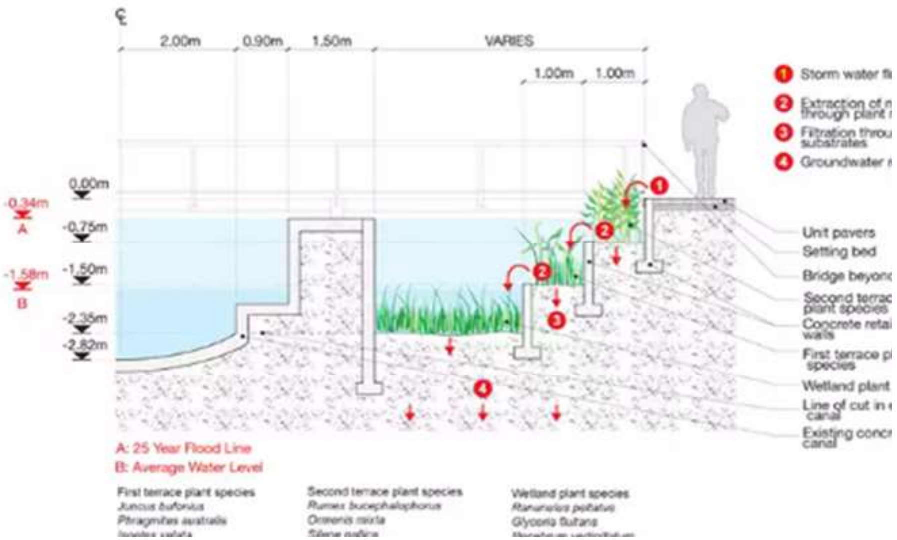


Figure 48: Tiered section of the river's edge showing different activities provided for (Chaouni, 2007).

The local economy, comprising mostly of traditional informal artisanal traders, flourished because they were catered for in the architecture surrounding the rehabilitated river. The patrons were also accommodated in the architecture; play areas were created for children and seating was created for adults which made it more likely that people would linger longer in the area. The river side became a destination for people from other communities in the vicinity. Because the river was clean, more people were likely to visit the area and spend time there.

The different tiers illustrated in figure 46 allow for many different types of activities to take place. Furthermore, along the entire length of the river, Chaouni made space for varying types of economic activity to happen, such as a leather tannery, which is endemic to the area. Making provision for all the existing economic and day- to day activities ensured the programmatic success of the project.

Figure 49: The rehabilitation of the Fez Medina (Chaouni, 2007).

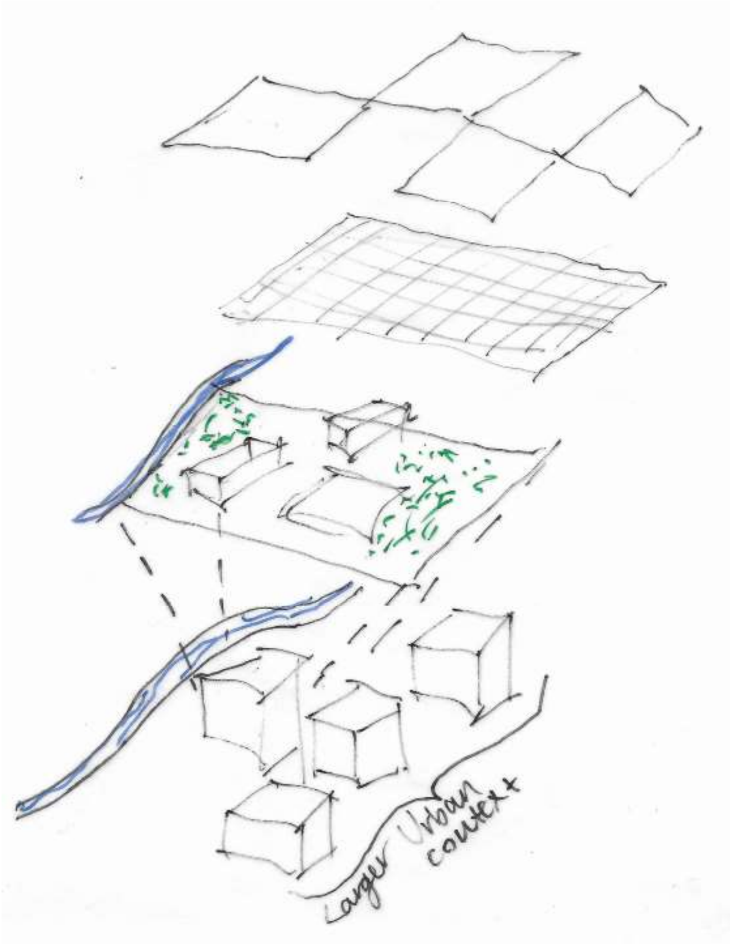
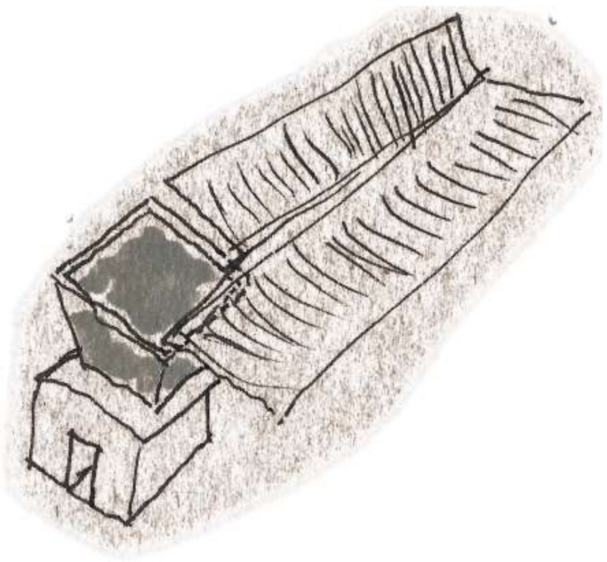


Figure 50: Analysis of Choiuni’s spatial layering (Author, 2020).

CHAPTER 6: DESIGN CONCEPT & DEVELOPMENT

Integrating water into South African architecture



Urban vision

Concept Development

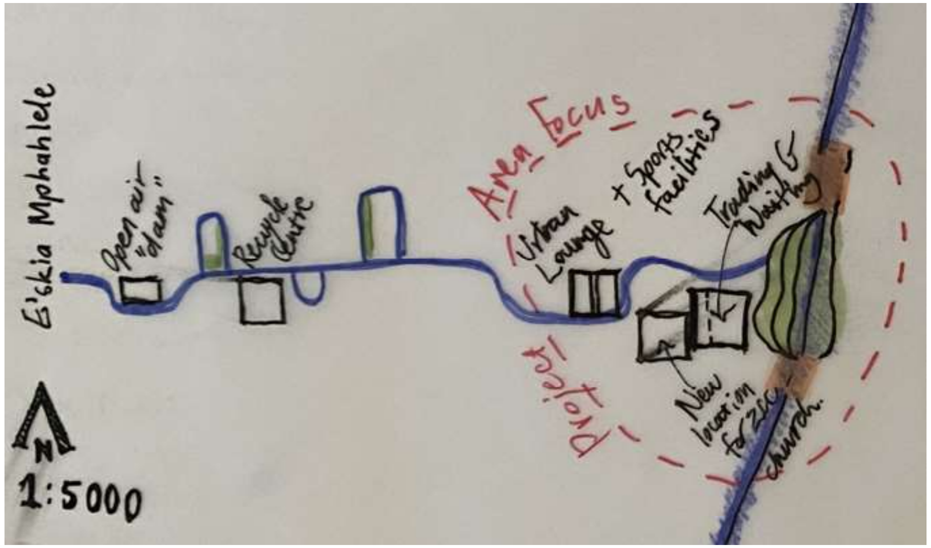


Figure 51: Concept sketch of urban vision (Author 2020).

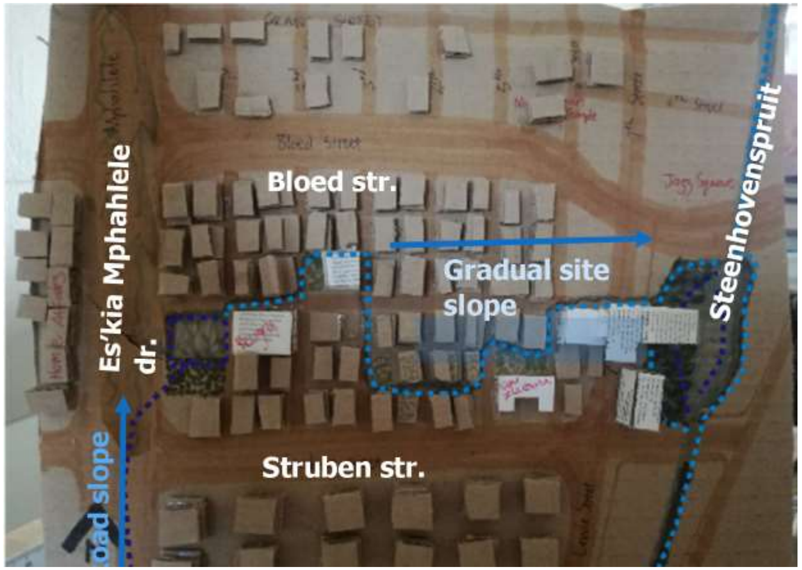


Figure 52: Concept model of urban precinct (Author 2020).

1. Collect storm water run-off from Es'kia Mphahlele drive

2. Create canal through precinct to purify water to send to Steenhovenspruit by:

- Slow sand filtration dam
- Constructed wetlands
- Bio-swales

3. Thus creating:

- Visible water purification (system) through the precinct
- Public green spaces
- Food growth opportunity
- Recreation spaces

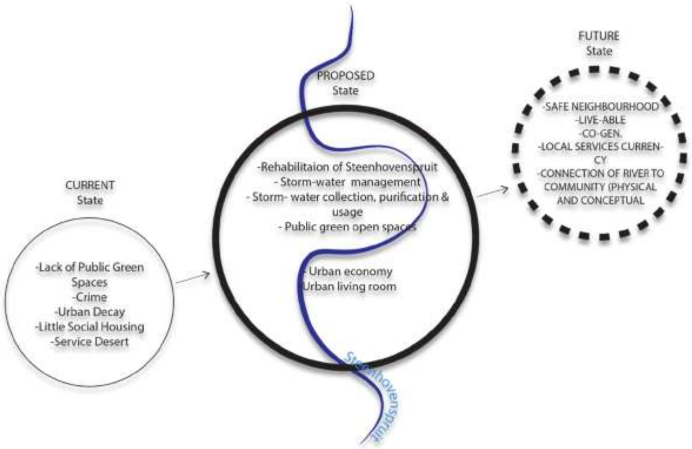
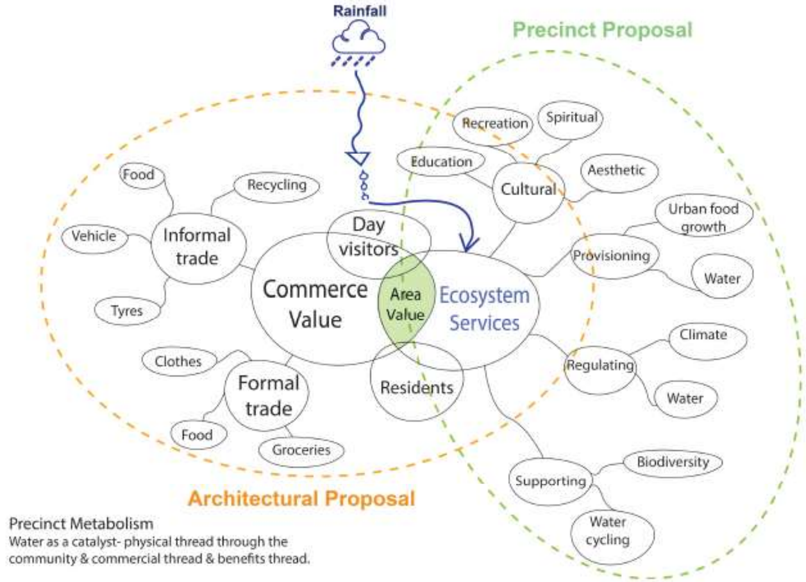


Figure 53: Kata concept diagrams of urban vision (Author 2020).



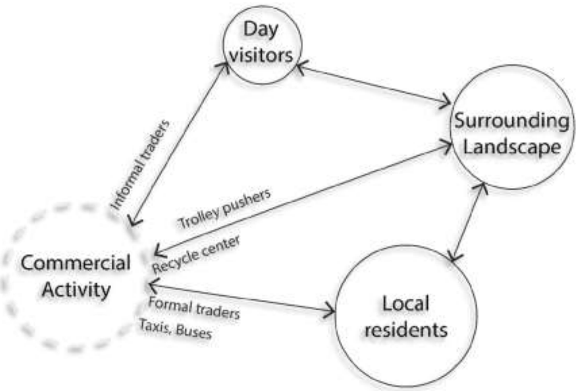


Figure 54: Business case for urban vision (Author 2020).

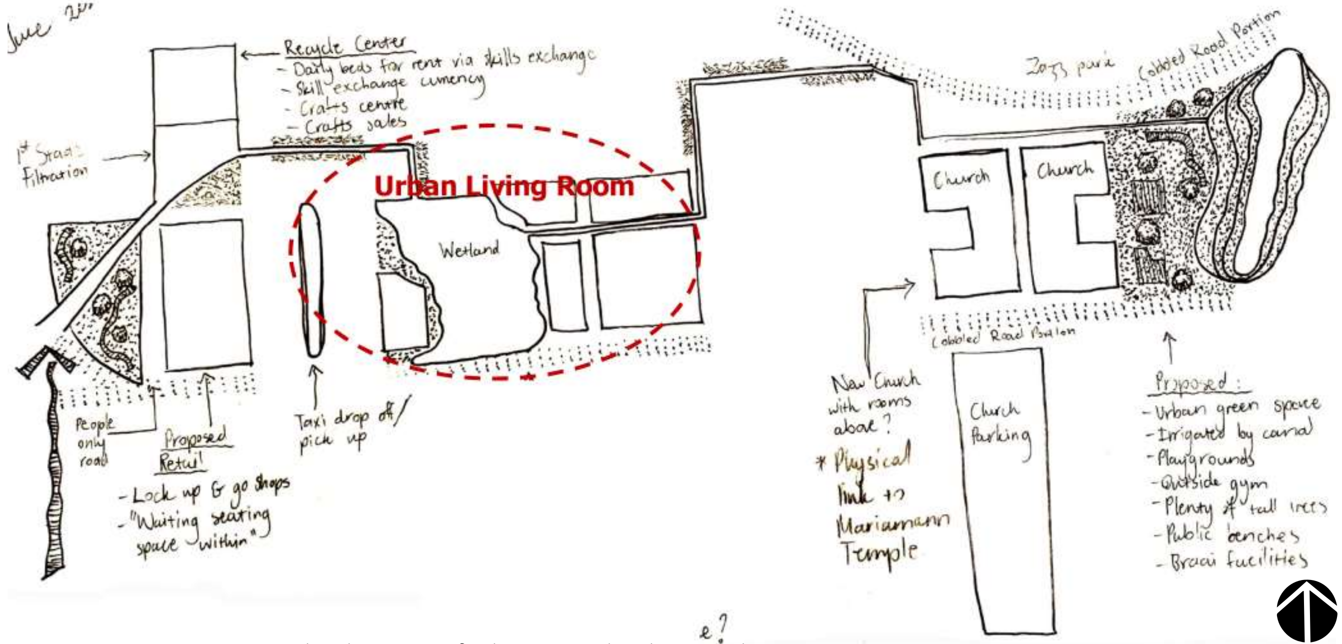


Figure 55: Concept development of urban vision (Author 2020)

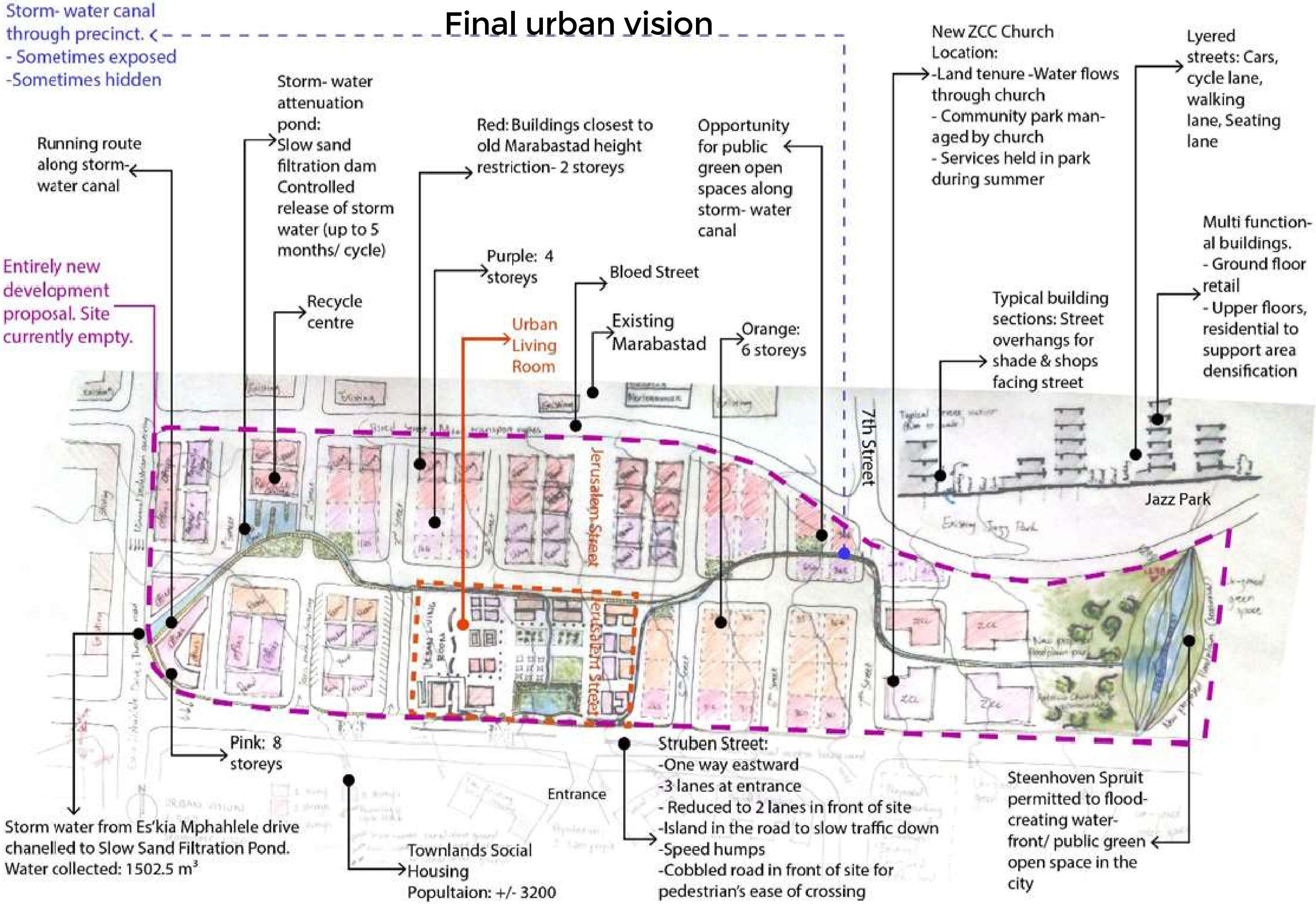


Figure 56: Final urban vision (Author 2020).

Urban vision in context

Figure 57: The urban vision in context (Auhor 2020, Image adapted from Google Maps 2017).

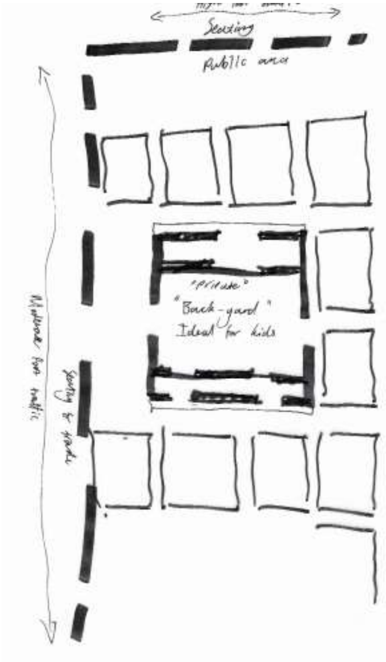
Projected massing of future development in the area

Figure 58: Projected massing of the area as per the West Capital SFD (Author, 2020 Image adapted from Google Maps, 2017).

As South Africa is an arid country, channelling the storm water that has been collected in the sand filtration dam will allow for pockets of public green urban spaces within the precinct to be affectively irrigated. The public green open spaces will attract good economic future investment in the area (Colette et. al., 2013). As the water weaves its way through the precinct, it will help to cool down temperatures around future building developments in this area through evaporation whilst the flora that will grow as a result of the water will keep the urban heat island effect in the area at bay (Bozovic et. al., 2017). Collecting the storm water and weaving it through the precinct will allow for ecosystem services to be realised in the area (Hales, McMichael and Butler, 2005). This design also gives a nod to Pretoria's long history with water.

URBAN LIVING ROOM

Site activities as spatial informants



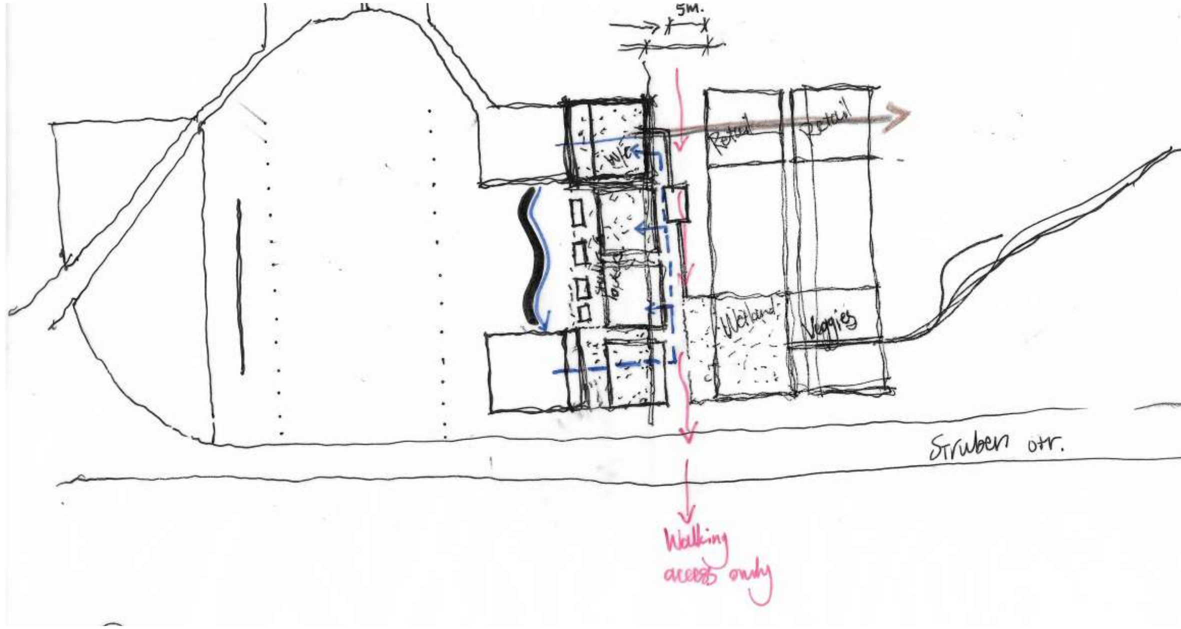


Figure 59: Spatial organisation by activities (Author, 2020)

Activities that need to be accommodated on the ground floor:

1. Recreational spaces- braai area
2. Kids' play area
3. Informal retail
4. Public ablution facilities
5. Public rest benches

Activities that can happen on the upper floors:

1. Individual work spaces
2. Group work spaces
3. Formal work spaces

Site elements that need to be accommodated on the ground floor:

1. Constructed wetland
2. Black water- Biogas

Site elements that need to be on upper floors:

1. Water tower
2. Roof- rain water capture

Precedent 1

Project Name: Warwick Junction, 2000

Location: Durban, South Africa

By: Context

Figure 60: Informal trader selling dry goods only needs a table to display goods (Dobson, R., Skinner, C. and Nicholson, J., 2009.)

Provision of appropriate work spaces for food prep. Robust material usage. Large central gutter for cleaning the area with a hose.

Figure 61: Food traders require a food prep surface and work area that can be washed down at the end of the trade day (Dobson, R., Skinner, C. and Nicholson, J., 2009.)

Robust materials

Figure 62: Robust materials such as concrete surfaces can serve as seating space or work counters that can be cleaned at the end of each day (Dobson, R., Skinner, C. and Nicholson, J., 2009.)

Figure 64: Lockers have been provided for traders to securely store their tools and products at the end of each trade day (Dobson, R., Skinner, C. and Nicholson, J., 2009.)

Robust materials

Figure 63: A section through the food traders' area showing the gutter that removes the waste water from cleaning the area (Dobson, R., Skinner, C. and Nicholson, J., 2009.)

Provision of lockers for traders to store goods over- night.

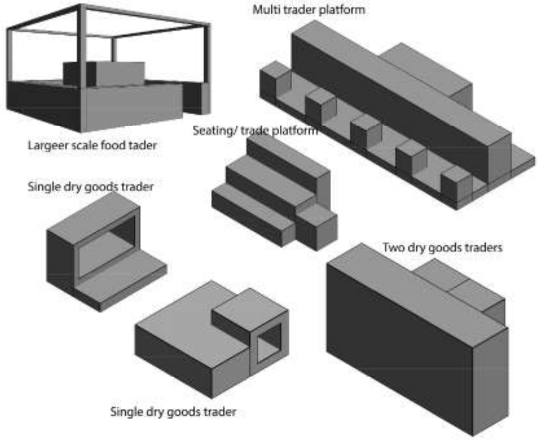
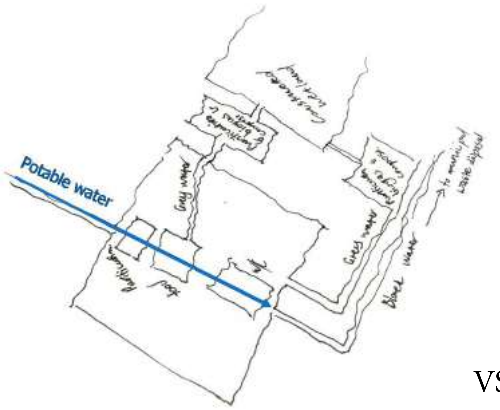


Figure 65: Analysis of trader stalls referencing Warwick junction (Author, 2020).

Water hierarchy as spatial informant



VS

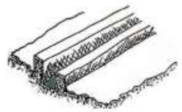


Figure 67: Water heirarchy diagram (Author, 2020).

Figure 66: Open water channels vs sealed water ducts vary depending on the water's destined usage (Author 2020)

The cleanest activities on site need to be located upstream from all the other events. The other activities can have the water passed onto them for secondary use. The clean water needs to reach the cooking areas and hand- wash stations first. The water coming from the hand- wash stations can be passed down to the toilets for secondary use. Water coming from the kitchen sinks needs to be sent directly to the biogas chamber due to health and safety protocols (Bénit-Gbaffou, C., 2015; foodstuffs, cosmetics and disinfectants act, 1972 (act no. 54 of 1972)).

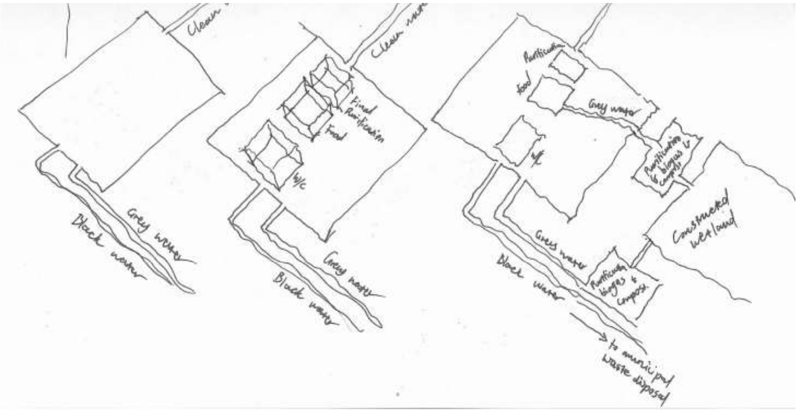


Figure 69: Floor plan development informed by water hierarchy (Author, 2020).

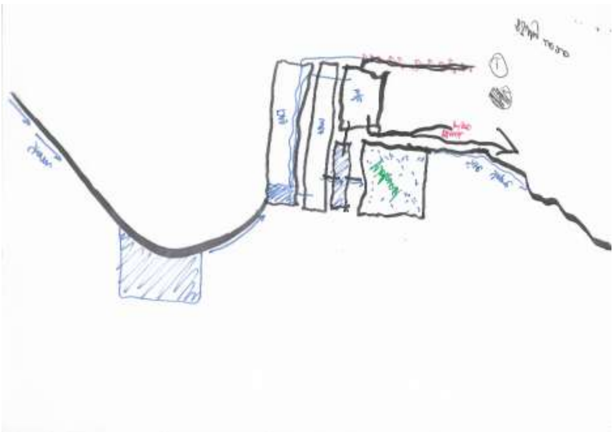


Figure 68: More detailed concept floor plan development informed by water hierarchy (Author, 2020).

he building needs to achieve the following:

1. Receive rain- water

2. Let water flow through

3. Absorb (collect) some of the water

4. Integrate serious games theory

a. Scenario: Making a water component that would usually be hidden, visible and accessible to users (e.g.: hand- wash basin)

b. User's traces: Integrating a practical tasks with the water component

c. Scoring: Each task should have a goal and tangible result

d. Learning: Communicating issues such as the way that different water quantities look

e. Enthusiasm: Making the tasks easily accessible to adults and children

The water plan is fundamentally informed by the fact the potable water has to floor down through the site from the highest point. The biogas chamber needs to be located in the lowest point of the site, preferably away from food areas because of potential odour issues.

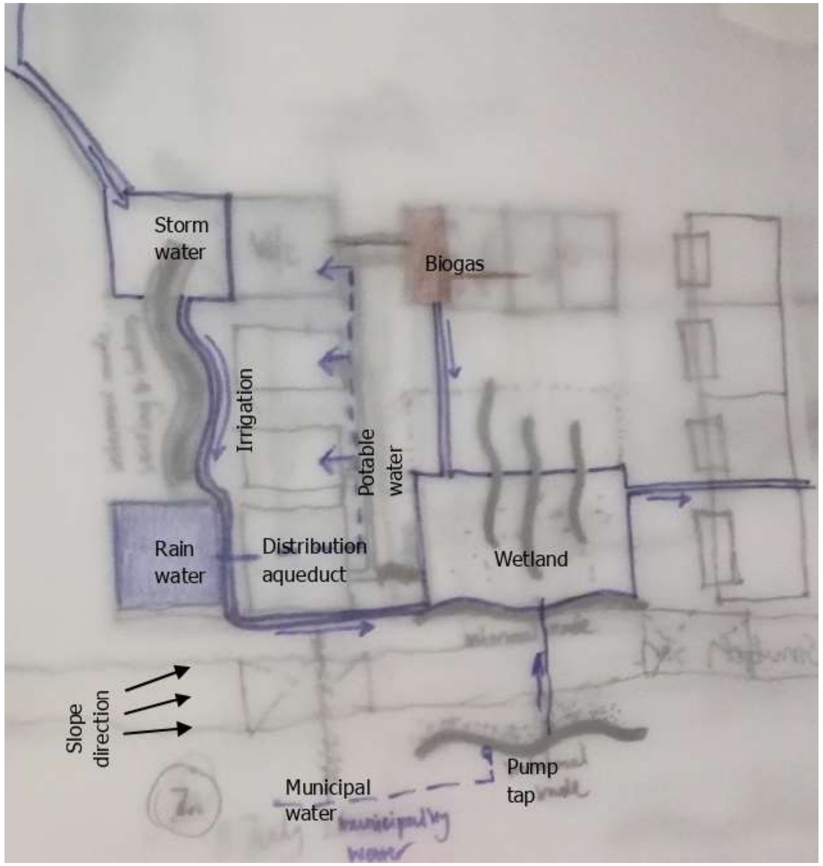


Figure 70: A more resolved conceptual floor plan layout informed by water hierarchy (Author, 2020).

Water types

There are 4 different types of water that will be moving through the site:

1. Roof rain water- highest plane. Which also speaks to its importance.

a. Potable water supply

b. Opportunity to illustrate potable water becoming a different type of water that can be utilised in a secondary function such as flushing toilets

c. Opportunity to illustrate different water quantities to users with interactive taps

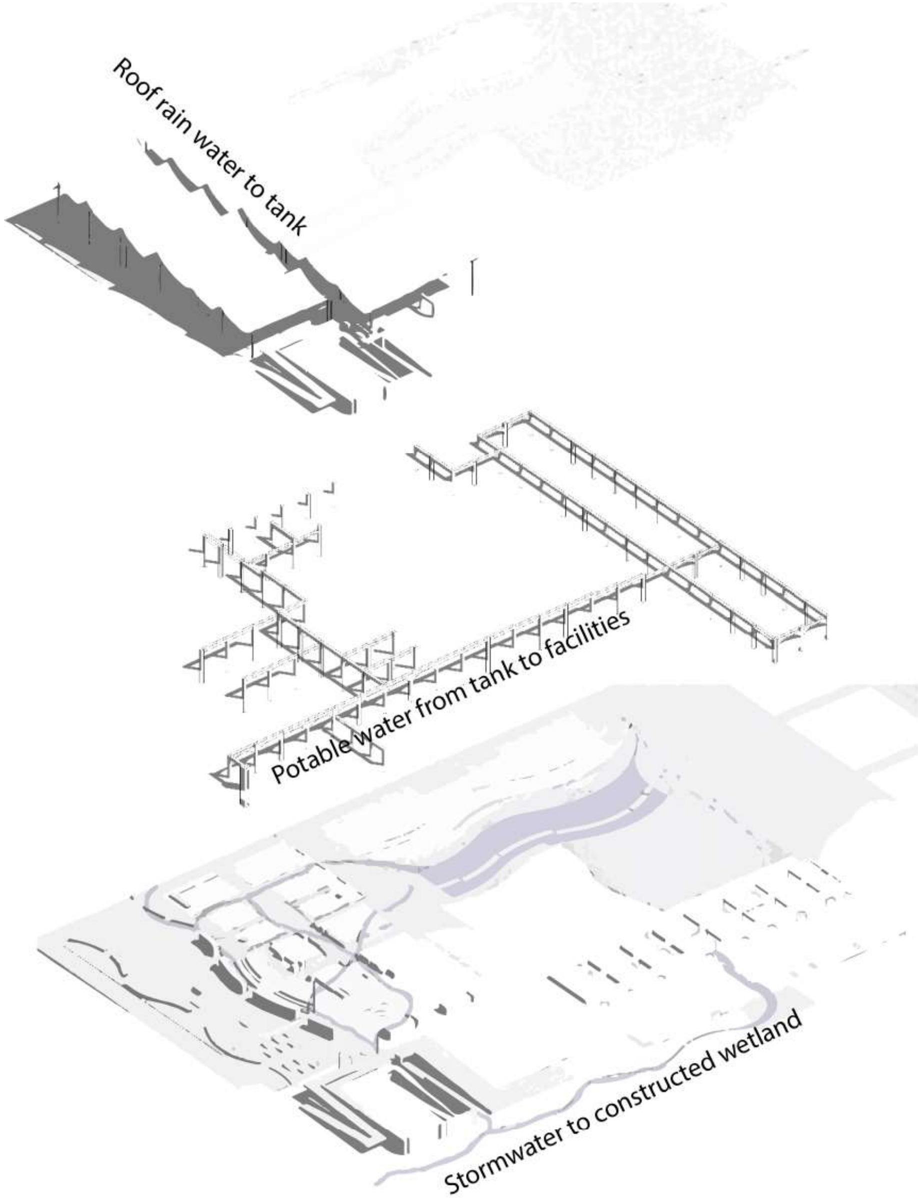
d. Opportunity to illustrate water scarcity by allowing water from the main water tank to finish

2. Storm water- the ground floor plane. Accessible to people to splash around in.

a. Mostly used for irrigation and cooling the building

b. Channelled to the constructed wetland.

c. Opportunity for the water purification and water to be exposed and accessible to the building's users



3. Black water- pipes buried beneath the ground and are not invisible to people. They will be represented with coloured paving on the ground floor plane along the path directly above them.

a. Which needs to be sealed and inaccessible to the public because of health and safety.

b. Opportunity for utilising colour to create a path comprising of different planes that turn into seating at various points and information boards

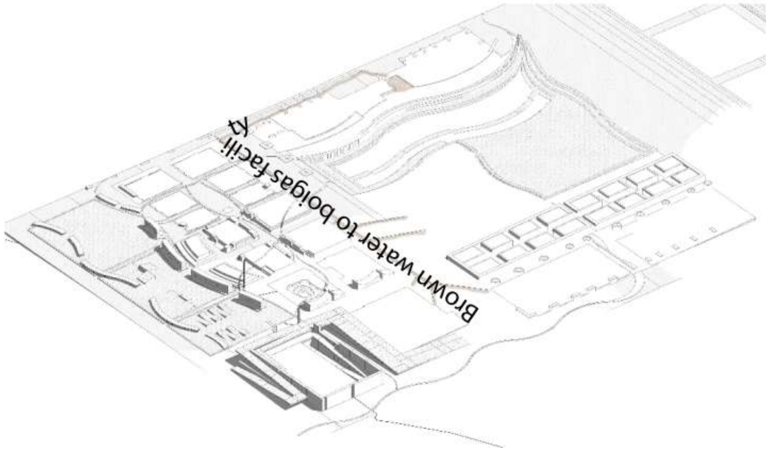


Figure 71: Water types (Author, 2020).

Moving potable water through the site

The water pressure required to ensure that amenities such as toilets and taps function correctly is 1.5 bar (m/s) in domestic environments. For other buildings, 2 bar is required (m/s). In order to achieve this, the water tower will have to be lifted at least 2m high for a 2500litre tank. However this rate changes depending on a couple of variables, including pipes material friction, distance from water source and the number of turns in the water supply system. Because of this, a specialist would have to be consulted to calculate the exact water pump required for this building (SANS 10252, part 1 and 2).

Potable water needs to remain sealed from the point of purification to ensure that it remains safe to drink (SANS 10252, part 7; LeChevallier, M. W. and Au, K.-K.,2004). The best way to ensure that water remains sealed is through the use of water pipes. There are a variety of pipes to consider for use at different points across the site. Pipes that are not visible to the user can be opaque pvc pipes. In areas where the there is opportunity to reveal the water's journey from the tank, clear pvc pipes may be utilised. In cases where pipes will interact with hot water, copper is the most suitable material (SANS 10252, part 5). The different types of pipes help to aid the design concept of the project.

Table 3 — Flow rates from terminal water fittings

1	2	3	4	5
Sanitary fixture or fitting	**Likely maximum flow rate per tap or fitting[a]** L/min	**Likely minimum flow rate per tap or fitting** L/min	**Design flow rate per tap or fitting** L/min	**Design flow pressure at tap or fitting for design flow rate[b]** kPa
Wash-hand basin				
15 mm taps (plain outlet)	25	5	10	10
15 mm taps (aerated outlet)	12	5	8	50
Mixer (plain outlet) (hot and cold separately)	25	5	10	15
Mixing valve (aerated outlet) (hot and cold separately)	12	5	9	50
15 mm taps (public facility) (flow controlled)	6	3	4	20
Bath				
15 mm taps (plain outlet)	30	12	15	15
20 mm taps (plain outlet)	40	20	25	15
20 mm taps (aerated outlet)	20	12	12	50
Mixer (plain outlet) (hot and cold separately)	40	12	25	15
Mixing valve (aerated outlet) (hot and cold separately)	25	15	20	50
Shower (wall mounted)				
Showerhead (standard) (hot and cold combined)	30	8	15	20 – 50
Showerhead (water saving) (hot and cold combined)	12	6	10	50 – 100
Water closet[c]				
Cistern float valve		3	5	100[d]
Automatic shut-off flush valve (low-pressure pattern)	–	–	110[e]	30 – 50[g]
Automatic shut-off flush valve (high-pressure pattern)	–	–	65[f]	150 – 200[g]
Urinal				
Siphonic type (automatic shut-off flush valve)	–	–	60	30
Wash-down type (automatic shut-off flush valve)	–	–	10	50
Bidet				
Mixer or mixing valve (hot and cold separately or combined)	12	5	9	50
Sink				
15 mm taps (plain outlet)	25	6	12	15
20 mm taps (plain outlet	35	15	20	15
Mixer (plain outlet) (hot and cold separately)	25	10	15	15
Mixing valve (aerated outlet) (hot and cold separately)	12	6	10	50

Figure 72: Tables providing a general indication of the water pressure needed for various systems and fixtures (SANS 10252 part 4, 2012).

Potable water in pvc pipes is conventionally transported around a site and building under the ground and within the walls of a building in South Africa (Fennemore et. al., 2014). The ambition of exposing these otherwise hidden water systems and processes present interesting options of ways that the water can be moved around the site and building.

Figure 73: Pompidou Center (Potable water in pvc pipes is conventionally transported around a site and building under the ground and within the walls of a building in South Africa (Fennemore et. al., 2014). The ambition of exposing these otherwise hidden water sys

Figure 74: Roman aqueduct (Potable water in pvc pipes is conventionally transported around a site and building under the ground and within the walls of a building in South Africa (Fennemore et. al., 2014). The ambition of exposing these otherwise hidden water sys

Perhaps one of the most famous buildings that achieves this in an unconventional fashion that also exposes the process to the user, is the Pompidou centre. By using different coloured pvs pipes to transport the different types of water and services of the building, a clear distinction is communicated to the user. This type of approach is aided by the lightweight steel frame structure which the building is made from. This type of building technology would be contrary to the prevalent typology of Marabastad. The other very famous and historically grounded method of moving water is the Roman aqueduct. The aqueduct reads as a dominant structure in a landscape and creates a statement with its fixed stance. It conceptually positions itself at the top of the spatial hierarchy which communicates the importance of the water that it transports.

There is a prevalence of colonnades within the existing fabric of Marabastad because of the covered walkways. The aqueduct mirrors these colonnades and appropriately compliments the existing architecture of the area. In his 2002 SDF, Aziz Tayob recognises the prevalence of the colonnade within Mrabastad and recommends that, "...the proposal for pavement colonnades to be pulled through to the southern area of Marabastad and the overall symbolic significance of Jerusalem Street in the context of the development concepts advanced herein".

Utilising an aqueduct to transport the water throughout the site allows for opportunities to break the structure at different points in order to reveal the water. It also allows for the water to travel from a height that will aid the water pump to deliver water at correct required pressures.

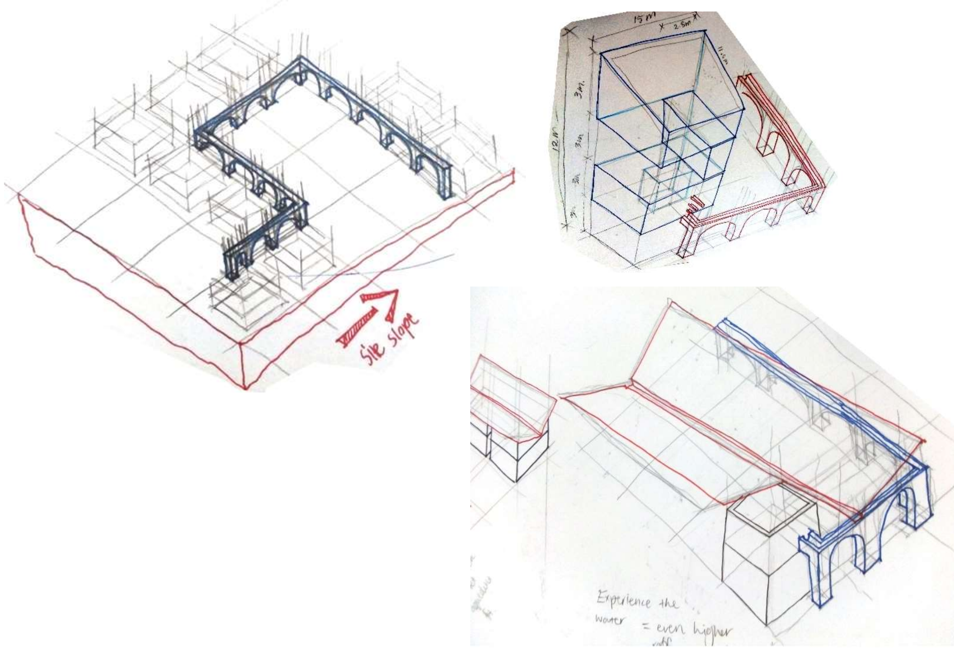


Figure 76: Conceptual sketches of aqueduct (Author, 2020).

Figure 75: Collonades in Marabastad (Author, adapted from Google Maps, 2017).

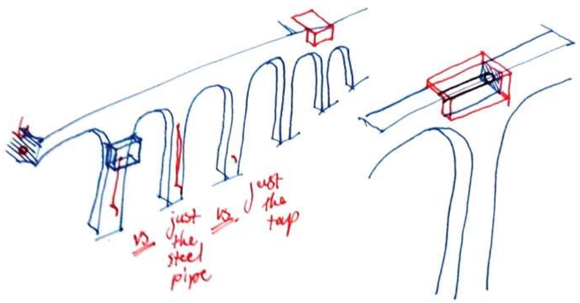


Figure 77: Different ways to expose water around the site (Author, 2020).

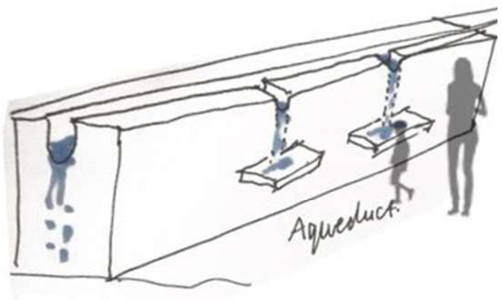


Figure 78: Exposed water aqueduct conceptual sketch (Author, 2020).

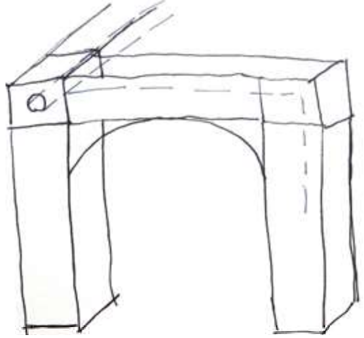


Figure 80: Concept sketch

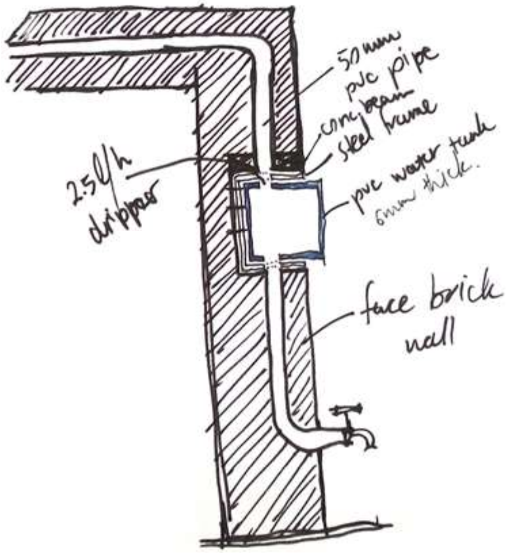


Figure 83: Sketch section through street tap with transparent water reservoir (Author, 2020).

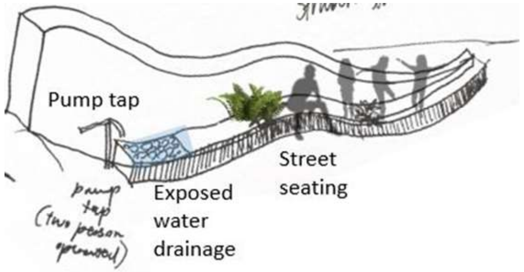


Figure 79: Seating integrated with wash- hand basin (Author, 2020).

The tap illustrated in figure 80 is a pump tap. This type of tap is not commonly found within urban environments. This tap requires the user to exert themselves in order to access water thus communicating the idea that one needs to work to access the valuable resource

Figure 81: Materiality reference image (https://www.pinterest.pt/pin/466474473894857915/)

Figure 82: Materiality (https://za.pinterest.com/aancoleman/water-feature/)

The tap illustrated in figure 84 is an example of an application of the serious games theory in the architecture of the building. This tap sits inside an aqueduct and is fed by a mini reservoir which also sits within the aqueduct directly above the tap. At the entry point into the reservoir, there is a drip valve which slowly fills it with water. The user will be forced to wait for the water to fill up inside the tank before they can get an adequate amount of water to use. The user will also be compelled to gauge the amount of water that they need. After the mini reservoir is empty again, the user will once again have to wait for the tank to fill up again. There are a variety of tanks, each of a different size holding different water quantities. The volume of water of each full tank will be printed on the tank.

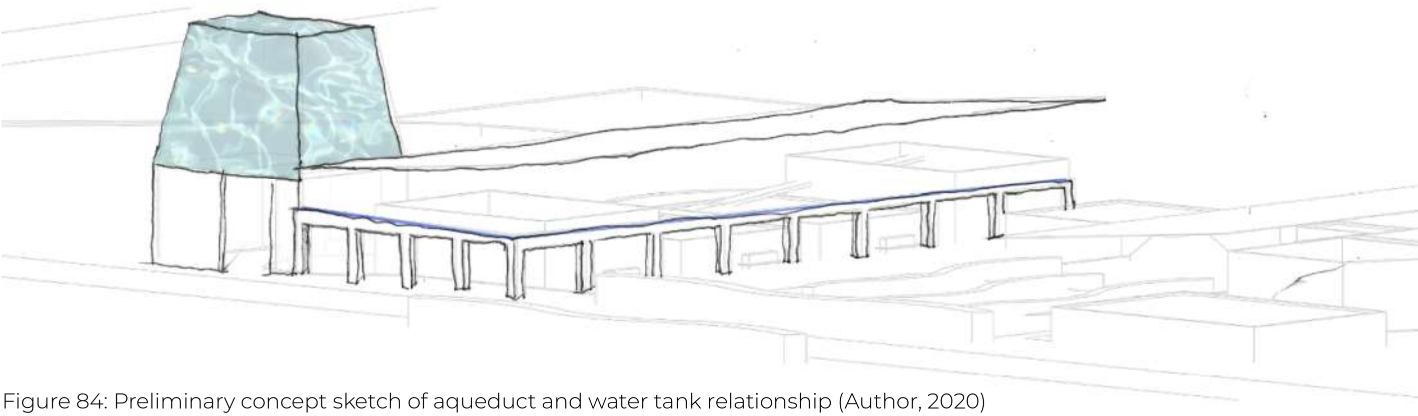


Figure 84: Preliminary concept sketch of aqueduct and water tank relationship (Author, 2020)

Defining the massing of the building

Precedent 2

Project Name: Iran Public School

Location: South Iran

By: BM Design Studios

(r)Figure 86: Clay bowl sit on top of the concrete roofs of the buildings to collect as much rain water as possible (BM Design Studios, 2020)..

(l)Figure 85: Water is allowed to flow between the buildings through the wind chimney thus cooling the spaces (BM Design Studios, 2020).

The bowls on the roof acutely collect the very scarce water in the area when it's available. The buildings are linked via flowing water which, because of the wind chimney on site, drive cool air through them. They are also sunken into the site thus allowing for even more water collection and shading thus protecting them from the harsh environmental conditions in the area.

Figure 88: Urban Living Room Precincti existing site conditions and existing SG diagram (Adapted from Google Maps, 2017, Tshwane GIS, 2020)

-Thermal mass of brick walls
-Large roof to capture any kind of moisture
-Buildings less then 8 m width to allow for passive cooling
Water flows through and around sunken site to create a cool micro climate

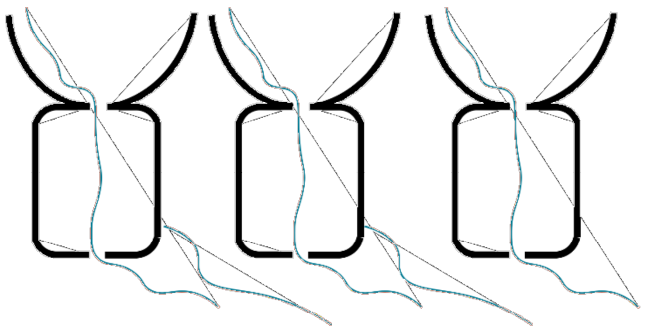


Figure 87: Analysis of Iran public school(Author, 2020)

The Precinct on which the project sits was part of the historical Marabastad. The area comprised a grid of a fine grain with small blocks that were easy for pedestrians to walk (Tayob Partnership, 2002). Although the site is currently empty, the municipality has re- surveyed it into the same small square 30m x 30m sites as those that existed there in the past. The architecture of Marabastad comprises many small buildings that are often connected via their walkway colonnades. Many of the buildings are no taller than 2 storeys. It is valuable to maintain the fine grain nature of this area as it is a pedestrian heavy region and the fine grain grid will allows for pedestrians to be able to easily walk through (Herber et. al., 2018). I have thus designed the project to comprise many small buildings. The small buildings will also ensure that the Urban Living room is well ventilated and also make for an interesting experience for the user as the storm water meanders around the buildings.

Design development

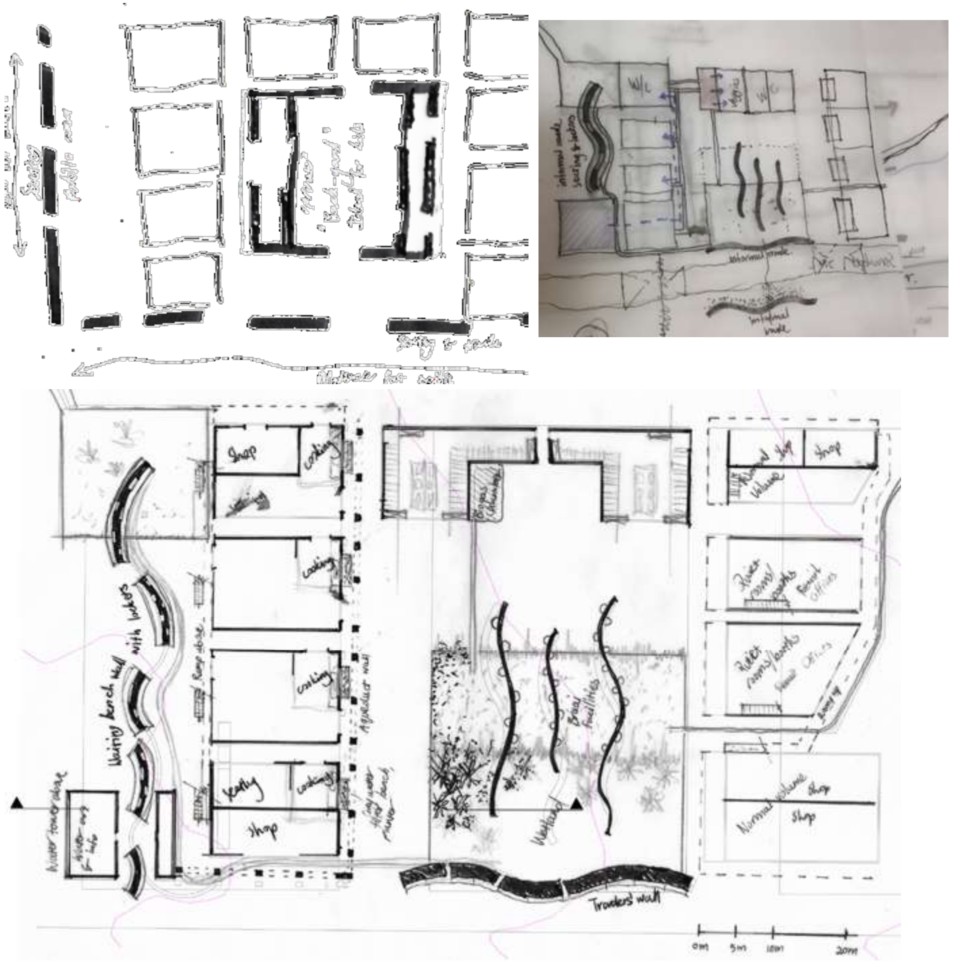


Figure 89: Floor plan development (Author, 2020).

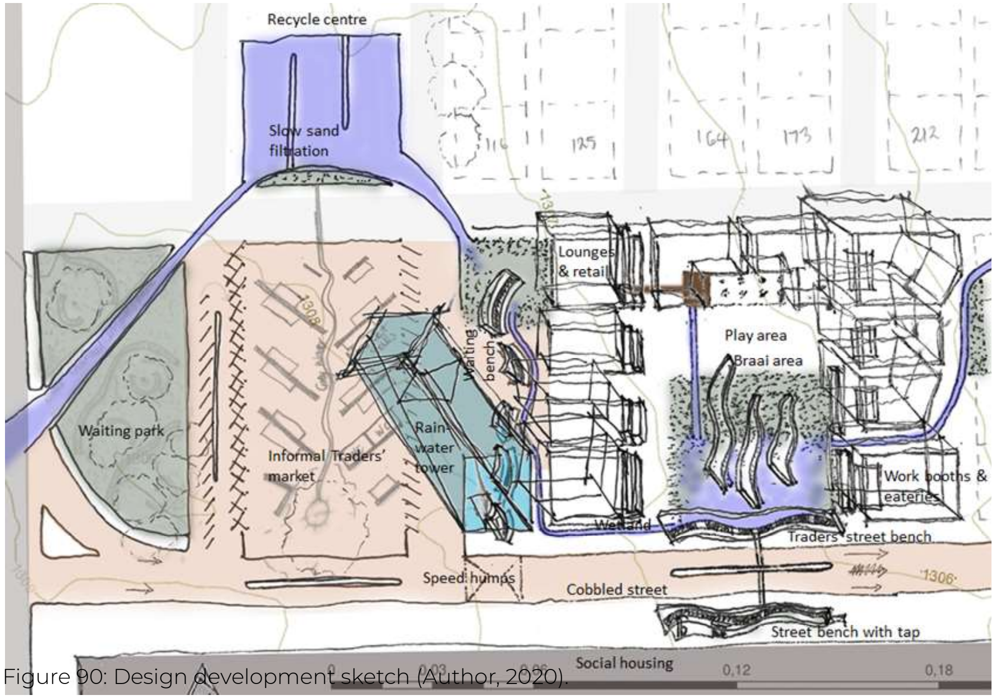


Figure 90: Design development sketch (Author, 2020).

Final floor plan

The main catalytic feature, the reservoir, is situated in the south west corner of the site- which is the highest point. There is an informal and formal lounge, and an informal market. Along the 3rd street edge, is the taxi, waiting and drop off area where a large curvilinear adobe wall with seating houses small lockers for day visitors. On the eastern side of the site, a public green open space has been provided which comprises a constructed wetland, a braai area and a sports field. Ablution facilities have been provided on the Struben Street edge of the site and the un- named street edge on the north.

Ground floor plan

1. Reservoir
2. Street bar
3. Street seating
4. Storm water
5. (Pilgrimage) Ramp to secret garden
6. Security office
7. Over- night storage lockers
8. Trade stall- wash-room concierge
9. Wash- room
10. Mechanical room
11. Aqueduct above
12. Taxi wait/ drop off
13. Adobe bench with lockers
14. Informal lounge
15. Semi- formal lounge
16. Water info course along black water route
17. Braai area
18. Market
19. Formal work spaces
20. Shops
21. Self –watering street planting
22. Trade stall- wash-room concierge
23. Shop
24. Street trader stalls
25. Street tap
26. Wash- room
27. Restaurant seating
28. Restaurant
29. Biogas chamber
30. Gas shop
31. Wash- room
32. Street stalls
33. Shop
34. Trade stall- wash-room concierge
35. Constructed wetland
36. Sports field
37. Street stalls with potable water access
38. Co- op veggie garden
39. Sports hall
40. Restaurants/ Shops
41. Mixed use buildings with street facing retail

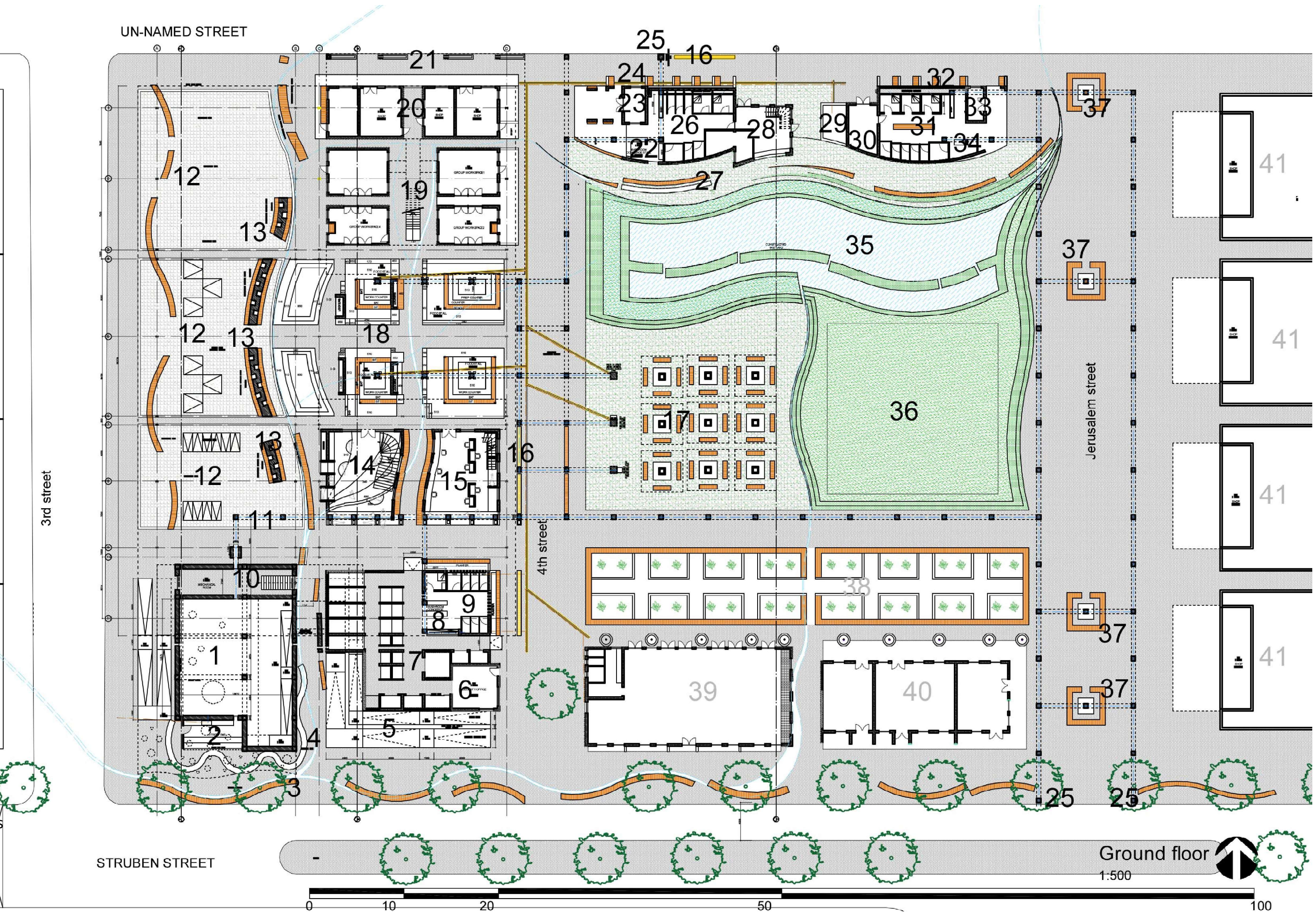


Figure 91: Final floor plan (Author, 2020).

First floor plan

1. Secret garden above reservoir
2. Gutter
3. Aqueduct below
4. Informal lounge
5. Semi- formal lounge
6. Formal work spaces
7. Formal work spaces/ offices
8. Restaurant balcony
9. Opportunity for residential units

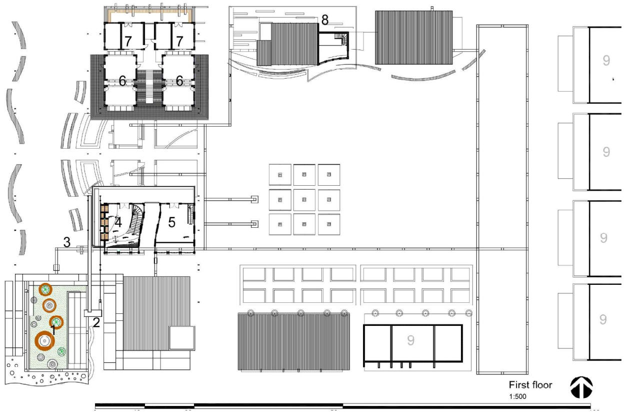


Figure 92: First floor plan (Author, 2020).

Site plan

The public green open space serves as a buffer between the busy Jerusalem street and the urban living room. The constructed wetland is fed by storm- water runoff from site and the precinct's storm water filtration dam. It weaves its way through the site.

Figure 93: Site axo (Author, 2020).

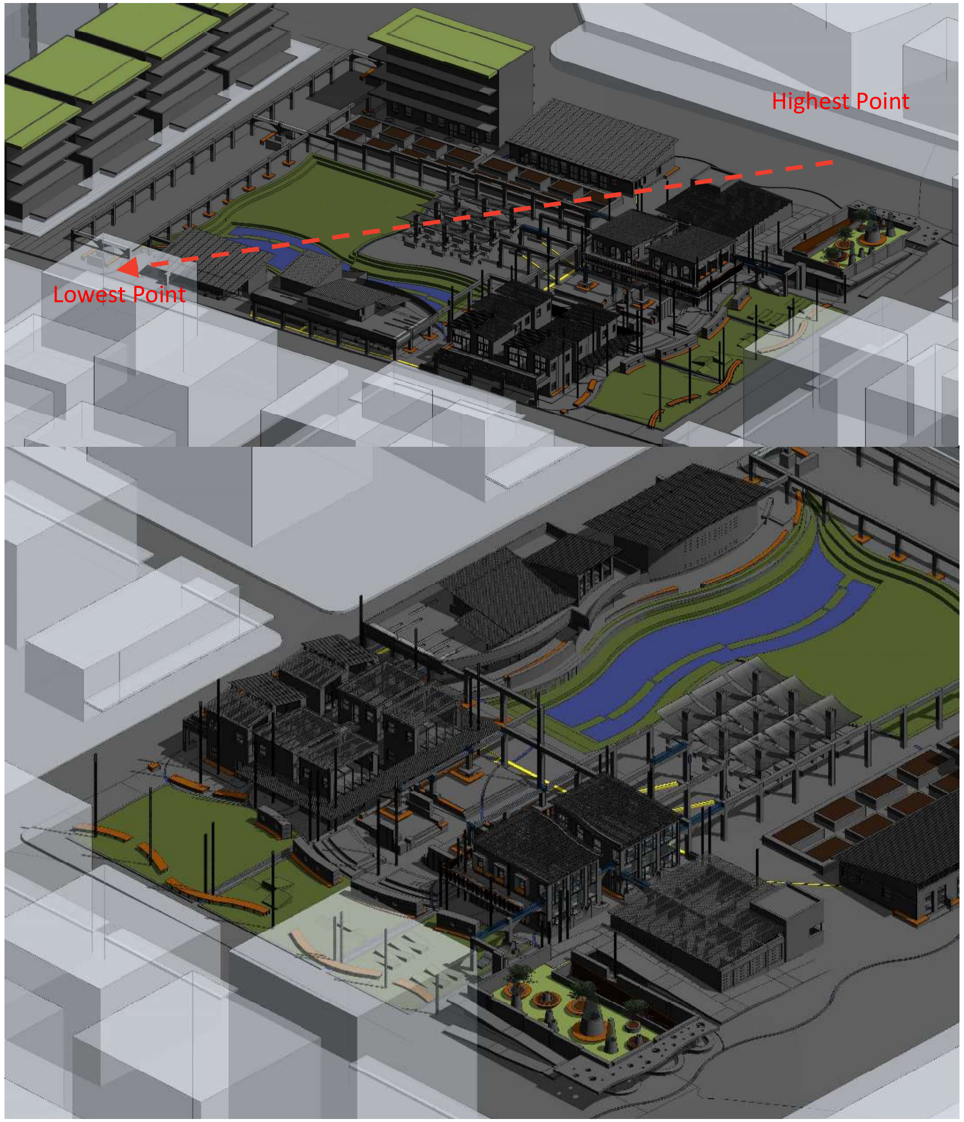


Figure 93: Site axo (Author, 2020).

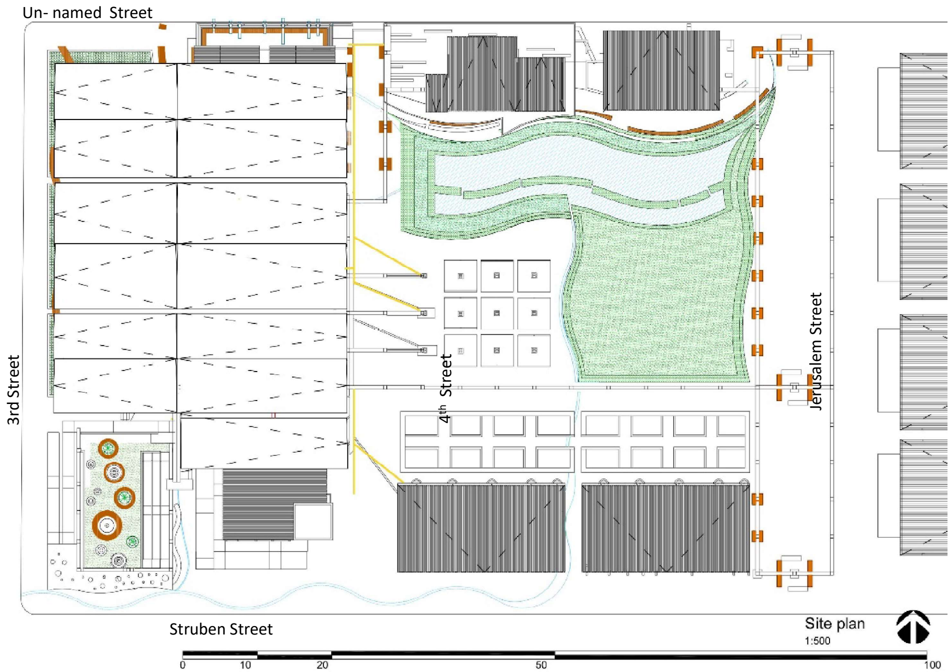


Figure 94: Site plan (Author, 2020).

Sections

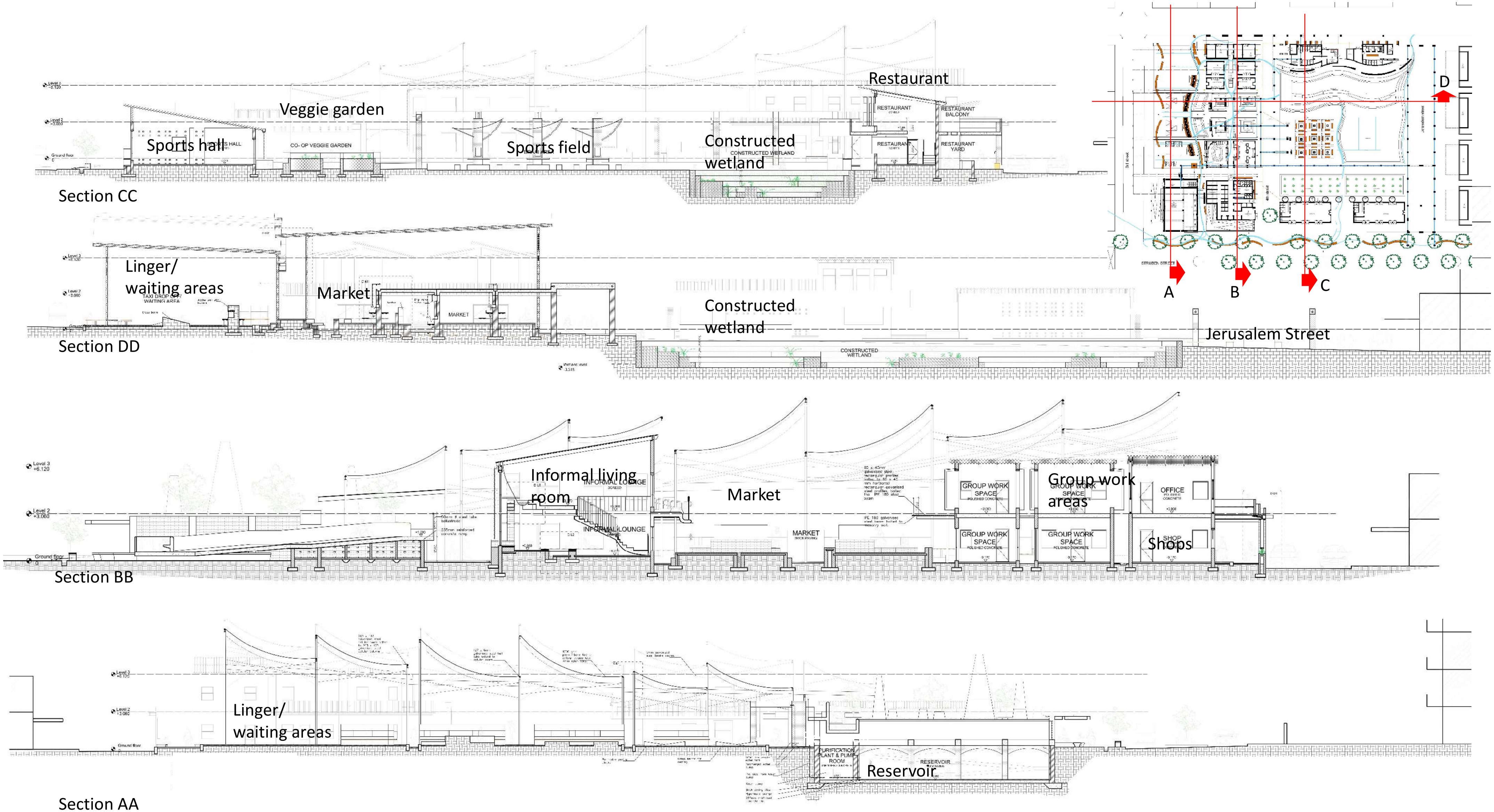


Figure 95: Sections (Author, 2020).

Reservoir

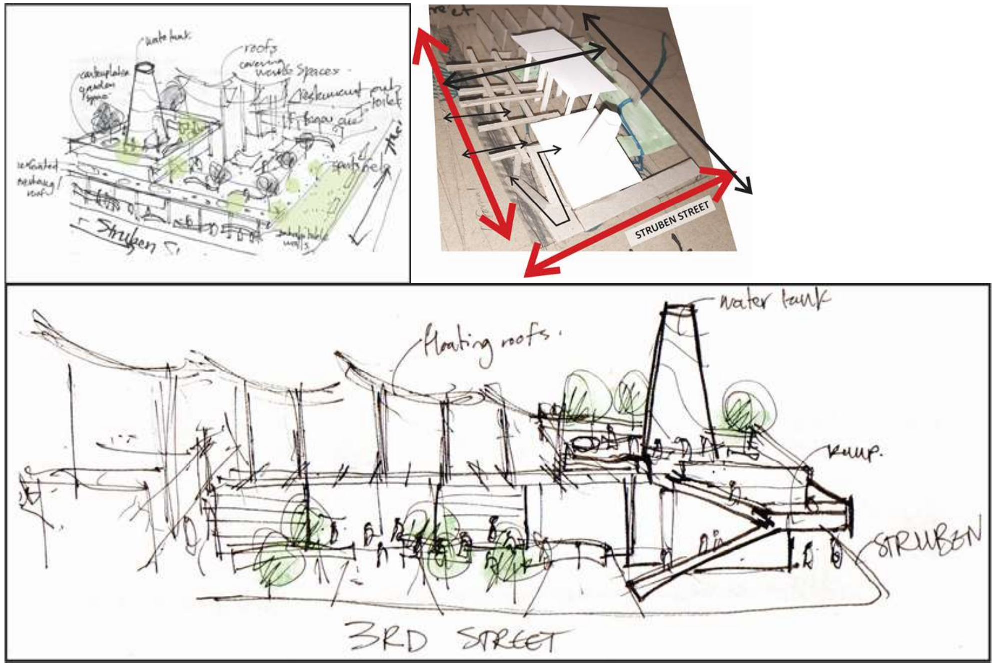


Figure 96: Reservoir concept sketches (Author, 2020)

Reference project

Project Name: Shcherbinka water tower

Location: Moscow, Russia

By: IND Architects


Figure 97: Illuminated water tower (IND Architects, 2020).

Although the water tower is currently not in use to hold water, the luminance of the lights in the tower communicate the concept that it is indeed a water tower.

Rain roof water calculation- to determine the size of the tank

Potable water AREA CALCULATIONS

Catchment	Area, A (m²)	Runoff Coefficient,	
		C	C (weighted)
Roof	2837,35	0,85	0,85
Paving	0	0,8	0,00
TOTAL	2837,35		0,85

TOTAL YIELD- Potable

Month	Total Yield (m³/month)
January	328,00
February	180,88
March	197,76
April	123,00
May	31,35
June	16,88
July	7,24
August	14,47
September	53,06
October	171,23
November	236,35
December	265,29
ANNUAL TOTAL	1625,52

TOTAL DEMAND

Month	Total demand (m³/month)
January	148,44
February	134,08
March	148,44
April	143,66
May	148,44
June	143,66
July	148,44
August	148,44
September	143,66
October	148,44
November	143,66
December	148,44
ANNUAL TOTAL	1747,80

WATER BUDGET (ACCUMALATIVE)	
January	179,55
February	226,36
March	275,68
April	255,02
May	137,93
June	11,16
July	-130,05
August	-264,02
September	-354,62
October	-331,83
November	-239,13
December	-122,28

Figure 98: Water demand calculations (Author, 2020).

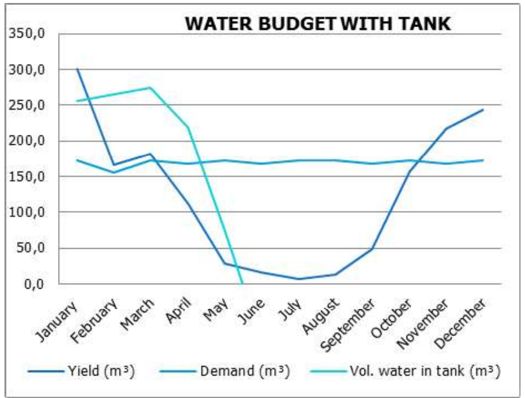


Figure 99: Water budget table for the urban living room (Author, 2020).

Table 1 — Daily water demand for different premises (excluding garden use)

1	2
Premises	**Water demand (including hot water)**
Boarding schools[a], children's homes and residential nurseries	135 L to 200 L per capita
Educational institutions	40 L to 50 L per capita
Kitchens (full meal preparation)	8 L to 12 L per meal prepared
Multiple dwelling units, such as flats	300 L to 400 L per dwelling
Hotels, boarding houses, motels and nurses' homes:	
with resident staff	200 L to 300 L per bed
without resident staff	200 L to 250 L per bed
Commercial premises:	
shops (staff only)	14 L to 18 L per 10 m² gross floor area
superstores, such as hypermarkets and warehouses	125 L per WC pan, or per 600 mm width of slab urinal
offices with canteens	10 L to 15 L per 10 m² gross floor area
offices without canteens	7 L to 10 L per 10 m² gross floor area
Clinics, hospitals, nursing homes and old-age homes	450 L to 550 L per bed
Factory ablutions	100 L to 200 L per capita

[a] Excluding kitchen but including laundry.

Figure 100: Water supply guide table (SANS 10252, 2014).

Due to the large amount of water that can be collected by the 2600 m² roof, it became clear that it would not be justifiable to suspend 1097 tonnes of water and that other means of making the water tank visible would have to be explored. The water reservoir would still need to communicate the idea of water running out during seasons when we don't have rain but be positioned on the ground floor. The reservoir began taking the form of a water tank that is situated in the ground rather than a light water beacon that is suspended in the air.

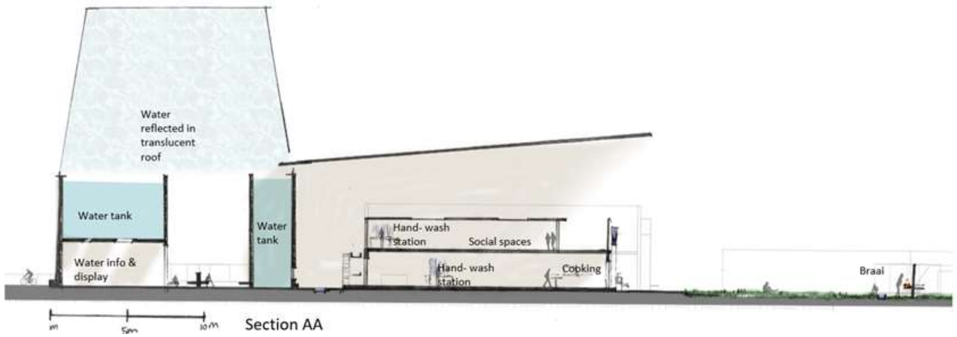


Figure 101: Reservoir section iteration (Author, 2020)

The purpose of suspending the tank was so that people at the Urban Living Room could witness the water in the tank finishing as the months went by. Other solutions that achieve the same concept have been found even as it sits partially busied in the ground. The inside of the water tank has been made accessible to users so that when the water has run out- the space can be used as a place of contemplation. This decision also allowed for a roof garden to be created above the water tank. The water tank is made from a concrete superstructure with brick infill walls.

Figure 102: Material choices and lighting characteristics (Dezeen, 2020).

The irony of this reservoir is that even though it holds water, it still needs to be waterproofed to ensure that the water inside doesn't escape into the surrounding soil. Normally, we waterproof basements to keep water out. There is opportunity to create special lighting in the water tank to create a cathedral- like ethereal atmosphere. To allow users to be able to witness the water running out over the months, slit windows have been positioned on one end of the tank and in the opposite with a clear view right through.

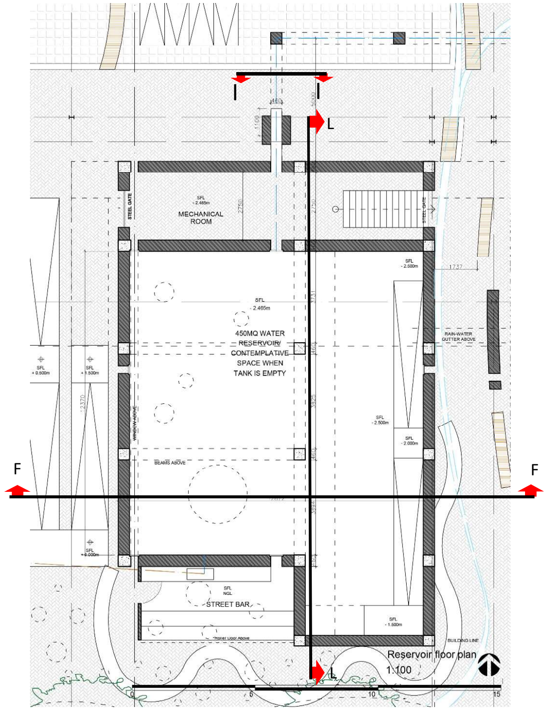


Figure 103: Reservoir floor plan (Author, 2020).

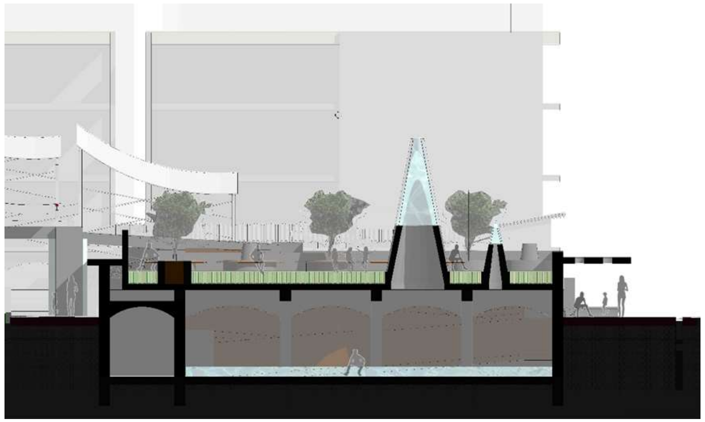


Figure 104: Section LL (Author, 2020).

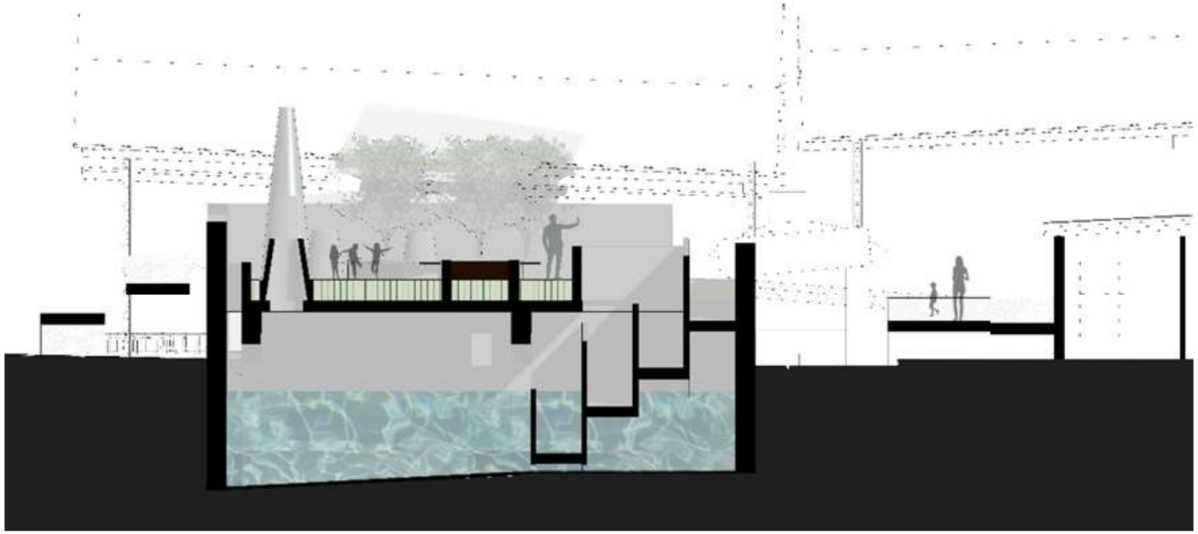


Figure 105: Section FF(Author, 2020).

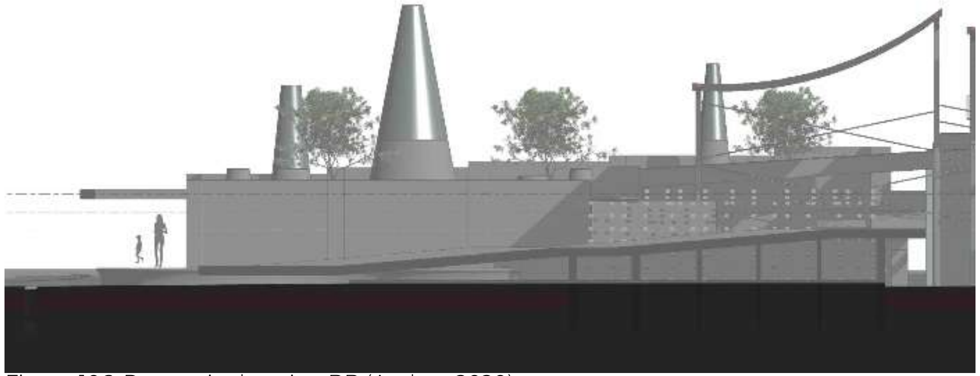
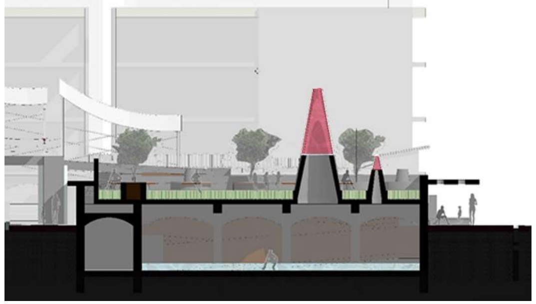
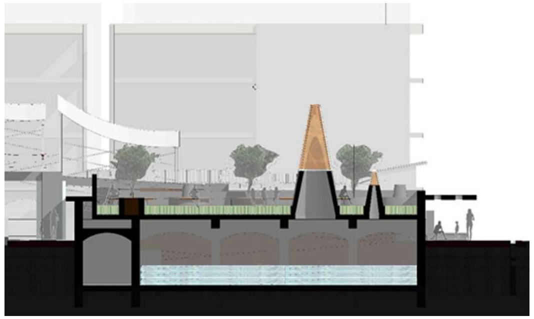


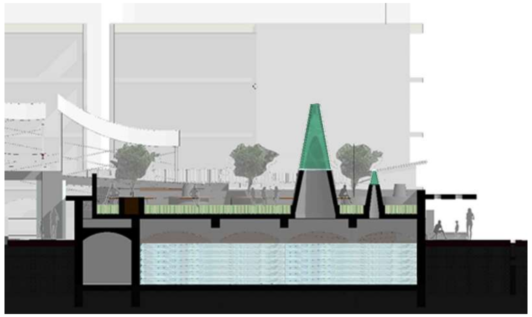
Figure 106: Reservoir elevation BB (Author, 2020).


3D renders of the inside and outside of the reservoir (Author, 2020)

The reservoir is a sunken building that comprises a concrete super structure with a brick infill. There is a roof garden on top of the reservoir which serves as a reward for people having walked up the ramp to the top of the reservoir. The reservoir can function as a space of contemplation when the water has run out. The mechanical room on the left houses a water pump and water purification system.







The acrylic cones can be lit up in green with led lights when the reservoir is full, orange when it is half empty and red when the water is about to run out. This gives the users an opportunity to witness the depletion of water in the reservoir and the seasonal replenishment.

Figure 107: Light indicators on acrylic cones (Author, 2020).

Reservoir pilgrimage ramp

Positioning the water tank on the ground floor and partially buried, meant that the roof could become accessible to users. There is a ramp that has a lane for pedestrians and a lane for cyclists, wrapped around the reservoir structure. This allows people to take a literal pilgrimage up to the top of the reservoir where they will find a secret garden- which is the reward for them having made the journey to the top. In order to be able to access the inside of the reservoir, one needs to walk down another ramp that leads down to the floor of the reservoir. This ramp can only be accessed via the roof garden. The garden space above the ramp can accommodate an open roof- top restaurant because ablution facilities are close to the space and its size is big enough to allow this function. The light beacons on top of the water reservoir also provide seating space. In the night time, these light wells are lit up like beacons to be seen from a distance away. Private art functions can be held on the roof garden and the art can be below, inside the reservoir during dry seasons.

Figure 109: Takao Shiotsuka Atelier (https://www.designboom.com/architecture/takao-shiotsuka-atelier-sj-building-japan-concrete-ramp-01-07-2020/)

Figure 108: The Great Mosque at Samarra's spiral minaret. (https://www.amusingplanet.com/2014/08/the-great-mosque-of-samarra.html)

Secret garden

Figure 110: Roof garden materiality (Dezeen, 2020).

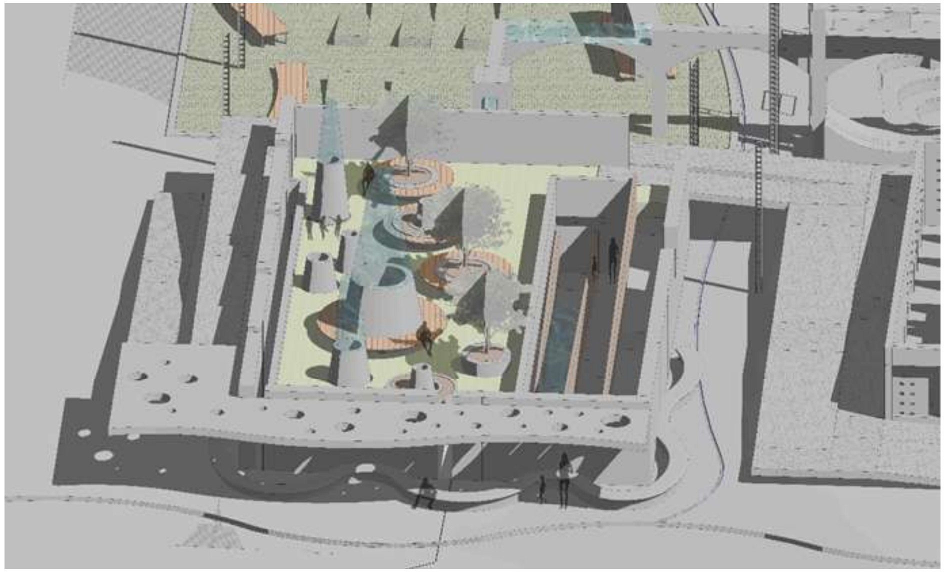


Figure 111: Roof garden view (Author, 2020).

Roof

Reference project

Project Name: House in Tanzania

Location: Tanzania

By: Pranav Thole and Rutu Kelekar

Figure 112: Kids play in the water (Pranav Thole and Rutu Kelekar, 2020)

The house is centred around a submerged water tank that the woven reeds roof feeds. Aquatic plants are used to naturally filter the water. The woven reed is naturally available in the area and is thus a suitable material for the house. The lack of structure in the roof material allows for it to fall inward as the architects have designed. It behaves like fabric allowing for a range of design possibilities.

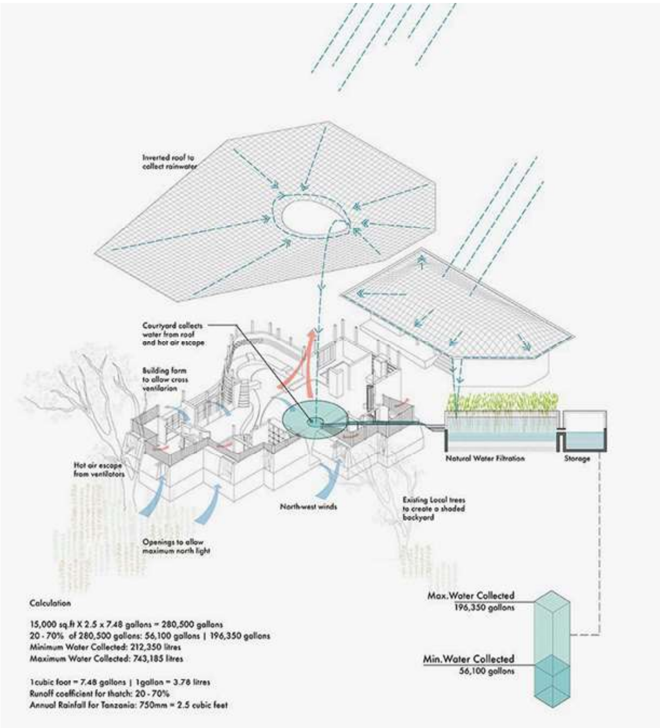


Figure 113: House roof system (Pranav Thole and Rutu Kelekar , 2020).

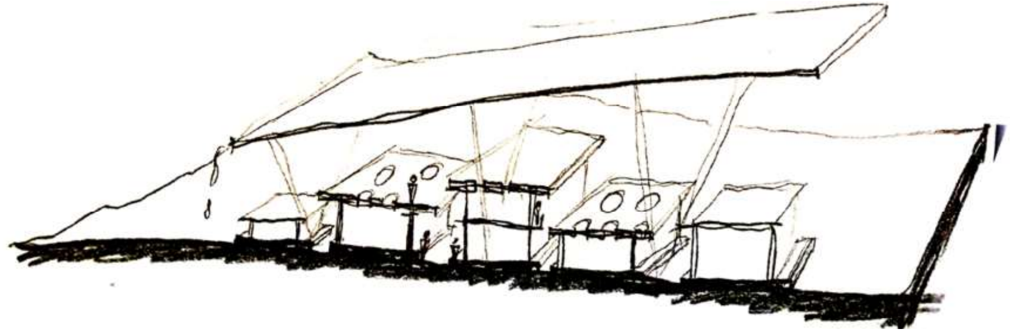


Figure 115: Sketch illustrating the relationship between the roof and the buildings beneath it (Author, 2020). .

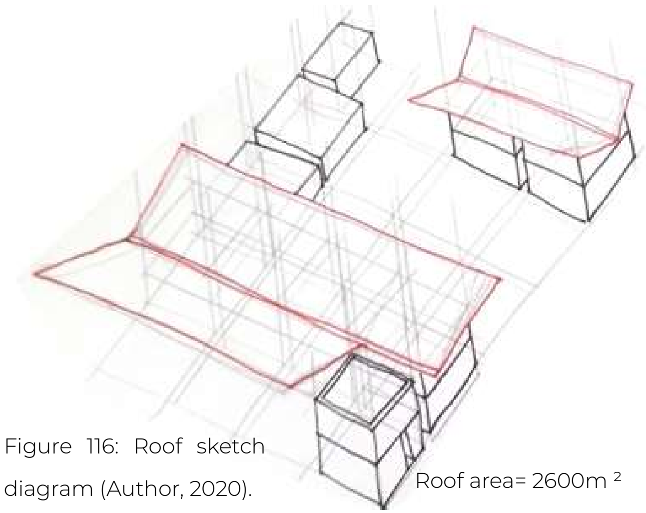


Figure 116: Roof sketch diagram (Author, 2020).

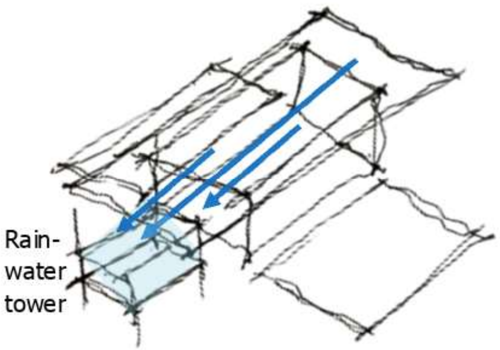


Figure 114: Conceptual sketch illustrating rain water from the roof to the reservoir (Author, 2020).

Roof area= 2600m ^{2}

Challenges posed by the size of the roof:

1. It could weigh a lot

2. It could result in light not being able to adequately penetrate through to the spaces beneath it

3. It may result in poor ventilation

4. The gutter needs to be large enough to carry the big volumes of water when it rains

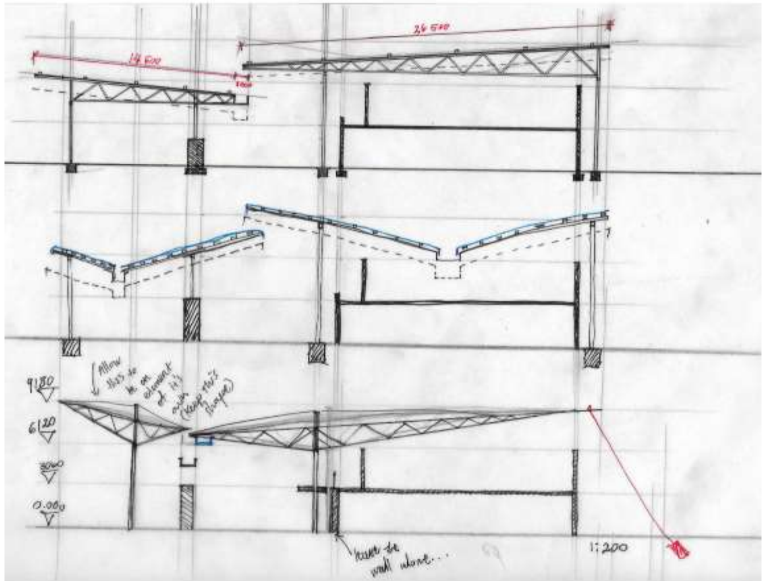
Reference project
Project Name: Olympic golf course pavillion, 2016

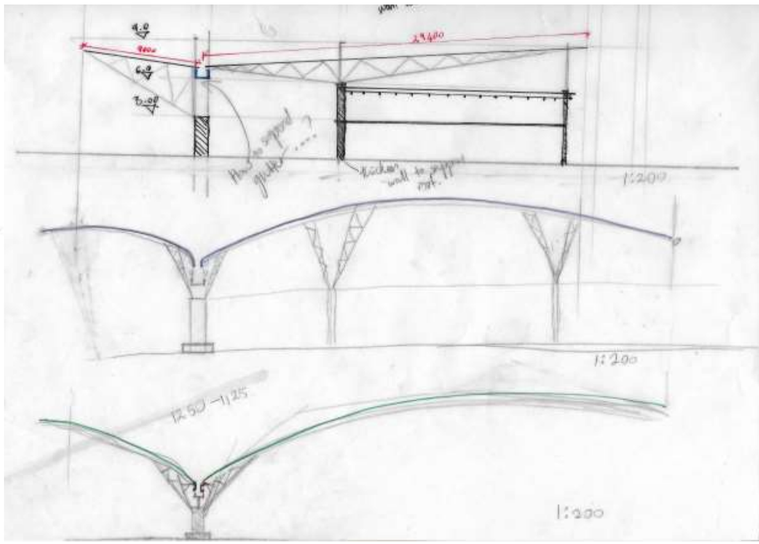
Location: Brazil

By: Rau Arquitetos

Figure 117: Olympic pavilion (Rau Arquitetos, 2016)

Roof design considerations





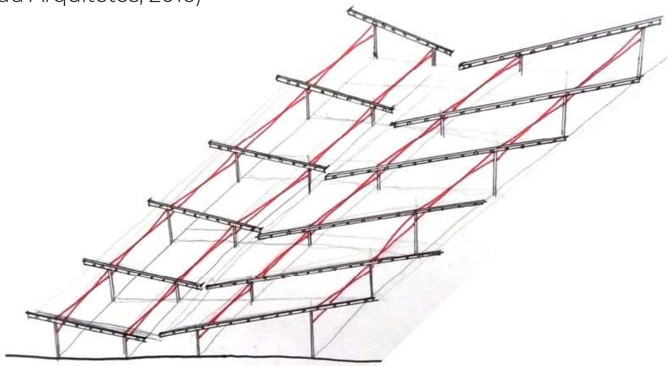


Figure 118: Roof design considerations (Author, 2020).

Cellular I beams appear to be less heavy than the composite light weight steel beams. Because of their rigidity, few beams are needed to support the structure. These beams can also span very large distances without requiring additional support. With the pvc membrane roof, not much else structure will be needed.

Figure 119: Cellular beams (Macsteel, 2019).

The final roof design comprises, steel cellular columns and beams with steel cross brace rods between them, a pvc membrane and central steel gutter. All the steel is galvanised. The pvc membrane allows for the roof to be stretched and pulled into these up- turned funnel like forms.

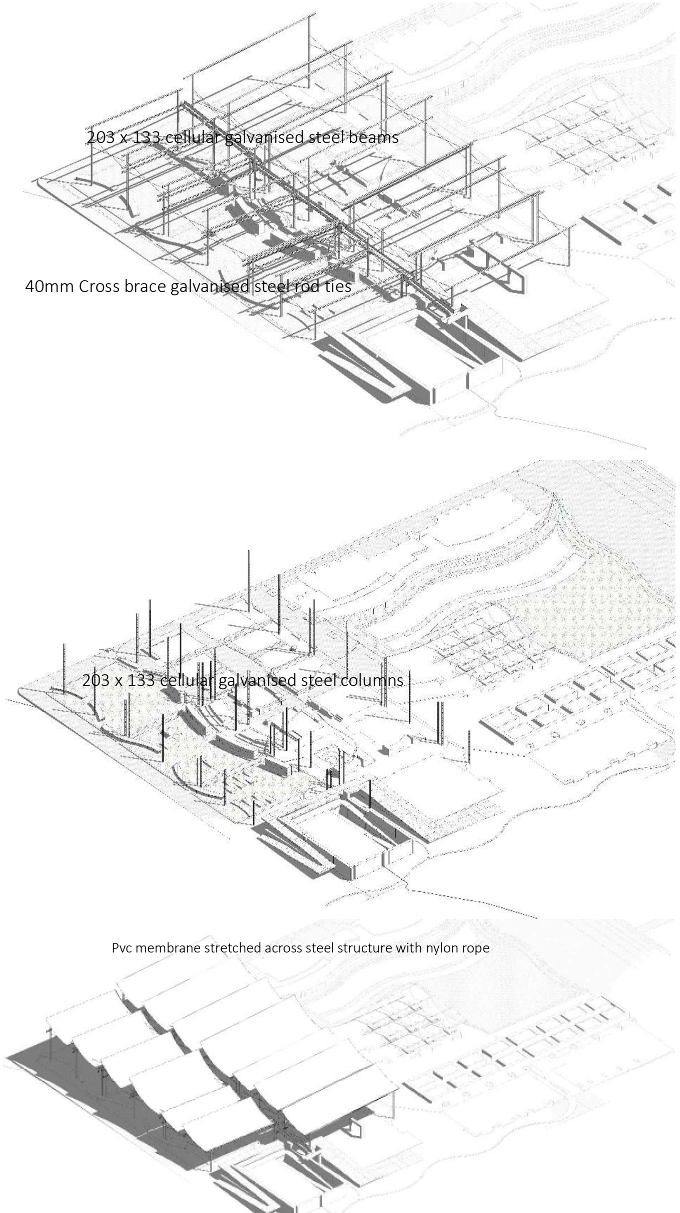


Figure 120: Final roof components (Author, 2020).

Figure 121: Stretched and pulled pvc membrane allows the roof to curve in all directions towards the central gutter (Author, 2020).

By staggering the roof and curving it upward, a chimney effect is created allowing hot air to escape. The roofs are also staggered in the northern direction to allow for light to filter through. By tilting the roof sails towards the gutter, the falling rain water will be clearly seen by the users of the building

Challenges addressed by this type of roof:

1. It could weigh a lot- pvc roof

2. It could result in light not being able to adequately penetrate through to the spaces beneath it- tilting each sail towards the north helps to let light into the space

3. It may result in poor ventilation- tilting the sails up helps to aid hot air escape at the top thus drawing in cooler fresh air

4. The gutter needs to be large enough to carry the big volumes of water when it rains- steel components allow for the gutter and water's weight

The central gutter becomes a spectacle when it rains as it has been designed to let water fall into its different segments both splashing and creating an audible experience for the user. It engages the user, visually, audibly and sometimes in a tactile way.

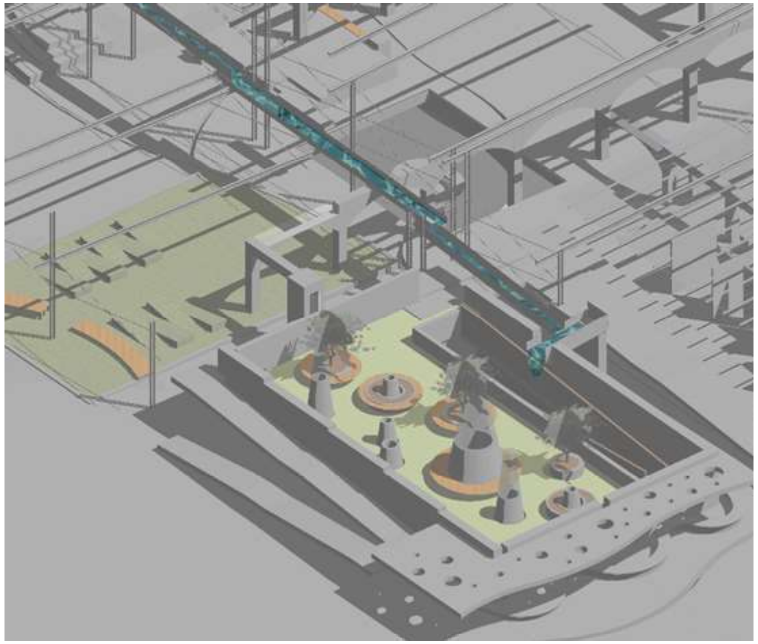


Figure 122: Roof gutter view (Author, 2020).

Informal lounge

The informal lounge is a technically simple masonry structure with plaster and paint mirroring Marabastad's prevalent tectonics. Various forms of seating have been provided and composite plastic wood benches have been used to soften the space whilst keeping the fittings robust enough for public usage.

Figure 124: Clear Modek roof sheets on buildings beaneath the main pvc roof membrane to let light into the spaces (Author, 2020).

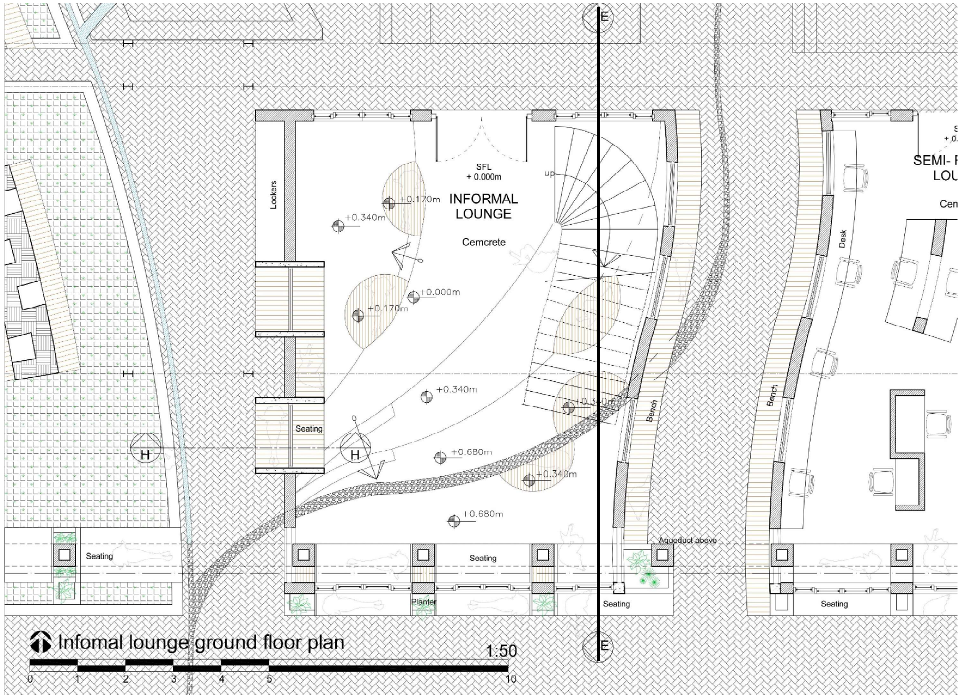


Figure 123: Informal lounge floor plan (Author, 2020).

Informal lounge representations (Author, 2020).

The aqueduct has been designed to pass through the building just as a normal pvc pipe carrying water would. A clear acrylic tank has been used in place to reveal the water inside the aqueduct at this point.

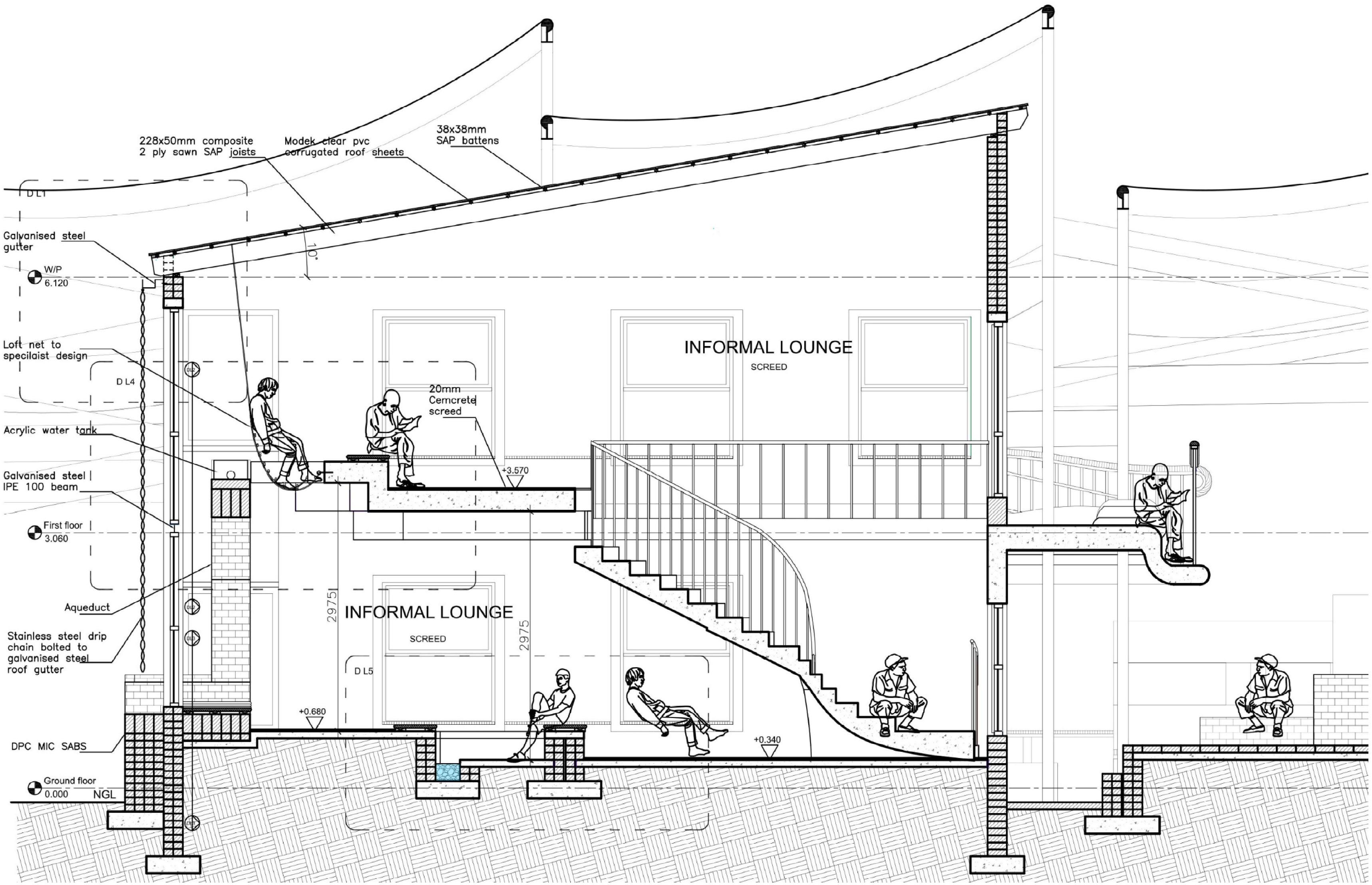


Figure 125: Infomal lounge section EE (Author, 2020). .

At the junction point of the aqueduct and the building, a glass brick wall in a galvanised steel frame has been designed. The glass brick wall reflects the water in the acrylic tank making dappled shadows on the surfaces. In reflection of the aqueduct, inverted arch seating has been provided along the façade of the lounge.

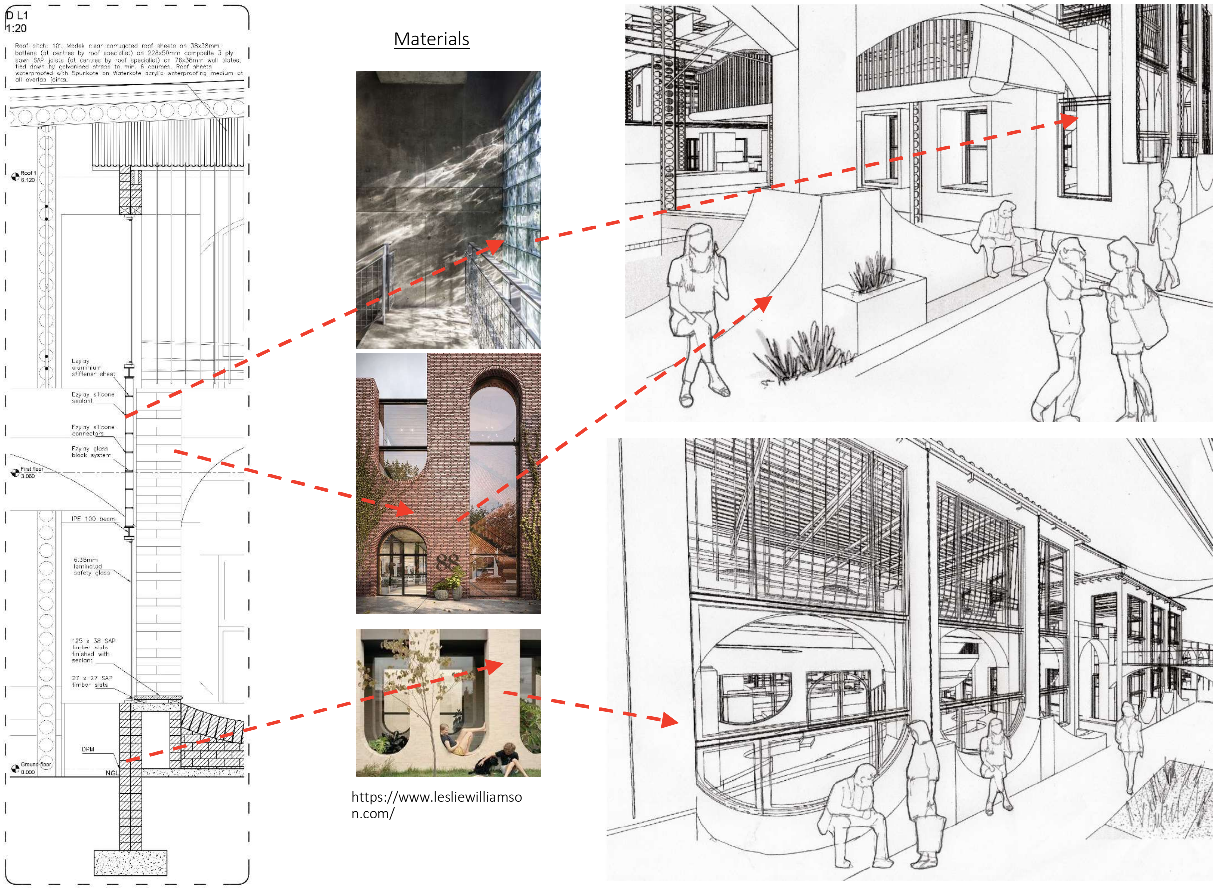


Figure 126: Infomal lounge materiality (Author, 2020). .

Ablutions

In his 2002 SDF, Tayob concludes that there is a need for public ablution facilities given the abundance of pedestrians within Marabastad. Given the nature of our societal issues, safety inside the public ablution facilities is of high importance. A design that accommodates a concierge at the entrance of the restroom and a generally more open design, have been found to increase people's safety within these spaces. These are called, "inclusive toilets", and were primarily designed with the safety of trans-gender users in mind as they tend to be attacked when utilising men's washrooms and are harassed when using women's wash- rooms

These spaces encourage a more inclusive environment while keeping the ablution activity private.

Precedent 3

Project Name: Stalled

Location: New York

By: AIA

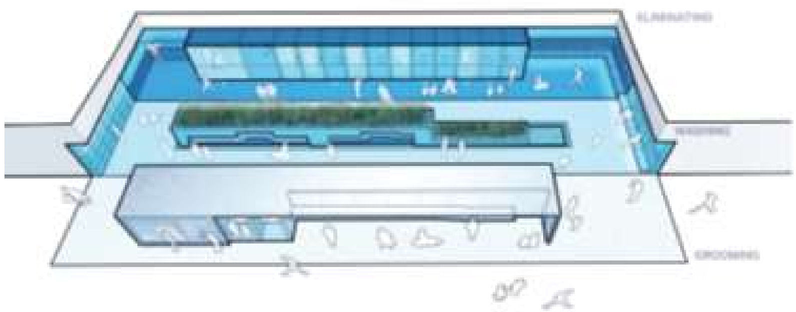


Figure 127 Safer public bathrooms (AIA, 2020)

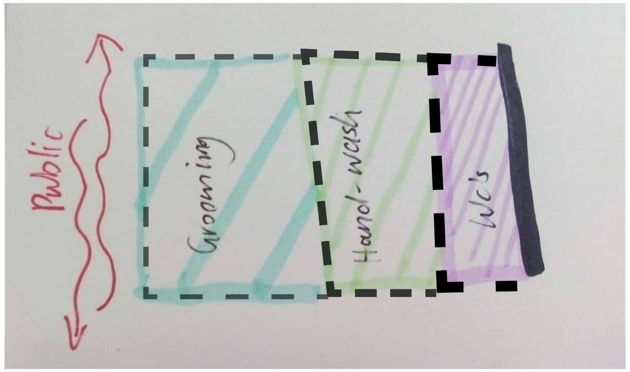


Figure 128: Analysis of spatial allocation for inclusivity and security (Author, 2020)

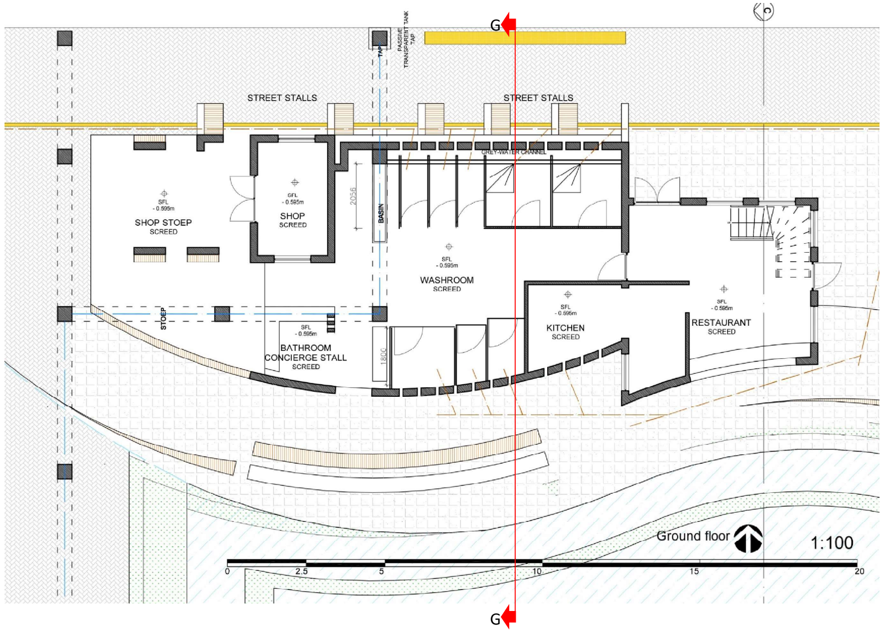


Figure 129: Typical ablutions floor plan (Author, 2020).

The ablution buildings have been designed for passive surveillance. There are three layers of space in the building, a public where trade happens, a semi private where grooming happens and a private, being the stall. There is also space provided for a concierge or trader to control traffic. All these elements provide passive surveillance.

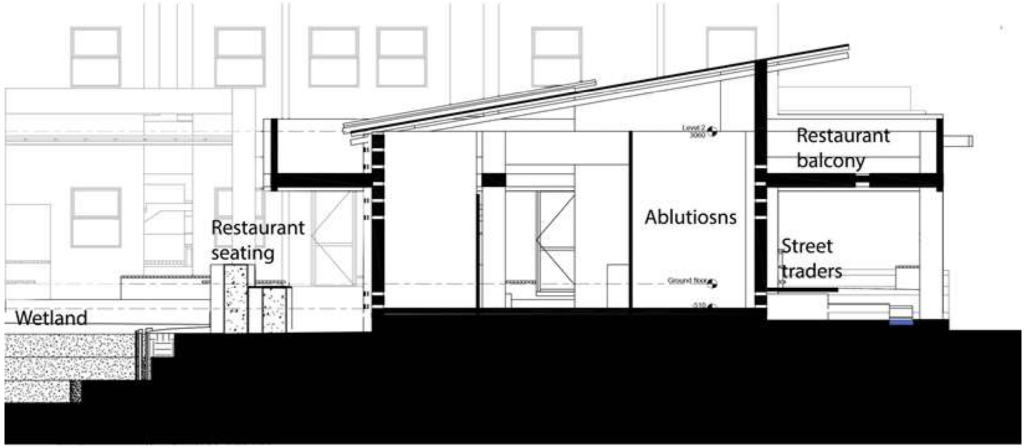


Figure 130: Street facing ablituins Section GG (Author, 2020).

Using perforated brick wall to naturally ventilate the ablution facilities and for passive surveillance.

Figure 131: Perforated brisk walls (https://br.pinterest.com/pin/327285097903967674/, 2020).

Choice basins

A water element that overtly harnesses serious games theory are the choice hand wash basins. A user is confronted by two types of wash basins, one that discards water directly to plants and one that discards water into a toilet cistern. The user is faced with a choice of which they prefer to use thus giving second thought to a water activity that we otherwise usually don't. The discarded water is channelled via an exposed gutter to either the planter or the toilet cistern in the adjoining cubicle thus allowing the user to witness the results of their choice.

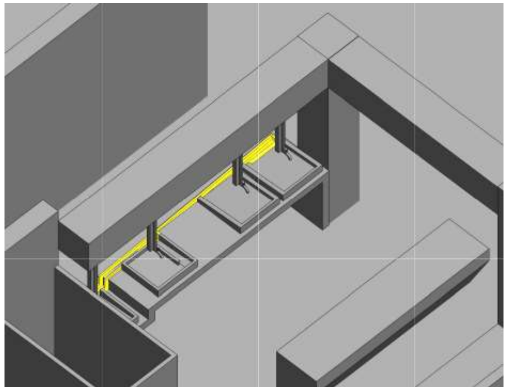
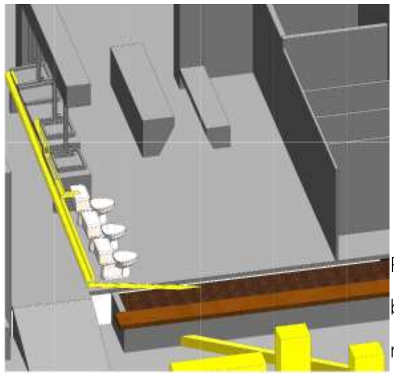


Figure 132: Choice basins (Author, 2020)



Yellow mosaic finish

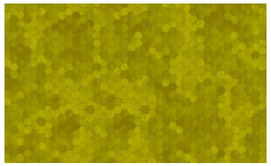


Figure 133: Choice basins gutter with a yellow mosaic finish (AIA, 2020)

Market

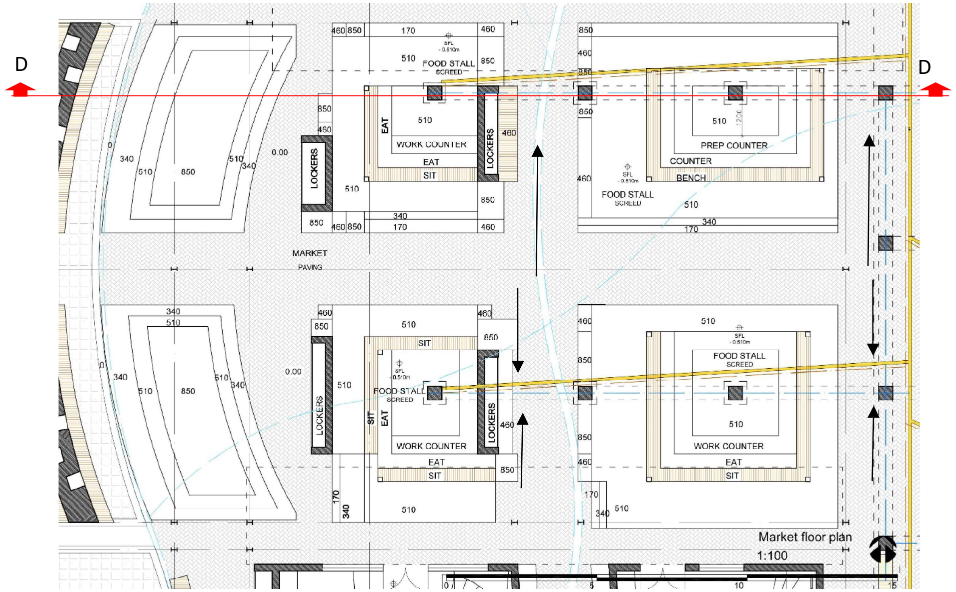


Figure 134: Market floor plan (Author, 2020)

The market has been designed to provide seating space and goods display space for mostly dry goods traders who display goods on tables. Four spaces have been provided for traders who require water such as food traders. The market has also been designed to facilitate performance arts when needs be. Lockers for day visitors have also been provided in this area. Brick has primarily used in this area in order to allow for it to be easily hosed down each day. The area is paved to slope towards the black water drains and all strom water channels in this areas are sealed.

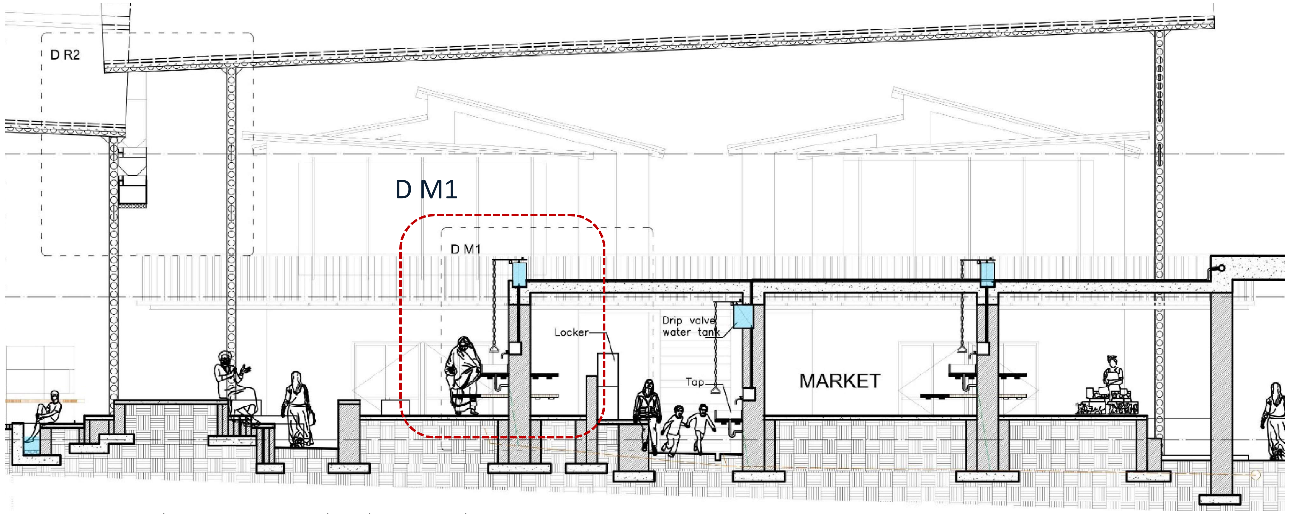


Figure 135: Market section DD (Author, 2020)

Figure 136: Market materiality (Author, 2020)

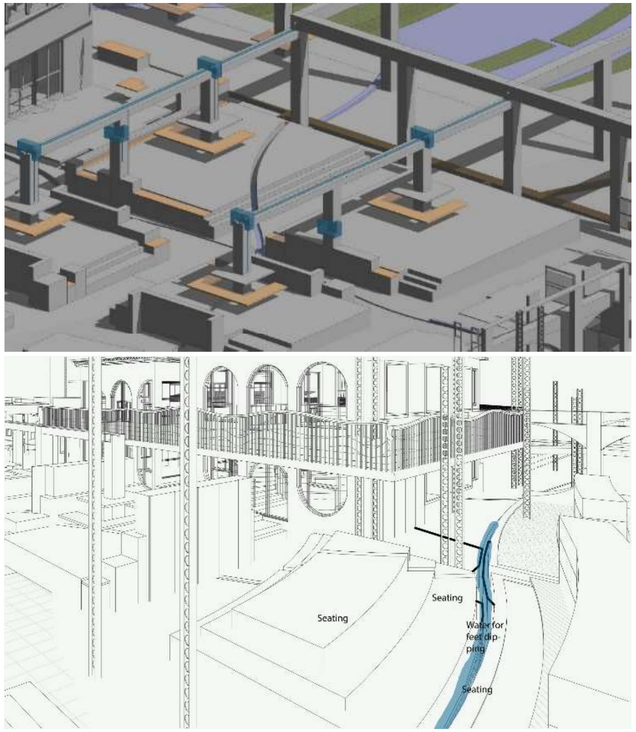


Figure 137: Market view (Author, 2020)

Braai area

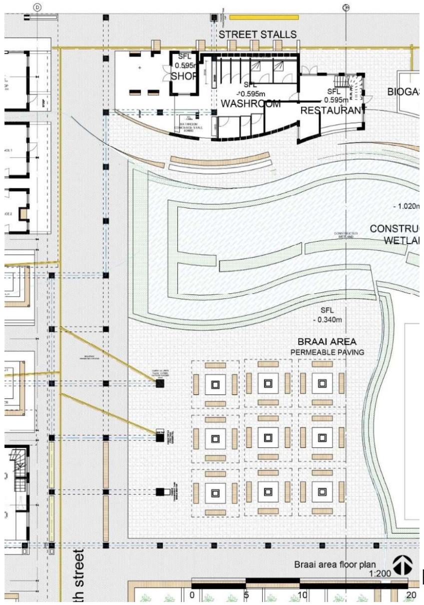


Figure 138: Braai area floor plan (Author, 2020).

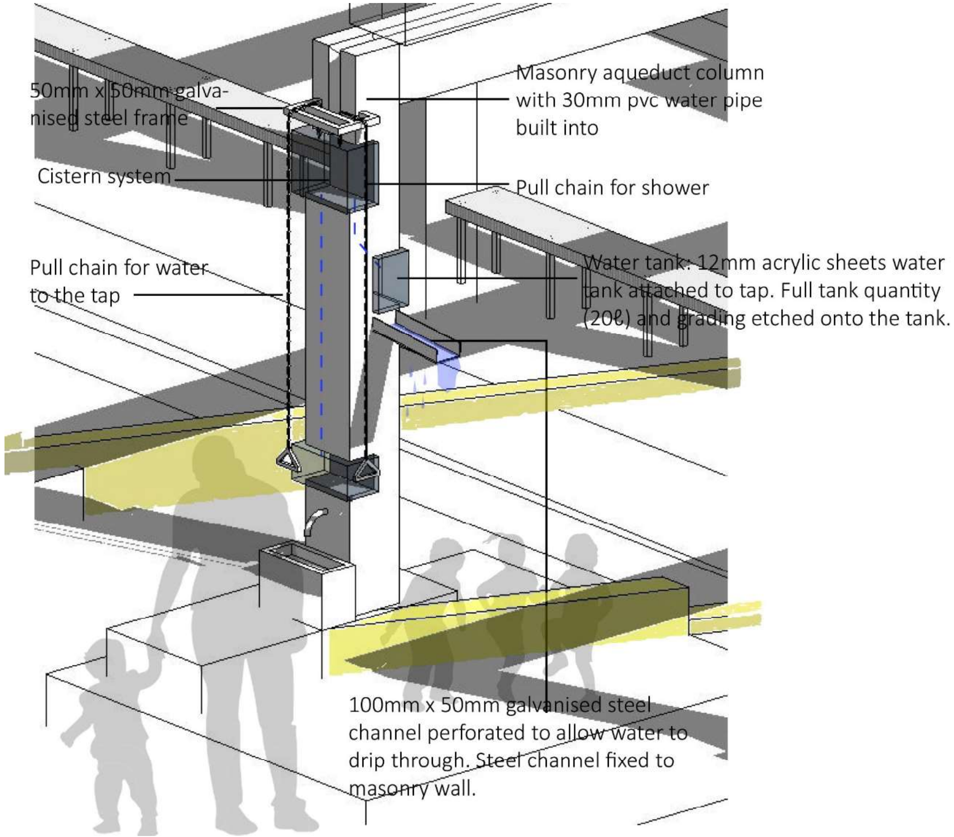


Figure 139: Braai area play shower choice tap (Author, 2020).

The braai area is situated in the area next to an open field to allow for custodians to be able to watch their kids as they play. The same type of cistern taps have been provided in this area too. A particular one of interest if the cistern that makes the user choose between a wash basin and an outdoor play shower.

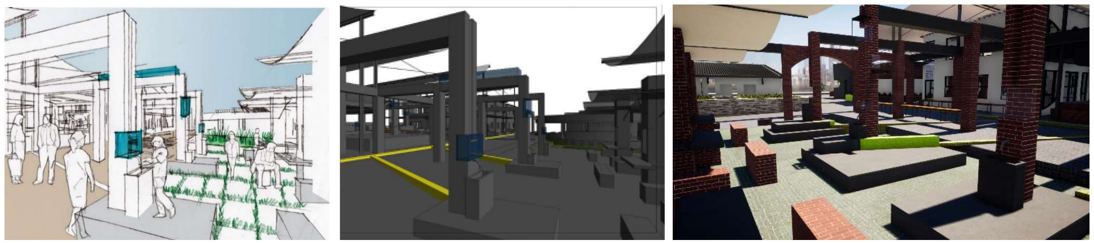
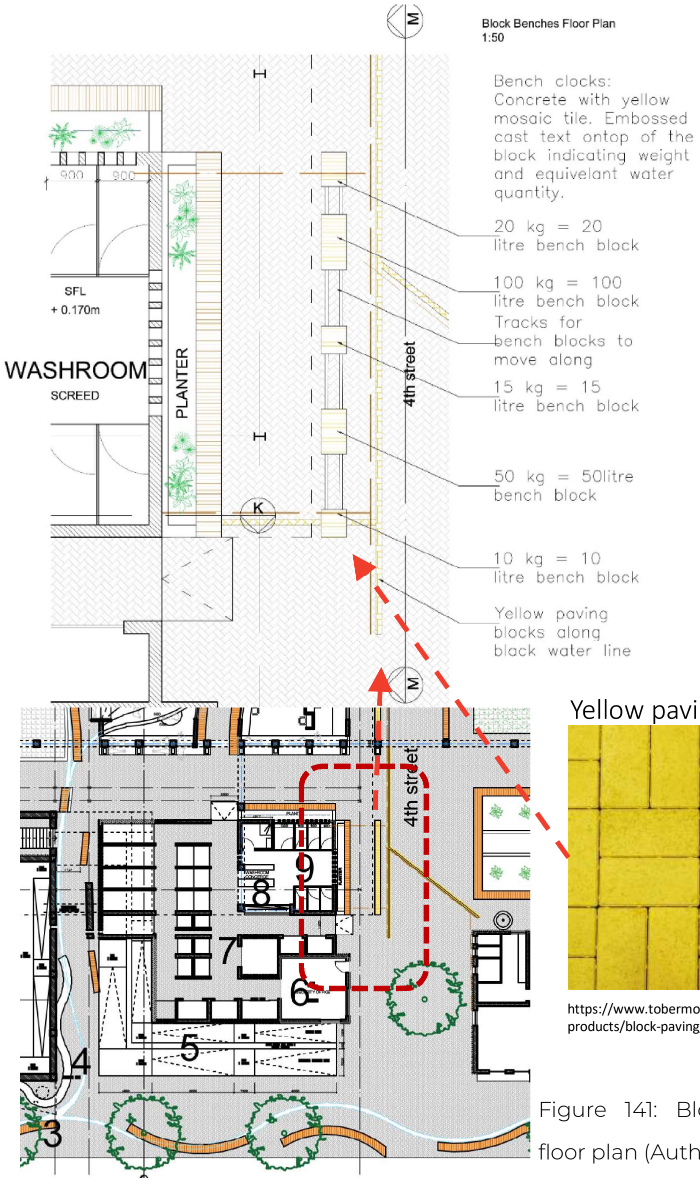


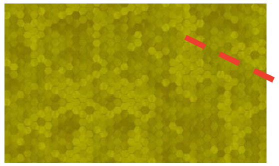
Figure 140: Braai area views (Author, 2020).

Block benches

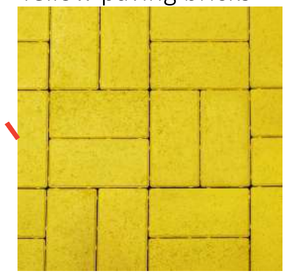
Another element that overtly harnesses the serious games theory are the foam concrete benches. These benches have been designed to be move-able along a track giving the user a choice of rearranging them. They are of varying weight quantities that relate to water facts cast into them. This gives the user a tactile understanding of how much various water amounts weigh.



Yellow mosaic finish



Yellow paving bricks



https://www.tobermore.co.uk/professional/products/block-paving/marker-block/

Figure 141: Block benches floor plan (Author, 2020).

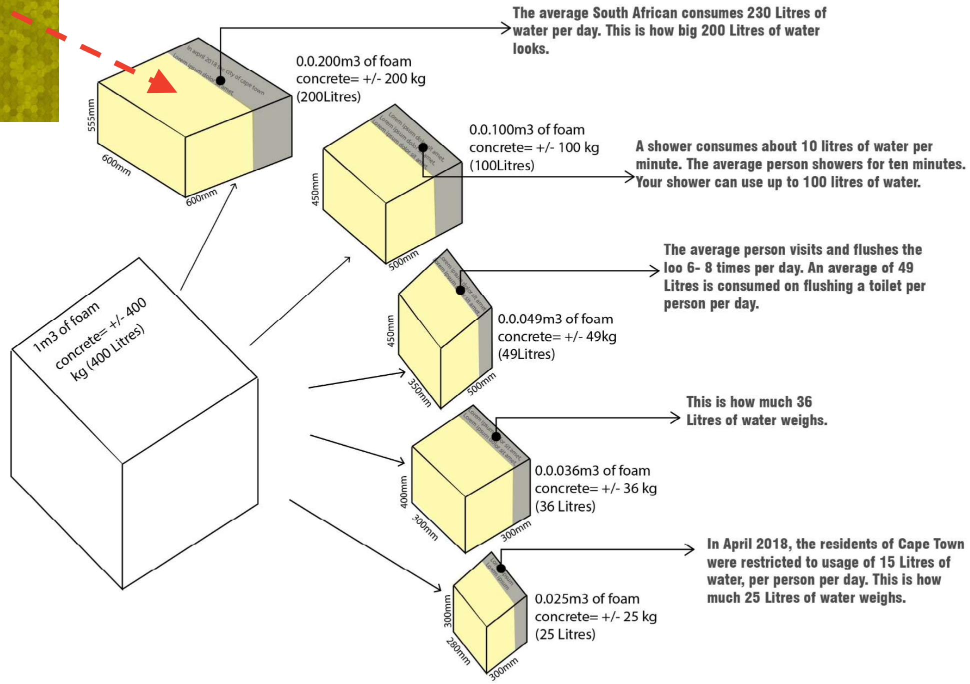


Figure 142: Block benches sizes (Author, 2020).

Taxi wait/ drop off area

The taxi drop off and waiting area provides various types of seating including grass berms, benches and an adobe wall bench with lockers. This is a place for the people who currently sit under the sparsely available shade waiting for home affairs services, to come and wait.

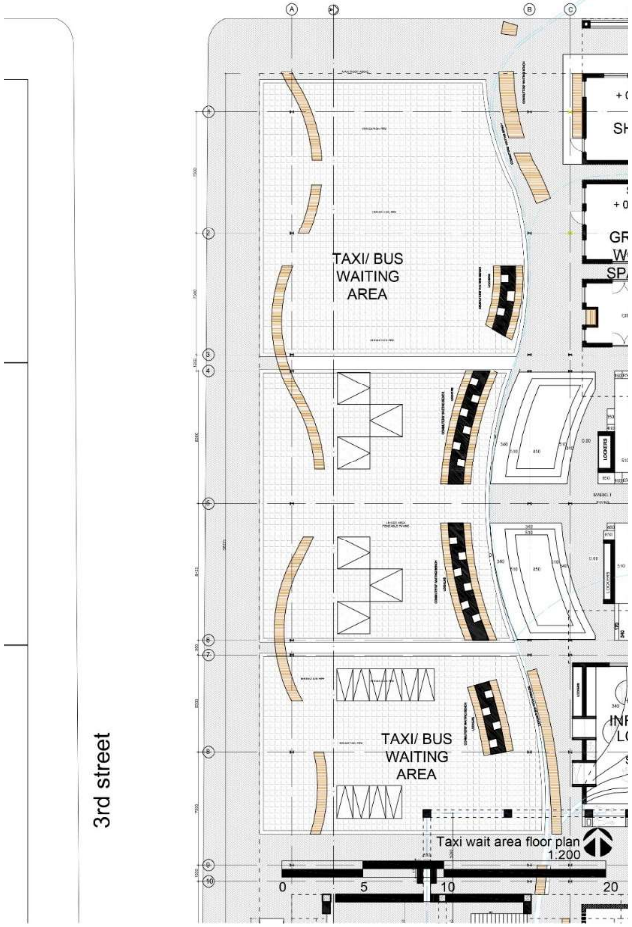


Figure 143: Taxi wait/ drop off area floor plan (Author, 2020)

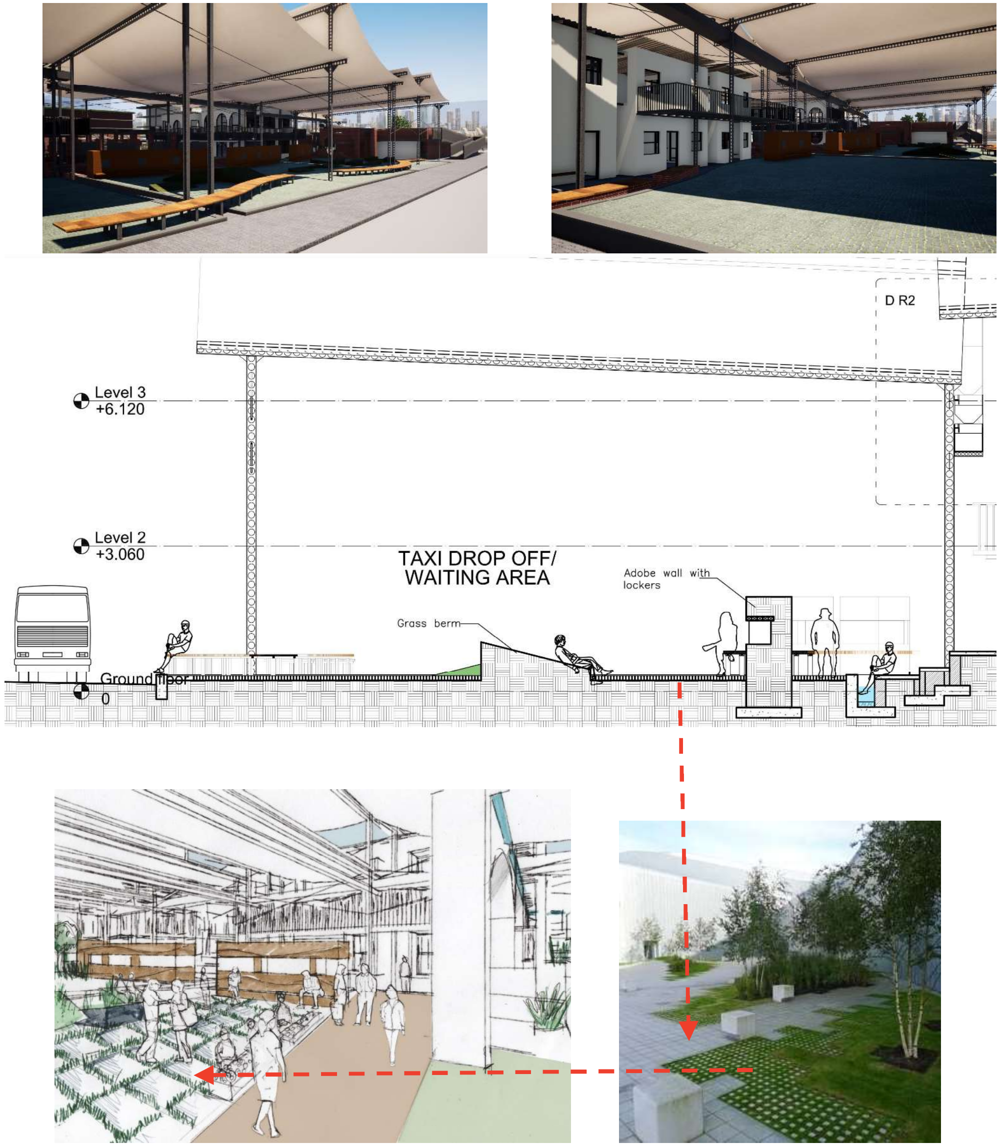


Figure 144: Taxi drop off/ wait area views and section DD (Author, 2020).

Conclusion

The design elements included in the urban living room employ lessons from the Serious Games theory that expose and engage usesrs with visually, and sometimes audibly accessible components. Elements such as open storm water canals and choice basins encourage the user to give second thought to otherwise automatic daily water functions that we seldom considers. By exposing the building's water systems and processes the user's water literacy may be increased.

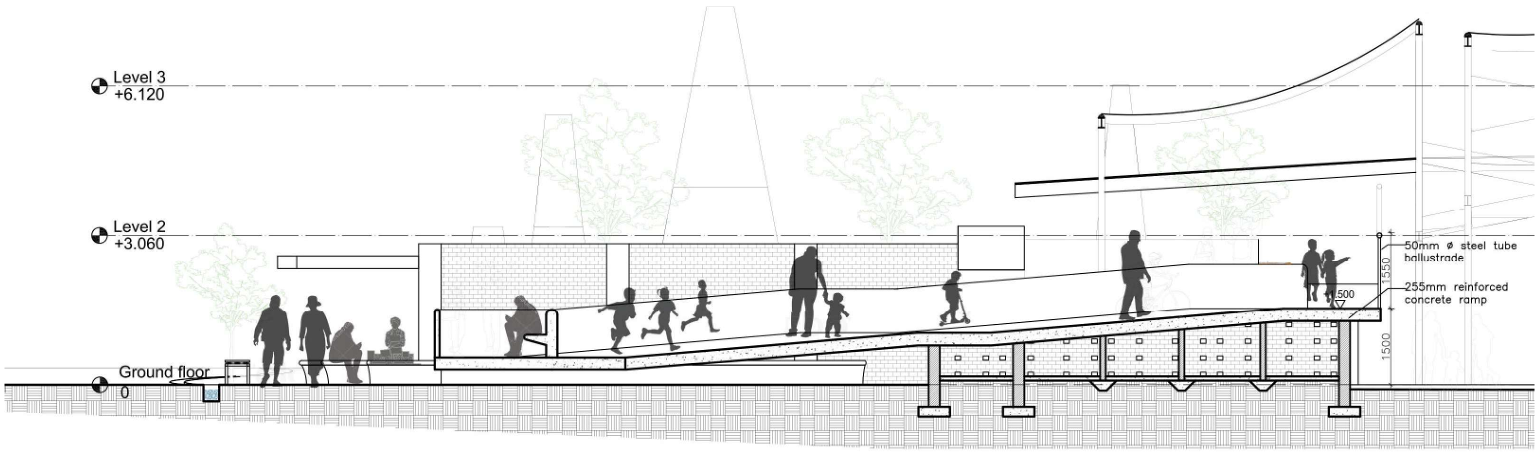


Figure 145: Ramp up to secret garden section BB (Author, 2020).

CHAPTER 7: TECHNICAL DEVELOPMENT

Potable water

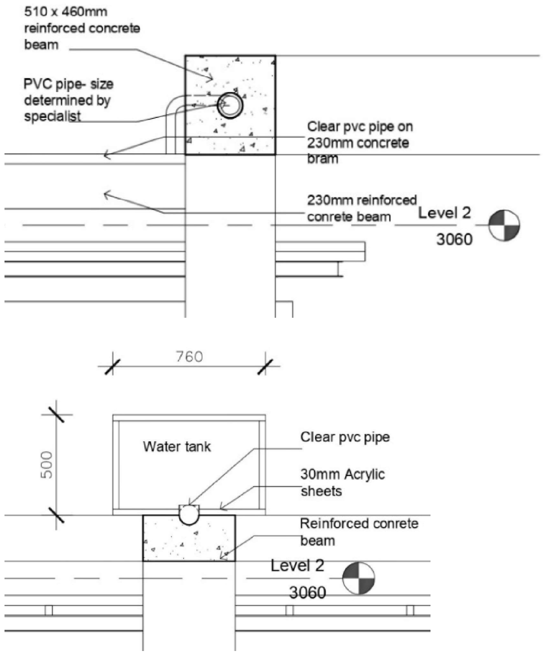


Figure 146: Typical aqueduct sections (Author, 2020).

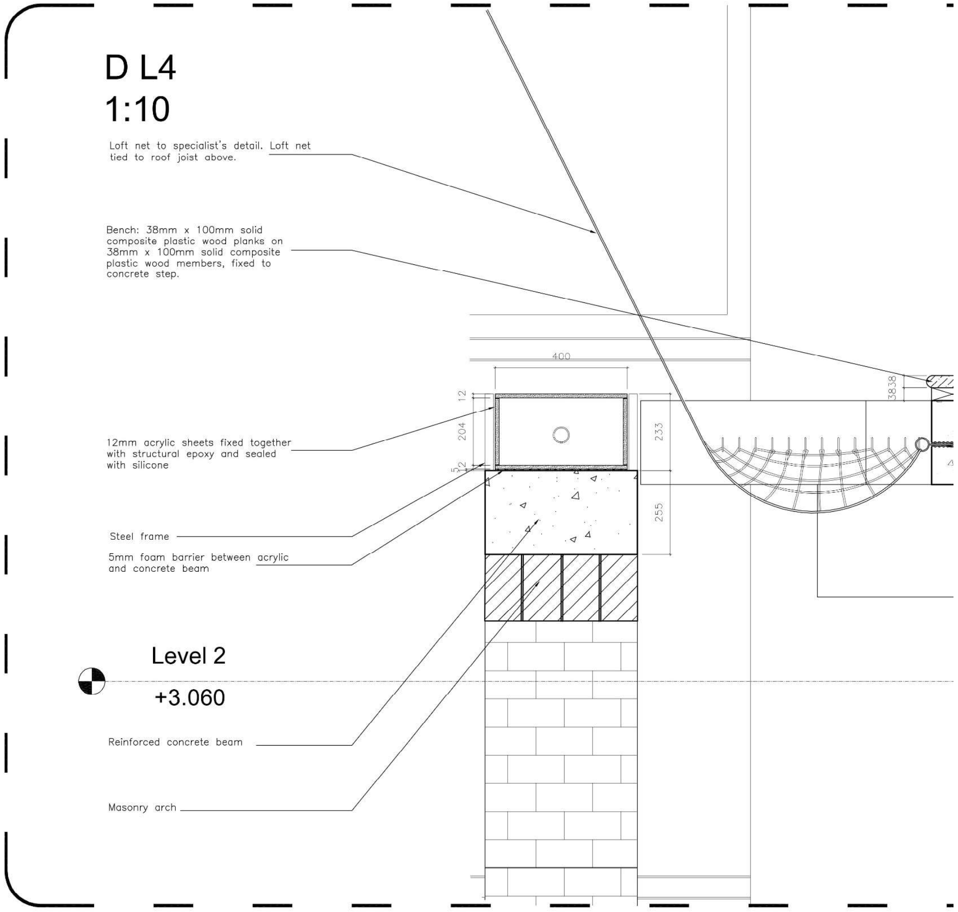


Figure 147: Typical section of exposed aqueduct (Author, 2020).

Storm water

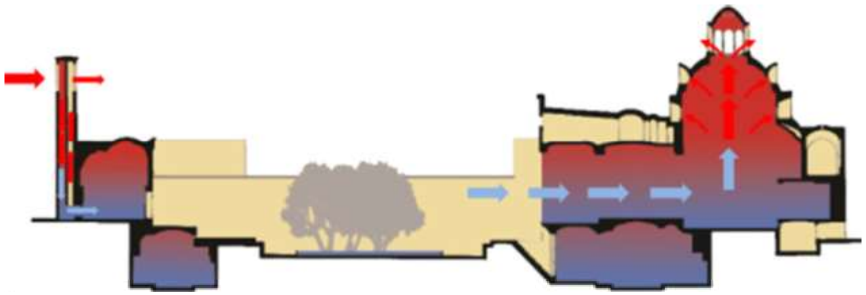


Figure 148: High ceilings with openings keeping the building cool through water movement in Borujerdiha House, Kashan, Iran. (Sigyah, 2013: 393).

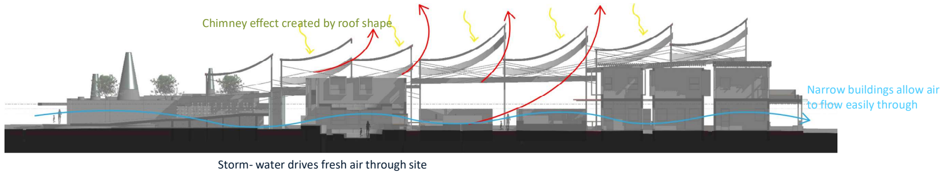


Figure 149: Storm water cooling the urban living room under the pvc roof membrane (Author, 2020).

Figure 150: Diana memorial park (https://za.pinterest.com/teresamisiurek/kensington-princess-diana-memorial-playground/, 2020)

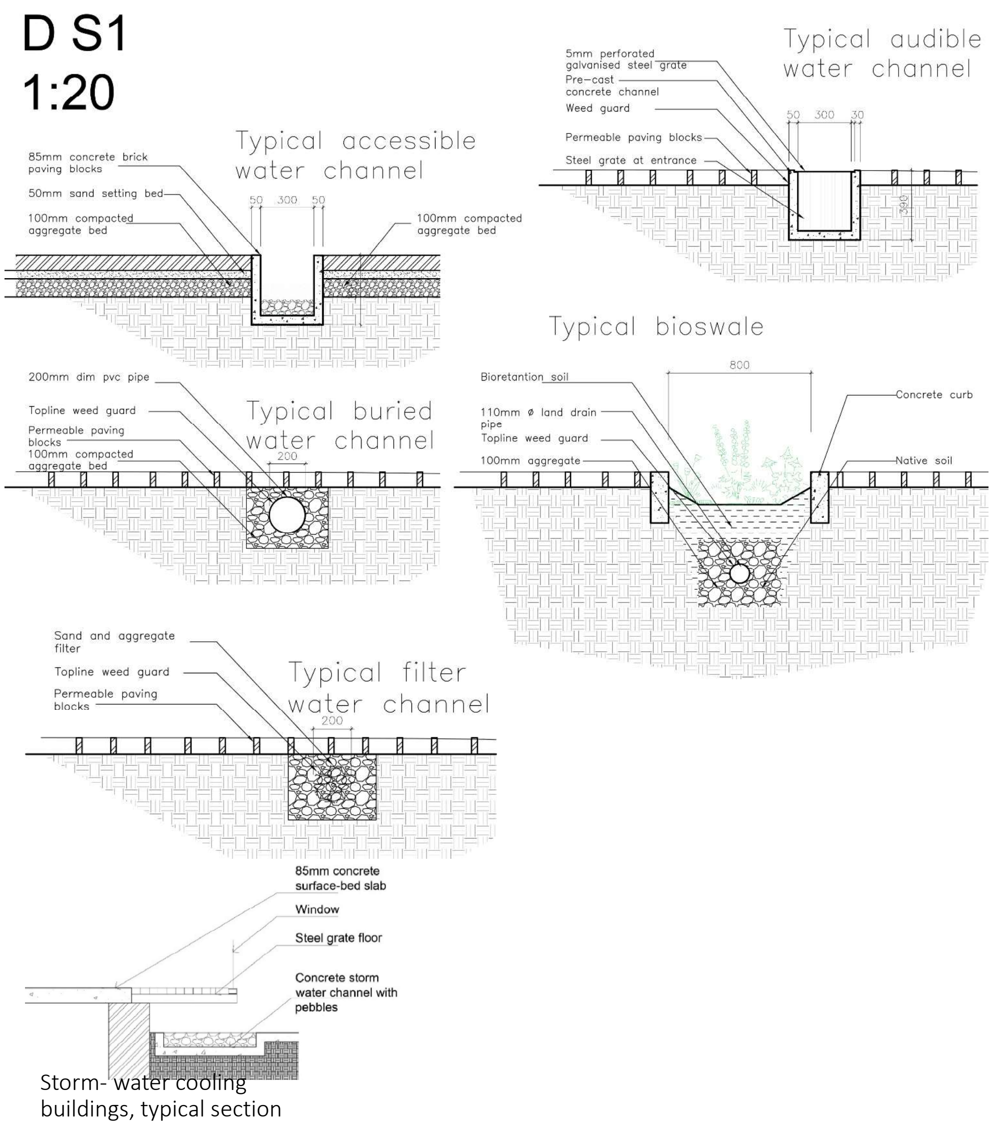


Figure 151: Different ways of dealing with stom water (Author, 2020).

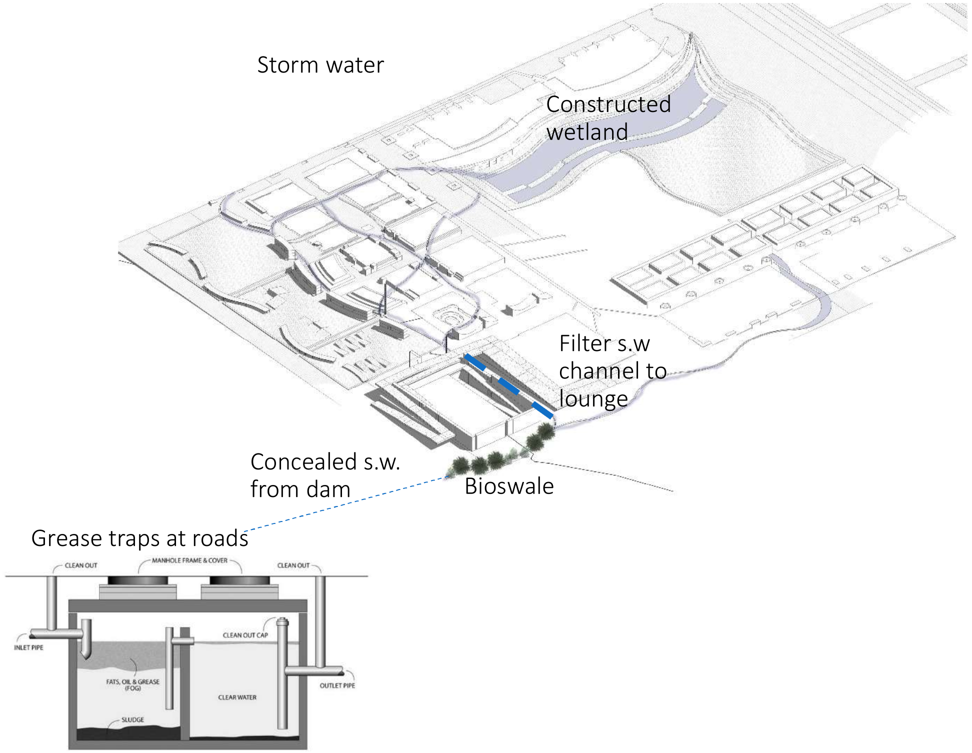


Figure 152: Storm water leading to infomal lounge (Author, 2020).

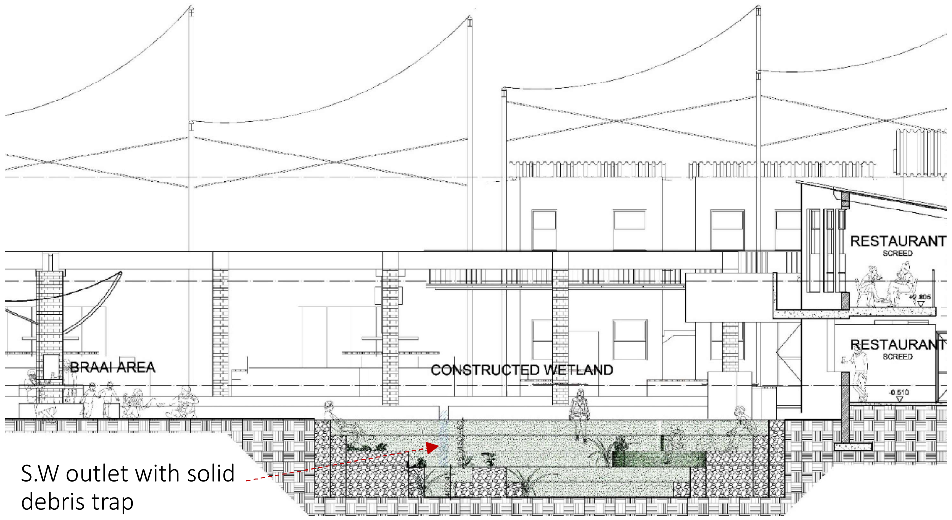


Figure 153: Constructed wetland section cc (Author, 2020).

There are various different types of storm water channels. A pre cast concrete channel which allows people to be able to see and interact with the water, a pre cast concrete channel with a grate, which only allows people to hear the water, a buried pvc pipe water channel, which mitigates for evaporation and is commonly used in areas where the water doesn’t need to be exposed for the users to enjoy; a sand and aggregate filter channel and the boiswale water channel, which purifies the water using plants. There are grease traps at points from roads and the use of steel grates has been made in order to trap solid debris.

Figure 154: Constructed wetland view (Author, 2020).

Black water

Figure 155: Yellow street furnitue visualisation (Author, 2020).

It is imperative to somehow communicate the existence of black water in the scheme. Being removed from these natural processes and life- cycle of water, has caused our lack of nature relatedness and water relatedness, Black water is an integral part of our daily water usage and we completely hide it in our current society (reference needed here). The trail of the black water will be traced on the ground floor plane through the use of colour and different planes that users can interact with in different ways. These colourful elements will be positioned varying planes in order to spark interest of interaction by the users. Water related information will be printed on the pieces of street furniture at various points along the path

Figure 156: Yellow street furnitue ((https://www.pinterest.co.uk/pin/728527677196245687/, 2020, 2020).

Building systems

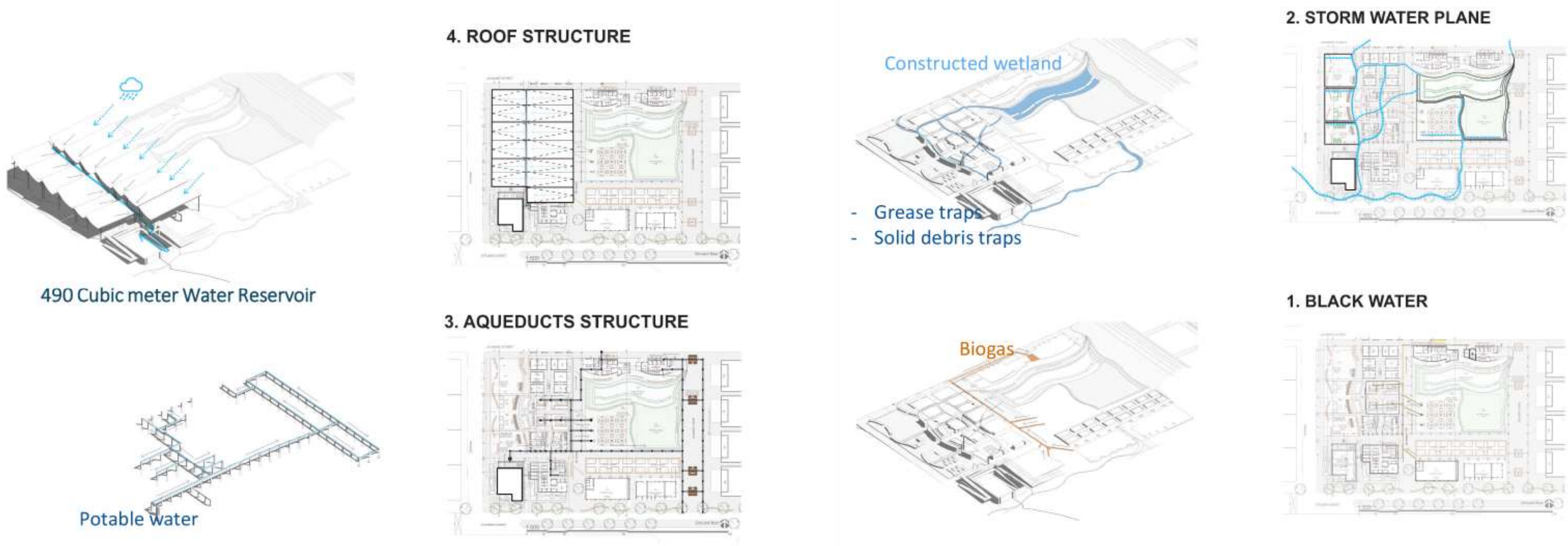


Figure 157: Building systems (Author, 2020)

The hierarchy of the water on site is expressed physically in that the potable water moves around on the top plane, the storm water on the ground plane and the black water at the bottom. The potable water is expressed in linear forms by the aqueducts, the storm water in curvilinear forms along canals that are sometimes visible, audible or accessible and the black water with yellow paving. All water systems are clearly visible to the user. The narrow size of the buildings aid in passive cooling and ventilation. The storm water helps to move cool air through the site and the shape of the tarp roof help to release the hot air from the urban living room.

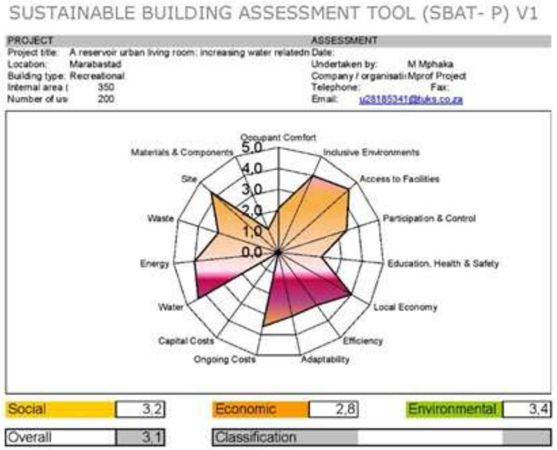


Figure 158: SBAT assessment (Author, SBAT CSIR, 2020).

The narrow size of the buildings aid in passive cooling and ventilation. The storm water helps to move cool air through the site and the shape of the tarp roof help to release the hot air from the urban living room.

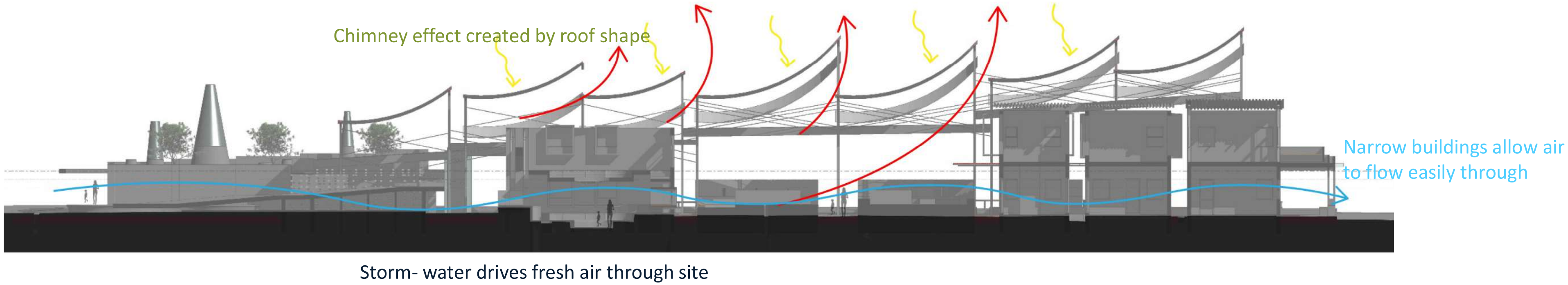


Figure 159: Roof and storm water building cooling chimney system (Author, 2020).

In section, one can see how the design embraced the fine grain nature of Marabastad's grid. The building's are also reminiscent of the mostly prevalent single and double storey architecture of Marabastad. However, in keeping with the West Capital SDF, the tall main roof embraces the city's ambition to build vertically

Reservoir

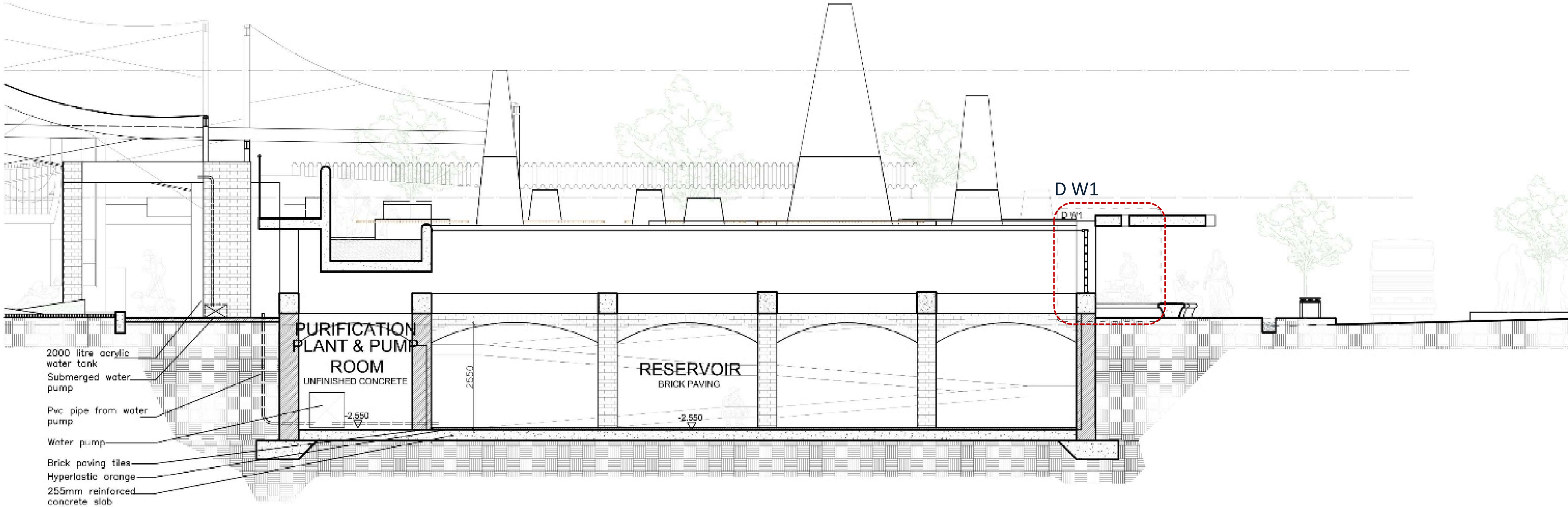


Figure 160: Water flow and purification system (Author, 2020)

The inside of the reservoir can be accessed via another ramp. Each of these ramps increases incline at a rate of half a meter per 6 horizontal meters, in keeping with building regulations. The usage of Hyperlastic orange between the walls and under the floor, ensures that the water doesn't leak out of the reservoir. The mechanical room on the left houses a water pump and water purification system that filters the water and runs it through uv light treatment.

The acrylic cones above the concrete light wells are fixed in place with a galvanised steel frame comprising various components. Adjacent to the steel frame for the cones, there is a steel frame that houses the LED lights that light the cones up in the night time. To ensure that the roof garden does not become a dam itself when it rains, weep holes and over- spill pipes have been cast into the light wells to allow the water to fall into the reservoir. In various areas, 12mm clear safety glass has been fitted into a custom steel frame cast into the walls. These allow the users of the urban living room a view into the reservoir from the street.

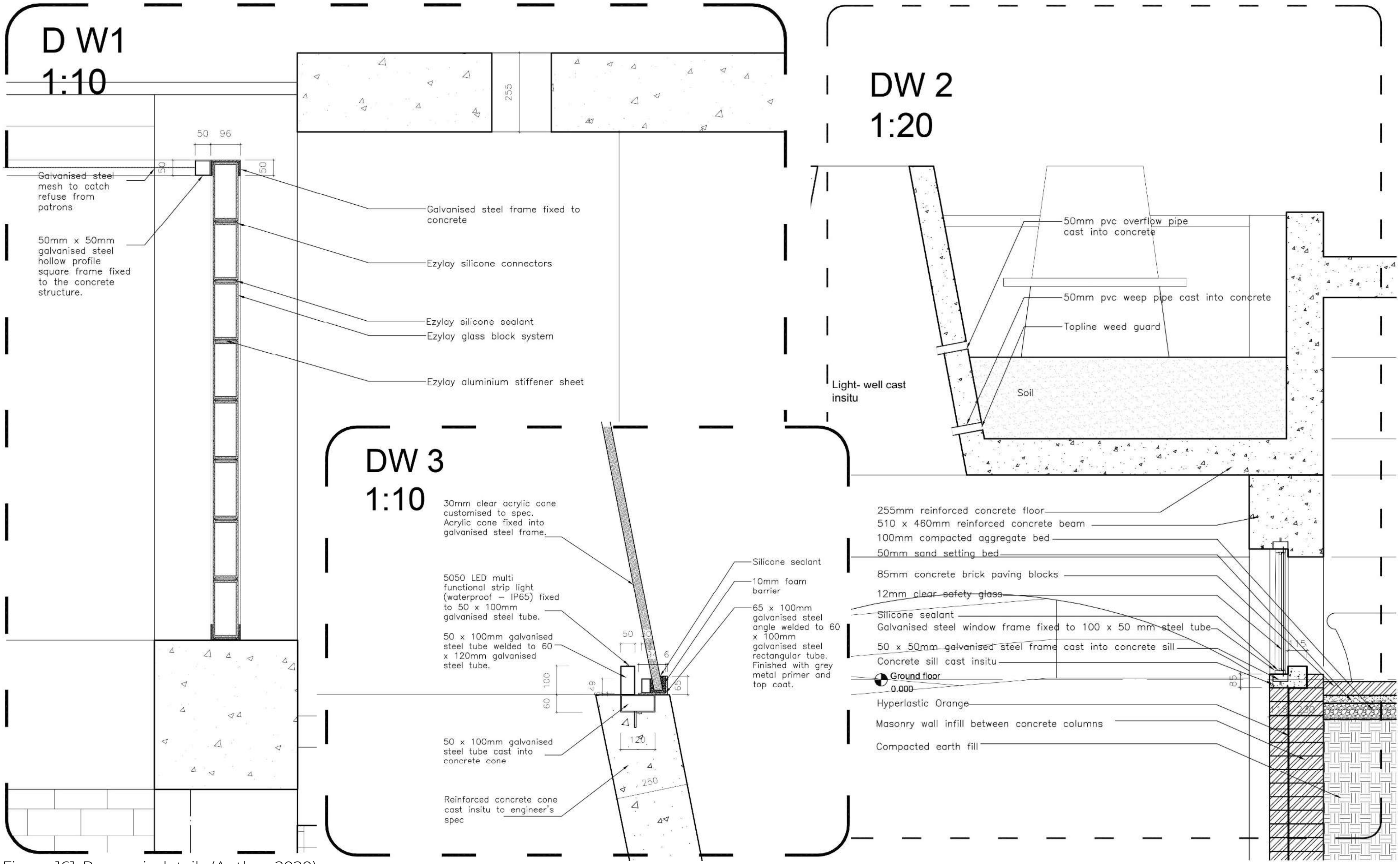


Figure 161: Reservoir details (Author, 2020)

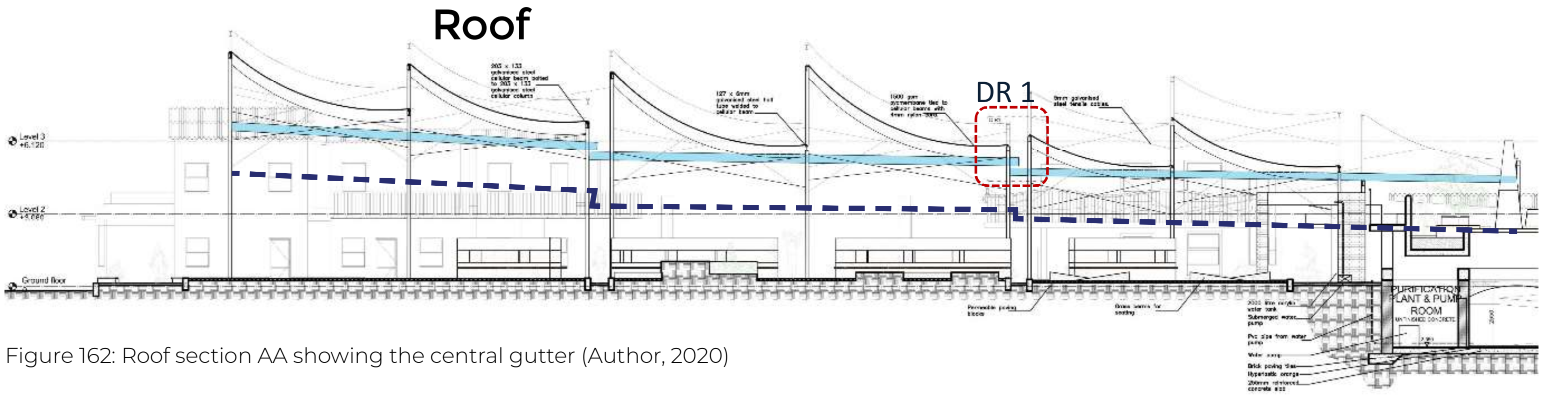


Figure 162: Roof section AA showing the central gutter (Author, 2020)

The steel beams are bolted to the columns with welded stiffener plates and gusset plates. The gutter is welded on to cellular I beams on which it sits so that it can remain water tight but is bolted along it's edge to the cellular column with angles. The column itself is fixed to a base plate that has been cast into the concrete footing.

Figure 163: Roof visualisations (Author, 2020)

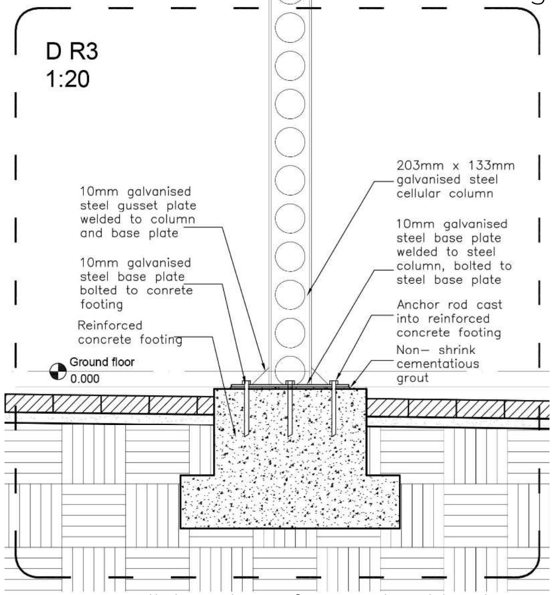
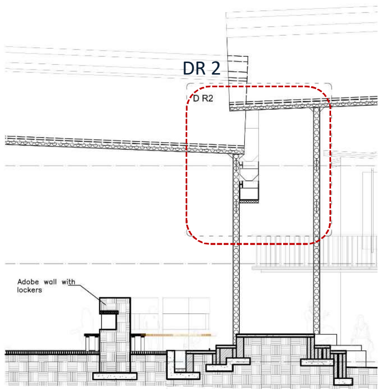


Figure 166: Cellular column footing detail (Author, 2020)

The pvc membrane is fixed to the galvanised steel structure with nylon rope woven through the cellular beams. It is also tensioned in the same manner along the perpendicular edges. The galvanised steel tube half, provides a smooth surface for the pvc membrane not to wear easily on.



Section DD

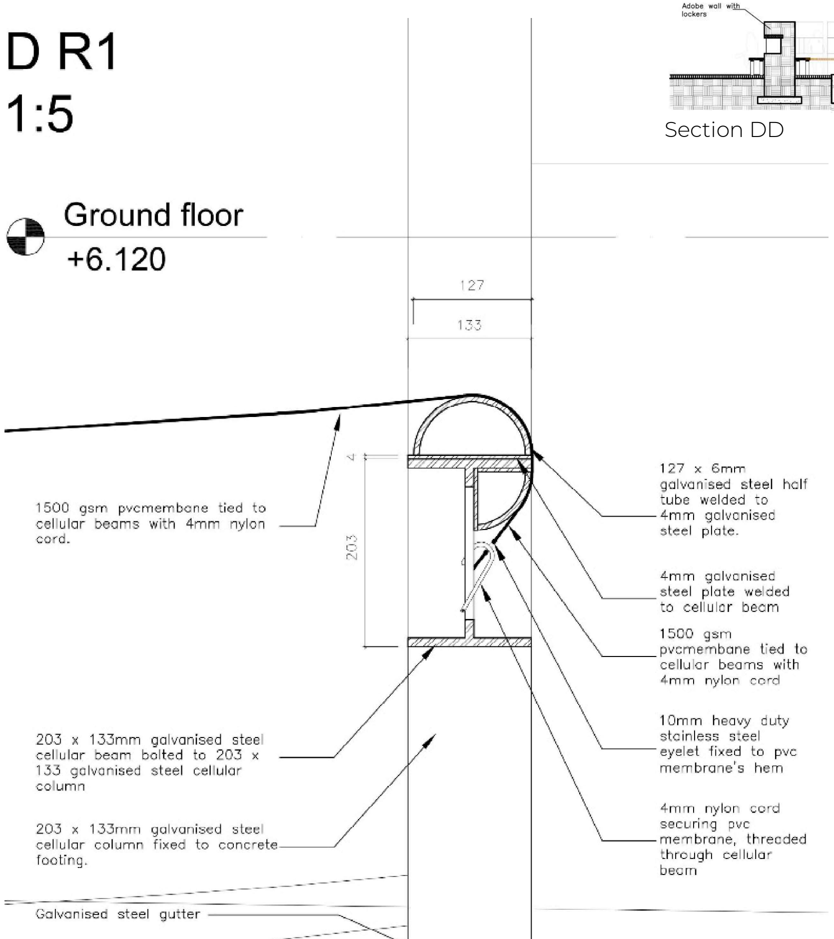


Figure 164: Pvc-membrane fixture details (Author, 2020)

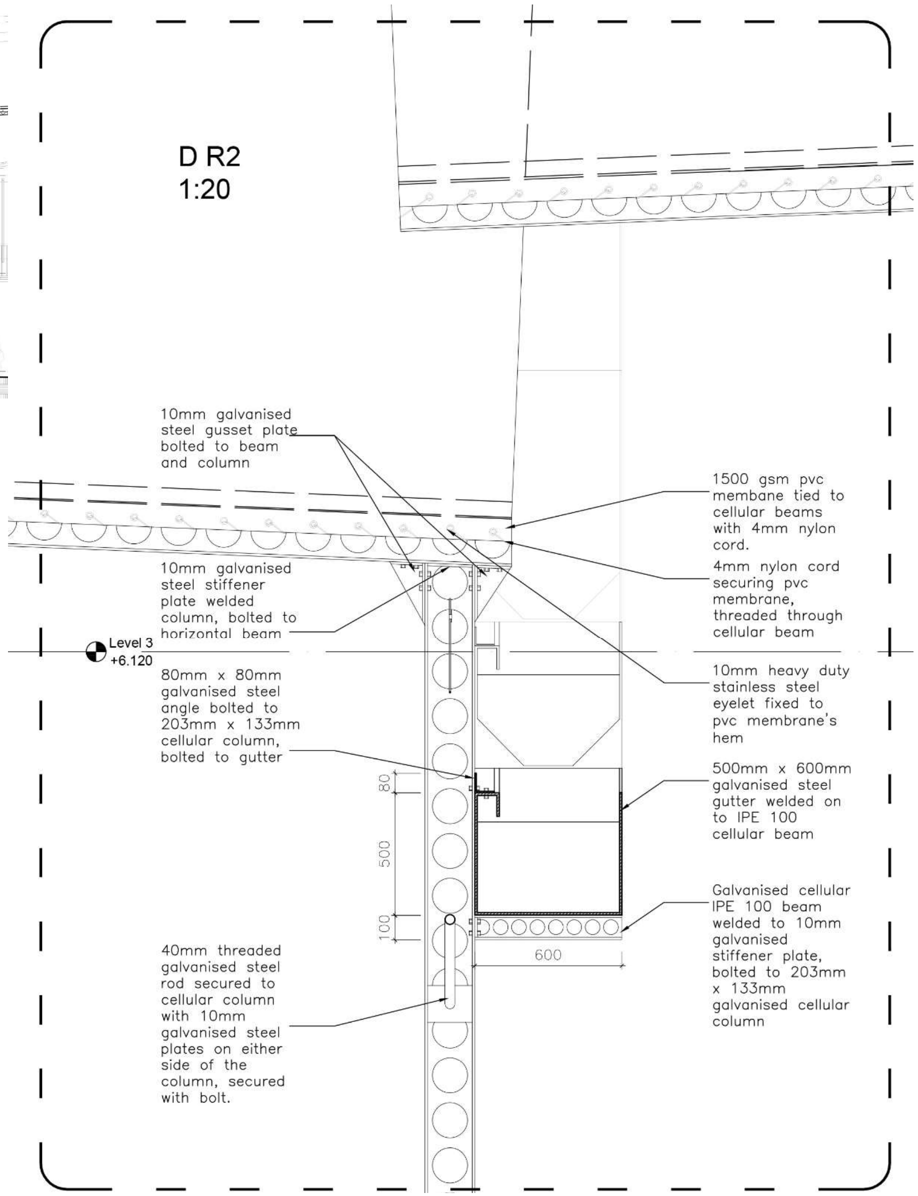


Figure 165: Roof gutter detail (Author, 2020)

Informal lounge

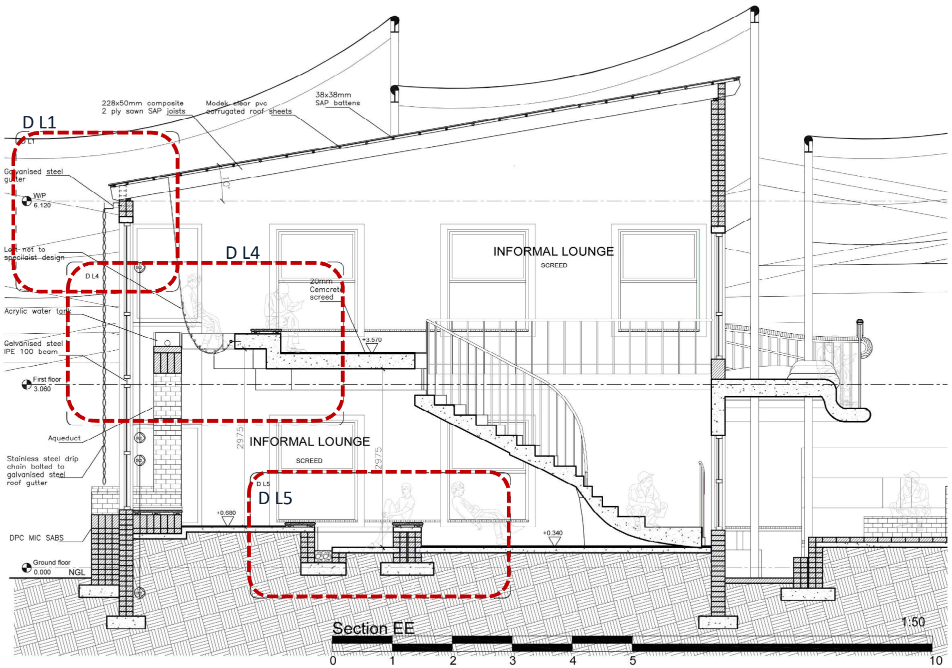


Figure 167: Informal lounge section EE (Author, 2020)

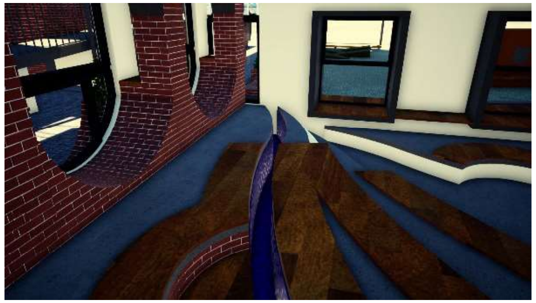


Figure 172: Informal lounge interior visualisation (Author, 2020)

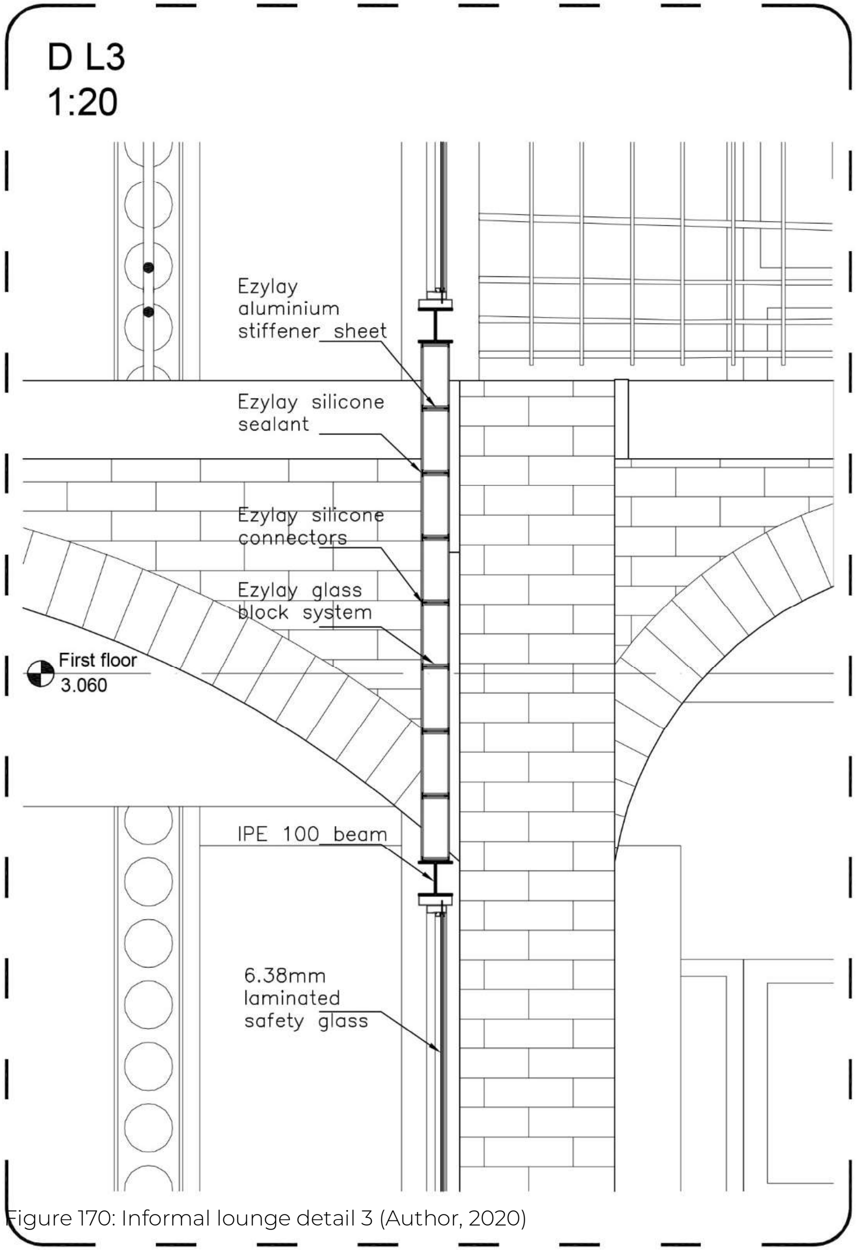


Figure 170: Informal lounge detail 3 (Author, 2020)

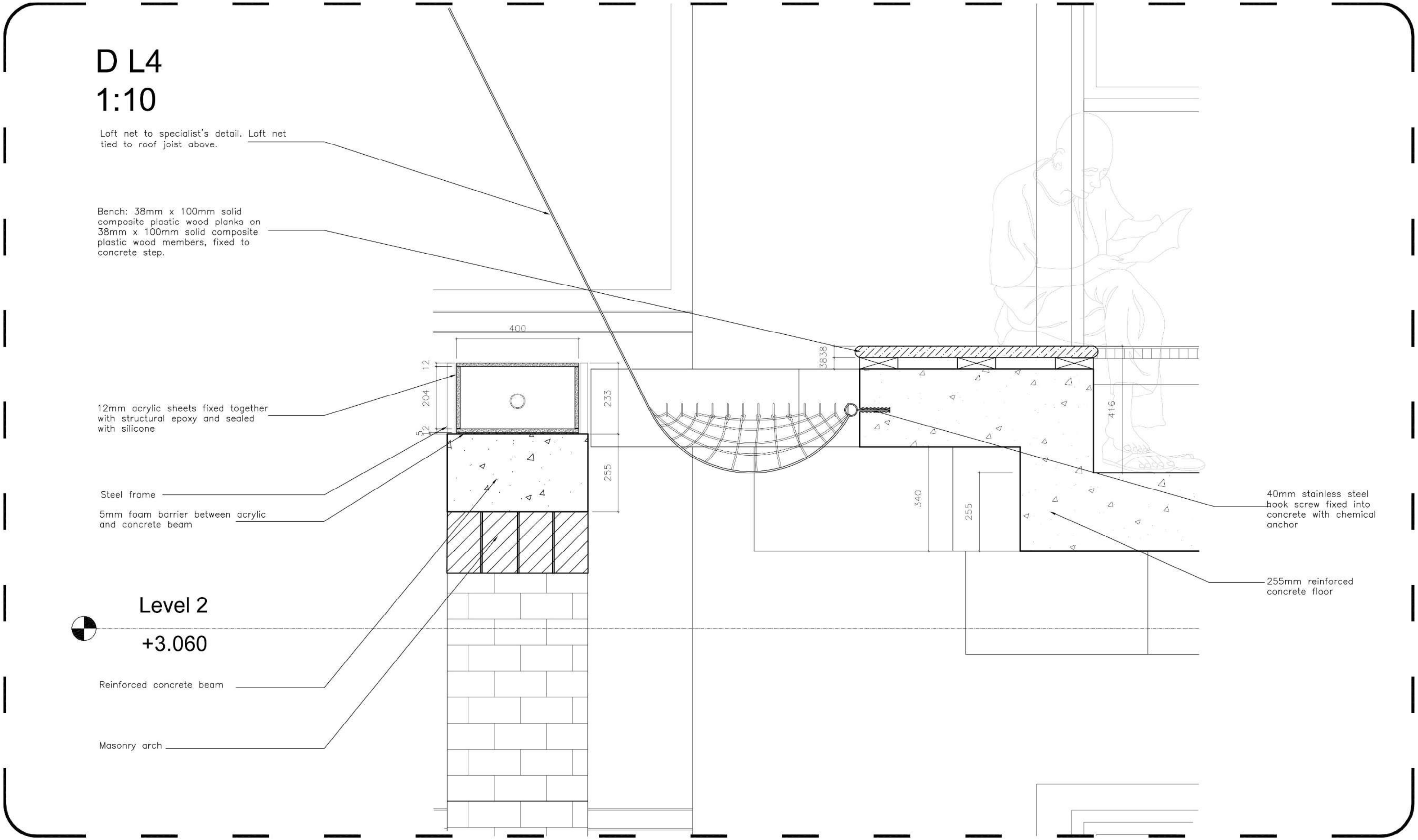


Figure 168: Informal lounge detail 4 (Author, 2020)

The storm water has been allowed to flow through the building to cool it down and to allow people to dip their feet into it. The wall and concrete floor have been finished with a mosaic tile with waterproof grout. A waterproof tile adhesive has been used for the mosaic. The benches are made from composite plastic timber. They are durable enough to withstand public usage and can withstand exposure to water.

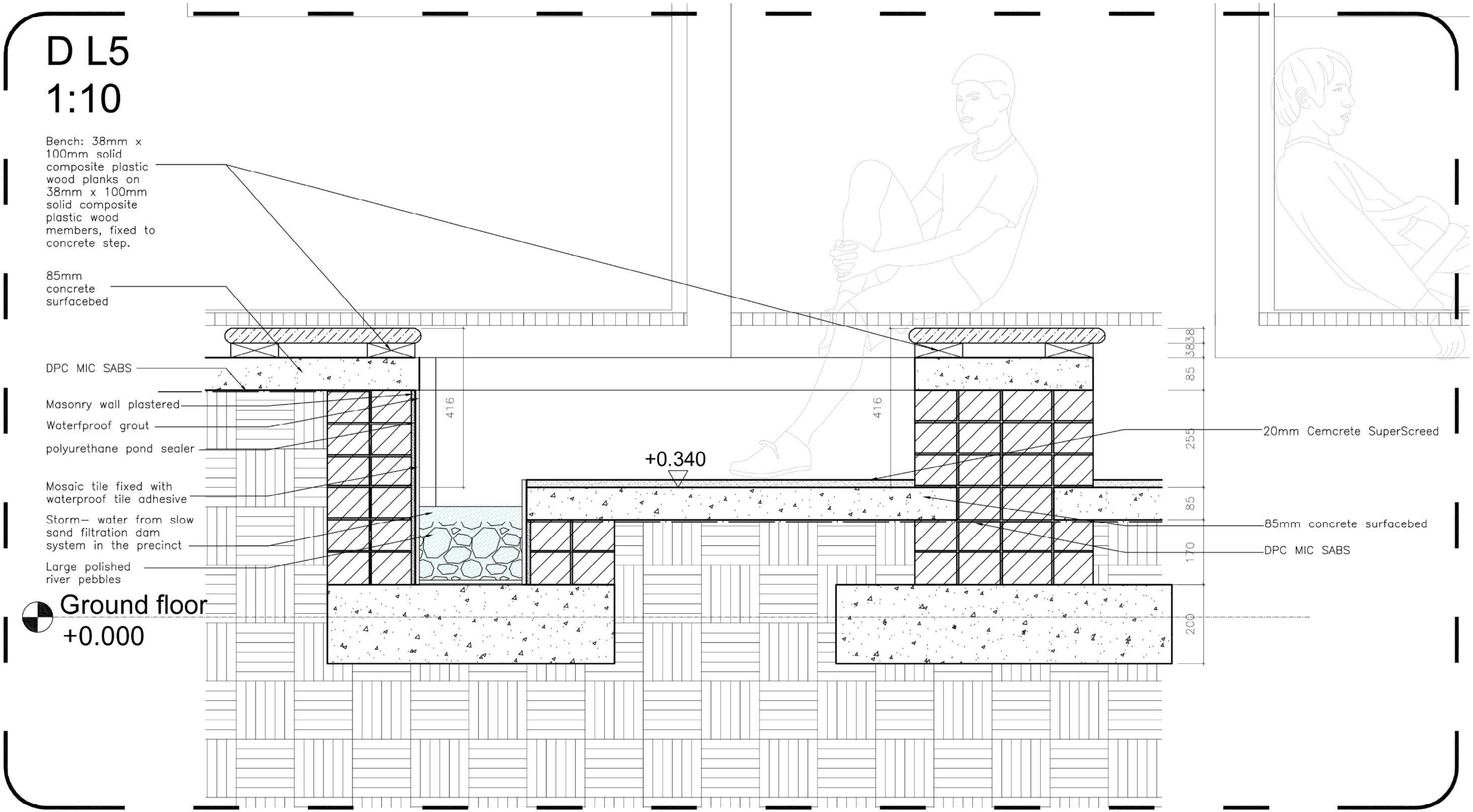


Figure 169: Informal lounge detail 5 (Author, 2020)

D L2
1:20

In reflection of the aqueduct, inverted arch masonry seating benches have been created. The wall finishes of plaster and paint and face brick mimic Marabastad's existing robust materiality.

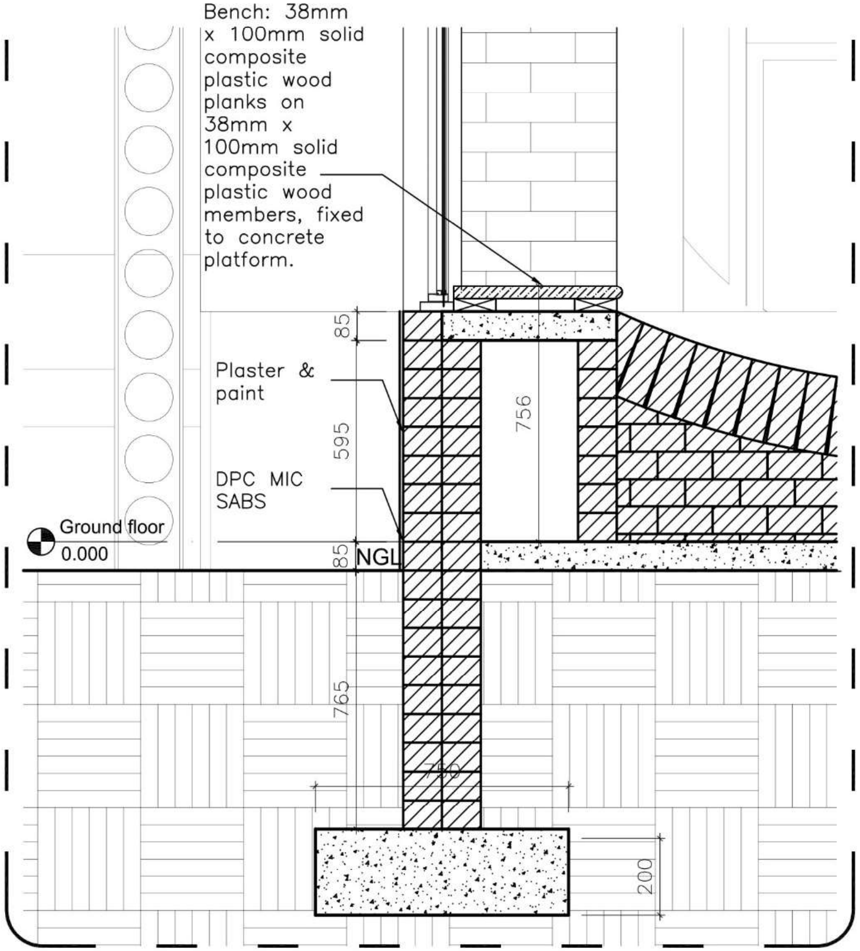


Figure 171: Informal lounge detail 2 (Author, 2020)

Ablutions

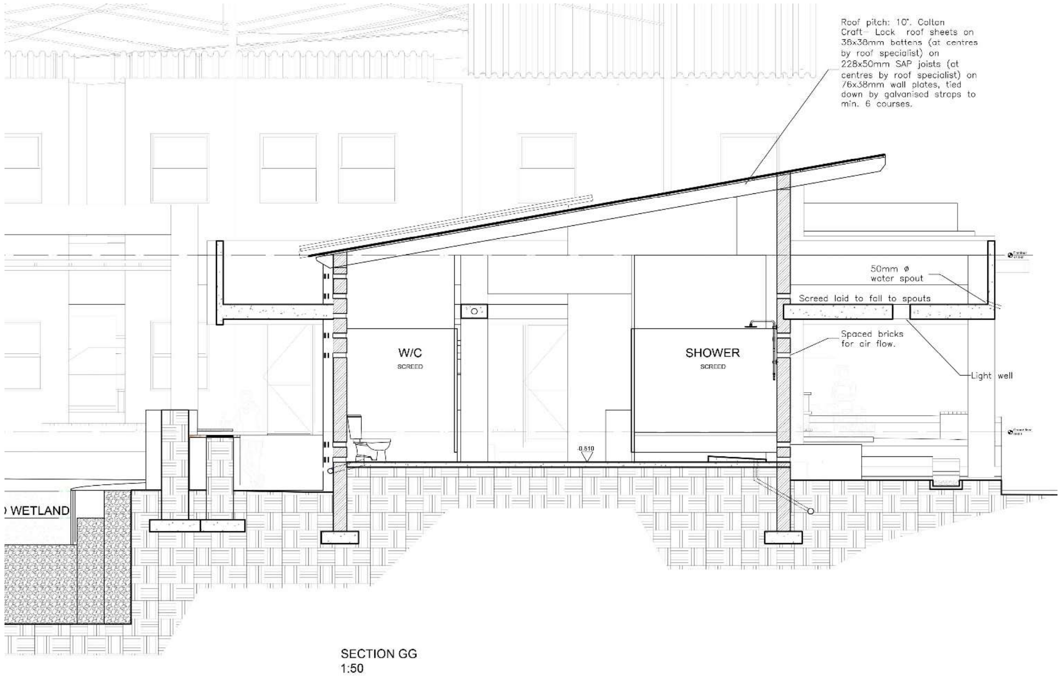


Figure 173: Ablutions Section GG detail (Author, 2020)

Choice basins

A user choice water basin that either discards water into the planter or the adjacent toilet cistern has been used. The disposal gutter leading from each basin type is open to allow the user to see the result of their choice. The water basins and open gutter are custom cast out of concrete. The gutter is finished with the yellow mosaic tile.

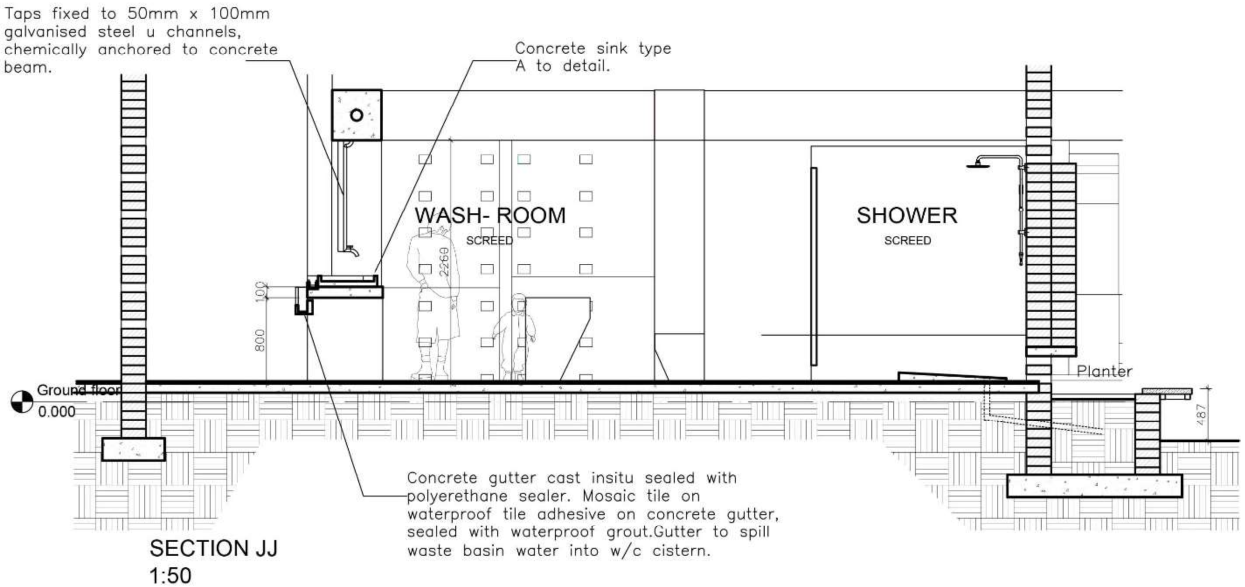


Figure 174: Choice basins section JJ (Author, 2020)

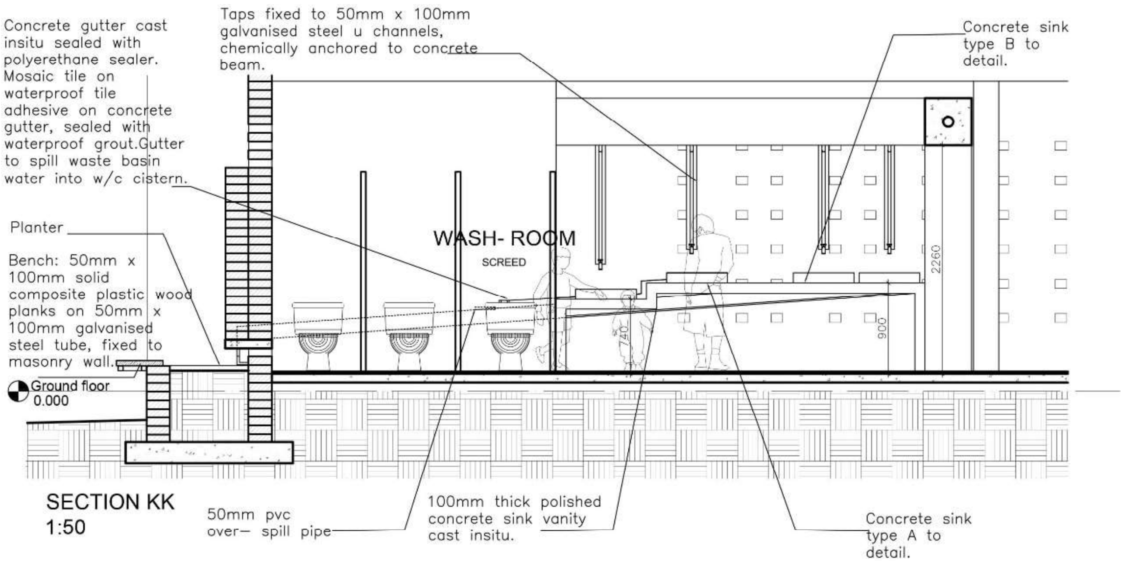


Figure 175: Choice basins section KK (Author, 2020)

Drip valve cistern tap

The taps provided in the market function on a drip valve and cistern system. An acrylic water tank has been designed to fill with water at a designated rate via a drip valve from the main water aqueduct line. In order for one access the water, they have to pull the chain to allow water to enter the secondary clear acrylic tank which is attached to a tap. This also confronts the user with the choice of whether to wait for the tank to fill up with water before they release it, or not.

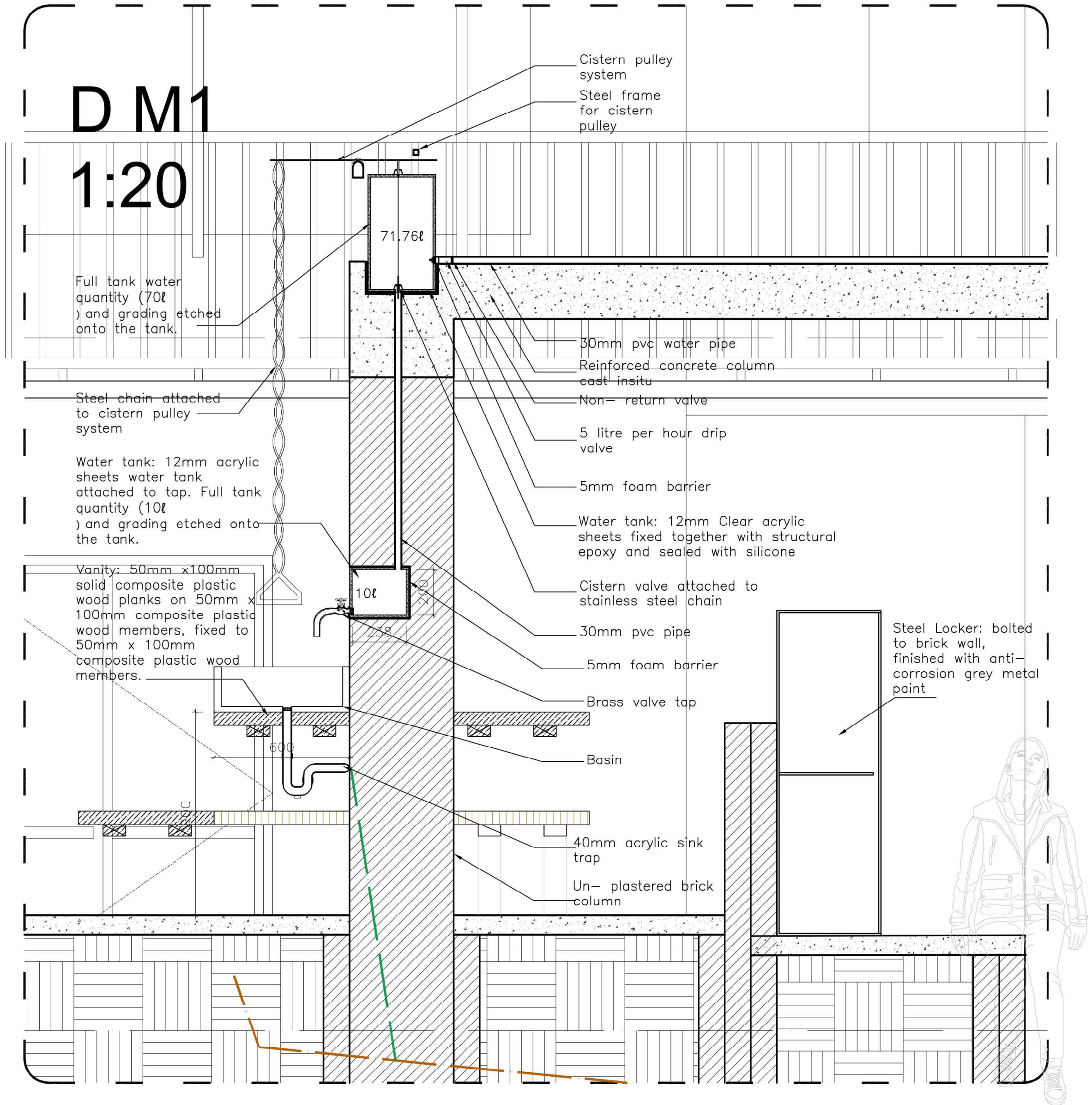
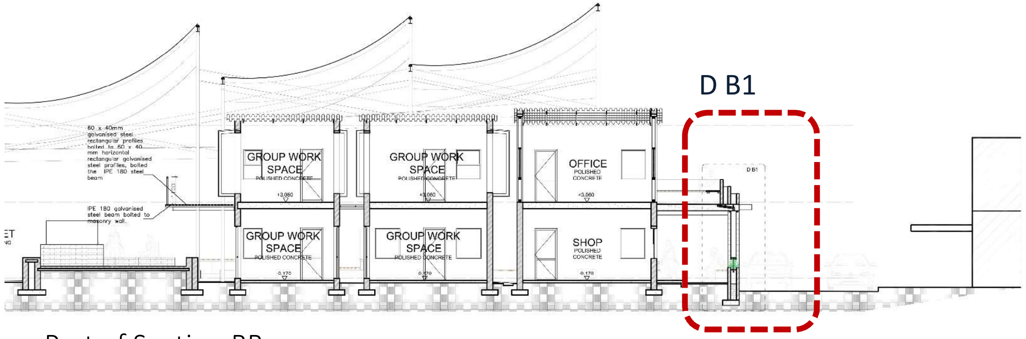


Figure 176: Drip valve cistern tap detail M1 (Author, 2020)

Planters



Part of Section BB

Figure 177: Planter section BB (Author, 2020)

Self-watering planters have been designed along balcony columns. The acrylic water tank gets filled with water that would otherwise be channelled away from the balcony with a water spout. It fills up when it rains and slowly releases the water into the soil from a buried perforated pipe in the planter.

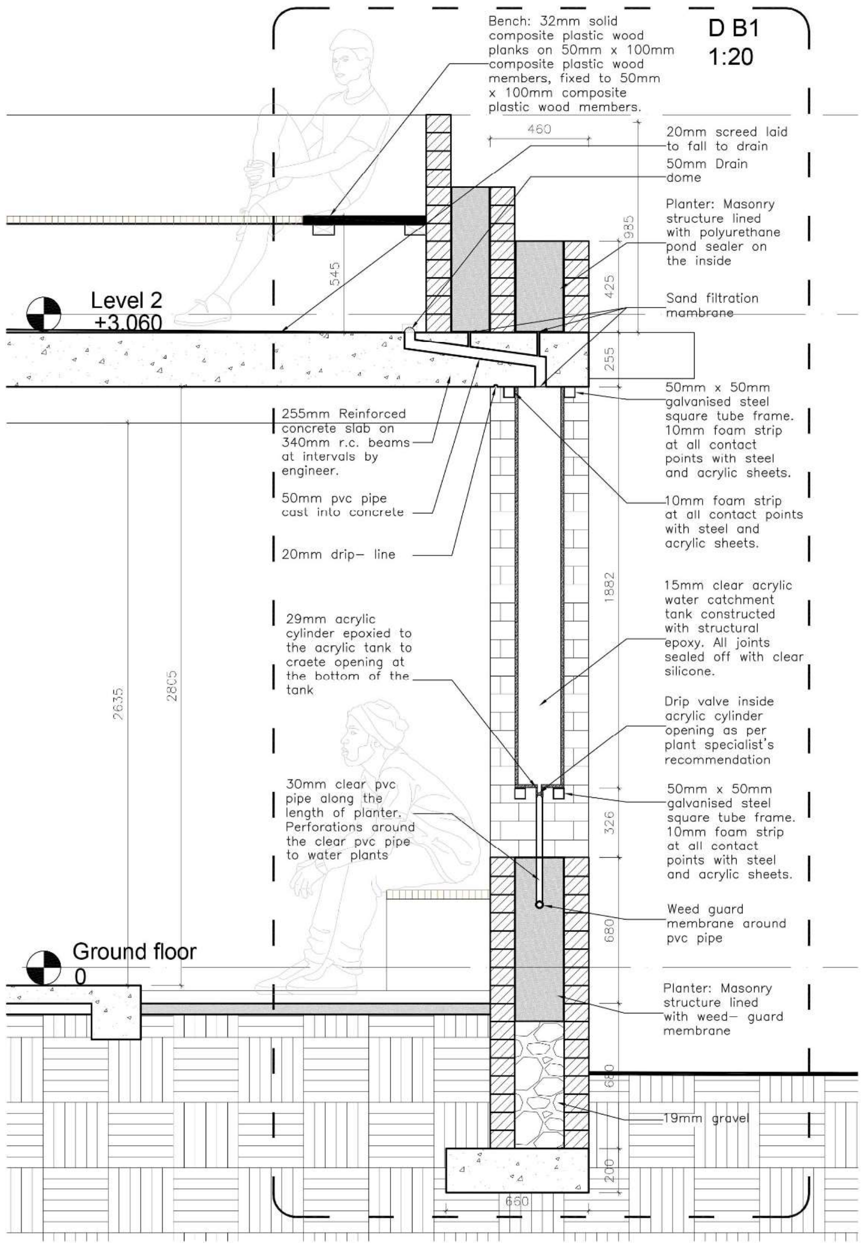


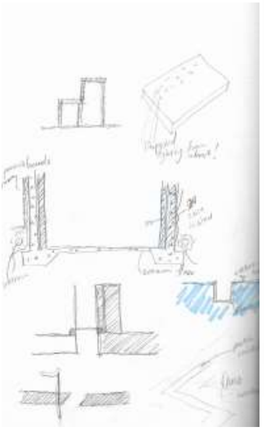
Figure 178: Planter detail B1 (Author, 2020)

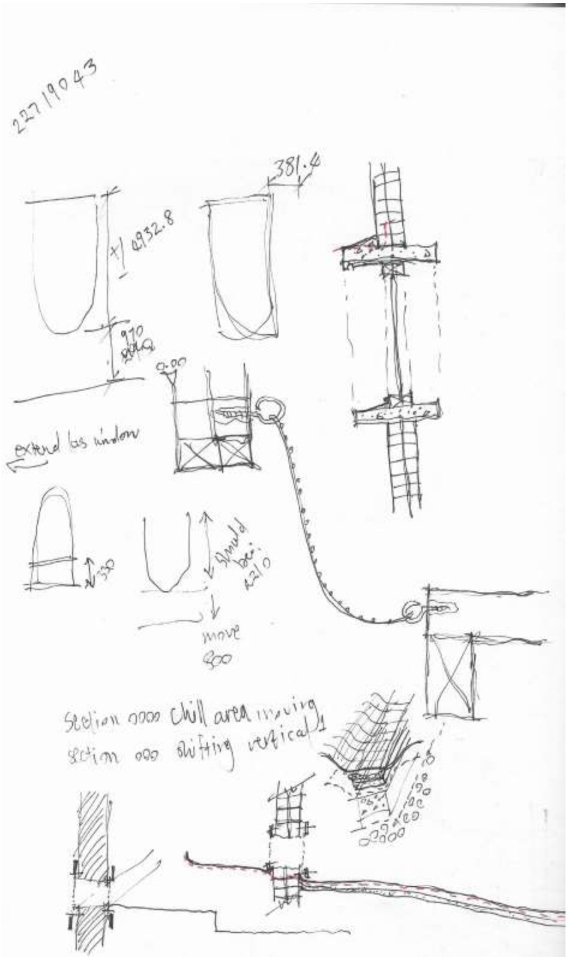
Conclusion

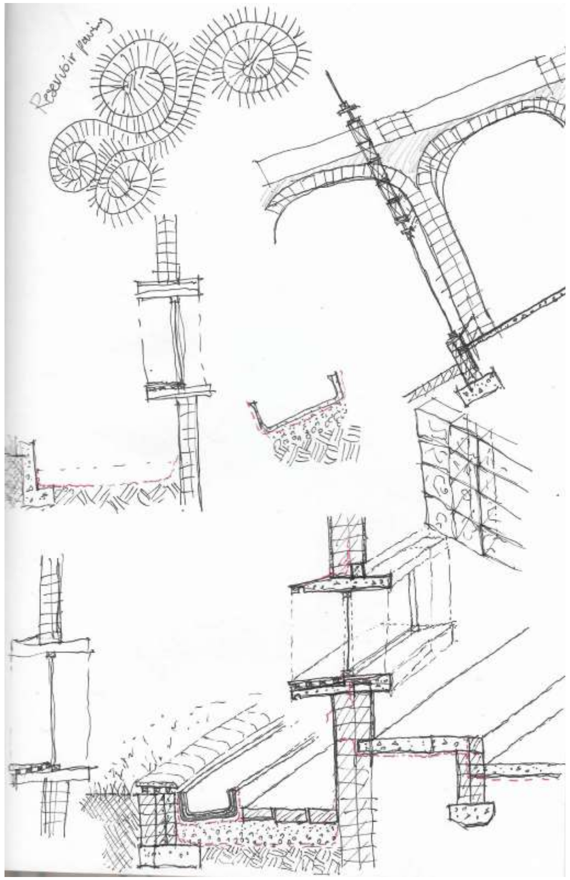
The usage of the pvc membrane allowed for the creation of a huge 2600 m^2 roof which is able to collect 773.5 m^3 annually. It also allowed for the roof to be contorted into a form that can let heat escape from the top while permitting light to penetrate through to the spaces beneath. Because of this, the reservoir was able to become the catalytic element for the urban living room, supplying potable water for daily functions through the aqueducts. The aqueducts allowed the users a view into a water system that would usually be hidden inside the walls of a building. This element together with the storm water that was harnessed to create public green open spaces within the precinct, and the interactive yellow marked black water path, exposes the user to traditionallyconcealed yet important water processes. By interacting with features such as the choice basins, the user's water literacy can increase. All of the above elements culminate into a buiding that aids with the global quest for water security.

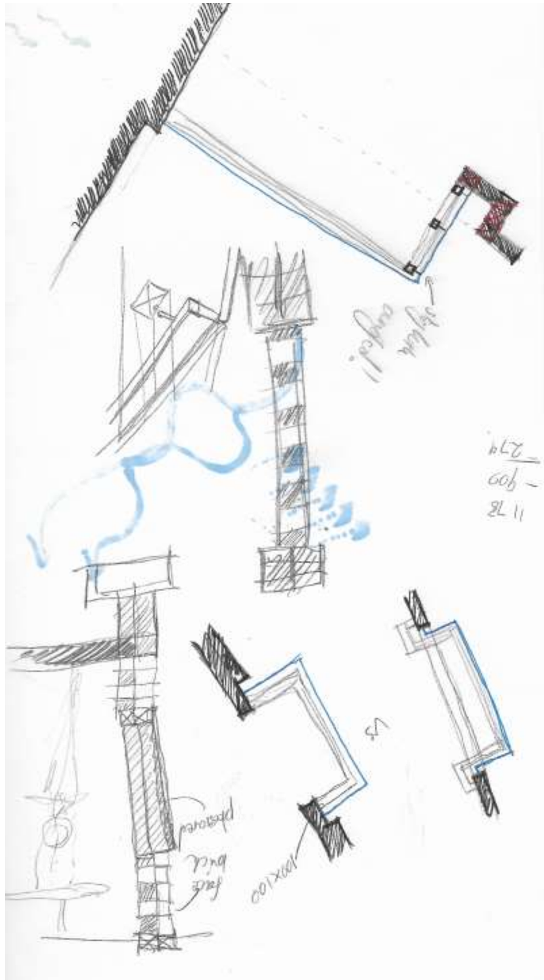
Figure 178: Sectional axo EE (Author, 2020).

Process sketches









RESEARCH DECLERATION

UNIVERSITY OF PRETORIA
FACULTY OF ENGINEERING, BUILT ENVIRONMENT & INFORMATION TECHNOLOGY
DEPARTMENT OF ARCHITECTURE

CPD 810 / DPD 801/2/3 / DIT 801/2/3

Student researcher declaration

(To be signed by each student and kept on record by the supervisor)

1. TITLE OF RESEARCH PROJECT: A Reservoir urban living room- Increasing water relatedness in Marabastad.____

2. I _Mamofella Mphaka_ student number __u28185341____ hereby declare that:

1) I am acquainted with the Code of Ethics for Research and will apply the principles contained in the Codes in all my research activities;
2) I will conduct the study as specified in the application and principally responsible for all matters related to the research;
3) I will communicate all changes to the application/or any other documents before any such is executed in my research with my supervisor;
4) I will explain the objectives and implications of the research to informants;
5) I will indicate to informants that their participation in the research is voluntary and that they can withdraw from the research at any stage;
6) I will obtain written informed consent from each informant;
7) I will not to ask informants any questions requesting personal information (e.g., questions on name, ID number, etc.) or questions beyond the theme of the abovementioned project;
8) I will treat all responses of informants confidentially;
9) I will not engage in any form of research fraud (e.g., falsifying or distorting data);
10) I will obtain written permission letters from organisation(s) that may be contacted as for data related to the abovementioned project; and
11) I will not engage in research that presents conflict of interest or financial benefit, whether for the researcher, company or organisation, that could materially affect the outcome of the investigation or jeopardise the name of the University of Pretoria.

Student signature: ________________________ Date: _11 January 2021

BIBLIOGRAPHY

- Bénit-Gbaffou, C., 2015. In Quest For Sustainable Models Of Street Trading Management, Lessons For Johannesburg After Operation Clean Sweep. [online] Johannesburg: CUBES, University of the Witwatersrand. Available at: <https://www.wits.ac.za/media/wits-university/faculties-and-schools/-engineering-and-the-built-environment/research-entities/cubes/documents/In%20quest%20for%20sustainable%20models%20of%20street%20trading%20management.pdf> [Accessed 8 January 2019].

- Bozovic, Ranko & Maksimovic, Čedo & Mijic, Ana & Smith, K.M. & Suter, Ivo & Van Reeuwijk, Maarten. (2017). Blue Green Solutions. A Systems Approach to Sustainable, Resilient and Cost-Efficient Urban Development. 10.13140/RG.2.2.30628.07046.

- Brian M. Deal & Stephanie N. Timm (2018) Understanding the behavioral influences behind Singapore's water management strategies, Journal of Environmental Planning and Management, 61:10, 1654-1673, DOI: 10.1080/09640568.2017.1369941.

- Brouwer, S., Koop, S., Van Dorssen, A. (2019). Enhancing domestic water conservation behaviour: A review of empirical studies on influencing tactics. Journal of Environmental Management, 247, pp.867-876.

- Bugan, R. D. H., Jovanovic, N., Israel, S., Tredoux, G., Genthe, B., Steyn, M., Allpass, D., Bishop, R. and Marinus, V. (2016) Four Decades of Water Recycling in Atlantis, western Cape, South Africa: Past, Present and Future, Water SA , 42(4), pp. 577–577. doi: 10.4314/wsa.v42i4.08.

- Caldwell, M. and Okoh, A. I., Onyenankeya, K. (2018), Sustainable water use and the nexus of behavioural intentions: the case of four South African communities. Water and Environment Journal, 32: 285-291. doi:10.1111/wej.12326.

- Campisano, A., Butler, D., Ward, S., Burns, M. J., Friedler, E., DeBusk, K., Fisher-Jeffes, L. N., Ghisi, E., Rahman, A., Furumai, H. and Han, M., 2017, Urban Rainwater Harvesting Systems: Research, Implementation and Future Perspectives, Water Research, 115, p. 195–209. doi: 10.1016/j.watres.2017.02.056.

- Clark, M., Potter, A., Wilson, S. and Parkerson, C., 2018. Towards Recommendations On The Regulation Of Informal Trade At Local Government Level. Johannesburg: Socio-Economic Rights Institute of South Africa.

- Collett, B., Friedmann, V., Miller, W. (2013) Low impact development opportunities for the PlanET region, The University of Tennessee, Knoxville, Landscape Architecture Program College of Architecture and Design College of Agricultural Sciences and Natural Resources

- Davis-Reddy, C.L. and Vincent, K. (2017) Climate Risk and Vulnerability: A Handbook for Southern Africa (2nd Ed), CSIR, Pretoria, South Africa.

- Dobson, R., Skinner, C. and Nicholson, J., 2009. Working In Warwick. Durban, South Africa: School of Development Studies, University of KwaZulu-Natal.

- Dunstan, N. and Sampson, J. (2013). Rainwater Harvesting Garden at the University of Pretoria: Construction, planting and proofing.. [ebook] Pretoria: University of Pretoria. Available at: https://www.up.ac.za/botanical-garden/article/2087479/the-rainwater-harvesting-garden [Accessed 8 Sep. 2019].

BIBLIOGRAPHY

- El Shakhs, A. and Ezzat, D. M. (2018) Water in Islamic Architecture : Study of the Water Dispensary (sabil), مجلة العمارة والفنون والعلوم الإنسانية (Journal of Architecture, Arts and Humanities), 12 Part 1(12 Part 1), pp. 1–16. doi: 10.12816/0047906.

- Fennemore, C., Buckley, C. A., Naidoo, S., Bux, F., Schmidt, S., Hanke, N., Dent, M., Stenstrom, T. A. and Rodda, N. (2016) Water Security in South Africa : Perceptions on Public Expectations and Municipal Obligations, Governance and Water Re-Use, Water SA, 42(3), pp. 456–465. doi: 10.4314/wsa.v42i3.11.

- Foodstuffs, cosmetics and disinfectants act, 1972 (act no. 54 of 1972).

- Geere, J.-A., Jagals, P. and Hunter, P. (2010) Domestic Water Carrying and Its Implications for Health: A Review and Mixed Methods Pilot Study in Limpopo Province, South Africa," Environmental Health, 9(1), pp. 1–13. doi: 10.1186/1476-069X-9-52.

- Graham, J., Hirai, M. and Kim, S., 2016. An Analysis of Water Collection Labor among Women and Children in 24 Sub-Saharan African Countries. PLOS ONE, 11(6), p.e0155981.

- Hales, S., McMichael, A. and Butler, C., 2005. Ecosystems And Human Well-Being - Health Synthesis. Geneva: World Health Organization.

- Illich, I. (1987) H2o and the waters of forgetfulness: reflections on the historicity of "stuff". Berkeley: Heyday.

- Knight, J, & Rogerson, CM (eds) (2018) The Geography of South Africa : Contemporary Changes and New Directions, Springer International Publishing AG, Cham. Available from: ProQuest Ebook Central. [18 May 2020].

- Kornwitz, J. (2017) Architecture professor leads effort to make water visible. News @ Northeastern. Accessed 10 June 2019. https://news.northeastern.edu/2017/09/15/architecture-professor-leads-effort-to-make-water-visible/.

- LeChevallier, M. W. and Au, K.-K. (2004) Water treatment and pathogen control : process efficiency in achieving safe drinking water. Geneva: World Health Organization (WHO drinking water quality series).

- Lindley, S., Pauleit, S., Yeshitela, K., Cilliers, S. and Shackleton, C. (2018) "rethinking Urban Green Infrastructure and Ecosystem Services from the Perspective of Sub-Saharan African Cities, Landscape and Urban Planning , 180, pp. 328–338. doi: 10.1016/j.landurbplan.2018.08.016.

- Makou, G., 2020. Does South Africa Guzzle 235 Litres Of Water Per Person Daily? | Africa Check. [online] Africa Check. Available at: <https://africacheck.org/reports/south-africans-guzzle-235-litres-water-per-day/> [Accessed 2 June 2020].

- Marais, M., Armitage, N. and Pithey, S., 2001. A study of the litter loadings in urban drainage systems - methodology and objectives. Water Science and Technology, 44(6), pp.99-108.

BIBLIOGRAPHY

- Muller, B. (2018) From grey to blue: how architecture plays a role in a water- wise world. International water association. Accessed: 25 May 2019, https://iwa-network.org/from-grey-to-blue-how-architecture-plays-a-role-in-a-water-wise-world/.
- Nguyen, T. T., Ngo, H. H., Guo, W., Wang, X. C., Ren, N., Li, G., Ding, J. and Liang, H. (2019) Implementation of a Specific Urban Water Management - Sponge City, Science of the Total Environment, 652, pp. 147–162. doi: 10.1016/j.scitotenv.2018.10.168.
- Ragsdale, J. D. (2009) American Museums and the Persuasive Impulse : Architectural Form and Space As Social Influence. Newcastle upon Tyne: Cambridge Scholars Publishing. Available at: http://search.ebscohost.com.uplib.idm.oclc.org/login.aspx?direct=true&db=nlebk&AN=522834&site=ehost-live&scope=site (Accessed: 16 May 2020).
- Rich, S. (2012). Making water use visible: could the design of a brita filter help us with how much water we waste? Smithsonian Magazine. Accessed 4 May 2019. https://www.smithsonianmag.com/arts-culture/making-water-use-visible-91887780/.
- SANS 10252, part 1 and 2
- Sayigh, A. (2013) Sustainability, Energy and Architecture: Case Studies in Realizing Green Buildings, First edn. Oxford, Uk: Academic press. Available at: Pretoria, University of Pretoria
- South African Council for Scientific and Industrial Research. Division of Building and Construction Technology and South Africa. Department of Housing (2000) Guidelines for Human settlement planning and design. Pretoria: CSIR Building and Construction Technology (Boutek report, no. BOU/E2001).
- Stitt, F. A. (1999) Ecological design handbook: sustainable strategies for architecture, landscape architecture, interior design, and planning. London: McGraw-Hill (McGraw-Hill handbooks).
- The Constitution of South Africa, (1997) Water Services Act, 108.
- United Nations. (2015) Sustainable Development Goals. Accessed 11 March 2019, https://www.un.org/sustainabledevelopment/sustainable-development-goals/.
- van der Vyver, Charles. (2016). Improving awareness of the water crisis in South Africa. International Journal of Applied Business and Economic Research. 14. 577.
- Vosloo, P. (2013) Efficient urban storm- water management and re-use.. Pretoria: De¬partment of Architecture, University of Pretoria.

BIBLIOGRAPHY

- weather, 7., weather, 1., weather, C., (beta), W., maps, W., ensemble, M., maps, C., outlook, S., Sports, O., Surf, S., seeing, A., pollen, A., forecast, T., Agro, M., windows, S., windows, S., trafficability, S., Climate, H., (modelled), C., (observed), C., verification, S., archive, W., comparison, C., overview, P., download, D., download, E., comparison, Y., rose, W., assessment, R., Climate, C., app, A., app, i., Map, W., 3h, W., Day, W., Seeing, W., news, W. and Africa, S., 2020. Weather Pretoria. [online] meteoblue. Available at: <https://www.meteoblue.com/en/weather/week/pretoria_south-africa_964137> [Accessed 2 May 2020].

- Willis, R., Stewart, R., Panuwatwanich, K., Williams, P. and Hollingsworth, A., 2011. Quantifying the influence of environmental and water conservation attitudes on household end use water consumption. Journal of Environmental Management, 92(8), pp.1996-2009.

- Wylson, A. (1986) Aquatecture: architecture and water. London: Architectural Press (Architectural Press library of planning and design)

- Zylstra, M., Knight, A., Esler, K. and Le Grange, L. (2014) Connectedness as a Core Conservation Concern: An Interdisciplinary Review of Theory and a Call for Practice. Springer Science Reviews, 2(1-2), pp.119-143.