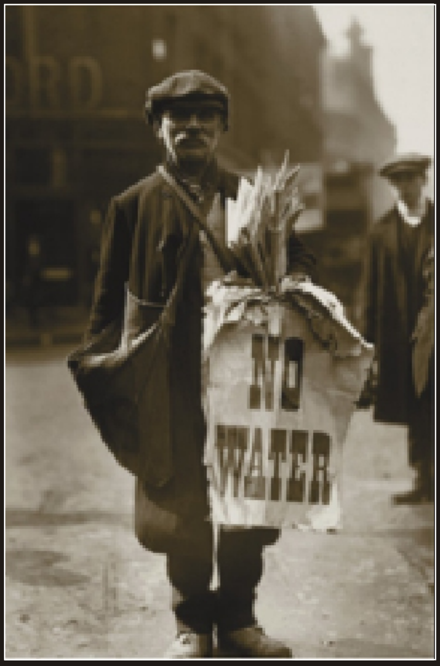
RAND WATER

WATER WISE CENTRE - PRETORIA



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Submitted as part of the requirements for the degree of Magister of Architecture (Professional), MArch(Prof), in the Faculty of Engineering, Built Environment and Information Technology

ACKNOWLEDGEMENTS

I would like to thank the following:

My God and saviour Jesus Christ, without whom I would never have been able to do this.

My parents, for their unmeasurable love, emotional and financial support through my years of study.

Mia, for being part of me.

My friends:
Floorie
Kurt
Lizette
Chrisna,
for always believing in my potential.

My fellow classmates, especially:
Minette Steyn
Pieter Steyn

My lecturers:
Gwen Breedlove
Roger Fisher
Hans Wegelin

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Client Profile

THE FULL SERVICE WATER UTILITY

Rand Water was appointed as the sole bulk water supplier to Gauteng in 1903, and has never totally failed to supply its customers with water. As times have changed, Rand Water has evolved to meet the progressive requirements of a growing population and expanding economy. It has been a key partner in the development of Gauteng, South Africa's industrial powerhouse and is well positioned to play and even more strategic role in the future.

Rand Water has a very large area of supply and the magnitude of this quantity of water it controls is significant. There needs to be a clear concern about environmental issues concerning the use and protection of our natural resources. Environmental Management has become integral to Rand Water's overall management strategy.

The water supply chain needed to provide the user with world class drinkable water is a very intricate system of interactive government and privatised wholesalers and retailers. There are many catchment and water purification techniques that form the source of supply and these are discussed in detail in the appendix on Rand Water.

Rand Water provides a wide range of professional services which assists this company in playing a dominant role in the decisions concerning water affairs in the country. Some of these include:

- Planning
- Surveying
- Geographical Information Systems
- Design
- Project Management
- Quality Management
- Construction Supervision
- Installation Supervision
- Commissioning

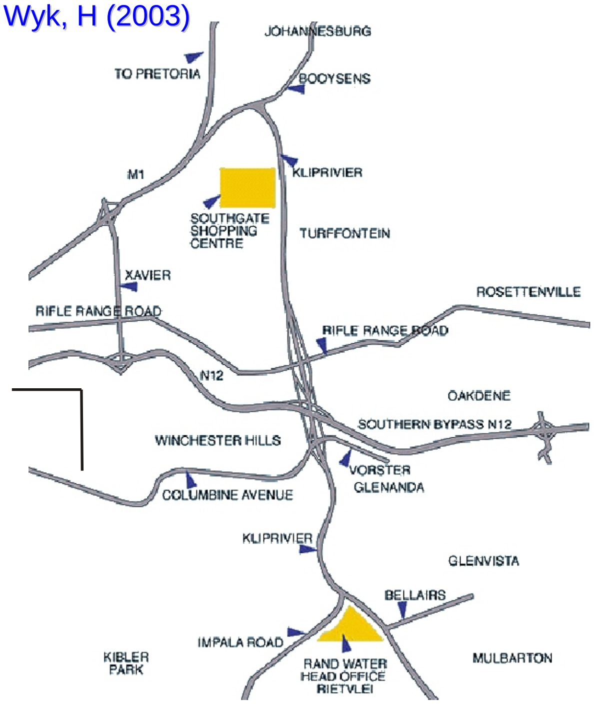


Fig1. Road Map (RAND WATER Corporate Profile, 2002) (not to scale)

Fig 2. Mother and Child at entrance to Rand Water

- Training
- Pipeline renovations
- Infrastructure refurbishment

All the above-mentioned services are structured to be 100% within the aim of Rand Water, which is the meeting of the water demand and provision of a product of purity and world class standard. Quality auditing and water quality research are high on their priority list.

Their endeavour to deliver a world class product is well balanced with the very important aspect of water cycle management. In trying to keep this balance, Rand Water realised the importance of getting the community involved. They have established many community-based projects where they are reaching out to the broader community to try and involve as many people as possible in the quest to protect our natural resources and more specifically our water resources.

Rand Water has a specific department dealing with these matters, called the Community Based Projects Department. Currently it has the following projects running:

- Mnweni Trust
- Winterveldt Water Supply Project
- Winterveldt Eco-Circle Vegetable Garden Project
- Bushbuchridge Infrastructure Project
- Ten Morgen Rural Community Sanitation Project
- DACE Alien Vegetation Eradication Project
- Informal Settlement Encroachment Project
- Leaks Repair Project

Specifics on each project are given in the appendix on the client profile.

The proposal for a Water Wise Centre in Pretoria will exactly suite the objectives of the Department of Community Based Projects and Education. This would be the ultimate community project run by Rand Water in trying to educate the nation in the awareness of methods on how to live water wise and ways of collecting, cleaning and storing water for your own personal use.

Fig 3. Water is our business and so are the people we serve.

Rand Water presents educational programmes to scholars of all ages. Earlier this year, the author was invited to join one of these programmes to witness what they do for the learners and to see what facilities they have for executing this function.

The programme starts at 9:30 in the morning when the children arrive by transport, organised by the school itself.

Fig 4. Learners arriving for educational programme

The only facility available at Rand Water itself is a thatched roof structure at the back of the office building. It is used for multiple functions such as personnel functions, as well as the Water Wise Educational Programmes.

Fig 5. Current facility available at Rand Water Nature Reserve

The learners enter the facility and here they are educated in basic principles on how to live Water Wise. They use different educational media for different age groups. For this specific group they used a puppet show and a live mascot to bring across certain principles.

Fig 6. Rand Water educational staff

The puppet show includes interesting characters that share their experiences with the learners. The learners can associate with the problems the characters encounter and learn along with them.

Fig 7. Puppet show

A live mascot, Manzi - the Water Wise Tapduck, talks to the learners and in these conversations it discusses many methods save water in our daily routine .

Fig 8. Live Water Wise mascot

The puppet show is presented by the Delta Environmental Centre and is externally contracted to fulfill and educational function.
After the puppet show the learners are taken on a nature walk and they learn how certain plant species are adapted specifically to store water in times of water scarcity.

Fig 9. Delta Environmental Centre - contracted for the puppet show

Fig 10. Nature walk

After each Educational Program presented by the staff of the Rand Water Nature Reserve, a responsible person from the participating school/institute receives an evaluation form to fill in on the spot. In this form they can make suggestions as to how the whole presentation can be improved. Ms. Maria Mphomane - Educational Officer Rand Water - gave me access to these forms and some of the suggestions that the schools/institutions had made are given below:

- Learners should be divided into smaller groups
- Learners should find the centre legible
- Water features where the learners can experience fish and catch some insects will be useful
- The purification process should be demonstrated in some way
- Work sheets should be provided for the children to make notes
- A mini lab where learners can do small experiments should be provided
- Many more visuals should be used to illustrate the concept of living Water Wise
- There should be hands-on activities in which the learners can participate
- A film on water should be shown
- A tuck shop would be welcome
- Drinking water should be provided at regular intervals
- Sufficient toilet facilities must be available
- More shaded areas should be provided

The Delta Environmental Centre in Johannesburg has better facilities for their specific needs.
They have an extensive list of Water Wise activities where learners can have an out-of-the classroom, hands-on watery experience:

- Puppet shows
- Manzi, the Water Wise Tapduck
- "Life is Water & Water is Life" Theatre Production
- Dipping for Water Life
- Are our Rivers Healthy?
- Water Ecology
- Water Wise Walks
- Water Wise Gardening
- Water Wise Orientation
- Discovering Water in the Water Wise room
- Exploring the Museum
- Water and Music
- How much water do you use?
- How Tap Water is Cleaned
- Wastewater: The Untold Story
- Educator Workshops
- School Projects

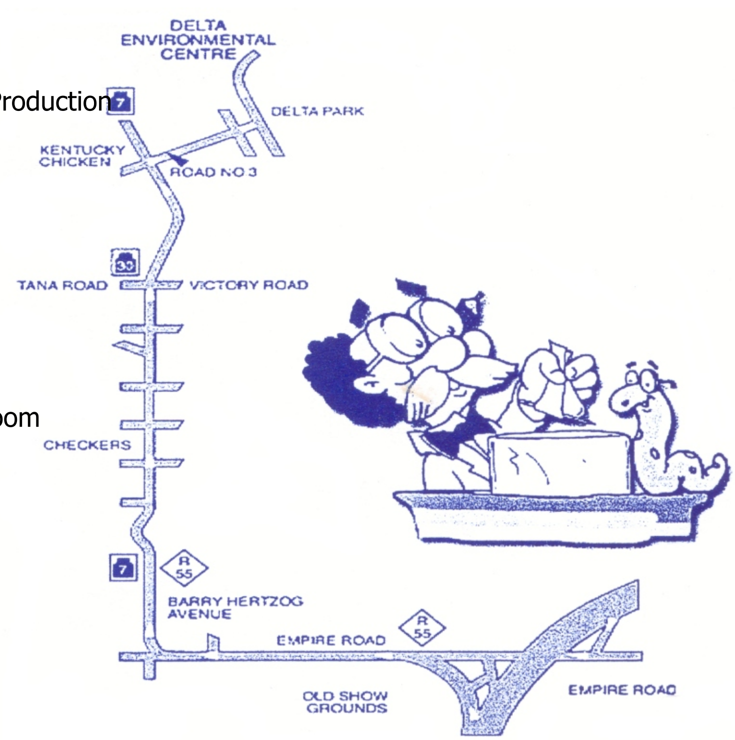


Fig 11. Road map to Delta Environmental Centre (not to scale)

Although they have a better facility, the spokesperson for the centre, Ms. Avril Owens - Educational Officer Delta Centre - was very excited by the idea of having a new centre designed from scratch. She gave some ideas generated from practical experience on what such a centre should provide:

- Try and use the walls for education. Colourful cartoons make the place interesting, and depending on what the cartoons are 'saying' can make what is on the walls educational for the learners in a fun way. Eg. the water cycle can be depicted in an interesting way on the wall.
- If benches or tables are going to be used for experiments etc., make sure that they are at the right level for learners and not too high. Keep in mind that some might be disabled.
- Use every possibility as a resource e.g.. the outside could be designed as a water wise garden instead of being just an ordinary garden or being covered by paving. The garden can then be used to teach water wise gardening principles to learners, and they can see just how many wonderful indigenous plants there are.
- The river near the building must be used for water quality analysis, but a man-made wetland could also be included into the design of the garden to highlight wetlands, their importance to us and their plight.
- Lots of toilets must be provided. The bathrooms must be retrofitted with dual-flush toilets, tap aerators, etc.
- The design must ensure that all the rooms are accessible to disabled learners.
- When teaching, one needs to use many different methods. Each room should be different, e.g. one for doing experiments and another for hands-on activities, one filled with exhibitions for information gathering, another possibly for showing video's, doing slide shows etc.
- It is important that a tuck-shop and a place for the learners to eat lunch should be provided. Recycling bins need to be provided.
- Energy saving devices e.g. energy-saving light bulbs must be used. The building should be well sealed so that heat does not escape.

Fig 12. Water Wise garden at Delta Environmental Centre

Site Analysis

Fig 13. The site relevant to Pretoria CBD

Prinshof 349JR/R/41 is the proposed location for the Water Wise facility. The site and its boundaries are indicated by the hatched gray area.
All municipal services are available and connections to these services can be made with the minimum effort, upgrades and costs.

Total Area	**8894.3** m^2
Coverage	**60%**
Max. Height	**19m**
Floor Space Ratio	**2**
Max. Footprint	**5336.58** m^2

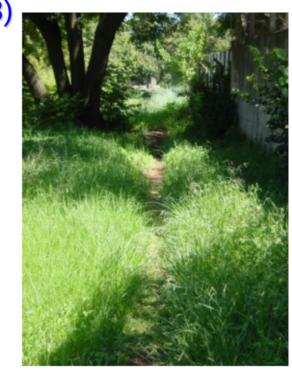


Fig 14. Pedestrian route along river

Fig 15. Pedestrian route along river

Fig 16. View of wall from Apies River

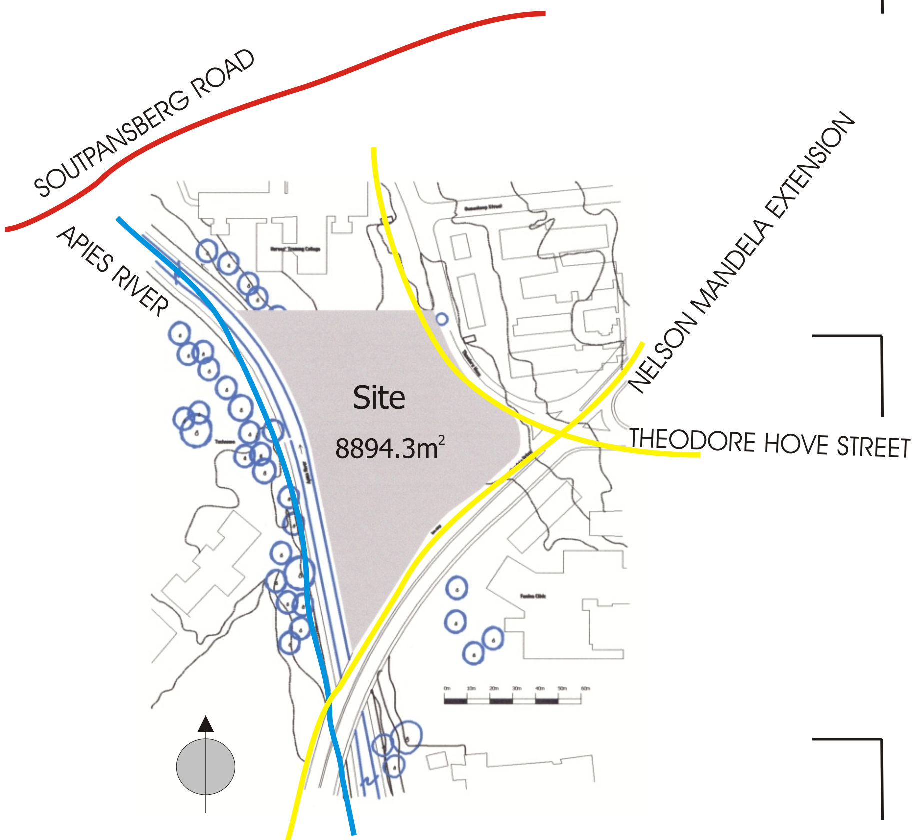


Fig 17. Figure ground of proposed site

Fig 18. Northern view of site

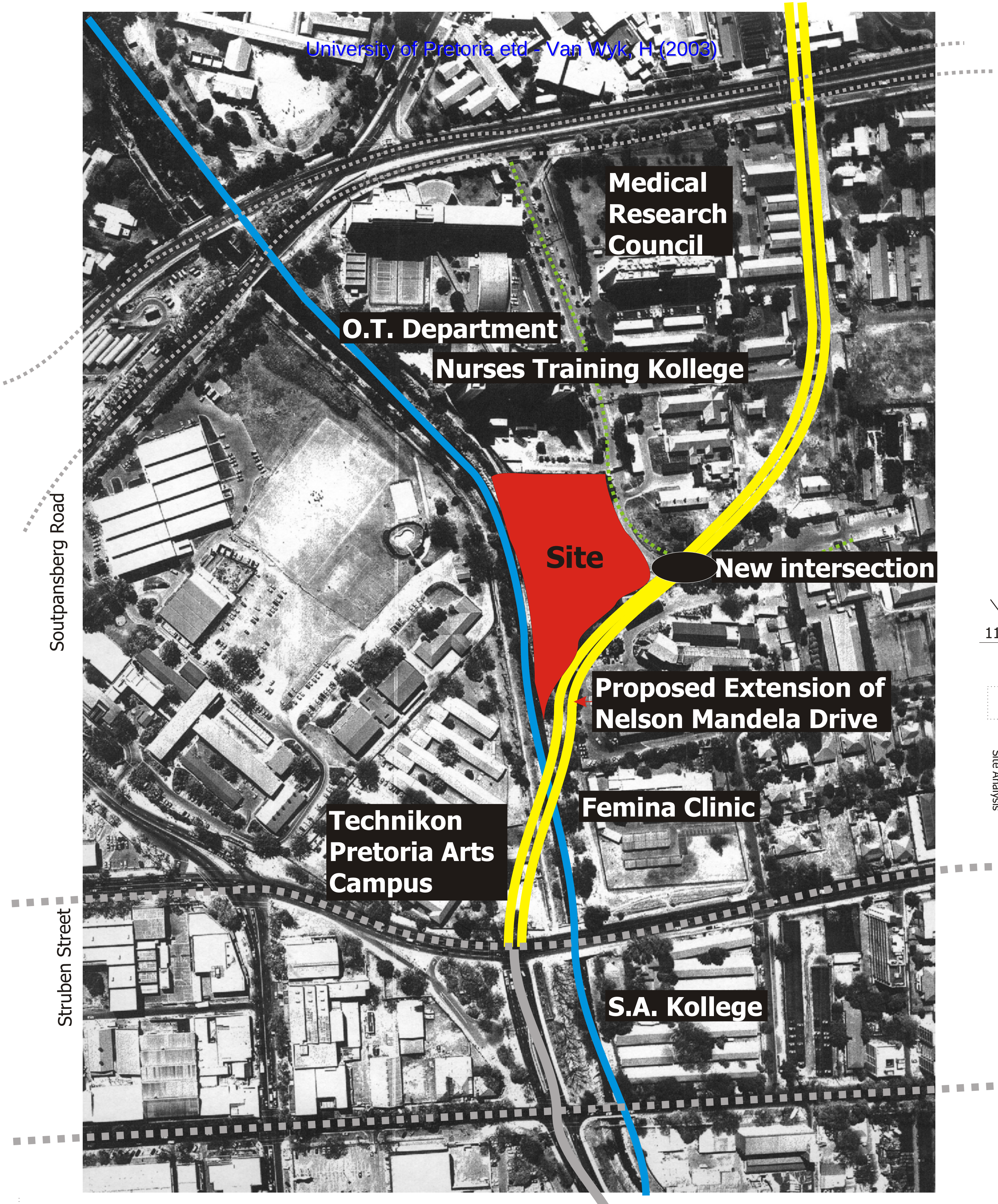


Fig 19. Site in context of immediate surroundings

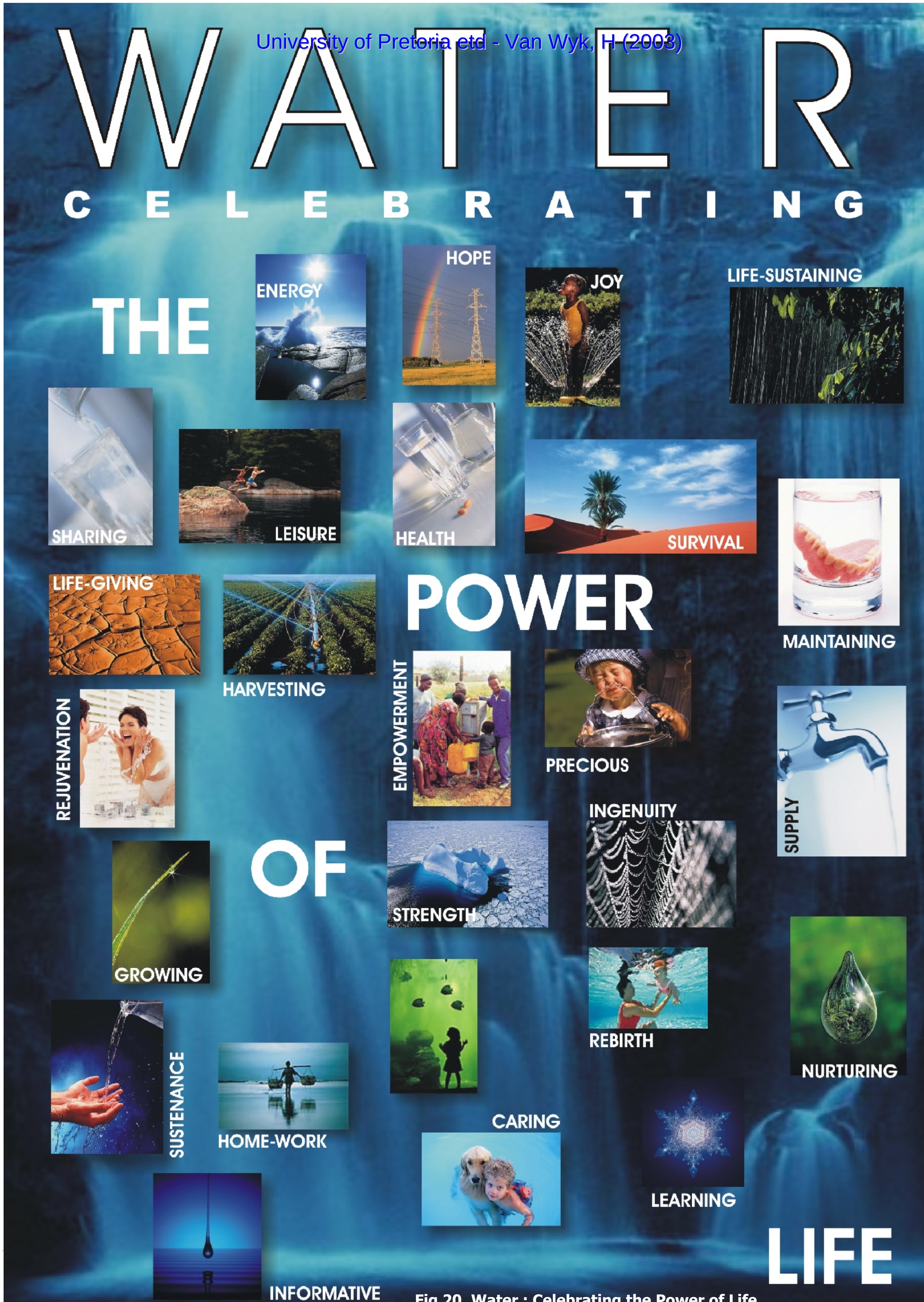


Fig 20. Water : Celebrating the Power of Life

NEEDS

Through the ages, WATER has been seen as maybe the most important resource available to man.
In Africa, and more specifically South Africa, we have limited water resources.
This leads to the universal issue of resource management, to prevent the depletion of our water sources. Educating the community in the essential techniques and methods of working wisely with water is becoming more imperative as time passes.

The proposed centre will house the main water management body in South Africa, Rand Water and more specifically a Water Wise Centre to house the activities needed to achieve the goal of educating the community in resolving the above-mentioned problems.

Architecture today, has become more multi-functional. Buildings have started to act as living organisms.
With this in mind, the proposed building can not house only one function, i.e. Administration, but it should be an interactive, living organism which will serve the community in a linear learning process. This learning process will teach people how little water we have, how to gather additional water, and how to purify water for their own use, or to redistribute it for use in the bulk water network of Rand Water.

In the process of exploiting the potential of space occupancy in this building, the three phases of water, liquid, gas and solids will play an intricate philosophical part in the design process. Knit together with this, three other aspects of water:

- Dirty undrinkable water
- Cleaner water
- Drinkable water

will intertwine with the three phases of water to depict possible 3D structures, form, space qualities, building materials, and the sensorial experiences of feeling, hearing, smelling, seeing and touching water.

In the end, water, in its guises of ice and steam as well as its liquid state, tantalises in its potential as a building component or element and is a reminder of its undeniable presence in the life of each living being.

Fig 21. View from hole in wall to the Apies River

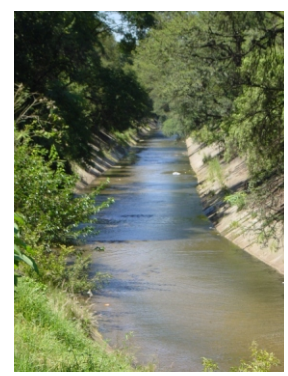


Fig 22. View of Apies River from Soutpansberg Road

Fig 23. View to Pretoria CBD form the site

Architecture, in response to these issues, should make a public investment. Public resources must be directed towards the greatest possible benefit. In order to ensure that this facility is sustainable, it should be an integrated facility that is inclusive and provides for a wide range of different aspects and issues relating to water.

A problem concerning urban sustainability arises from the nature of society and the way in which it is organised. In order to create a civil society, improvements in social equity, diversity, opportunities and 'quality of life' issues need to be addressed. Physical development cannot be dealt with in isolation from the dynamics of the prevailing political and economic environment. While political systems may come and go, human issues, raised as a result of the process of urban growth, will always remain.

The aim of the project is to create an urban educational environment that facilitates and enriches the daily activities of human life.

Fig 24. Atmosphere under shady trees alongside the Apies River

Fig 25. Panoramic view of site from the Apies River

SITE DESCRIPTION

The proposed site, Prinshof 349JR/R/41, is located adjacent to the Apies River and falls within the Hospital and Institutional precinct. The site can be described as one with immense potential. It is currently a vacant grassland next to the Apies River, with traces of active pedestrian routes along the length of the river. The site has a sharp incline of about 4 m on the eastern side of the river. The greater part of the site is generally flat. The site is bordered by the Apies River on the west side, Theodore Hove Street on the east, Soutpansberg Road on the north and the proposed new extension of Nelson Mandela Drive. A sense of enclosure is reinforced by the 11 storey Nurses Training College and the 5 storey apartment block on the south-eastern side. However, these buildings are of little architectural merit. The Apies River forms a natural enclosure on the western side.

At present the site is used for parking by the Occupational Therapy Department of the University of Pretoria. There is a crude wall between the site and the Apies River, as the area next to the River is regarded as unsafe. Presently it has restricted accessibility. Access to the site is given by Theodore Hove Street, which turns out of Soutpansberg Road. With the construction of the extended Nelson Mandela Drive, the new intersection created on the axis of Theodore Hove Street and Nelson Mandela Drive will enhance accessibility to the site.

Fig 26.Neighbouring building on northern side of the site

Fig 27. Neighbouring building on south-eastern side of the site

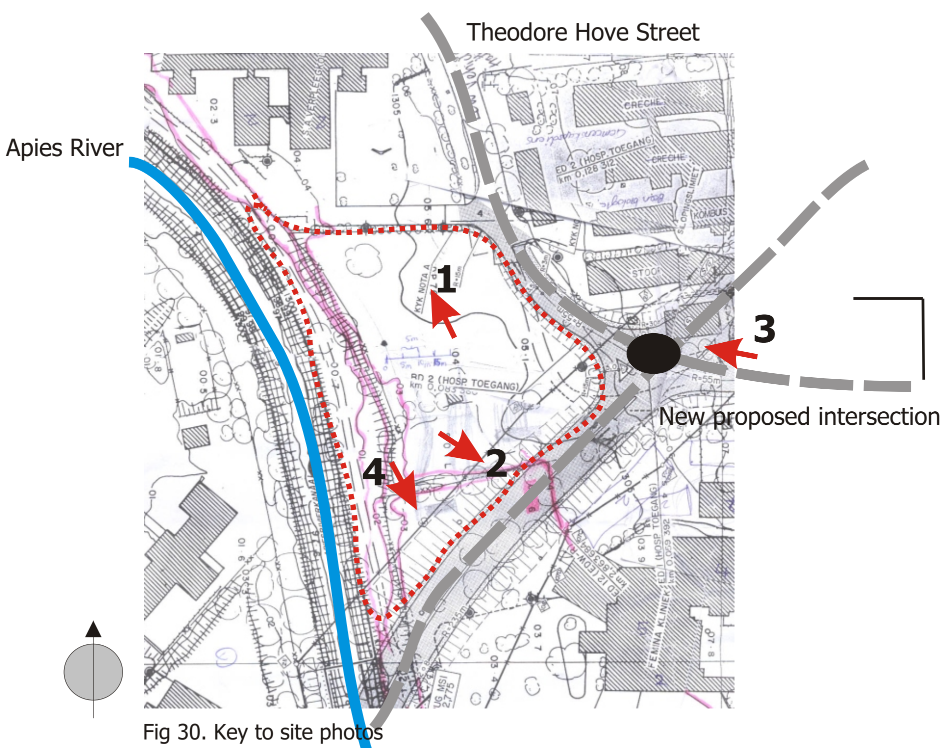


Fig 30. Key to site photos
[Overlay on Department of Public Works Drawing]

Fig 28.Road on eastern side of site

Fig 29.Southern view from the site

Traffic

Traffic levels on Theodore Hove Street are currently of low intensity but with the proposed new intersection in place it will increase traffic flow dramatically. Therefore, the entrance to the proposed site is located in Theodore Hove Street. A second entrance to the site wouldn't be necessary, due to the fact that the new intersection would avoid congestion and aid the streamlined flow of traffic.

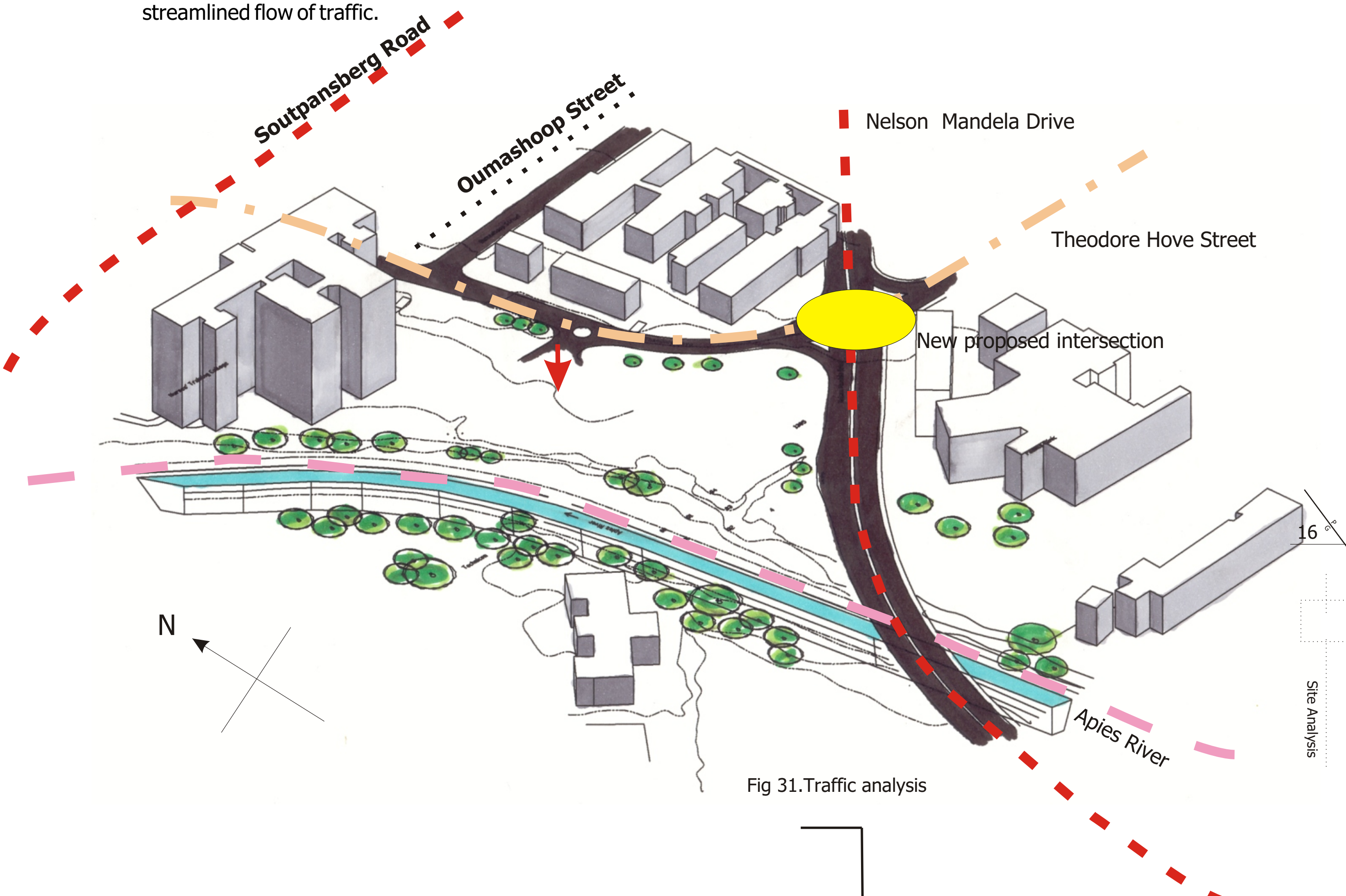


Fig 31.Traffic analysis

Vehicular traffic intensity levels:

- High intensity
- Medium intensity
- Low intensity
- Very low intensity

Diagrammatic representation of site boundaries.

The existing building on the north boundary forms a hard edge. The far eastern section of the site is framed by the Pretoria Academic Maternity Hospital. The southern end of the site will be the facade seen by most people as they pass on the new proposed Nelson Mandela Drive. On the southern side of Nelson Mandela Drive the Femina Clinic with it's 4-5 story building also has a view over the site.

All the buildings surrounding the site are of little architectural value and have a negative impact on the site. Development of the site could improve its contribution as a whole to the Hospital/Institutional Precinct, provided that the development is sensitive to its context and masks the building behind it.

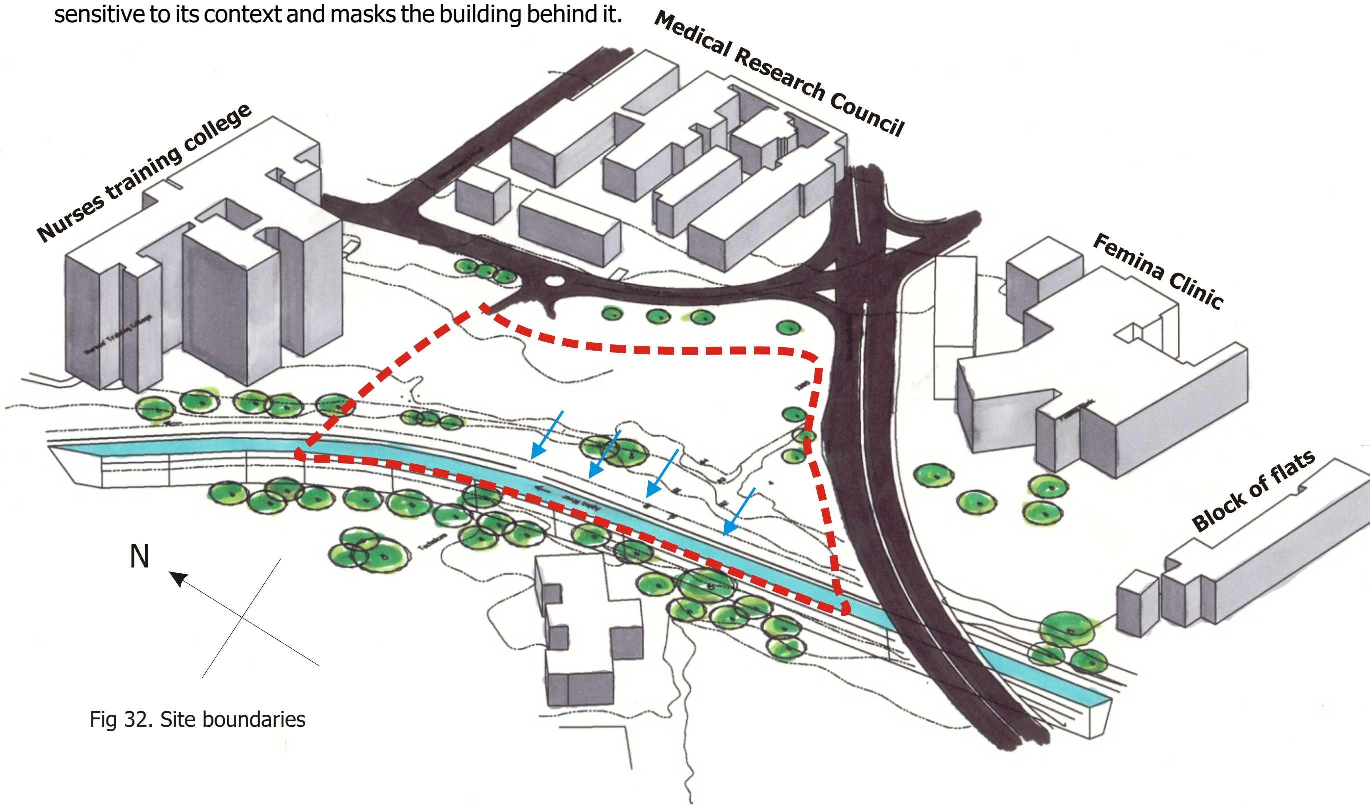


Fig 32. Site boundaries

View from the pedestrian route down the Apies River

View from the vehicular route in Nelson Mandela Drive

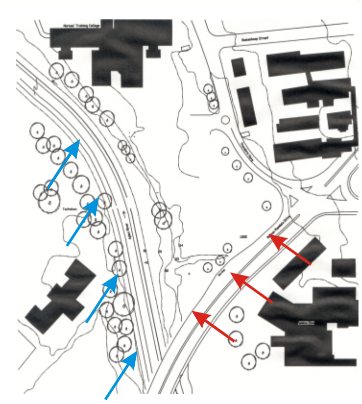


Fig 33. Views towards the site

Diagrammatical section of site

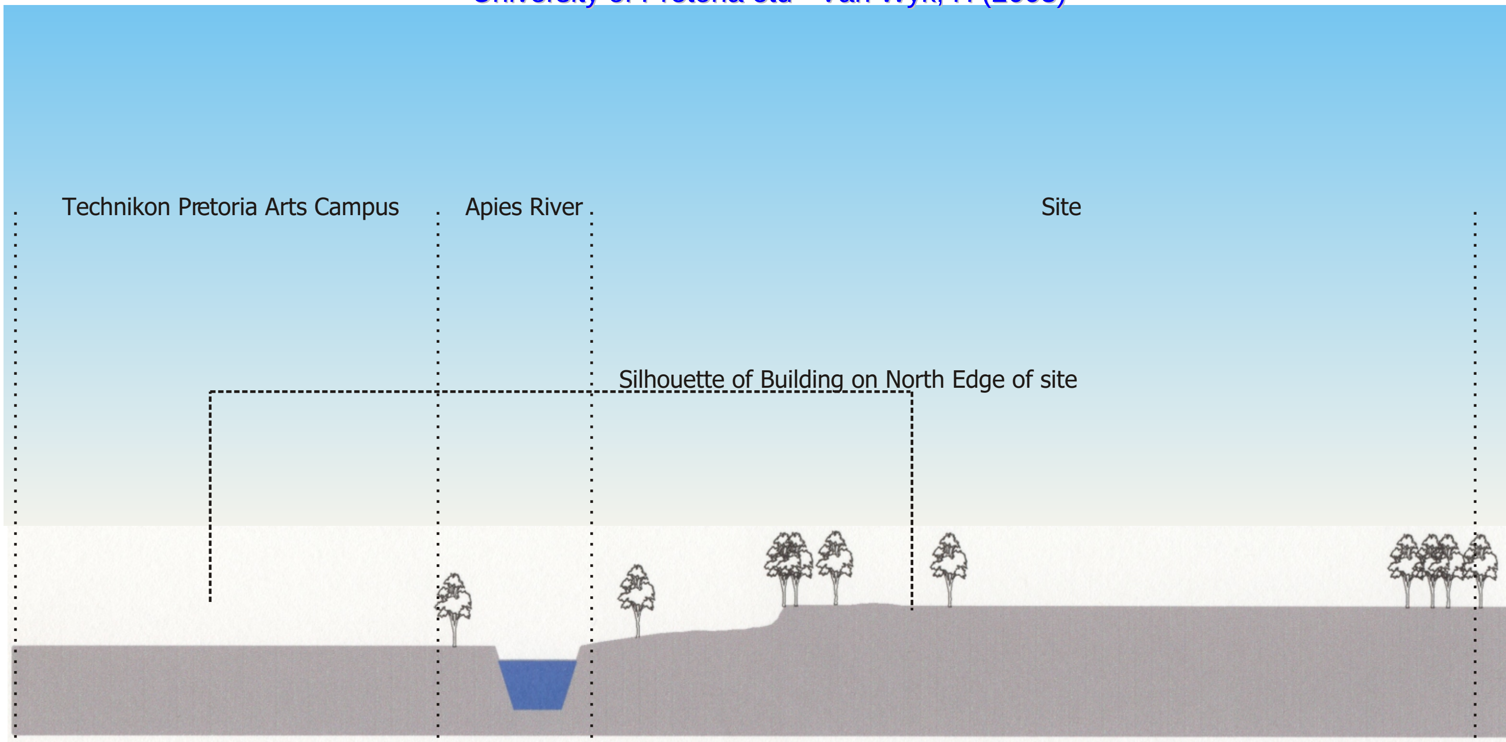


Fig. 34a East-west section of the site

The site is located on the edge of the Apies River and in the Hospital and Institutional Precinct. The site also falls within the Apies River Framework and calls for a sensitive approach with regard to development in this area. The above section clearly illustrates the presence of the building on the north edge of the site. There is a clearly visible edge that runs along the length of the Apies river that is articulated by the sudden rise in slope of about 4 metres and by the planted lane of trees.

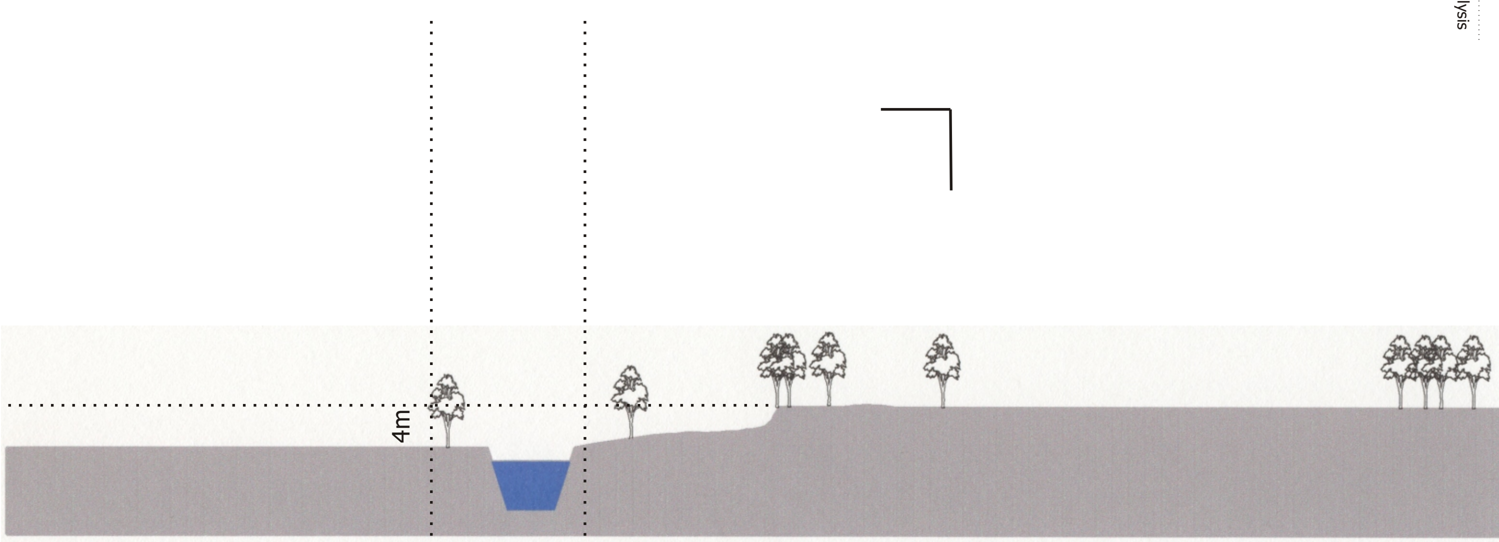


Fig. 34b East-west section of the site showing the change in level

TOPOGRAPHY

The topography of the site doesn't differ a lot from that of the surrounding sites. Apart from the sharp incline on the edge of the river the greater part of the site slopes very little from east to west. Drainage should follow this natural slope and access water should be disposed of down the Apies River.

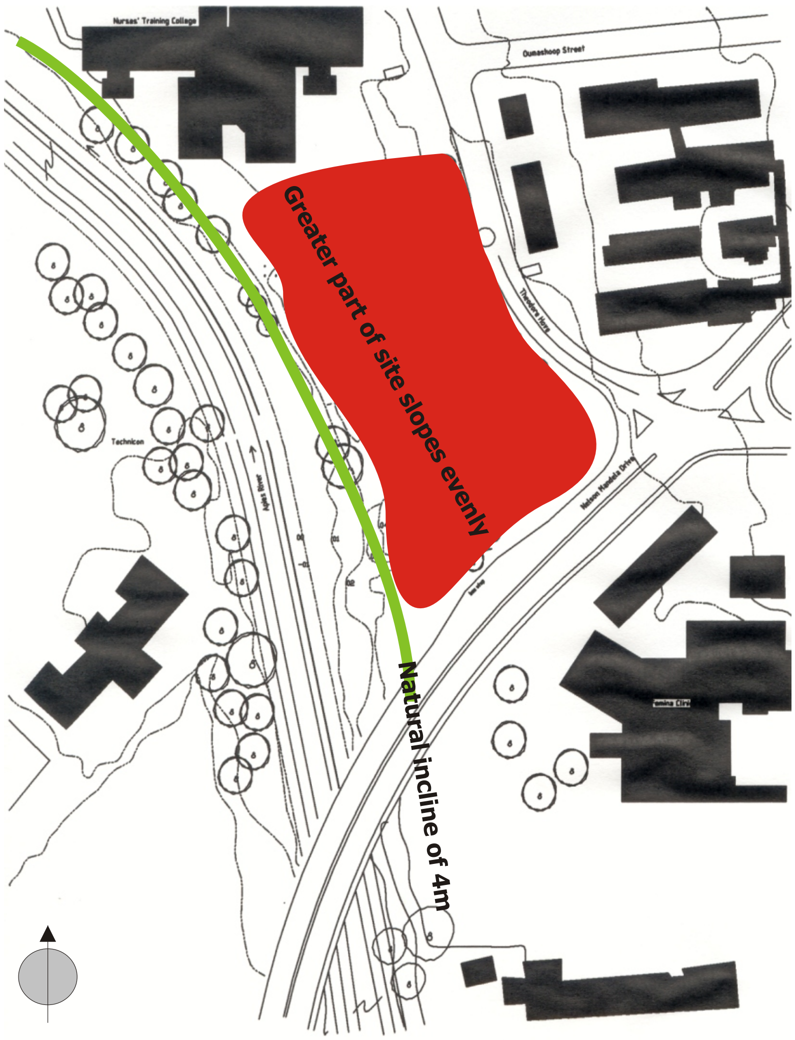


Fig 35. Site plan with contours (at 1m intervals)


Fig 36. Northern view of site showing greater part of site

VEGETATION

A number of plant species on the site act as space-defining elements. The combination of several Acacia, Rhus and Celtis Africana species articulates the transitional area between the site and the Apies River. Apart from the concrete wall on the western border of the site, the trees form a natural buffer between the public domain of the river and the more private domain of the site. From a practical point of view, they order the site, set the boundaries and have the potential of becoming generators with regard to design elements. The large tree specimens are mostly Acacia and Quercus species that could very well be incorporated into courtyards of the proposed development due to the relatively large shade areas they create.

For more detail on species, see section on vegetation in the appendix.

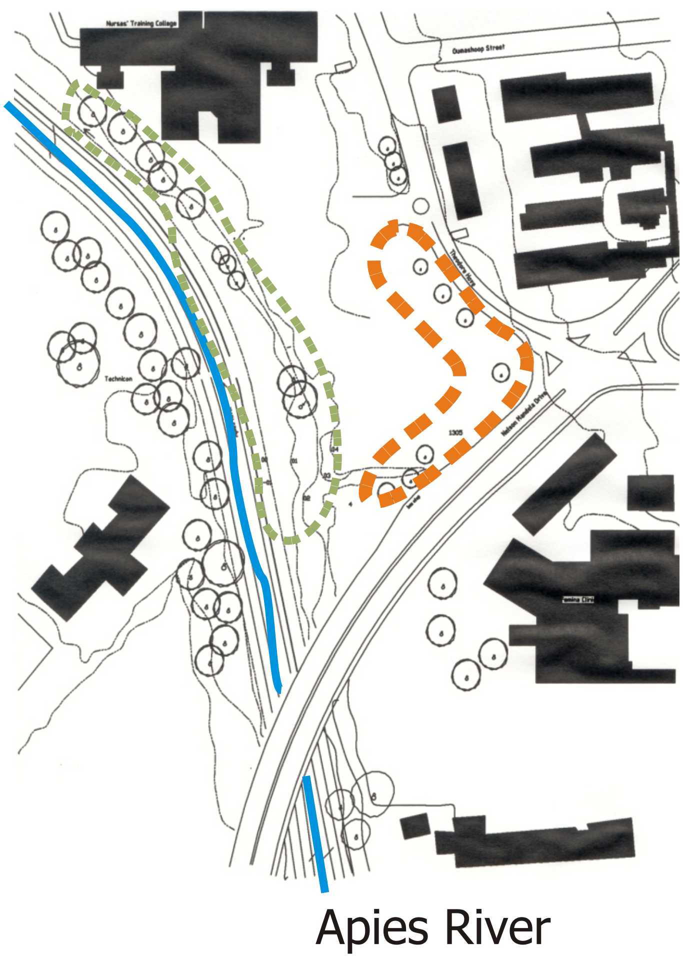


Fig 37. Position of plant species on site

INTERESTED AND AFFECTED PARTIES

Every person in this world should be interested in Water Wise methods of living. Certainly it is clear that everyone in South Africa using the same water resources are parties affected by this building.
According to Rand Water and the Delta Environmental Centre in Johannesburg everyone should be made aware of ways to live Water Wise.

To achieve this they target our young people at various stages of their primary and secondary education. Mrs. Jennevive Koopman from the Department of Education informed the author that they try to promote water and water-based issues as many times as they can throughout the whole spectrum of school grades.

"We would like to make an impact on children's lives at as many levels of their education as we can" said Avril Owens, the Educational Officer at the Delta Environmental Centre in Johannesburg. According to her, they desperately need a similar facility in the West and East Rand, as well as in Pretoria.
They only receive scholars from the Johannesburg area and surrounds, due to the fact that transport from places further away is just too expensive.

The following tables show the number of learners and educators that have attended a Water Wise Education Programme at either the Rand Water Nature Reserve, the Delta Environmental Centre or the purification plant in Vereeniging.

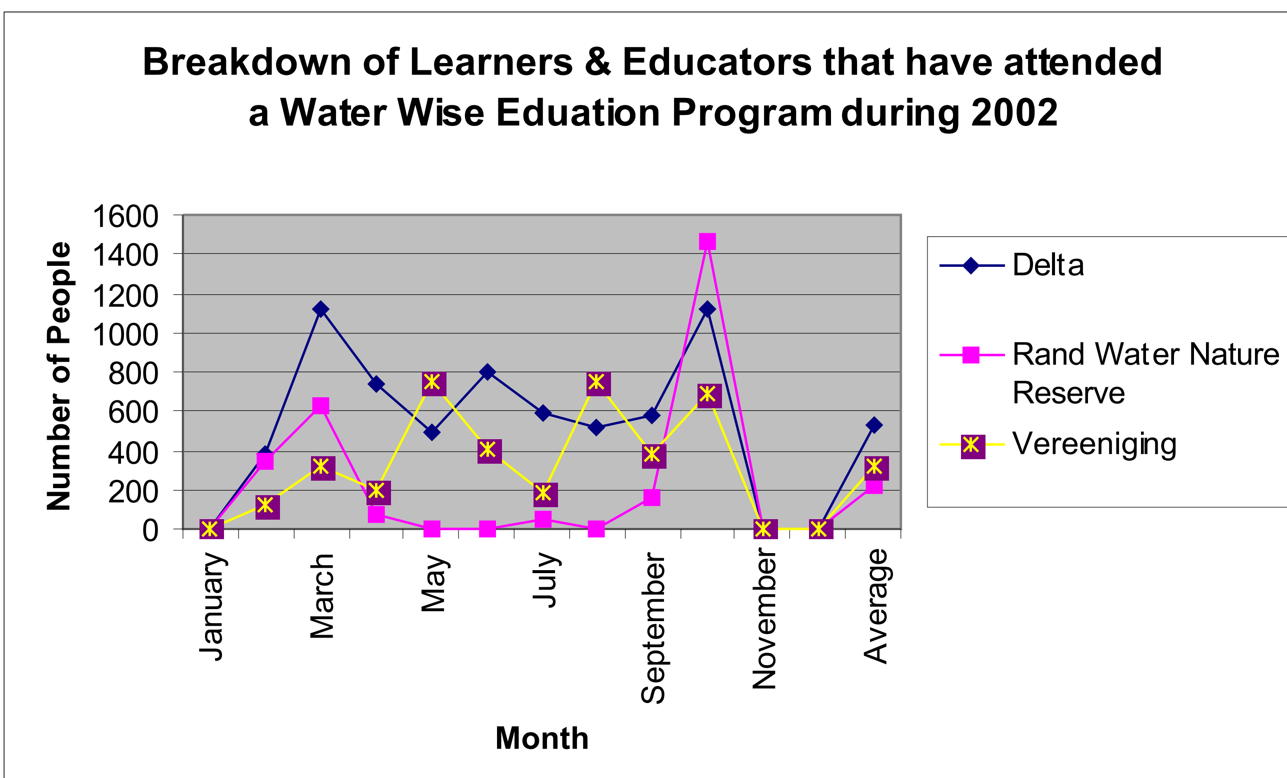


Fig 38. Based on data provided by Rand Water Nature Reserve

COST REGENERATION

The following graphs show the amount of capital generated by two of the centres respectively.
These costs can be seen as part of each centre's cost regeneration programme and shows the capital possibilities for similar centres or programmes.

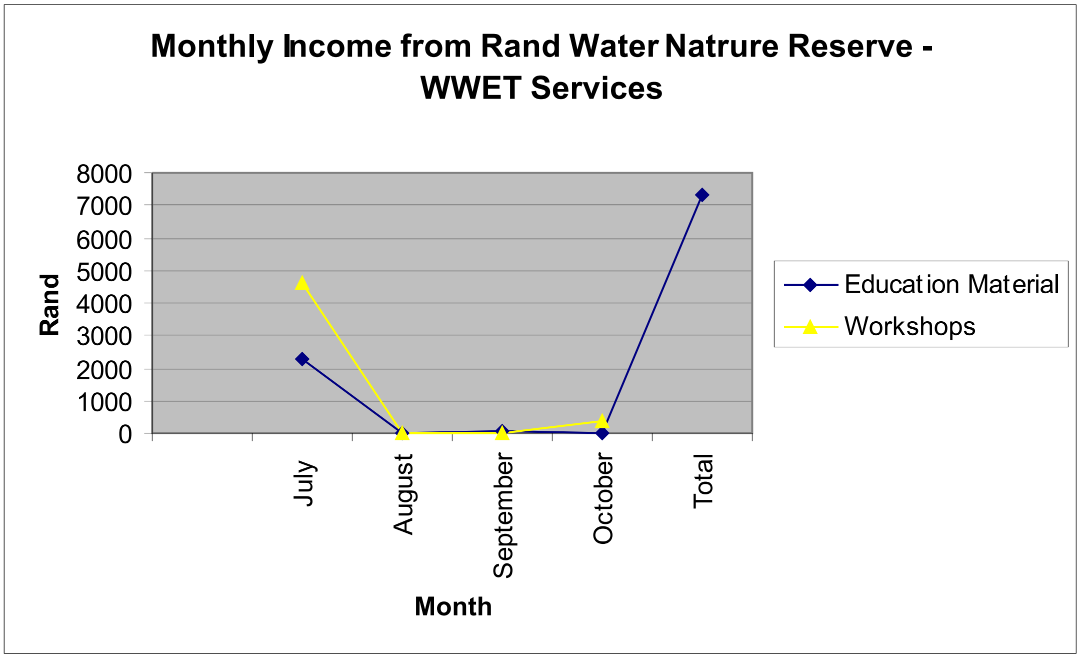


Fig 39a. Based on data provided by Rand Water Nature Reserve

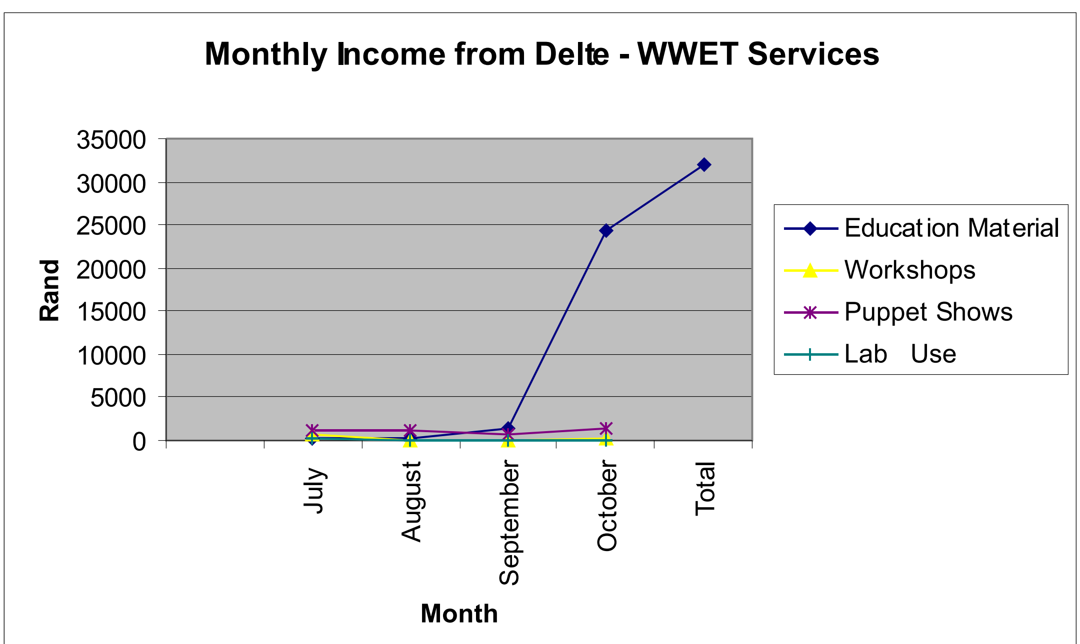


Fig 39b. Based on data provided by Rand Water Nature Reserve

POTENTIAL USERS OF THE WATER WISE CENTRE - PRETORIA

All residents in Pretoria should ideally be the users of this building, which will be used to guide communities in the process of becoming aware that we should start to live 'Water Wise'. This centre will be the educator of all, young and old.
Due to the fact that the Department of Education prescribes a Water Wise programme or water based activities in different stages of a child's education, and due to the fact that very few schools have the facilities to teach these skills, the need for a Water Wise centre in Pretoria is increasing daily.

Gauteng is divided into twelve educational districts, as can be seen on the map below. Pretoria, or the Tswwane Metropolitan district, is divided into three sub-districts that are called: D1, D3, D4. D1 district enclose areas outside the Tswwane Metropolitan district for the sole reason that there are so few schools in these areas.
The map below shows the placement of the three districts in Pretoria and the location of the Water Wise Centre relative to each district.

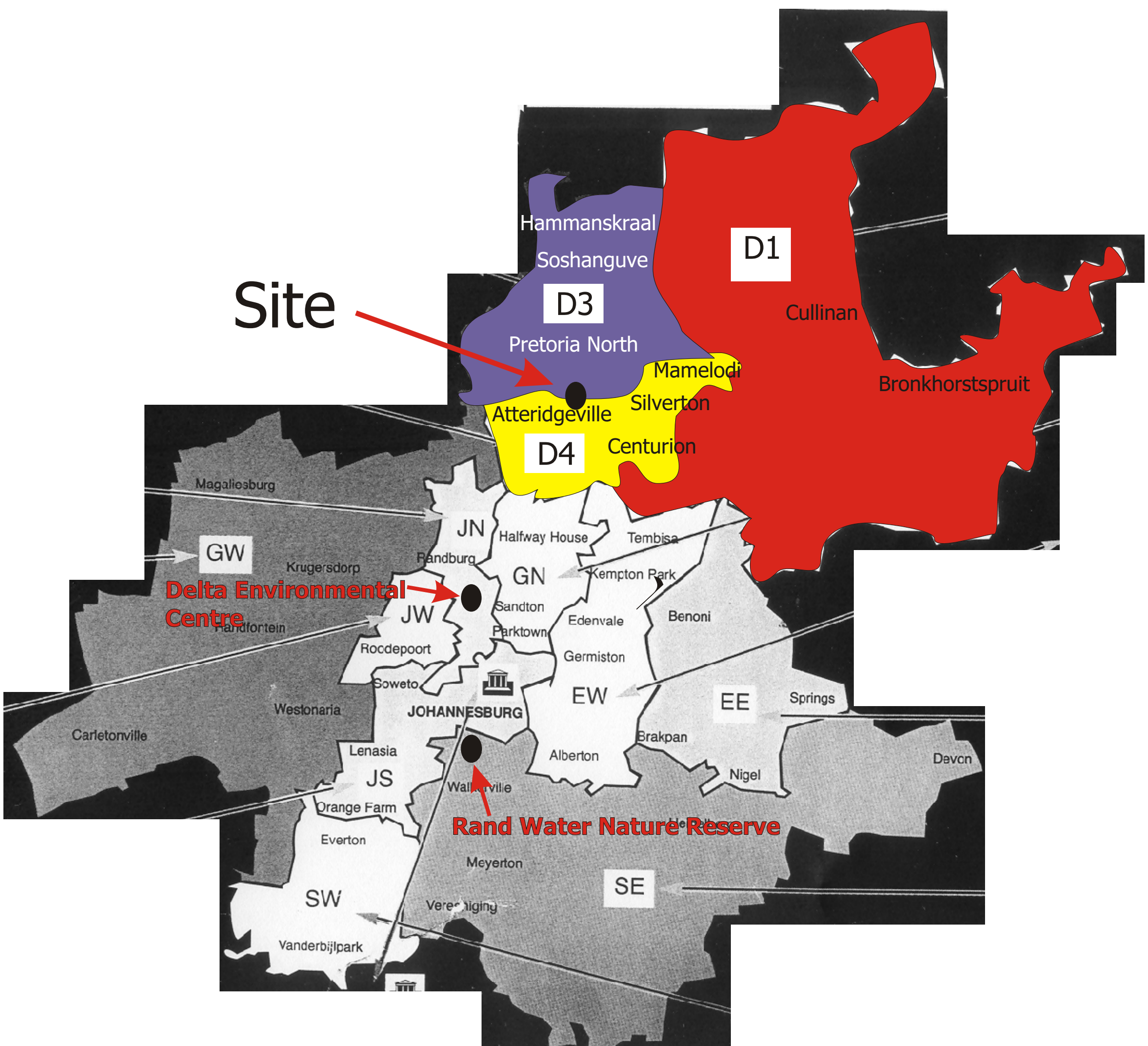


Fig 40. Different districts of the Department of Education

Design Investigation

General design objectives

A number of design objectives were identified during interviews with the Rand Water Nature Reserve and with the Delta Environmental Centre in Johannesburg. Additional objectives were generated from site specific conditions with regard to climate, topography, vegetation and traffic.

- Pragmatic design is an obvious prerequisite. The building should have a dual function. It is to provide for public functions as well as to accommodate a private office sector. Public functions include a restaurant, conference facilities, and exhibition space.
- Office layouts should be flexible, and provide ways of adapting to the specific needs of the client.
- Circulation routes should be legible and must allow for wheelchair access.
- The design should be environmentally responsible and responsive to the climate.
- The design should incorporate the existing landscape and vegetation as far as possible.
- The building should be a 'living organism' managing all the resources it uses or creates in such a way to be sustainable.
- Disposing of waste should be handled responsibly and environmentally-friendly ways.
- The design of the building and facilities should be such that with proper scheduling of times and venues it could be used for various community activities.
- The design of the building should be representative of the role **water** plays in our lives.

CIRCULATION

In a conventional office building circulation would be limited to 15% of the total floor area. In this building, the circulation and the linear flow and progression of the building form one unified element. Therefore, the circulation would be incorporated throughout the whole of the building (the value of this can not be quantified). Vertical circulation through ramps and stairs. Staircases should be close to ramps and must serve as an alternative means of vertical circulation in the event of fire.
Escape routes should comply with the requirements of the NBR, section TT19.

Norms and Standards

- Offices 12m^2
  Meeting rooms 2m^2/person

- Parking
  Typical bay 2,5mx5.4m
  Bus 3.5mx13.5m
  Aisle width 7.2m up to 15m for a bus

- Ablution
  To comply with NBR part "P" as a minimum requirement for a class A2 building.

Population = 500		Men			Women
	WC	Urinals	Hand wash basins	WC	Hand wash basins
	3	7	3	12	6

Fig 45a. Table 7 - National Building Regulations SABS 0400

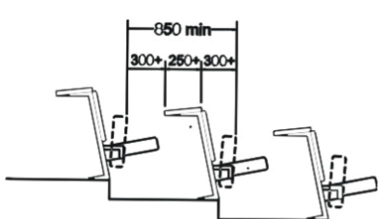
- Fire safety
  To comply with NBR parts "T" and "W".

- Facilities for the disabled
  To comply with NBR part "S".

- Auditorium / Lecture room

Auditoria/Lecture Room		
SEATS	200	
DIMENSIONS	Auditorium	12x8
	Stage	5x7
TOTAL AREA		200

Fig 45b. Criteria for auditorium



The following seating dimensions must be complied with:

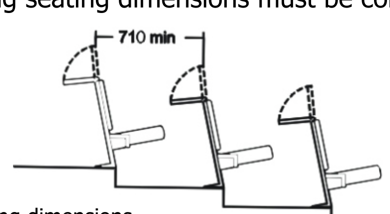


Fig 45c. Seating dimensions

Ramps and stairs offer the primary source of vertical circulation within the office sector.

ATRIUM

The lighting in the interior of the building would range from very sharp direct light, to very cozy diffused light, as the building progresses from 'dirty water' towards 'clean' water. Parallel to this runs the progress from 'gas' towards 'solids'. In the atrium of the building the quality of light would be a mixture of all these aspects, to embody the symbolism of dirty undrinkable water and chaos in the 'gas' phase.
The atrium does not only contribute to achieving these qualities, but also creates the potential of integrating the surrounding landscape with the building. The idea is to create a vibrant social space, the nucleus of the community of employees.

ATRIA

Atria naturally temper variations in the external environment. A buffer zone is created which acts as an intermediate climatic sector between the external and the internal environments. In the case of this building the external spaces flow into the internal spaces to create one new space with it's own characteristic climate and sensorial experience.

As a result of the atrium being exposed to the external environment to some extent, it becomes dynamic in the sense that gradual temperature swings occur in relation to outside changes in temperature. These gradual changes have the effect that they keep the occupants alert in contrast to controlled, static conditions.

Certain plant species can be used to assist in achieving indoor comfort levels.

(Fourie, 2002)

Fig 46. Water Technology Museum interior, Osaka, Japan by Tadao Ando

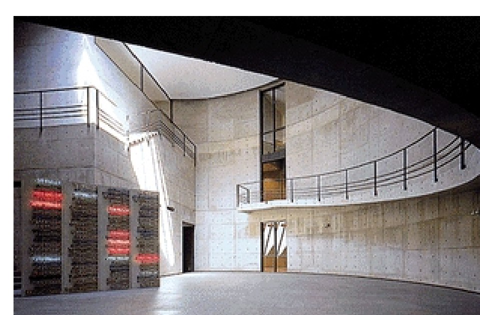


Fig 47. Naoshima Contemporary Art Museum interior, Kagawa, Japan by Tadao Ando

IDENTITY

The first clue concerning the identity of the proposed building can be derived from the site and its context. As discussed in the context study of this document, the site has a prominent character, mainly as a result of its location. If the site is developed in the same way as the surrounding buildings, the new building would have no architectural character and would form part of yet another blunt building pattern. To give this site an 'address', development thereon should aim to achieve prominence.

This characteristic can be emphasized by providing the building with a prominent entrance that would be seen from the pedestrian route along the Apies River on the west and by the main vehicular traffic along Nelson Mandela Drive on the south eastern side of the site.

Furthermore, the site asks for a design that is visually stimulating, draws attention and evokes emotion, due to the sensorial experience of water in all its phases. According to Mrs. Jennevive Koopman from the Department of Education, the building should be functional, but it shouldn't only follow function. The building or parts of the building may also function as a monument or object in the landscape.

The identity of the new Water Wise Centre should be representative of the cardinal role that water plays in the life of every person. This identity is associated with stability or instability, local technological expertise, awareness of environmental issues and the importance thereof and an understanding of the value of education in Water Wise living methods for the community, society and world today. Just as important is the ability of the building to reflect its context.

(Fourie, 2002)

Fig 49. Water Technology Museum interior, Osaka, Japan by Tadao Ando

Fig 48 Walkway with cascading water on side

MATERIALITY

Public functions are housed mainly on the southern side of the building, due to its accessibility and visibility from all important movement axes.

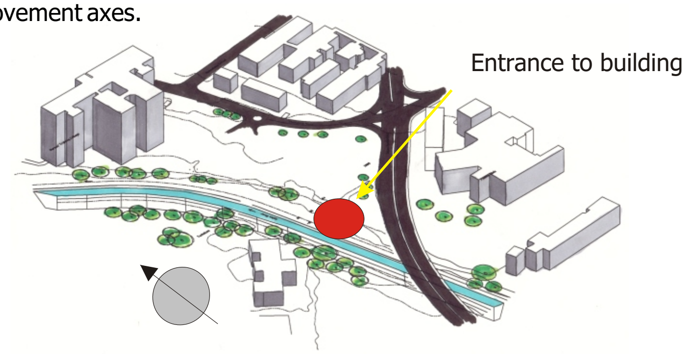


Fig 50. Showing location of entrance to building

As discussed in the foregoing paragraph, this part of the building serves the purpose of being visually stimulating, a concept which is achieved to some extent by introducing organic shapes. The decision to use such shapes has the consequence that building materials and construction techniques need to be selected carefully. Aesthetic goals need to be met, but the relevance of an appropriate construction technique which adheres to practical criteria cannot be underestimated.

A variety of possibilities exist. One possibility was implemented by Tadao Ando, at his Museum for Water Technology in Osaka, Japan.

Here stone cladding is fixed to a prefabricated metal sub-structure. The cladding is precision-cut under strict factory conditions. The result is a smooth wall which appears to be solid and can be manipulated to suit a variety of organic forms.

A second possibility is the use of stone cladding fixed directly with mortar to a concrete or masonry structure. This construction technique has its limits, but is commonly used in South Africa. The concern with this technique is the constant contact that the materials have with water.

Tadoa Ando's language in the pursuit of pure geometrical form is clearly visible even in the selection of material.
Mud banks, rough timbers and weather-stained stone form the bulk of materials used in the museum.
By negotiating an intricate series of courtyards and blind concrete walls he dignifies the blandly anonymous setting.
He added sheet metal cladding to the concrete and expressed diagonal structural bracing on the exterior. This has the effect of softening the impact of the concrete that he uses with such deftness.

The counterpoint for the overwhelming spaces is a circular drum, open to the sky, that is linked with the water court at one end. As one moves from the rectangle to the circle you are gently channelled up by an eliptical ramp to the front door of the museum, like water trickling uphill. This sequence of architectural experiences delivers one to the introductory space of the museum.

Fig 51. Stone and sheet metal cladding.

Fig 52. Spherical staircase to the front door.

Fig 53. Blunt concrete walls with water cascades

(Fourie, 2002)

BUILDING CLIMATE

Moderate Highveld climate

The main factor of concern in this type of climate is the wide daily temperature swing, accompanied by strong solar radiation levels in summer. Humidity levels are naturally moderate, but might change to higher levels due to the nature of the building. The distinct rainy season is during summer and the dry season during winter.

Design Implications

In general, negative aspects should be minimised and positive aspects exploited. Openings should be arranged in such a manner as to allow for solar gain during winter and to control solar gain during summer. Solar control devices, when applied indoors, should have a low thermal capacity to eliminate heat gain, and could have reflective qualities to promote natural lighting.

Thermal mass is advised on east and west facades and at roof level to limit indoor temperature swings. Facades that are exposed to direct sunlight, should be shaded by external shading system. Natural ventilation should be maximised during summer, provided the supply air is from a cool source. A air displacement system would be used for to achieve the above. The natural water source on the west edge of the building should be integrated into the above. Natural ventilation should be minimised in winter.

(Fourie, 2002)

Indoor comfort conditions.

1. Effective temperature 21° to 24°C
   = 60% air temperature
   + 40% mean radiant temperature

2. Relative humidity 40% - 60%
   (This excludes the exhibition spaces where water features would be part of the space)

3. Air Supply
   Fresh air supply 5l/s per person
   Indoor air movement< 0.3 m/s

This should ultimately be achieved through passive design techniques and will be discussed later on in this document.

BUILDING DESIGN

The main factors that influence the climate within and energy consumption of a building are as follows:

1. Shape and orientation

Energy losses occur mainly through the envelope of a building, i.e. facades and roof. The shape of the building impacts dramatically on the amount of energy that is lost and gained through the envelope. The ratio between the north and west facades can be optimised to limit exposure to the west and exploit exposure to the north, especially during winter. A typical ratio is roughly 1:2. Different climatic regions obviously have different optimal values, but in temperate regions this value can be accepted as average.

Another factor to take into account is the floor area relative to the facade. The optimal scenario is to limit the facade area and to enlarge the floor area. The greater the floor area, the smaller the influence of the outside temperature on the building and the smaller the structural cooling load per m^2. The higher a building, the larger the energy consumption due to the fact that energy is required to transport for example water and people vertically.

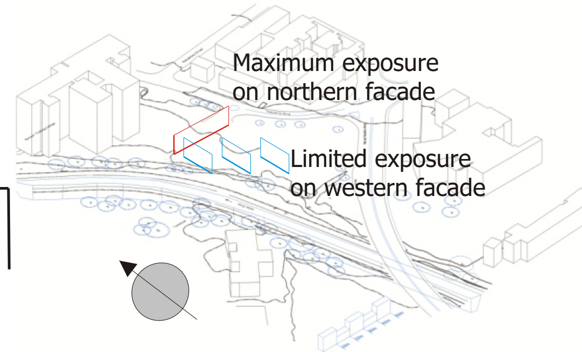


Fig 54. Exposure on northern and western facades

Temperature influences on building interior
Natural ventilation maximised in summer
East-west orientation
Medium colours (direct exposure to sun)
Thermal mass
Shaded north facades

Fig 55. Indoor temperature influences

2. Mass

It is common knowledge that the mass of a building can be utilised as a heat store. Buildings that are thermally heavy are recommended for areas where the outside temperature is consistently above or below the interior temperature. Thermal mass delays the passage of heat and causes a thermal lag effect. Hence heat can be stored during the day, possibly in the structure of the building, and be applied during the night to assist in limiting internal temperature swings. An open floor plan could assist in thermo-siphoning, in that it allows the heat from the warmer, usually northern, parts of the building to spread to the cooler parts. This scenario is applicable to winter circumstances. During summer, heat can be removed by cold night air, provided there is sufficient ventilation.

(Fourie, 2002)

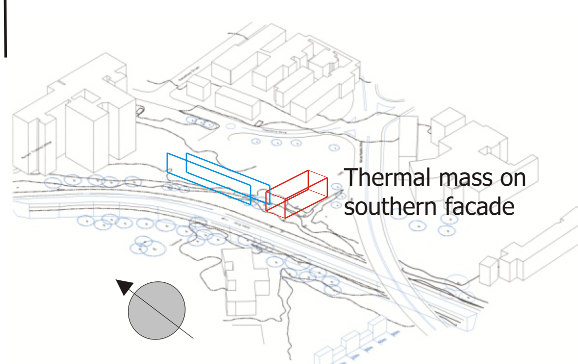


Fig 56. Thermal mass on southern facade counteracts heat loss

3. Insulation

The building envelope has a significant impact on heat gain during summer and heat loss during winter. The prime function of insulation is to reduce these gains and losses. The table on the right suggest typical insulation values of external surfaces of a building. The facade should optimally have a maximum value of no more than 10 W/m^2 (heating or cooling load) of the net usable area.

External Surface	U-value (W/m2K)
Roof	0.3
Walls	0.5
Exposed Floors	0.05

Fig 57. Diagram with U-values of materials

4.Glazing

As a general rule glass should be selected for functional rather than aesthetic reasons. Energy consumption increases proportionally with glazed area. Large glass facades, although their function is to provide a view and natural interior lighting, contribute vastly to excessive heat gains and losses. For this reason no glazing is required at levels below 600mm above floor level or 2000mm above floor level. In short, if the glazed area is less than 25% of the facade area, single glazing is sufficient.

As far as lighting is concerned, diffused light is better than direct sunlight, since the latter causes glare and internal heat gain. Only 44% of the solar energy spectrum is light, whereas 53% is heat energy. Heat energy can penetrate a building through conduction or radiation, and it is therefore recommended that both the U-value and shading co-efficient of the chosen glass be taken into account.

(Fourie, 2002)

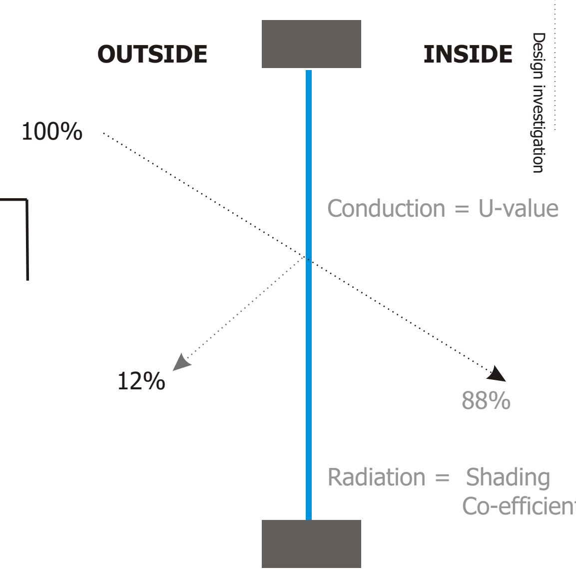


Fig 58. Heat transfer through clear glass

ENERGY CONSERVATION

Factors to consider

- Alternative energy sources: solar, wind, photovoltaic, biological.
- Waste heat recovery from exhaust air. Thermal storage.
- Energy management systems. Continuous monitoring of energy use.
- Thermal transport factor: rate of heat supplied or removed, divided by the energy used by the distribution system.
- Energy contracting: The owner appoints a specialist to manage energy consumption and shares the savings with the specialist.
- Flexibility of building usage or load changes.
- Occupancy: The building is divided into climatic zones which operate independently. Occupancy varies - some zones have higher occupancy levels than others. Occupancy also varies within one zone over a period of time. Through monitoring, energy consumption can be regulated in relation to occupancy.
- Embodied energy of materials used:

(Fourie, 2002)

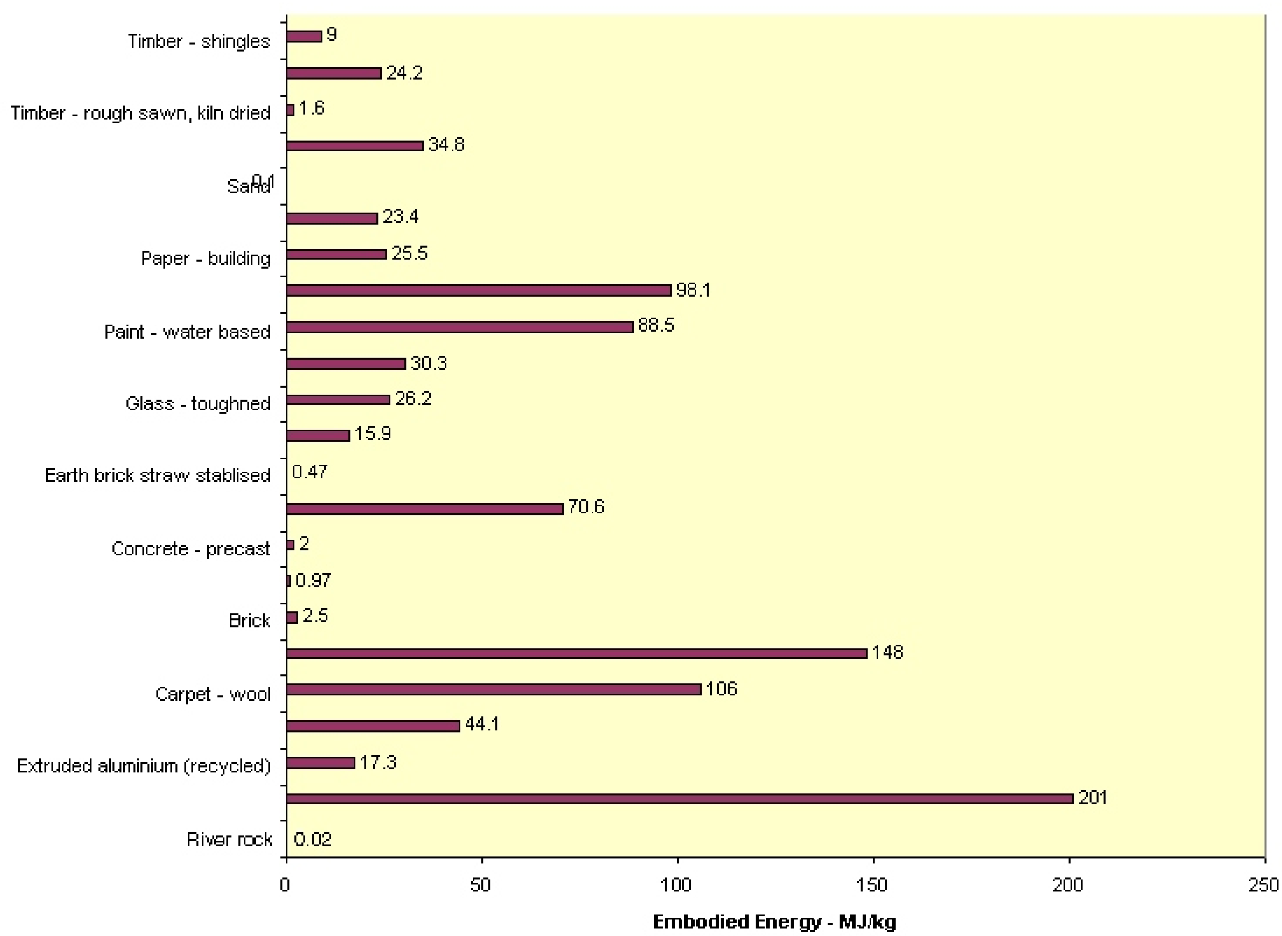


Fig 59. Embodied energy of building materials

ENERGY CONSUMPTION

Energy conservation goal

Energy consumption goals were set out in collaboration with the client, taking into account the level of energy conservation as illustrated in the diagram below:

LEVEL OF GOAL	CONSUMPTION GOAL	STRATEGY
	kWh/m2.annum	
Technical limit	<100	Latest technology with no regard to cost
Excellence	100-200	Innovative design with strong focus on energy
Good	200-300	Energy conservation as high priority
Average	300-400	Energy conservation up to competitive commercial limits
Energy Intensive	>400	Energy conservation is not considered

Fig 60. Table showing energy conservation goals. (Krige, 1997:20)

(Fourie, 2002)

ENERGY CONSUMPTION

Based on 2 500 operating hours per annum.

The desired goal is somewhere between excellent and good. Typical values for an office building of roughly 3000m^2 would be in the range 250 - 410 kWh/m^2 annually. Architects can diminish energy consumption levels. Activities generating heat, e.g. computer rooms, can be localised in the cooler zones of the building, whereas non-heat-generating activities can be arranged in the hotter zones of a building. The diagram below illustrates this concept.

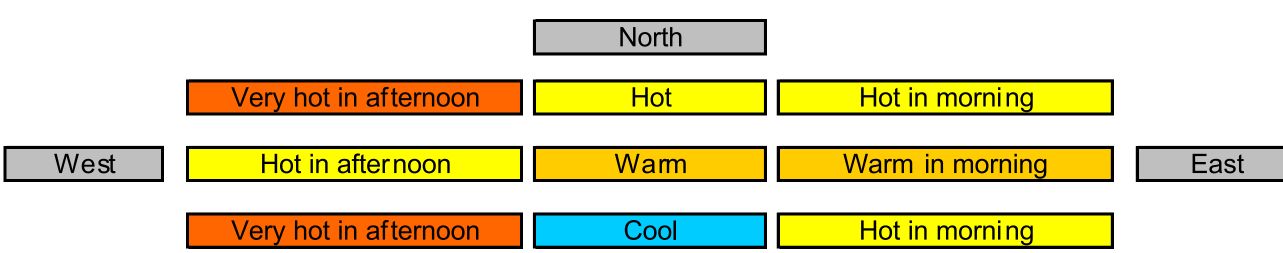


Fig 61. Heat gain of building facades

(Fourie, 2002)

LIGHTING

The energy consumption involved in the lighting of a building can be in the order of 30% - 60%. Energy can be conserved by allowing for individual control of lighting levels and also by dimming perimeter lighting when daylight levels are high.

Heat gain as a result of lighting need not necessarily be a negative factor. Return-air light fittings can be specified to allow the heat generated by lighting to be released through the ceiling.

Performance criteria : luminance levels

General offices	-	300	lux
Parking	-	50	lux
Storage	-	200	lux
Reception	-	100	lux
Conference rooms	-	100	lux

(Fourie, 2002)



Fig 62 & 63. Kiasma Museum of Contemporary Art / Helsinki, Finland.....................Architect: Steven Holl Architects / New York City

The use of natural light during day time can achieve required luminance levels. Not only are energy costs cut, but a more humane atmosphere is created.

Accommodation Schedule

Accommodation Schedule

DESCRIPTION	NO. OF PERSONS	NO. OF SPACES	AREA PER SPACE	TOTAL NET AREA
Entrance		1	50	50.00
Atrium		1	70	70.00
Retail/shop		1	100	100.00
Offices (permanent staff)	10	10	12	120.00
Offices (secretaries)	3	3	25	75.00
Store rooms		3	25	75.00
Board room		1	40	40.00
Outside smoking area		1	8	8.00
Information Centre				
Library/ info centre		1	100	100.00
Reading area		1	80	80.00
Archive		1	50	50.00
Exhibition Spaces		3	150	450.00
Laboratory		1	25	25.00
Lecture room / Auditorium		1	200	200.00
Services				
Toilets				80.00
Kitchenette		1	10	10.00
Staff toilet		1	6	6.00
Canteen				
Kitchen		1	20	20.00
Scullery		1	10	10.00
Counter		1	8	8.00
Lounge		1	40	40.00
Dining area		1	100	100.00
Waste disposal		1	50	50.00
		1	50	
Emergency Generator		1	20	20.00
Fire routes or stairs				
Lift rooms				
Access control (vehicular)				
Parking				
Covered			15	202.50
Bus			5	236.25
Car			10	135.00
TOTAL NET AREA				2,360.75
Circulation & utility factor 0.2				472.15
TOTAL GROSS AREA				**2,832.90**

Fig 64. Accommodation schedule

Precedent Studies

PRECEDENT STUDIES

The proposed building would not only educate people in ways to live Water Wise, it will also lead you to discover the realms of impossibility when it comes to water. It will demonstrate water in all it's phases : gas, liquid and solid; water as an aesthetical catalyst, water as a building element the sensory experience when in contact is made with water, either by smell, touch, hearing, seeing, tasting and sensing.
The following precedent studies are used to open the mind to the possibilities when confronted with the enigma of water. Water will be experienced in its totality. The first precedent study is the Swiss Water Expo by Diller and Scofidio.

(Lim, 2002)

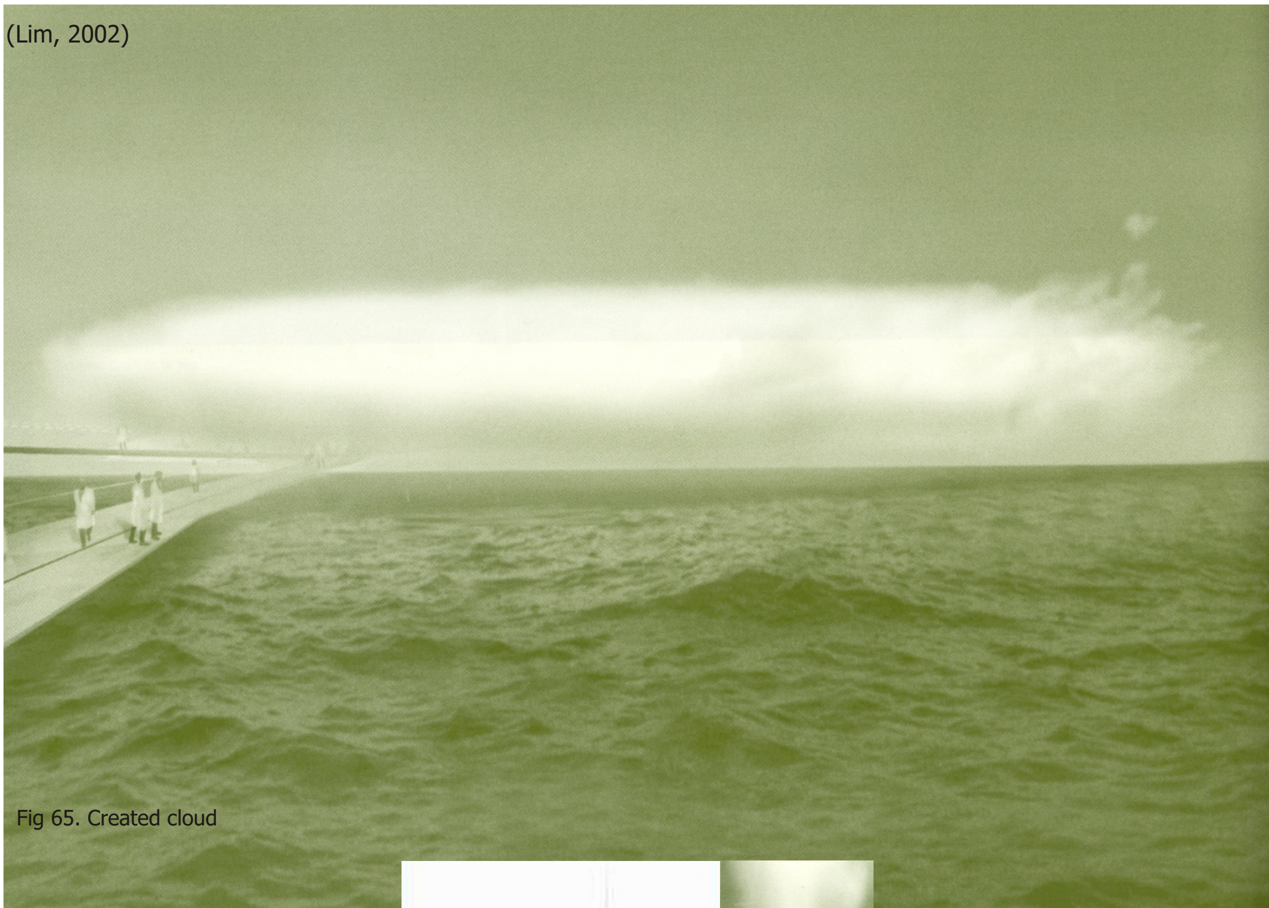


Fig 65. Created cloud

Fig 66. Visitors inside cloud

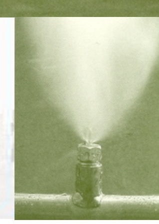


Fig 67. Nozzles used to create fog

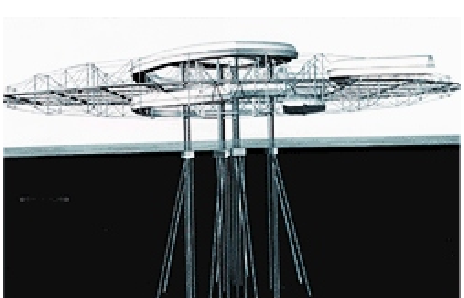


Fig 68. Construction

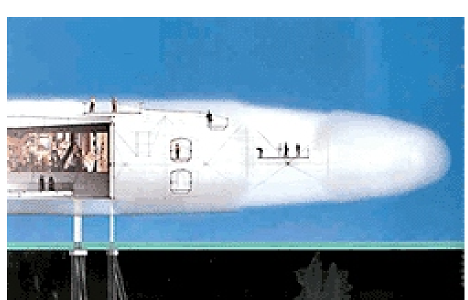


Fig 69. Construction detail

Fig 70. Walkway to entrance of building

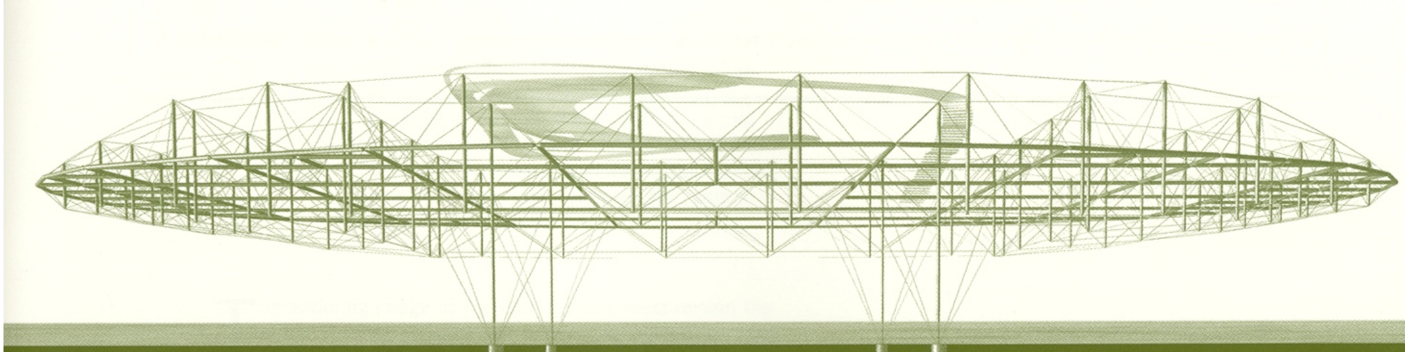


Fig 71. Detail of building

The centrepiece pavilion of the Sixth Swiss National Exhibition is a suspended platform shrouded in a perpetual cloud of man - made fog, designed by architects Elizabeth Diller and Ricardo Scofidio. The cloud can host up to 400 visitors.
The so-called 'blur pavilion' is visible from afar. The building consists of a 60 x 100 x 20 - metre metal construction that sprays innumerable tiny drops of lake water from 31400 jets. The high-pressure spraying technology ensures that the fleeting sculpture will be visible in all weathers, rain or shine.
The high-pressure spraying is carried out by high-grade steel jets with tiny apertures only 120 microns in diameter, through which the water is forced at a pressure of 80 bars onto fine needle points directly above the apertures and atomised into innumerable tiny droplets 4 to 10 microns in diameter. The droplets are so small that most of them remain suspended in the air. If sufficient jets are installed in a specific volume, they saturate the air with moisture and create the effect of mist or, in this case, the effect known as the blur.

Walking down the long ramp, visitors arrive on a large open - air platform at the centre of the fog mass where the only sound to be heard is the white noise of pulsing water nozzles. Computers are adjusting the strength of the spray according to the different climatic conditions of temperature, humidity, wind speed and direction. The fog mass changes from minute to minute. The blur building expands and produces long fog trails in high winds, rolls outward at cooler temperatures, and moves up or down depending on air temperatures.

Raincoats
The interactive media project also features wearable, wireless technology embedded into 'brain coats', technologically - enhanced raincoats. Visitors' rain coats react to each other, indicating either positive or negative affinity between visitors through colour changes and sound.

Diller & Scofidio
The focus of Diller & Scofidio is as much about the nature of space as it is about creating spaces. Their architectural practice utilizes design, performance, and electronic media with architectural and cultural theory as accompanying tools to investigate architecture as a field of social relationships and to remind us that architecture is everywhere.

(Lim, 2002)

Fig 72. Cloud visible from a distance

Fig 73. Cloud visible from a distance

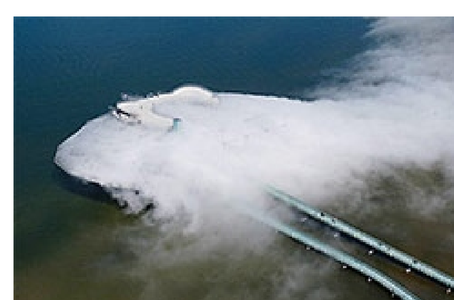


Fig 74. Cloud visible from above

SPLASH!!

OSAKA, Folly (1990)
Peter Cook + Christine Hawley

Every 1$^{3/4}$ minutes, a giant splash projects from the otherwise calm metal mask which clads this structure. To understand the mechanism, the visitor must enter the body of the structure. A small internal corridor reveals a large glass pane over which a thin veil of water periodically runs, blurring the view of the lake outside. The water is collected in a pebbled trough beneath the transparent walkway, and then into a hopper from which the collected body of water is then tipped through the facade causing the 'splash'. Observing the water's passage, the visitor becomes part of the event.

(Lim, 2002)

Fig 75. Osaka Folly (1990)

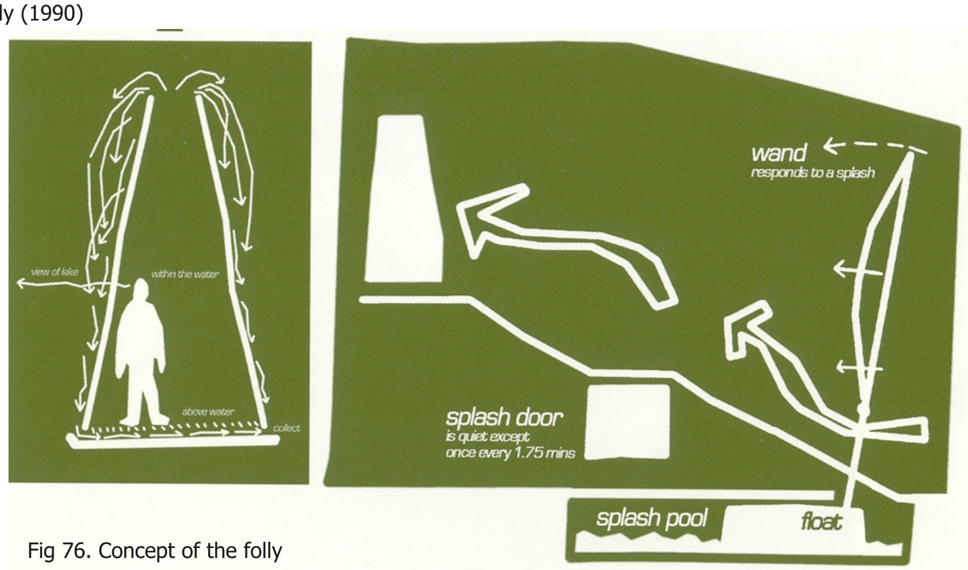


Fig 76. Concept of the folly

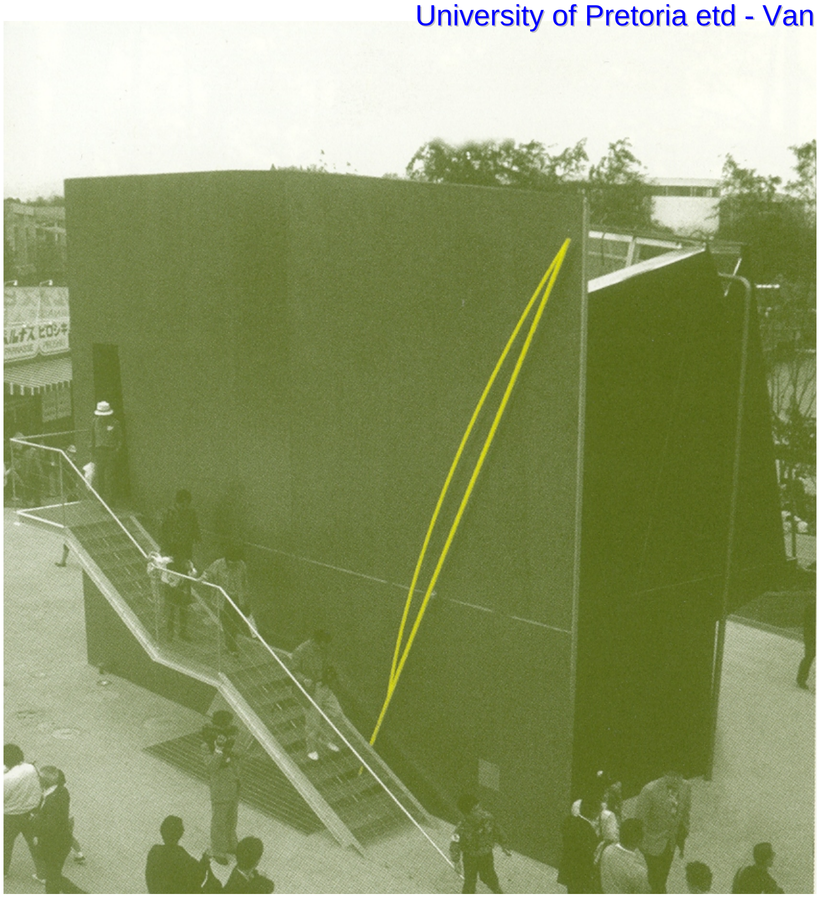


Fig 77a. Entrance to folly

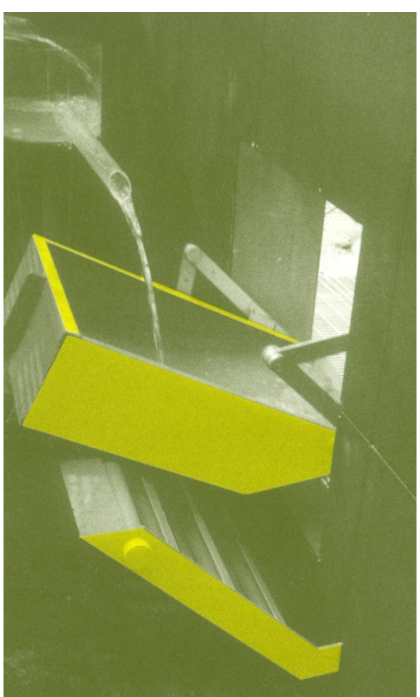


Fig 77b. Preparation for 'splash'

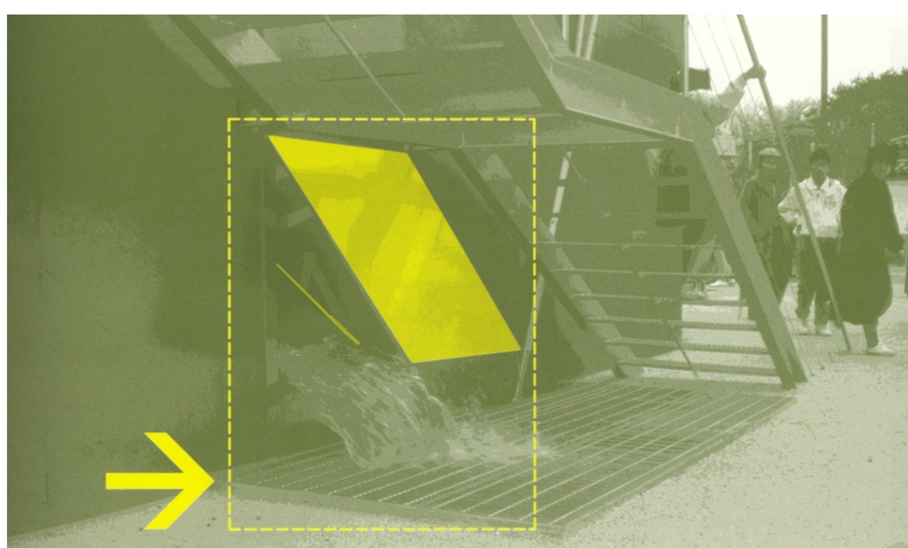


Fig 77c. 'Splash'

The following precedent studies will show the materiality, and possibilities of material use for the building. A variety of materials will create a sense of diversity which will link to the variable nature of water.

FELIX NUSSBAUM MUSEUM, OSNABRUCH, BERLIN, GERMANY

Architect: Daniel Libeskind

The museum sought to provide an emotional architectural experience. This is achieved through the simple intersection of three rectangular volumes. It's a 'museum without exit', which symbolises the artist's exile and search for orientation.

The design is highly unconventional and contain areas displaying layers of space and meaning. Disorienting effects riddle the interior spaces. For example, a particular space may appear to allude to one thing upon entering and then appear to be something quite different when looking back from another side. This was achieved by three-dimensional spatial manipulations, such as sloped floors and ceilings and non-parallel walls. Spaces even fold back upon themselves. Spaces are familiar, yet different in form and concept, questioning the occupant's.

This techniques can be incorporated in the Water Wise centre to distinguish between the different phases of water and the different volumes required to illustrate to it's allocated water-phase.

The building consists of three main components. Made of exposed concrete, the two-story Nussbaum Corridor is 45-metres long and 3 metres wide. The two-level zinc-clad Nussbaum Bridge links the new museum to the old. The oak-clad box contains most of the gallery and work space. (Grayston Trulove, 2000)

Fig 78. Design based on a series of interrelated lines

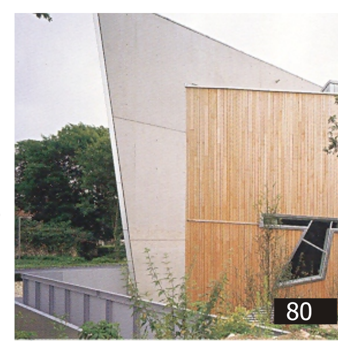


Fig 79-81. Use of wood, concrete and zink sheeting in the maze-like building

Fig 82 & 83. The spacial illusions extend into the gallery spaces

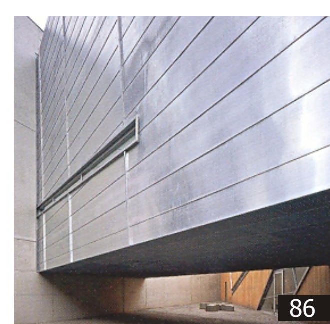


Fig 84-86. Use of wood, concrete and zinc sheeting in the maze-like building

Fig 87. Exhibition spaces with defused lighting

For an interactive building like the Water Wise Centre, the landscape surrounding the building should be integrated with the whole design. The landscape will be the place where scholars or visitors have the opportunity to interact with water, to experience, smell, see, hear and feel the water. The landscape should flow into the interiors.
The next precedent study shows the possibilities there are to create a playful yet practical landscape to fuse site and building into one.

ENRIC MIRALLES - NEW PARK, BARCELONA

The areas around the site lacked specific characteristics and this demanded a redefinition of the site.

The overall experience in this landscape is one of entering a dreamlike space. From any entrance point one is guided by the frozen landscape. There is an outdoor theatre with staircases, new topographies and a multicoloured floor. Pieces of old graffiti walls were kept and combined into the new lines and shapes of the site. The light sifting delicately through screens, create varying zones of sun and shade, and redefine the zones of activity according to the hour of the day or the time of the year. The radical geometry of the Park of Colours gives one a sensation of moving through timeless space.

The park is an authentic display of different time shapes, of varied notions of the passage of time, most ingeniously resolved in the idea of a place 'where it rains every morning', evoked by the traces of water left by the discontinuous spurts of the fountains. Their rounded shells, covered with blue ceramic, glitter through the trees like small pools of petrified water.

The design provokes one to engage with the sense of scale in a playful game of details, alternately making one feel too small, dangling ones feet above the ground while seated on one of the benches, or too big, coming up too close to one of the sturdy, gnome-like lampposts. Vegetation contributes to the functional division of the park.

Through its combination of differently textured materials (coloured concrete, brick, ceramic, steel and wood) and the ever-changing lights and shadows, the park appears iridescent and unpredictable.

(Grayston Trulove, 2000)

Fig 88. Landscape

Fig 89. Landscape

Fig 90.

Fig 91.

Fig 92.

Fig 93.

In the following local example we can see how the architects achieved greatness with less than expected. Visitors are drawn into the experience of "Apartheid" and undergo an emotional and physical experience as they progress through this linear path of experience. There are places that upset the emotions, there are places that calm the emotions, there are places to get involved hands-on and there are places to leave one's own legacy. It is in looking at this building and it's architectural characteristics that one should take note of simple but very effective ways of getting visitors involved in the holistic experience of architecture.

APARTHEID MUSEUM, JOHANNESBURG, SOUTH AFRICA

The museum came about as part of a casino bid seven years ago. Bidders were obliged to include a social responsibility project, and the winning consortium indicated that they would build a museum.

R80-million was committed to the building of the museum by Claude Grundman, from the Akani Egoli consortium. The consortium is committed to the running costs of the museum for a further two years, by which time they would have spent around R100-million on the project. Linda Mvusi Architecture and Design and Mashabane Rose Architects were some of the architects working together with GAPP Architects on this project.

The Museum occupies approximately 6 000 square metres on a seven-hectare site, which consists of natural recreated veld and an indigenous bush habitat containing a lake and paths, alongside the stark but stunning building.

The synergy between the natural elements and the building finishes of plaster, concrete, red brick and rusted and galvanised steel, creates a harmonious relationship between the structure and the environment.

A multi-disciplinary team of curators, filmmakers, historians, musicologists and designers were assembled to develop the exhibition narrative which sets out, by means of blown-up photographs, artefacts, newspaper clippings, and film footage, to graphically animate the Apartheid story.

Tickets for the Museum are plastic credit-card size cards indicating either "Non-white" or "White", and procuring one heralds the start of a harrowing journey.

As one swings through the turnstile, one stars a journey beginning with the early peoples of South Africa, and ending with the birth of democracy in the country. One is greeted by cages, inside which are blown-up copies of early identity cards,

Fig 94. Entrance to Apartheid Museum

Fig 95. Bench for Europeans only

The remainder of the Museum is just as graphic:

One can sit in a large yellow and blue armoured police vehicle, nicknamed a "casspir", and watch footage taken from inside the vehicle driving through the townships.

- Dangling from the roof, 121 nooses represent the political prisoners hanged during apartheid.
- A June 16, 1976 room with a curved wall of monitors shows footage of that day from around the world.
- A cage displays dreadful weapons that were used by the security forces to enforce Apartheid.
- Footage is shown of a remarkable 1961 BBC interview with Nelson Mandela when he was in hiding from the authorities, as well as footage of prime minister Hendrik Verwoerd addressing a crowd in English, explaining how the country could be happily ruled only if the races were separated.


Fig 96.


Fig 97.


Fig 98.

At times one feels overwhelmed by the screens and the sounds and the powerful images they are projecting. One is lead through room after room in a zigzag of shapes, some with tall roofs, some dark and gloomy, some looking through to other images behind bars or cages that make it clear that Apartheid was evil.

And just when one feels that the bombardment of the senses has become intolerable, one reaches a quiet space, containing a glass case with pebbles on its floor, which holds a book of the post-apartheid Constitution.

One can express solidarity with the victims of Apartheid by placing one's own pebble on a pile. Then one is led out on a grassland with paths, which take one to a small lake, for much needed time to reflect.

There is also a recording studio in which visitors can leave their experiences under Apartheid, if they had any, for others to hear.

It is not only important to tell the Apartheid story, but it is also important to show the world how it has been overcome. There certainly is a lesson for other countries here, and this is related through the complexity and sheer power of the installations.

The overriding message is to show local and international visitors the perilous results of racial prejudice and how this, in the case of South Africa, nearly destroyed the country, and in so doing, destroyed people's lives and caused enormous suffering.

An architectural consortium consisting of five leading architectural teams was assembled to design the museum. The museum is a triumph of design, space and landscape fused to create a building of international significance.

The building itself has power, which is what is needed to put across the powerful message the Museum conveys. It is the most important public building to be built in South Africa in the last 20 years.

Fig 99.

Fig 100.

Baseline Criteria & Technical Report

BASELINE CRITERIA:

Non-renewable resources are being depleted and there is increasing environmental damage as a result of human activities. It is therefore increasingly important that this is addressed, and sustainability becomes a key issue in the way society live and work. Buildings can play an important role in supporting sustainability. This is done through careful planning in which design decisions, material specifications and so on are carefully evaluated in terms of their long term impact on the economic, social and environmental sustainability of a society and the natural environment.

The Sustainable Building Assessment Tool (SBAT) has been designed to help evaluate the sustainability of buildings. This is done by assessing the performance of a building in relation to a number of economic, social and environmental criteria. The tool is particularly appropriate for use in developing countries, and therefore includes aspects such as the impact a building on the local economy, as economic issues are often a priority.

The tool can be used in the design stages of a new building, or for the refurbishment of an existing building. It is designed to encourage the development of more sustainable buildings by enabling different options to be rapidly evaluated and compared. The tool also enables buildings to be rated in terms of their sustainability, and to be compared to each other in order to set up baseline criteria with which the end product should comply.

The following graph shows the different criteria that need to be addressed to achieve a sustainable design:

(Gibbert, 2002)

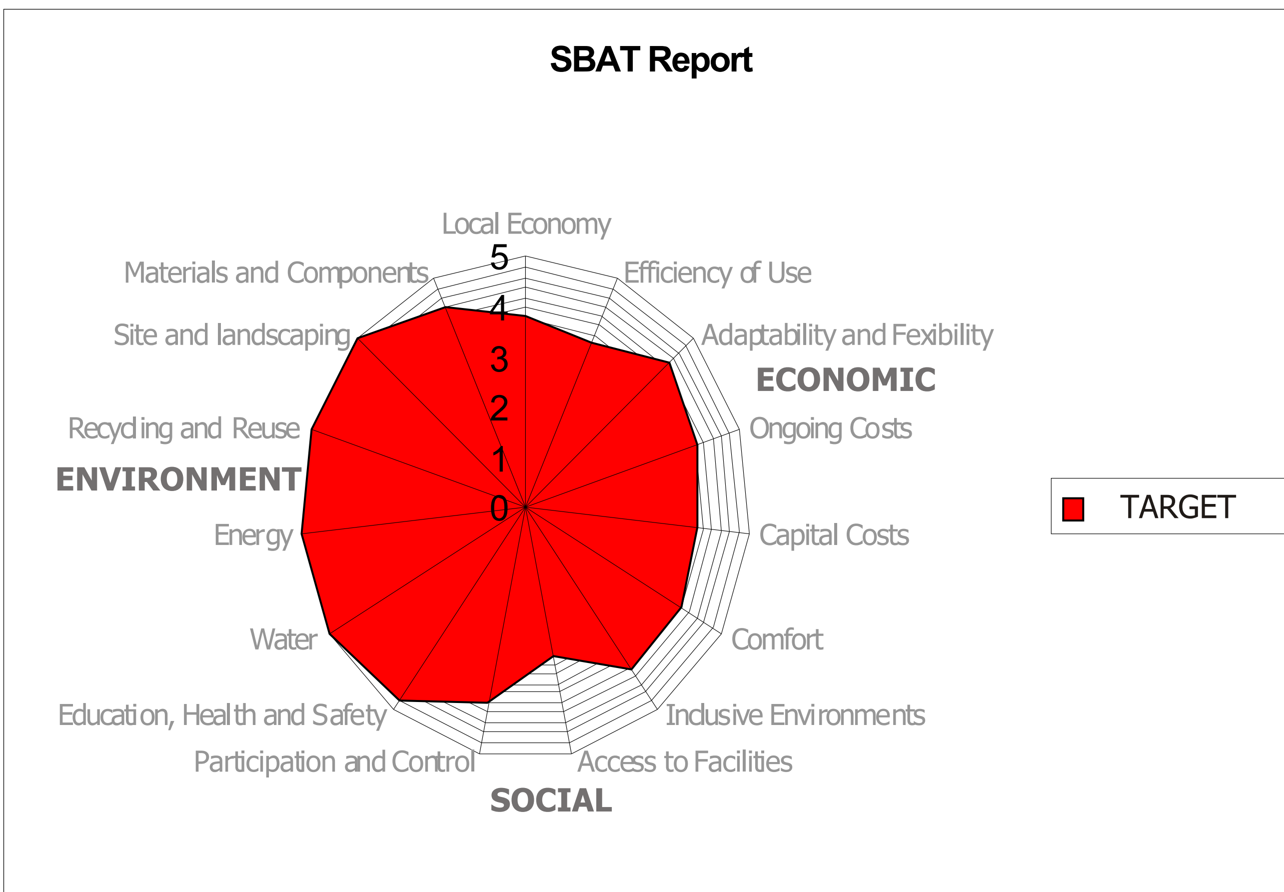


Fig 101 Sustainanable Building Assessment Tool

ENVIRONMENTAL ISSUES:

Water:
Water is required for many activities. However, the large-scale of the conventional water supply has many environmental implications. Water needs to be stored (sometimes taking up large areas of valuable land and disturbing natural drainage patterns with associated problems due to erosion etc). It also needs to be pumped (using energy) through a large network of pipes (that need to be maintained and repaired). Having delivered the water, a parallel effort is then required to dispose of it after it is used, i.e. Through sewerage systems. Reducing water consumption supports sustainability by reducing the environmental impact required to deliver water, and dispose of it after use in a conventional system.

- Rainwater

Water harvesting:

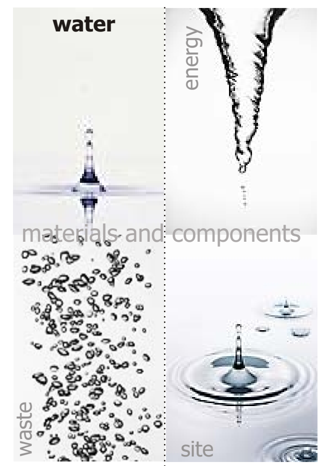
The population of the proposed building will vary through the day. The maximum population has been calculated to be **+- 400 people**. Part of the roof structure of the building is used to collect water for purifying and usage in the building. A baseline of 200 occupants, thus **50%** of the total population, should be used to calculate the capacity of the water catchment system.

Population:
200 people

Water use per person:
+- 20l per person per day, thus 4000l per day.
For a month a quantity of 1**20 000l** of water will be needed.

A storage tank of adequate size, is used to store water after it is purified by the cistern system described below:

ENVIRONMENT



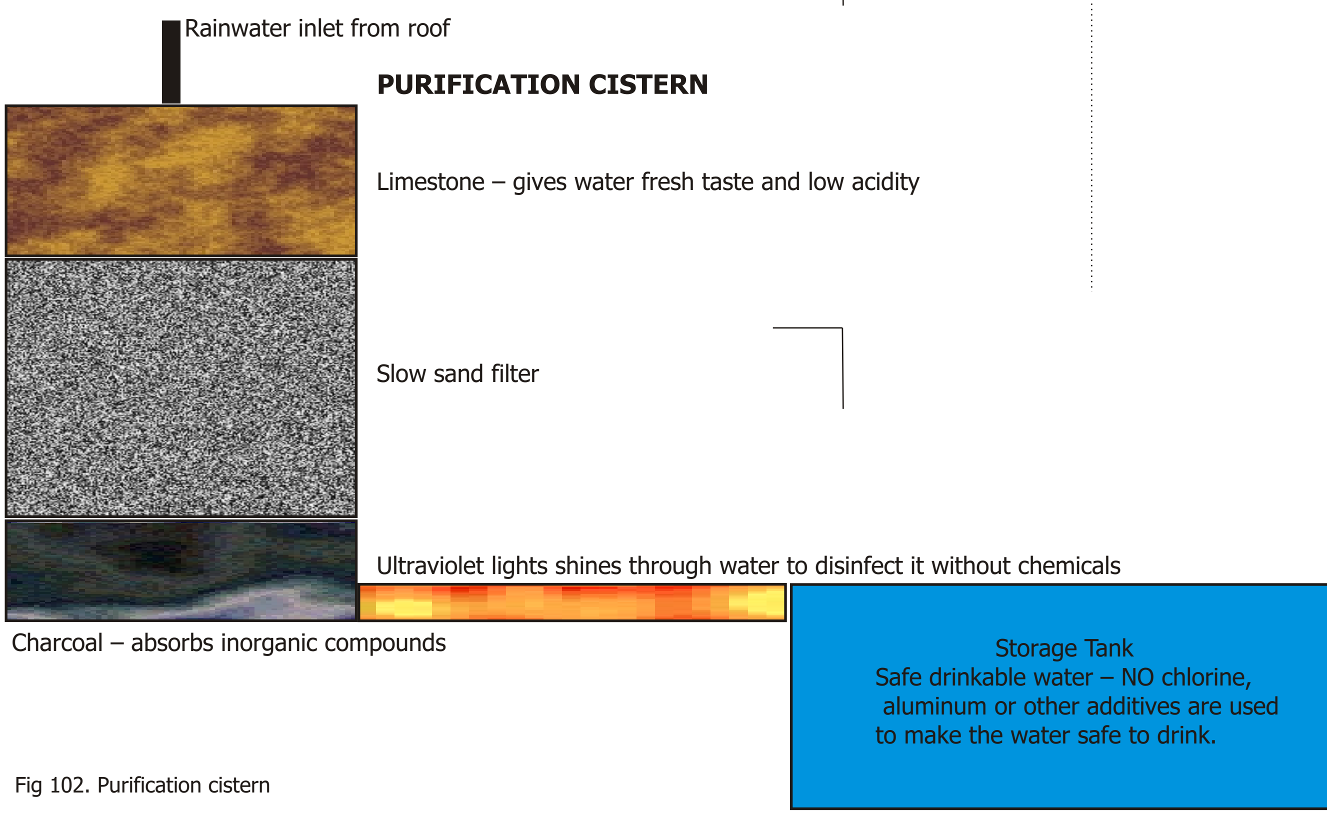


Fig 102. Purification cistern

Rainwater

The average rainfall f or 8 sites next to the Apies River is 204l per month on a site of average size, 3650m2 (according to the precipitation table below).
Thus it is assumed that a site with size 8894.3m2 will receive an average of 497l of rainwater per month.

From this it is clear that the demand on water, generated by this building, would not be met only by the collection of rainwater.
The rainwater that is being harvested by this building will merely reduce the bulk amount that it will receive from the municipal connection.

The roof structure of the office and laboratory building will harvest water for conducting experiments in the laboratory as seen in Fig. below.

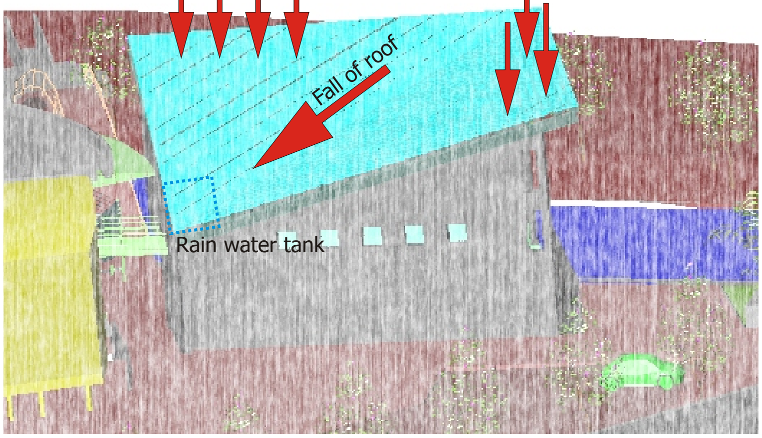
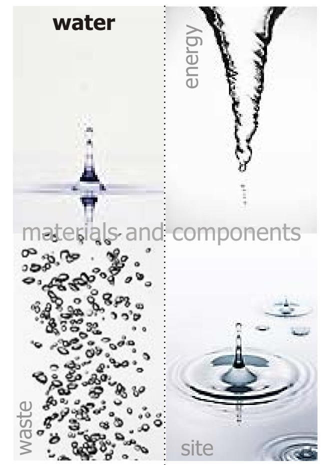


Fig 103. Rainwater harvesting on northern roof

ENVIRONMENT



Water harvesting:

The roof with an area of 393m2, will harvest an average of 22l of water per month.

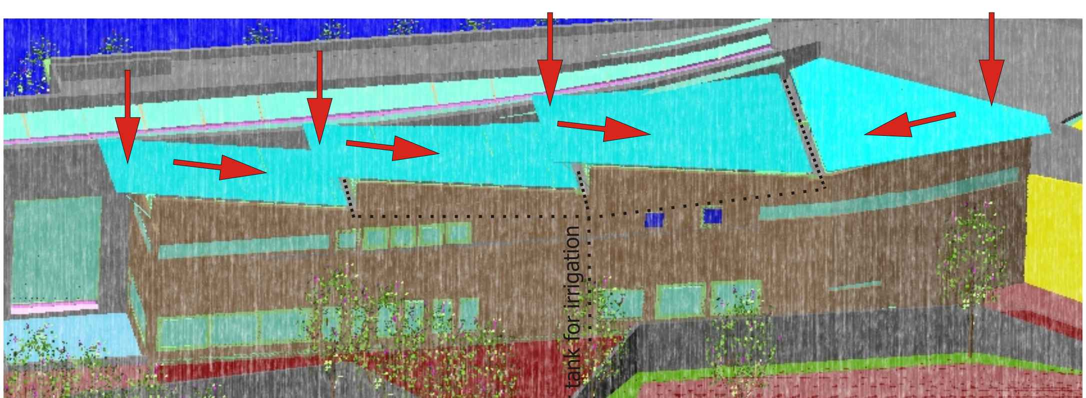


Fig 104. Rainwater harvesting on eastern roofFig 104. Rainwater harvesting on eastern roof

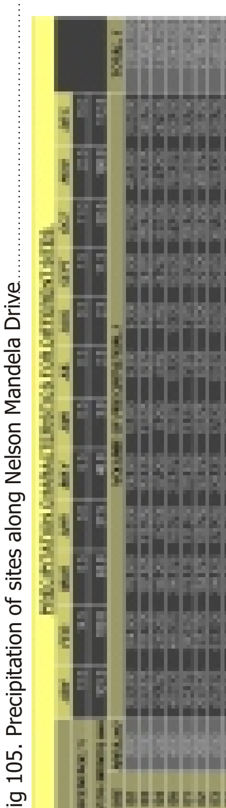


Fig 105. Precipitation of sites along Nelson Mandela Drive.

Water harvesting:

The eastern roof area are used to harvest water for irrigation. The water from the 3 gutters are collected and stored in a tank for the sole purpose of irrigation.

Grey Water Recycling

In addition to the reduction of the water demand, the collection, storage, treatment and redistribution of grey effluent is used for sanitary applications. Any excess water could be added to the irrigation or laboratory tank and visa versa.

Benefits:

- water consumption is reduced
- sewerage charges are reduced

As water can be recycled multiple times for various purposes, the water demand can be reduced drastically.

Recycling System:

- collection of waste water:
  all grey water are channelled into a central storage tank.
- treatment:
  before the water enters the storage tank it is filtered through a very simple and basic sand filter system.
- storage:
  it is stored in a large tank where it is ready to be redistributed.
- redistribution:
  grey water is only redistributed for use in sanitary systems.

All grey water produced by the building is harvested and recycled for reuse.

ENVIRONMENT

Very important:
This is not a building focussing on the availability of water technology in the built environment and the demonstration thereoff.
This building demonstrates exactly the opposite - that we don't have enough water to let them run over gabion wall structures to evaporate in the quest of cooling down our buildings.

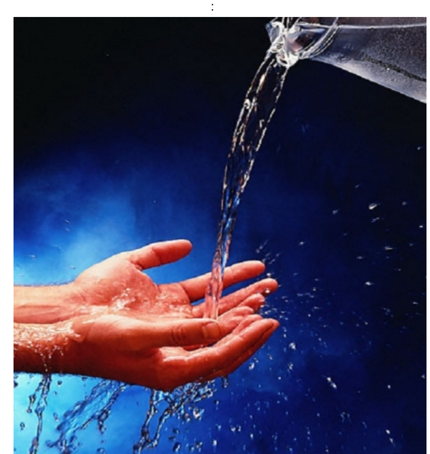


Fig 106. Purified water

Water use:

Only **water-efficient devices** are used throughout the building, especially where sanitary devices are concerned.

- Ultra-low-flush toilets (low-flush toilets are designed to use six litres of water per flush, significantly less than conventional toilets)
- Urinals that are manually flushed when required
- Taps that automatically stop after a few seconds
- A **40 %** reduction in water use can be achieved
- **Long term water conservation** strategies are employed

ENVIRONMENT

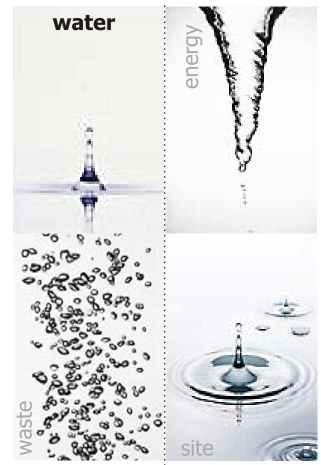



Fig 107. Ultra-low-flush toilet


Fig 108. Water-efficient urinal

Run-off

Run-off is reduced by the use of pervious or absorbent surfaces around the building. Remaining spaces are landscaped to fit the principles of a Water Wise garden. Hard landscaping is minimised, and pervious surfaces are used for car parking and paths.

Grass paving systems are used as an alternative to asphalt. They are strong enough to support heavy vehicle loads and yet are water permeable.

Benefits:

- they reduce surface temperatures around buildings
- they permit surface water filtration/drainage
- they eliminate the need for a catch basis system

Grass paving installations are used in any situation where low to medium use parking surfaces are required. The open cell system is used to support the load of heavy vehicles. Grass paving is appropriate for both drive aisle and parking stall applications.

The grass paving is designed to suit the soil conditions and loading requirements while allowing for drainage. Wood blocking is not used, to prevent a dam effect in heavy rain.

Parking stalls are marked with buttons that clip into the support structure. Concrete curbs are installed with lines to contain and designate stalls.

The installation takes 2-3 months to develop a root system from seed, so construction installation must be timed for the opening of the building. The installation can be ready for immediate use if turf is installed.

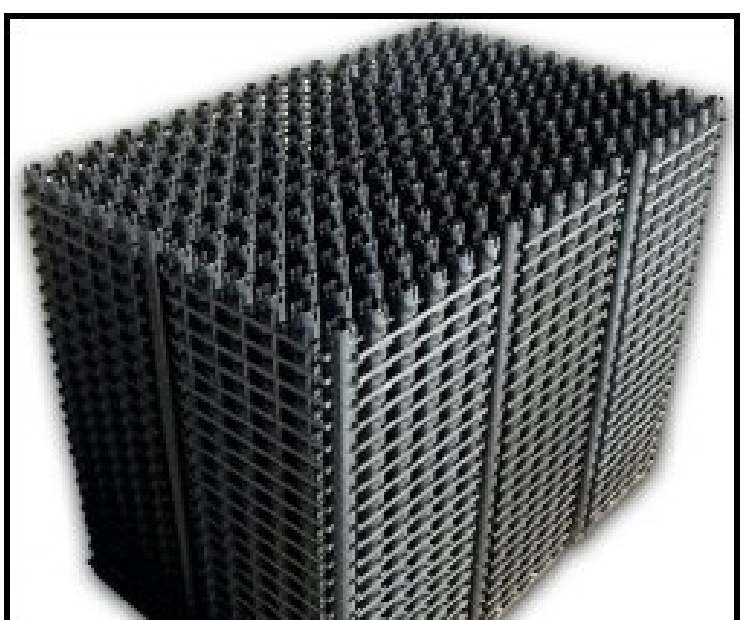


Fig 109. Grass paving system

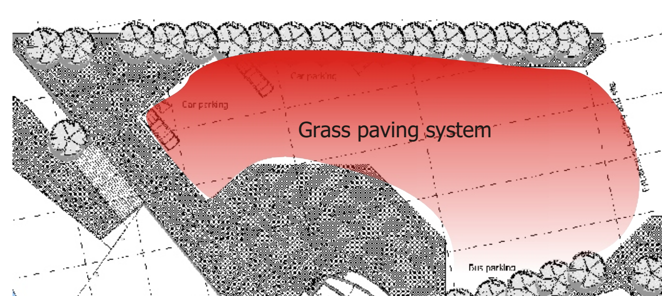


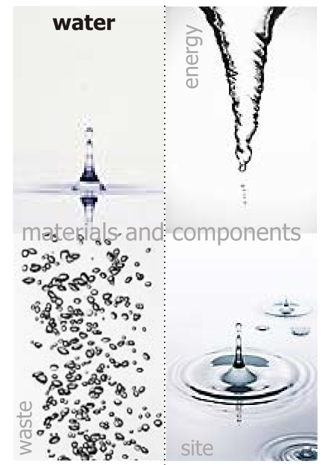
Fig 110. Grass paving system used at parking lot

Planting

Planting is incorporated into Water Wise gardens to serve as examples to demonstrate Water Wise principles. Plants with low water requirements, such as indigenous species, are used. The gardens are planned to be water efficient.

Fig 111. Example of a Water Wise garden

ENVIRONMENT



Principles of Water Wise Gardening

Design:
A Water Wise design maximises the use of water in the landscape. It takes into consideration microclimates, functional utilization, and aesthetics.

Mulching:
Nature's blanket slows down wasteful evaporations of water.

Watering:
Water should always be applied efficiently. Grey and lag water from the bathrooms should be reused. Rainwater should be collected and channelled into the garden..

Appropriate lawn:
The "hardiest" variety of lawn suited to the particular circumstances should be chosen. Narrow strips of lawn should be replaced with mulch, paving or ground covers.

Plant selection:
Attractive plants that cope with the local climate can form a sustainable bulk structure in the garden. Plant water thirsty varieties in focal points to create interesting areas in the garden.

Zoning:
The overall water consumption of the garden can be reduced by grouping plants with similar water requirements together.

Soil improvement:
Healthy soil is fertile with plant nutrients; it holds enough water and air for the plant, and does not compact easily.

Watering efficiently

Maximise rainwater:
Water can be directed to a settling pond, depressed lawn areas or a wetland by using stone-packed or grassed water channels. The stones help to slow and desilt the flow of the rainwater. These channels can be used to create a "dry riverbed". Trees planted in hollows will often flourish with no extra water.

Re-use water:
Excess grey water that is not recycled for sanitary use can be used for watering the garden.

Watering:
A well-designed irrigation system must be installed. The bigger the droplets from the sprinkles the less likely that the water will evaporate or get blown away by the wind. (High pressure causes fine droplets). Irrigation should be switched off during rainy weather or when soil is moist. Watering should be done in the early morning, or early evening, not in the heat of the day. Sprinkler water is wasted when it falls onto paving and not on the plants. Large, wide sprinklers for individual plants should be avoided. A direct hose or watering can should preferable be used.

Zoning

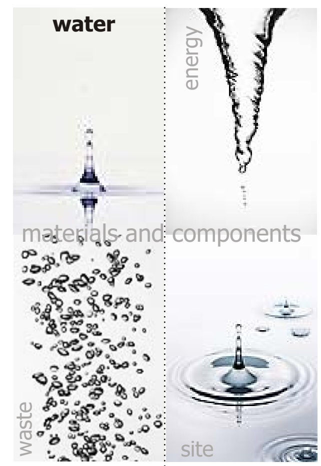
The overall water consumption of the garden can be reduced by grouping plants with similar water requirements together.

High water use zone:
Focal areas are where the garden is most apprecieted, for example at the gate, doorways and areas for relaxation, where garden furniture is situated). Focal areas can be high water use zones. This can be achieved by adding extra detail using colour and exciting features.
The way to make thirsty plants (like annuals) more Water Wise is to position them in the shade and in containers, if possible.

Medium water use zone:
Most plants in the garden can receive rationed water to keep them well maintained. A large variety of perennials can be used to create colour.

Low water use zone:
Areas should be created that will survive mostly on rainwater. These zones only receive occasional watering. Hardy ground covers under shrubs can be added to fill up large bare spaces.

ENVIRONMENT



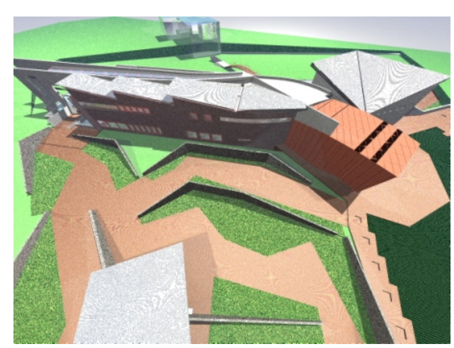


Fig 112. Water Wise garden at the Centre

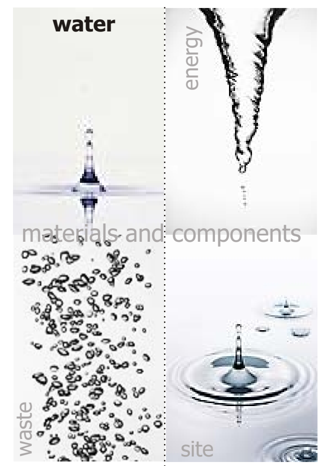
Watering efficiently

The layout of the Water Wise Garden is done in accordance to the prescriptions given in the previous pages. Suggestions by Rand Water were also taken in consideration.

It was split into three zones - high water use zone, medium water use zone and low water use zone.
The garden is used as a very important part of the learning process, while visiting the building.
A shaded are is provided by a simple roof structure and each 'sector' is provided with enough seating for a group of 25 people.
There are water drinking point at regular intervals during the walk through the garden.

The garden also forms part of the final stage of the circulation route as one exits the building and walk back to ones car/transport.

ENVIRONMENT



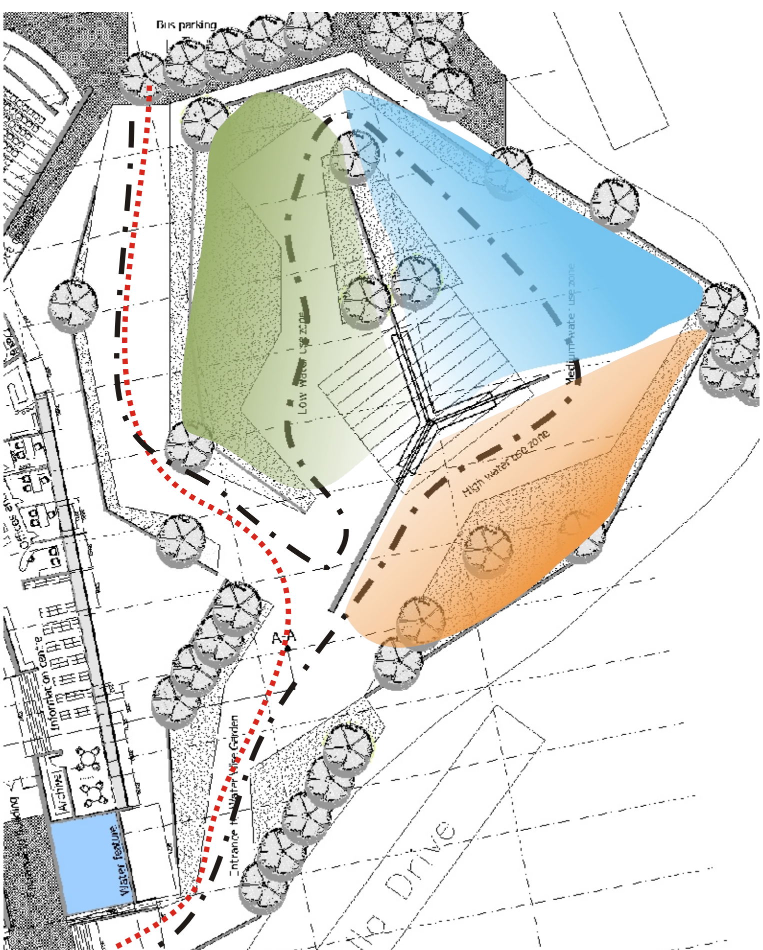


Fig 113. Water Wise Garden

Low water use zone

Medium water use zone

High water use zone

End of circulation route

Circular route through garden

ENERGY:

Buildings consume about 50% of all energy consumed by man. Conventional energy production is responsible for making a large contribution to environmental damage and non-renewable resource depletion. Using less energy or using renewable energy in buildings therefore, can make a substantial contribution to sustainability.

Location:
The building/site is located **within 500m** of a large **public transport** node. See figure below.

ENVIRONMENT

Fig 114. Public transport node

Fig 115. Panoramic view of the taxi rank

Natural Ventilation System:
Outdoor air flow should be used in buildings to provide ventilation and space cooling. Windows that can be opened and closed as desired by the occupants to provide better control of office space conditions.

Benefits:

- gives occupant control over some work space conditions
- improves occupant satisfaction with the work space
- provides free cooling with use of fans
- operates as a back-up ventilation system
- connects to the outdoors
- provides ventilation (outdoor air) to ensure safe, healthy and comfortable conditions for building occupants without the use of fans
- provides free cooling without the use of mechanical systems
- reduces building construction costs and operation costs
- reduces energy consumption for air conditioning and circulating fans
- eliminates fan noise

At least 20% of the facade windows should be openable.

Further discussions will follow under the occupant comfort section of this document.

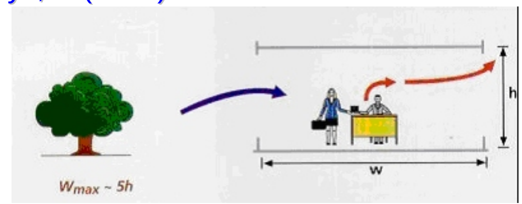


Fig 116. Natural ventilation

ENVIRONMENT

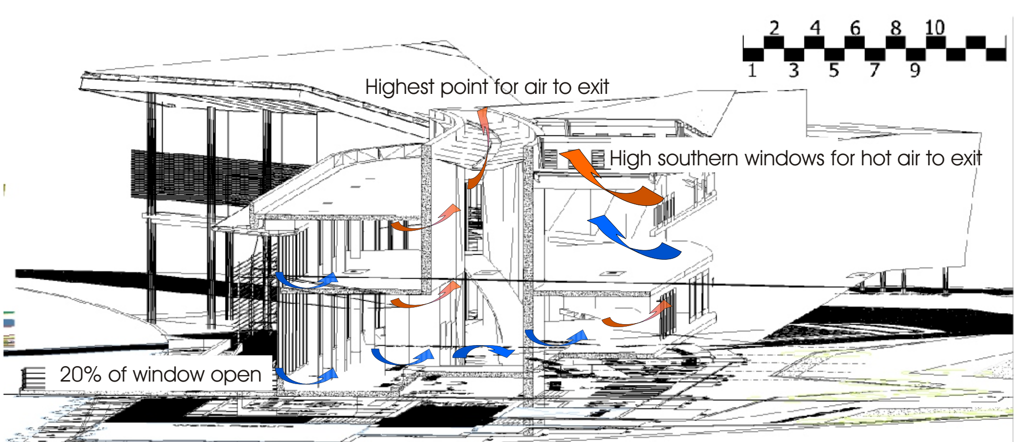


Fig 117. Natural ventilation through building


Fig 118. Occupant comfort

Heating and cooling systems:

Passive solar heating:

The building will make use of solar energy to meet it's heating demands.

Criteria:

- windows should have a U-value of 2 W/m²K
- west windows which receives the most heat should be shaded
- morning light from southern windows should be maximised
- window to wall ratio should be: 0.4 to prevent OVERHEATING

Displacement heating:

AN AIR DISTRIBUTION SYSTEM IS USED. IN THIS SYSTEM, INCOMING AIR ORIGINATES AT FLOOR LEVEL AND RISES TO EXHAUST OUTLETS AT THE CEILING.

BENEFITS:

- removes internal heat gains and entrain pollutants

HEAT EXCHANGE PIPES ARE BURIED IN THE GROUND THAT HEAT OR COOL VENTILATION AIR.

The earth, at a depth of 3,5 m, retains at a fairly constant temperature year-round,+-15 degrees Celsius. Thus during summer the ground temperature will be lower than room temperature and during winter the ground temperature will be higher than room temperature. Passing incoming air through the buried pipes, heats or cools the air to close to ground temperature. The ventilation air is distributed throughout the building using the displacement duct system.

A 120mm PVC pipe system is installed underneath the floor slabs.

This system will guarantee a systemic flow of fresh air through the building and will keep the process running throughout the day. This will be done by a simple and energy efficient mechanical fan.

ENVIRONMENT

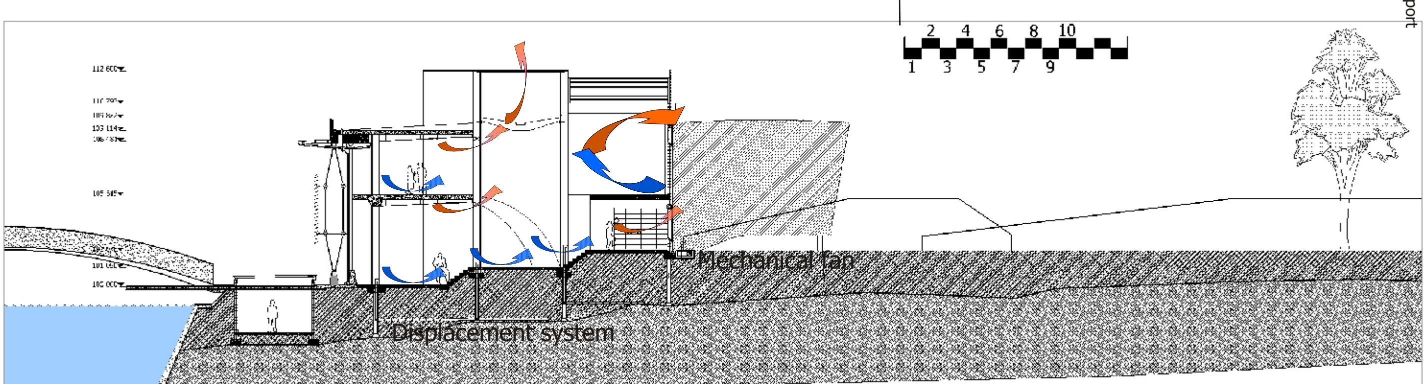


Fig 119. Displacement ventilation in building

External shading devices:

Western and northern windows will be shaded to limit internal heat gain resulting from radiation.

Benefits:

- reduces cooling loads
- increases occupant thermal comfort
- reduces glare
- increases architectural design

The extended western facade is shaded by a steel and aluminium louvre system. This system also provides the "scaffolding" needed to clean the windows on the outside. The office block are protected by a overhang on the northern facade and a simpler shading device on the western facade.

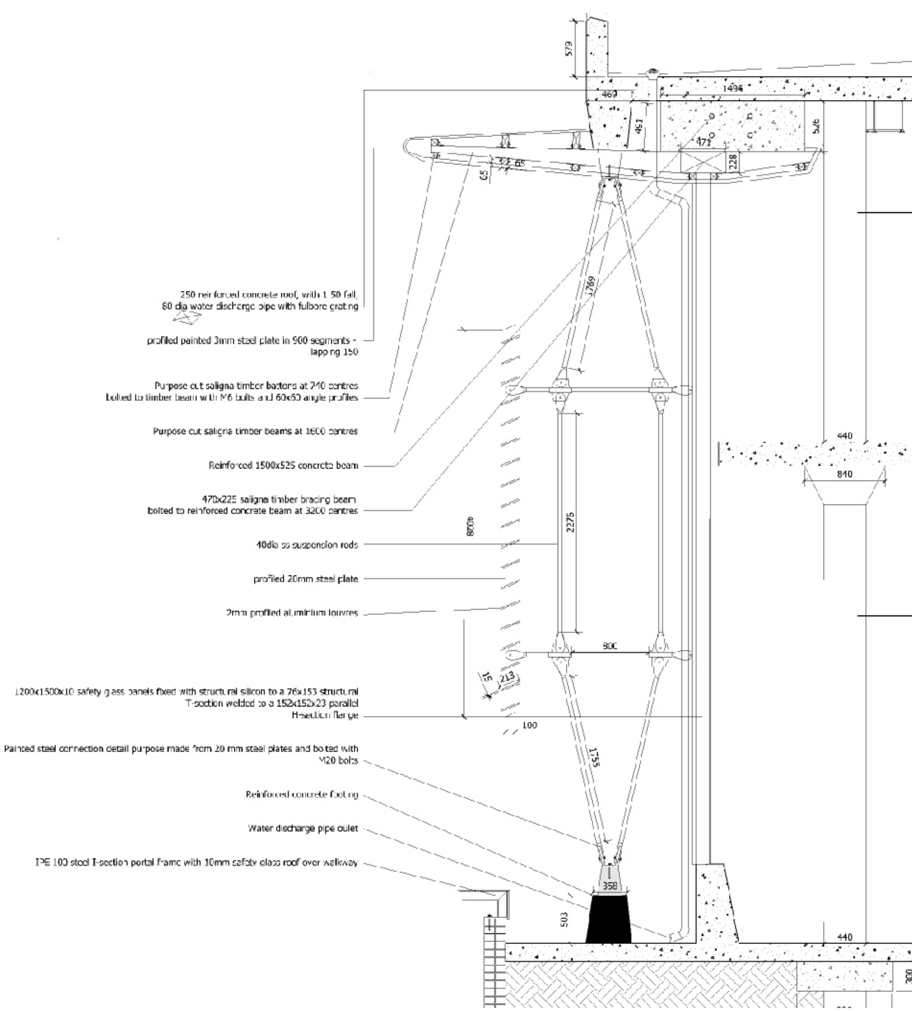


Fig 120. Detail of sun screen on western facade of the building

ENVIRONMENT

External shading devices:

The following 3D shows the structure and assembly of the shading device:

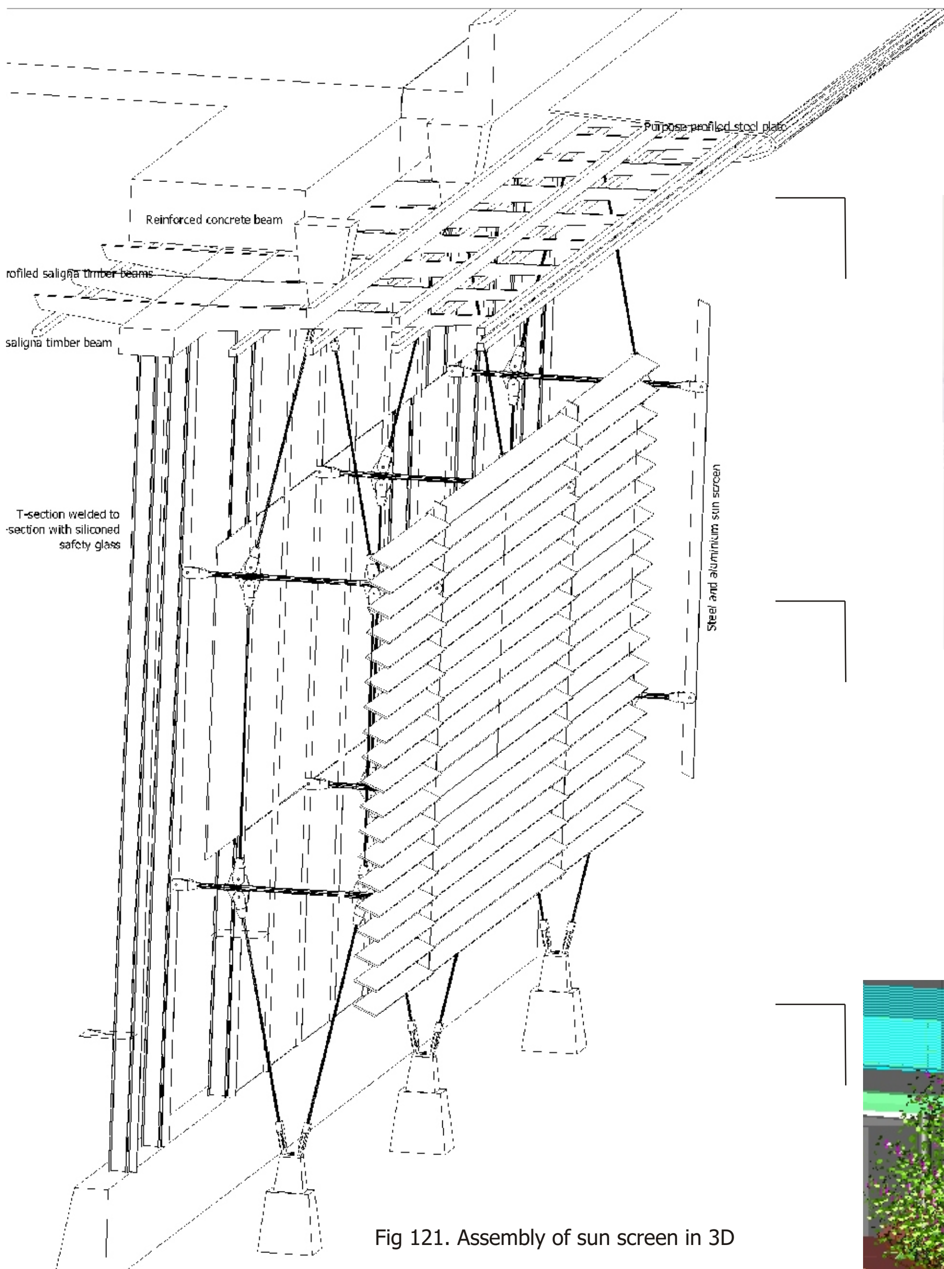


Fig 121. Assembly of sun screen in 3D

ENVIRONMENT

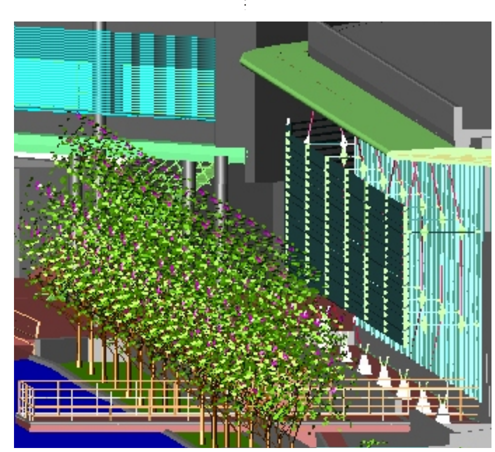


Fig 122. Boulevard of trees to shade western facade.

Additional precautions:

- On the western side of the second floor it is advised to have a simple internal blind system to shade off the late afternoon sun.
- A boulevard of trees on the western side of the building also shades off the late afternoon sun.

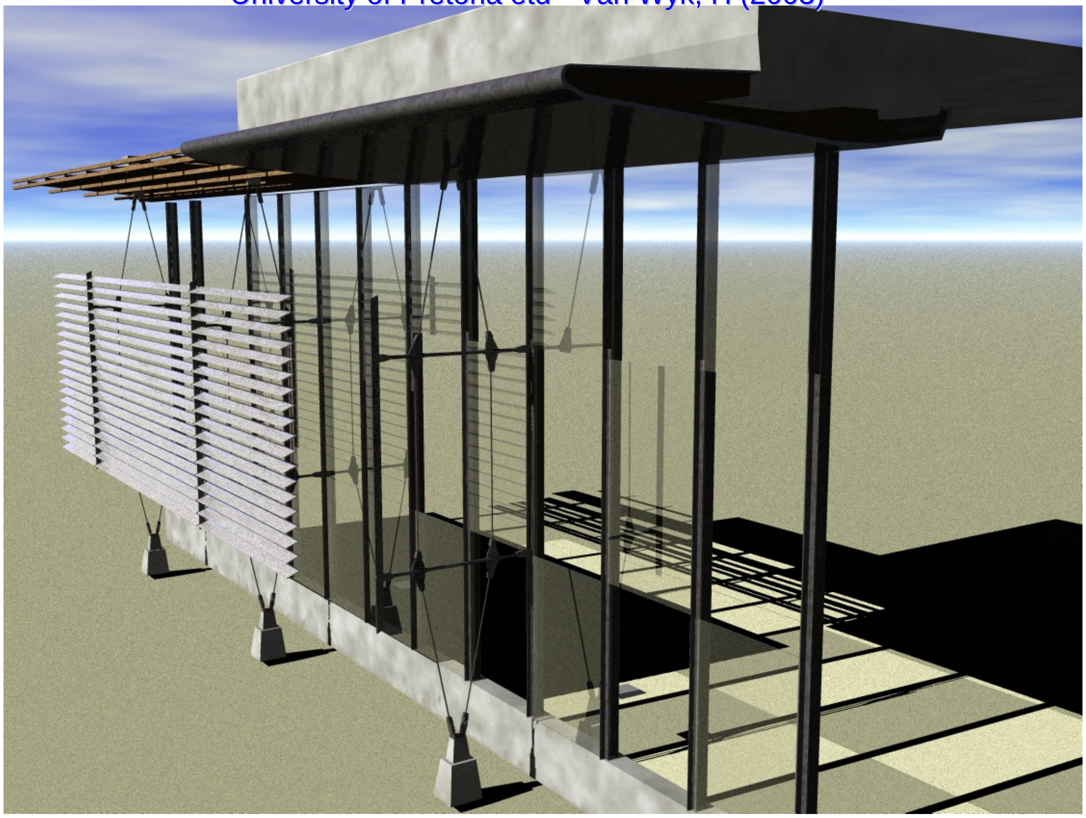


Fig 123. Assembly of sun screen in 3D

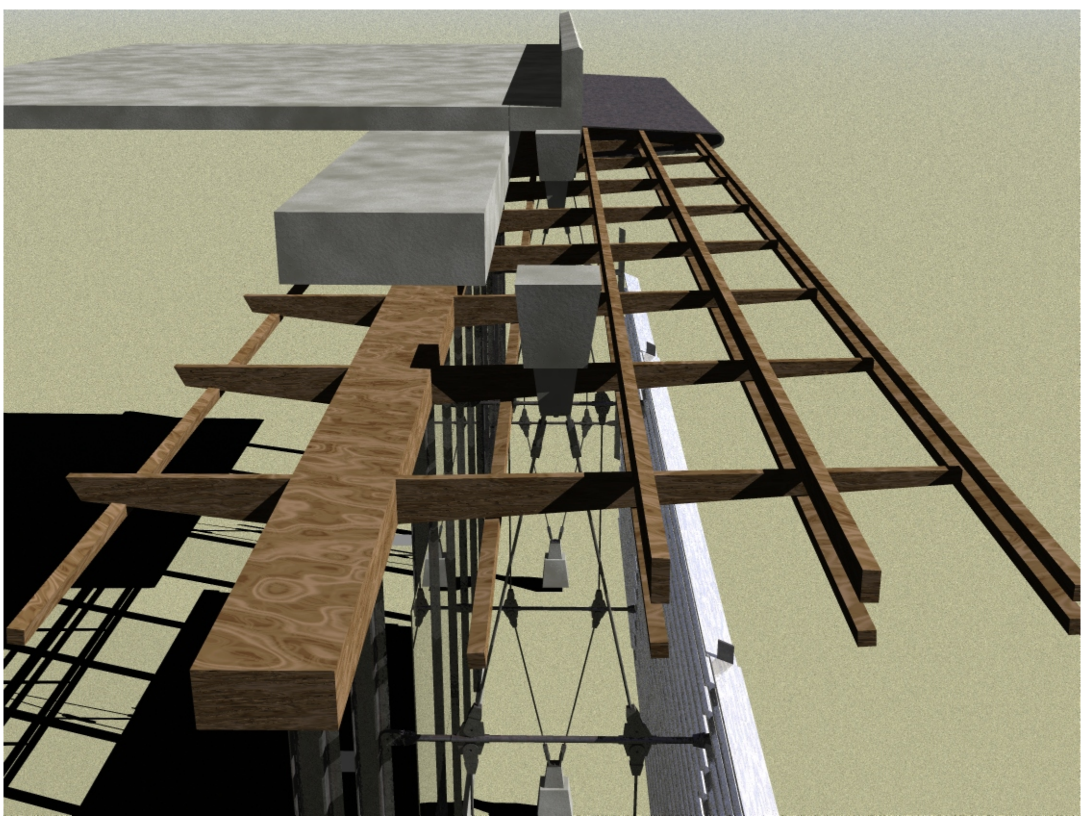


Fig 124. Assembly of sun screen in 3D

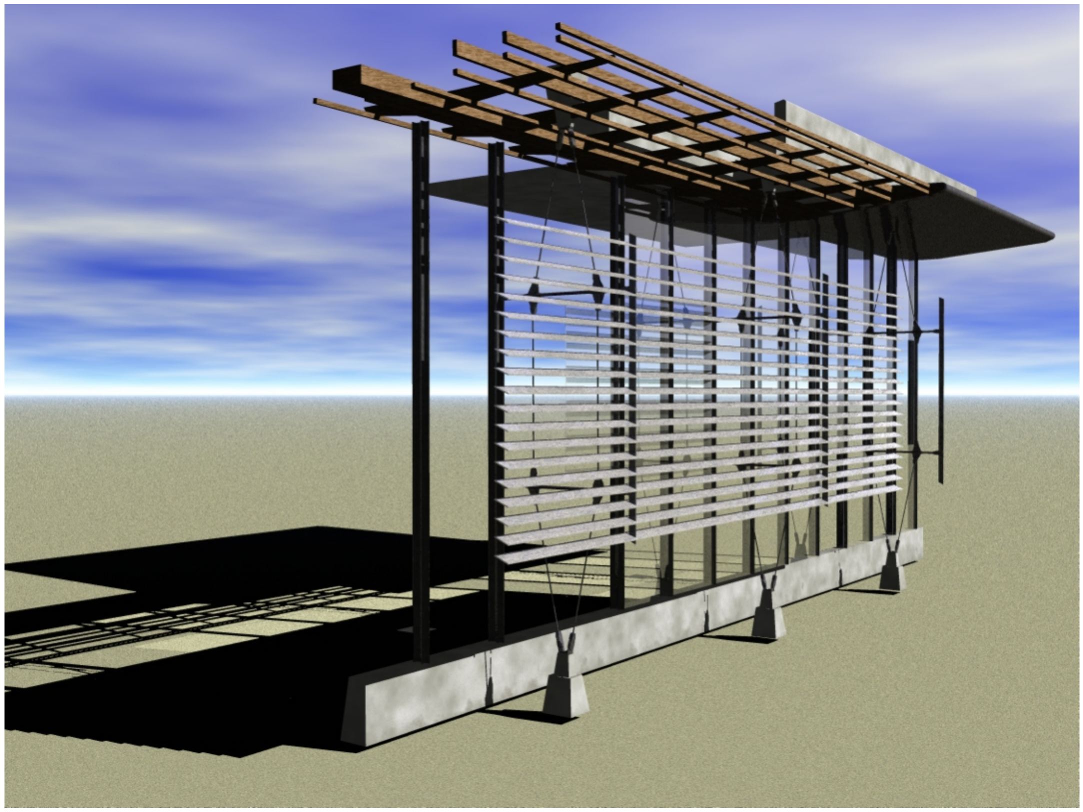


Fig 125. Assembly of sun screen in 3D

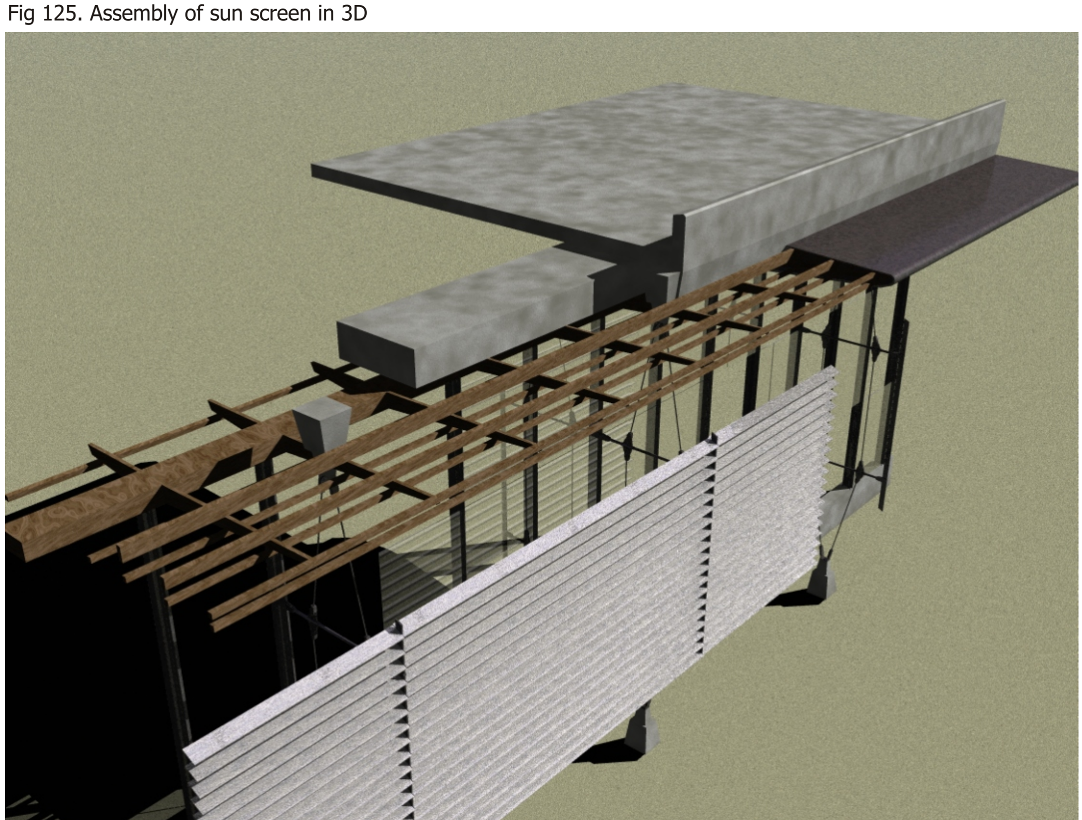


Fig 126. Assembly of sun screen in 3D

Appliances and fittings:

Energy efficient office equipment:

Computers, printers, photocopiers and fax machines equipped with power management settings, and printers and photocopiers capable of double-sided printing will be used.

ENVIRONMENT

EQUIPMENT	DESCRIPTION
Computer	3.3 volt components, which use 40-50% less energy
Printers	Powering down to 15-45 W, which reduces energy by 50%
Photocopiers	Heat and pressure uses the most energy. In idling mode, an energy saver can reduce consumption by 50%
Fax Machines	Powering down to 15-45 W. Inkjet printing is more energy efficient

Fig 127. Energy efficient office equipment

Benefits:

- reduces operating costs and energy consumption
- occasionally increases mobility (for example, laptop computers)
- reduces paper and printing costs
- Reduces filing space

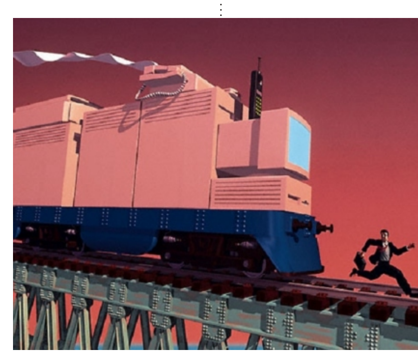


Fig 128. Office equipment

Renewable energy:

Photovoltaic cells:

A solid-state semi-conductor device produces direct current electricity through radiation.

Benefits:

- reduces non-renewable energy demand
- lowers electricity consumption costs
- reduces peak electrical demand charges
- reduces infrastructure costs

Uses:

- parking lot lights
- pathway lights
- sign lighting

Space should be provided on the roof for **140m²** of photovoltaic cells. The energy produced by this system would be sufficient for the use of smaller functions and can be used as mentioned above.

On the western roof of the building there is ample space for the placement of the necessary photovoltaic cells. From there it will have an undisturbed exposure to northern light to maximise performance.

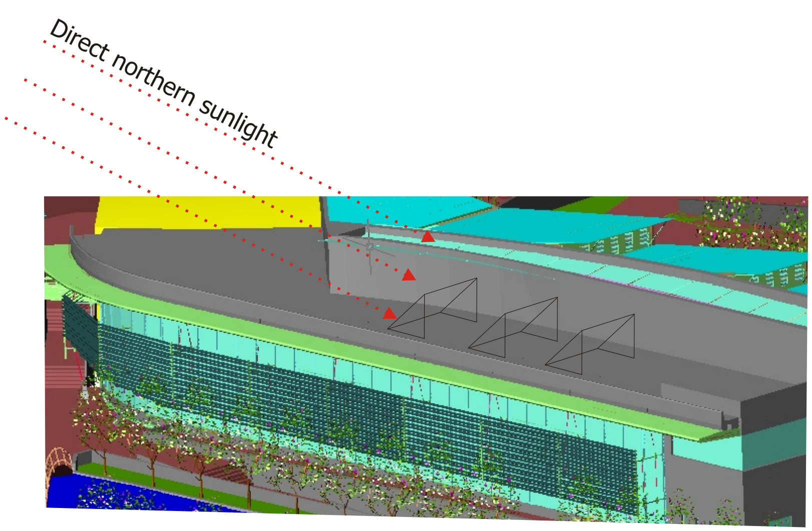


Fig 129. Placement of photovoltaic cells

ENVIRONMENT

Fig 130. Photovoltaic cells

WASTE:

Recycling and reuse:

- **ORGANIC WASTE**
  Organic waste produced by the canteen is collected in air-tight containers, stored and given to local pig farmers as food for their animals. Collection takes place once a week by the farmer himself, and the collection by him counts as payment. Transforming organic waste collected from toilets into methane gas was considered, but storage and environmental impact on the Apies River was a bigger concern.

- **INORGANIC WASTE**
  Inorganic materials are sorted into different bins in each office. The main source of inorganic waste in offices is – paper. Bins would be provided for the collection of these materials and collection and removal thereof would take place once a week.

- **TOXIC WASTE**
  Toxic materials like batteries are collected in a separate bin. This could be sold to battery companies, for the reuse of whatever they see fit.

- **SEWERAGE**
  Removal of sewerage will be handled by the municipal service.

- **CONSTRUCTION WASTE**
  After construction, building waste is sold to demolishing companies in the area, which can sort and resell it as used building materials.

Recycling bins should be provided for use by visitors. These should be clearly marked to streamline the recycling process.

ENVIRONMENT

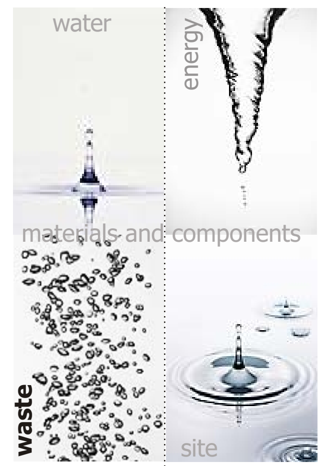


Fig 131. Recycling bin used at Rand Water Nature Reserve

Fig 132. Waste management

SITE:

Buildings have a footprint and a size that take up space that could otherwise be occupied by natural ecosystems which contribute to sustainability by helping create and maintain an environment that supports life. Buildings can support sustainability by limiting development to sites that have already been disturbed, and working with nature by including aspects of natural ecosystems within the development.

Brownfield site:
The chosen site has never been developed. It is in a dilapidated state and the development will focus on environmental sensitivity. This will have a effect on the site and its surroundings.

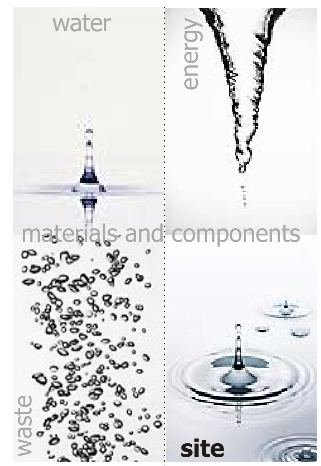
Neighbouring buildings:
The new building's scale does not impose on surrounding buildings by casting shadows where access to sunlight is important. The new building stays within the height limit of 19m. See figure below.

Vegetation:
The site should have extensive vegetation. Most of the indigenous vegetation is retained. New plants are planted in car parking areas, and in the atrium and Water Wise garden.

Habitat:
The site and newly created landscape has immense possibilities for being habitats for various animal and insect species. A coordinated landscaping strategy is followed, as discussed in the Water Wise garden principles.

Landscaping inputs:
The input into creating this new landscape was done with the most natural methods possible. The specifics thereof were suggested by a Landscape Architect. The otherwise heavy artificial input, i.e. fertiliser, insecticides and pesticides, is to be limited.

ENVIRONMENT



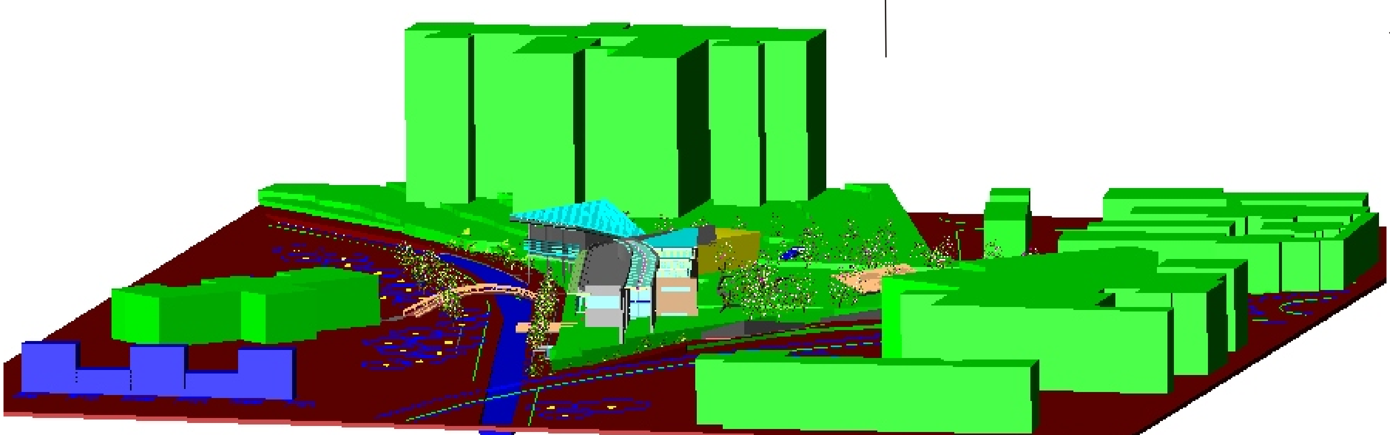


Fig 133. Scale of new building to existing buildings

Materials and Components:

The construction of buildings usually requires large quantities of materials and components. These may require large amounts of energy to produce. Their development may also require processes that are harmful to the environment and consume non-renewable resources.

Embodied energy
80% of building materials and components will have low embodied energy. Low embodied energy materials include locally made and sourced (i.e. Within the country), timber, concrete, concrete blocks timber windows and doors.

Material / component sources
90% of materials and resources will come from renewable resources

Manufacturing processes
Environmental damage should be limited during product component development. **No** green house **gases** should be released, and **no pollution** should be caused.

Recycled / reused materials and components
10% of building materials and components are reused or come from recycled sources.

Construction processes
Building and construction processes are designed to **minimally impact** the environment. Requirements for large scale vegetation clearing and earth movement is minimised.

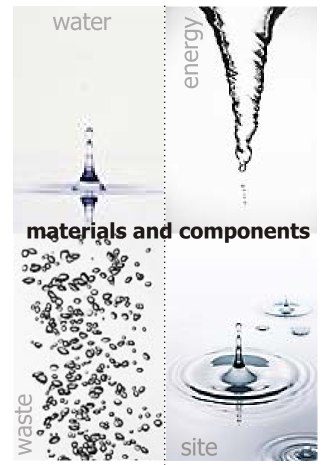
MATERIAL	FOR 1 TON
Brick uses 1.3 % of the total water consumption for steel	2 200 L
Concrete (for 42.5kg cement)	23 L

Fig 134. Water used in materials

MATERIAL	
Wood	From nearest dealers, which get stock from Lowveld
Concrete	From local PPC; stone and sand from nearest dealer
Glass	Pilkington Glass in Koedoespoort
Bricks	From local brick manufacturer or Demolition company
Sheet metal	Identified local dealer

Fig 135. Where materials come from

ENVIRONMENT



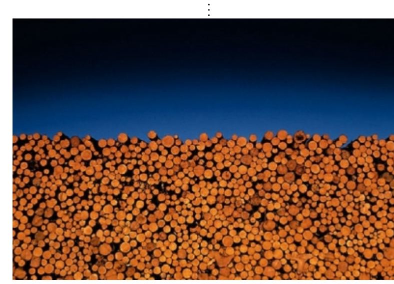


Fig 136. Wood

ECONOMIC ISSUES:

Local Economy
The construction and management of buildings can have a major impact on the economy of an area. The economy of an area can be stimulated and sustained by buildings that make use of and develop local skills and resources.

Local contractors
90% of the construction should be carried out by contractors based within 40km of the building.

Local building material supply
75% of construction materials: cement, sand, bricks, etc, should be produced within 200km of site.

Local component manufacturers
90% of building components i.e. windows and doors should be produced locally (within 200km).

Outsource opportunities
Opportunities should be created and provision made for small emerging businesses. This includes outsourcing of catering, cleaning services and security, as well as making space and equipment available for businesses to use for retail, education, etc.

Repairs and maintenance
All repairs and maintenance required by the building (including servicing of mechanical plant) can be carried out by contractors based **within 200km** of site.

	% Local
Support Local Economy	80
Local contractors	90
Materials and suppliers	75
Component manufacturing	90
Outsourse opportunities	80
Repairs	70

Fig 137. Local economy

IF NECESSARY, CARRY OUT TRAINING:

- to reduce transport output
- to create a stronger diversified economy
- to develop the local skill base

RECYCLE MONEY IN LOCAL SECTOR

ECONOMIC

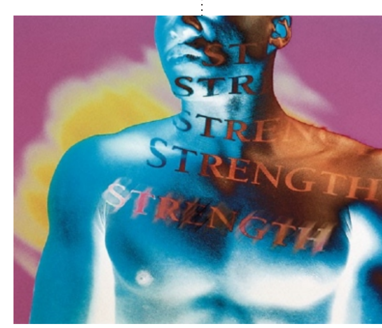


Fig 138. Strength of local economy

Efficiency of Use
Buildings cost money and make use of resources, whether they are used or not. Effective and efficient use of buildings supports sustainability by reducing waste and the need for additional buildings.

Useable space
Non-useable spaces such as plants, w.c's. and circulation spaces do not make up more than **20%** of the total area of the building.

Occupancy
The building and all working/living spaces are occupied for an average equivalent minimum of **30 hours per week**.

Space use
The use of space should be intensified through a space management approach and policy, by creating spaces with duel functions. The areas marked in blue are spaces that can be implemented for whatever is needed according to the user. These spaces are usable and available even after official closing hours of the building. More specifically the yellow part - the theatre, which can be used after hours as a venue for various kinds of performances.

Use of technology
Communications and information technologies are used to reduce space requirements. Spaces are designed for human use with the human proportions as basis. According to the NBR the whole design complies with the requirements for use by disabled people.

Space management
A policy should be implemented to ensure that space is well used. This should include regular audits and a space management system.

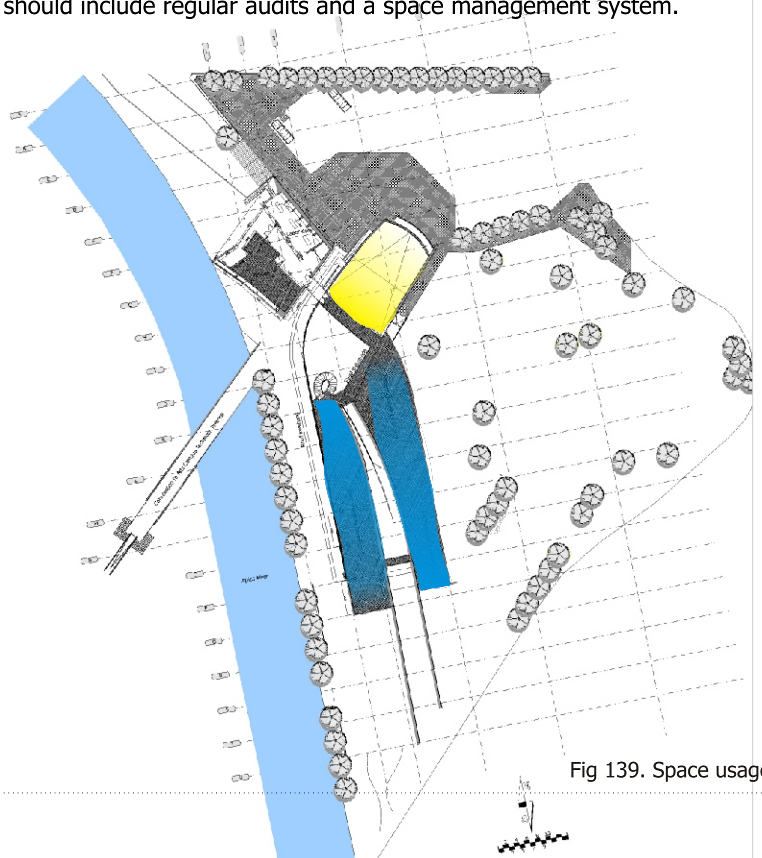


Fig 139. Space usage of the building

ECONOMIC

Adaptability and Flexibility

Most buildings can have a life-span of at least 50 years. It is likely that within this time the use of the building will change, or that the feasibility of this will be investigated. Buildings which can accommodate change easily support sustainability by reducing the requirements for change (energy, costs, etc) and the need for new buildings.

Vertical dimensions

The minimum structural dimension from the floor to the underside of roof, or to the slab of the floor above is **3m.** This will allow for many different options when changes to the building have to be made. See figure below.

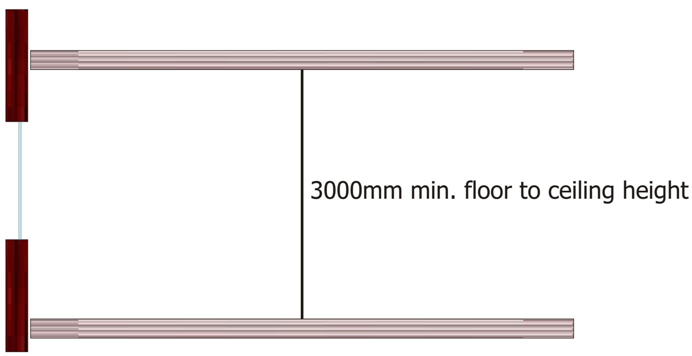
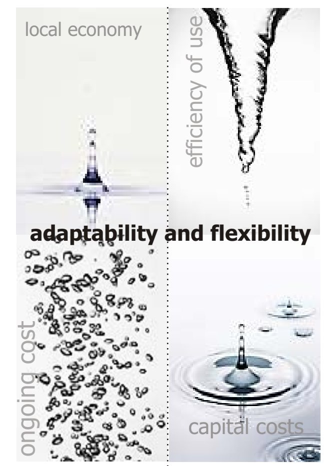


Fig 140. Floor to ceiling height

Many of the spaces can easily accommodate an optional mezzanine level if so required.

ECONOMIC



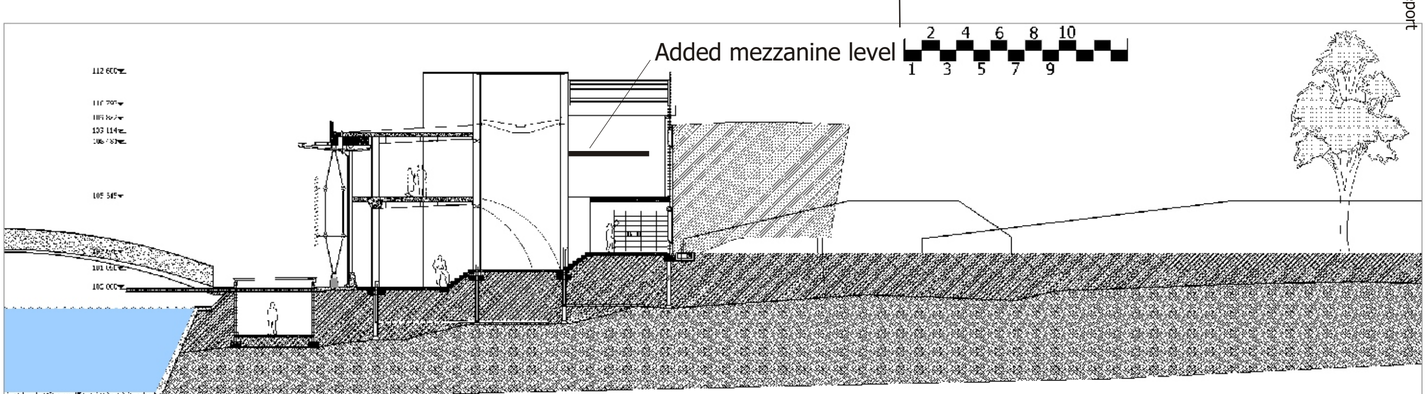


Fig 141. Adaptability of spaces

Adaptability and Flexibility

Internal partitions

Internal partitions between work spaces are non-load-bearing, especially in the office areas (i.e. non-load bearing brick / block or plasterboard partitions) and are easily demountable.

Services

Access to services is easy. Services include: electrical and communication. Provision is made to allow easy modification of systems.

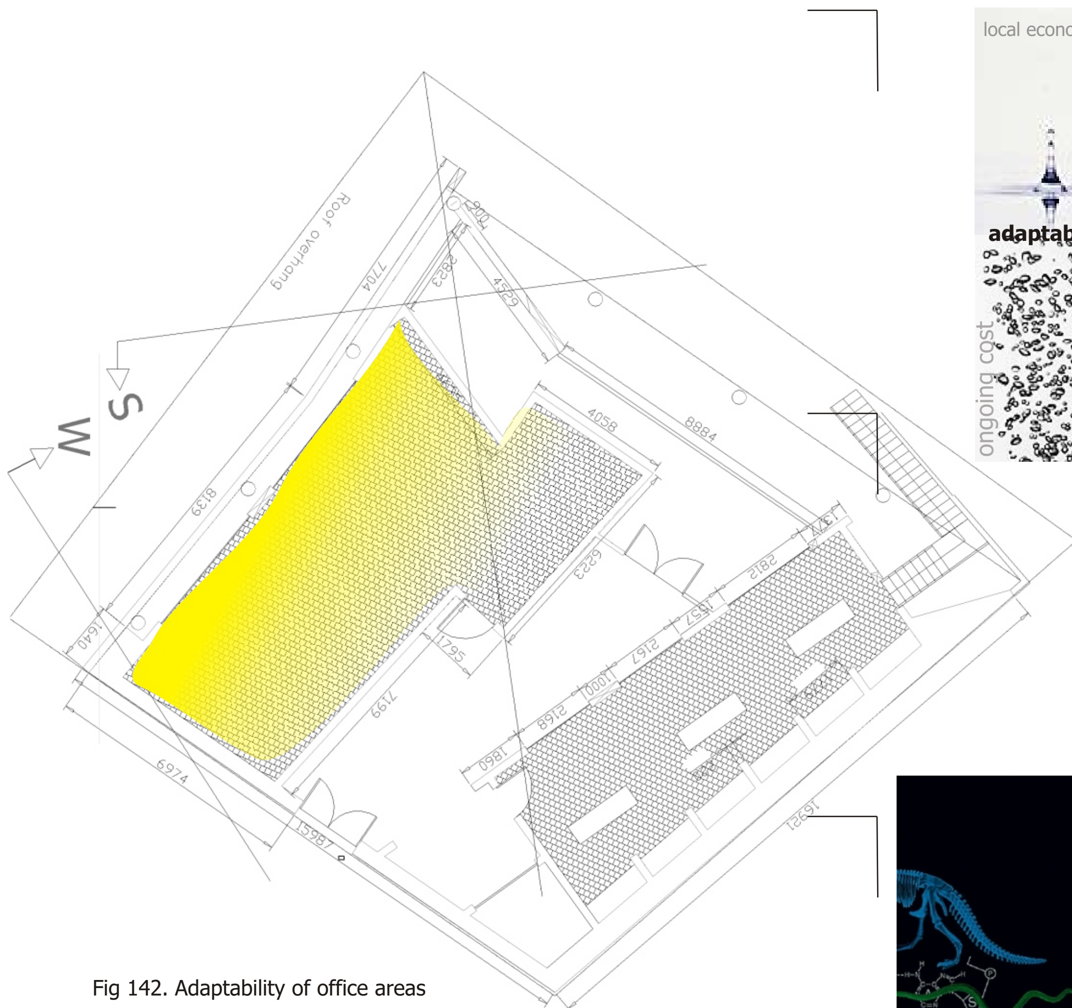


Fig 142. Adaptability of office areas

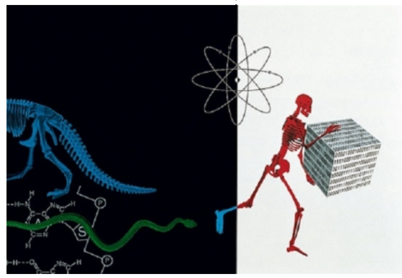


Fig 143. Adaptability

An open area is provided for the offices on the second floor. This area can be subdevided by the client as they wish and for the purpose they need.

ONGOING COSTS

Maintenance

Concrete and brick are materials with low maintenance and low maintenance cost. The maintenance cycle is set to a period of 2 years. Maintenance can be carried out cost effectively.

Cleaning

Measures are taken to limit requirements for cleaning. Hard-wearing solid flooring (limiting carpets to offices and theatre) is specified. Windows are easily accessible for cleaning.

Type of building	Side Windows	Rooflights
Office	Every 3 months	Every 12 months
Shops:		
Outside	Every week	Every 6 months
Inside	Every 2 weeks	

Fig 144. Recommendations for frequency of washing of particular building types

With the building having to comply with a height restriction of 19 m, it is necessary to keep to simple, easy and cheap methods of cleaning windows.

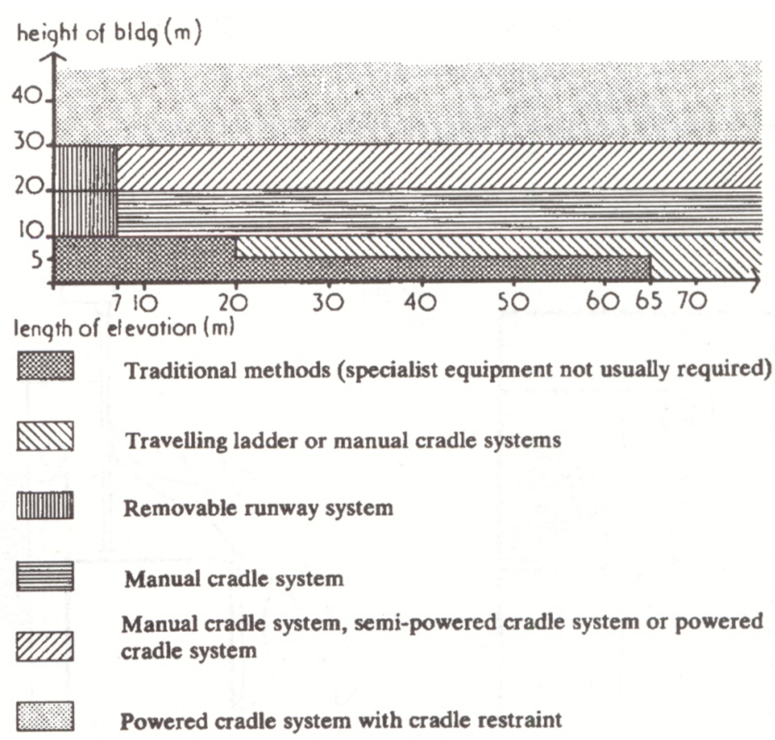


Fig 145. Chart for selecting system for external access

ECONOMIC

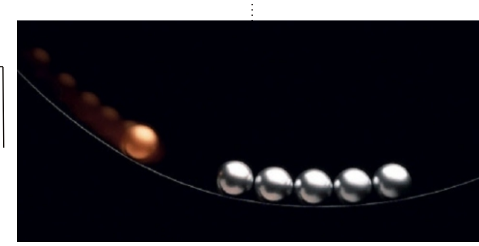


Fig 146. Ongoing costs

Security / care taking
Measures should be taken to limit the requirements. This would include neighbouring buildings, like the Nurses' Training College, overlooking the building and it's exterior spaces.

Insurance / water / energy / sewerage
Costs of insurance, water, energy and sewerage are monitored. Consumption and costs are regularly reported to management and users. It is more efficient to have the security guard go through the building, switching off the lights that have been left on, than to install an automatic system.

Disruption and 'downtime'
Electrical and communication services are located where they can be easily accessed with a minimum of disruption to the occupants of the building. Access is maximised to form circulation areas rather than work/living areas.

ECONOMIC

MAINTENANCE	Low maintenance cost due to materials selection – 5% of building cost
CLEANING	Salaries for 4 -5 cleaners working full time @ R 1500 per month per worker. **THUS** R 72 000 per year
SECURITY/CARETAKING	Two 24 hour security guards, patrolling @ R 2500 per month each, **THUS** R 60 000 per year
SHARED COSTS	Transport system to be arranged by client for collecting workers and taking them home, depending on quote by transport company
COST MONITORING	The monitoring of building costs must be planned even before the design process starts. A **FEASIBILITY STUDY** should be done in order to determine the amount of money needed and to set the timetable of which amount would be needed at what stage of construction.

Fig 147. Controlling ongoing costs

Ongoing costs should be minimised to 18% of the building cost

Capital Costs
A building should be one of the most valuable assets to client and users. Money spent on buildings is not available for other uses such as health. This building is a huge investment in the education of the nation. Buildings that are cost- effective support sustainability by helping to provide access to services for low-income areas, and by enabling money to be spent on other areas that support sustainability.

Consultant fees
Consultant fees are not just calculated on a total project cost basis. Incentives are provided to consultants to reduce capital cost and ongoing costs.

Build-ability
The building is designed to be easily built. The building form is not too intricate. The replication of elements and components lower the costs.

Construction
A construction approach to design is used to reduce the initial capital cost of the building. The building processes are undertaken in a series of phases. The building is first built as a shell with finishes added later. The building can be split into 4 main phases. The main body of the building as phase one, and the theatre as phase two. The northern office block as phase three, and the Water Wise garden as phase four.

Shared costs
The cost of the building is shared with other users (such as those hiring the auditorium, laboratory and information centre).

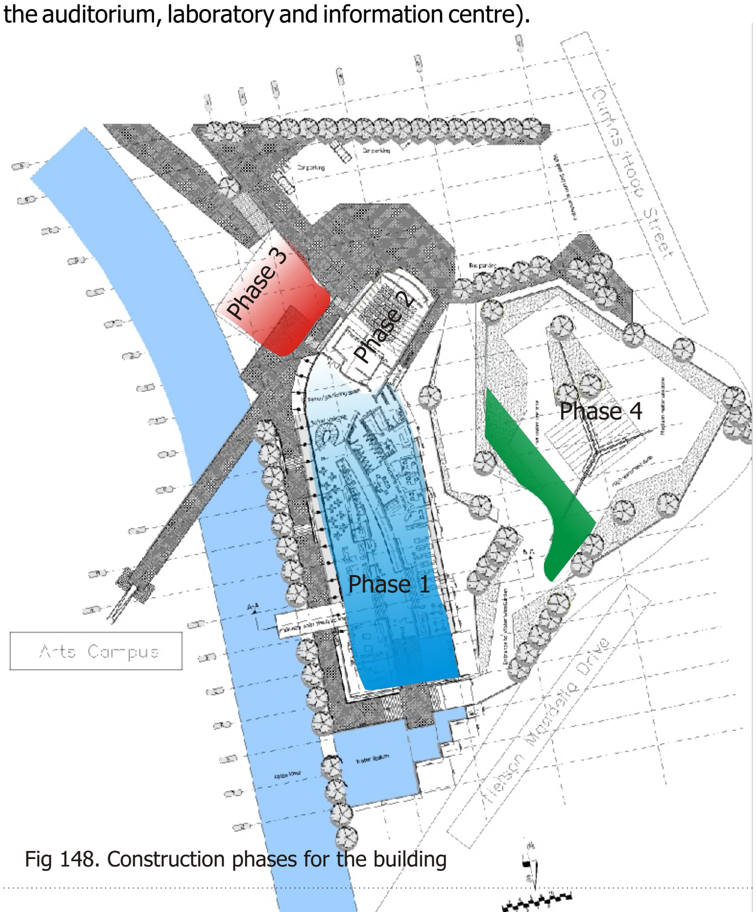


Fig 148. Construction phases for the building

ECONOMIC

Fig 149. Capital costs

SOCIAL ISSUES

Occupant Comfort

The quality of environments in and around buildings have been shown to have a direct impact on the health, happiness and productivity of people. Healthier, happier, more effective people contribute to sustainability by being more efficient, and therefore reduce resource consumption and waste. However the quality of this environment needs to be achieved with minimal cost to the environment.

Lighting

All work and living environments are provided with ample daylight. Daylighting is controlled and glare is minimised. There are no spaces that require constant electric lighting.

Daylight potential of the new development:
The site has no obstructions on its boundaries that will limit direct daylight falling on the building. Odd trees could be ignored. There is no obstruction that projects above the 25° horizontal roofline, thus a target vertical sky component of at least 27% is achieved.

- Window-wall face should be within 90° of north

Colour of light:
The appearance of any light source can be categorised as: warm, intermediate or cool. This fact links directly to the three phases of water: gas, liquid, and solid. The different phases of the building correspont to the following colours of light:

Phase of building	Apperance of light
Gas	Warm
Liquid	Intermediate
Solid	Cool

Fig 150. Appearance of light sources

Type of space	Lux
Parking	50
Walkways	100
Reception	100
Offices	300
Storage	200
Conference rooms	100

Fig 151. Standard maintained illuminance

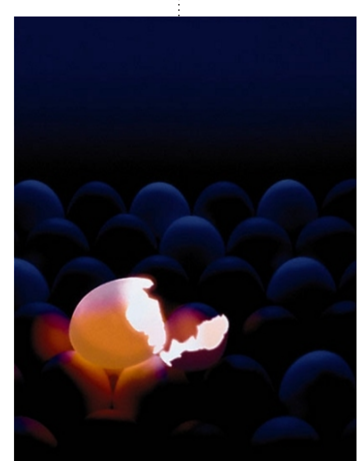


Fig 152. Occupant comfort

Ventilation

Ventilation is provided by natural means. **No mechanical** ventilation is used in the building other than in toilets and kitchens.

Air filtration:

Air filtration is the term used to describe the fortuitous leakage of air through a building, due to imperfections in the structure such as:

- cracks around doors, windows, infill panels
- service entries, pipes, ducts, flues, ventilators
- through porous construction, bricks, blocks, mortar joints

These conditions are **limited** early in the design stage and caution is applied, throughout the whole building process.

Natural ventilation:

Natural ventilation entails the **movement of outdoor air** into a space through intentionally provided openings, such as windows, doors and non-powered ventilators. This in addition to the ventilation due to air infiltration. In many cases, for much of the year, infiltration alone will provide sufficient outdoor air to ventilate the building. However, it is uncontrollable, and if excessive, it can incur a high-energy penalty and/or make the building difficult to heat (or cool) to comfort levels.

Ventilation in spaces is maximised by keeping to the following dimensions and ventilation patterns:

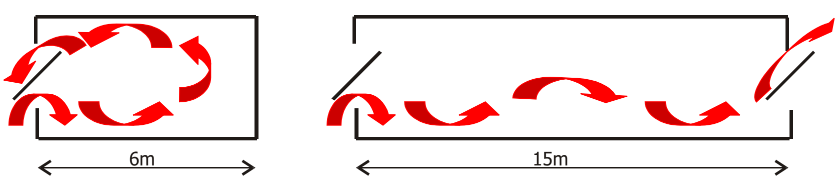


Fig 153. Single sided & cross ventilation

Noise

It is estimated that the new extension of Nelson Mandela Drive would be a source of high noise levels.
Since the building will be located on the western side of the site, the only portion of the building that would need to accommodate high noise levels would be its lowest end on the **southern side** of the site.

The formal working areas are located further from this noise risk and therefore no drastic measures need to be taken. The southern side of the building responds to this problem by incorporating **thicker walls** (which will be effective in terms of the **mass law**), and a **vegetation barrier** between the road and the building. This effectively reduce any levels above **55dB** to a level, fit for communicating normally.

Views

All living and work areas have access to a **view of the outside**. All users located in 6m or less from a window.

Access to green outside

Access is provided to green outside spaces

SOCIAL

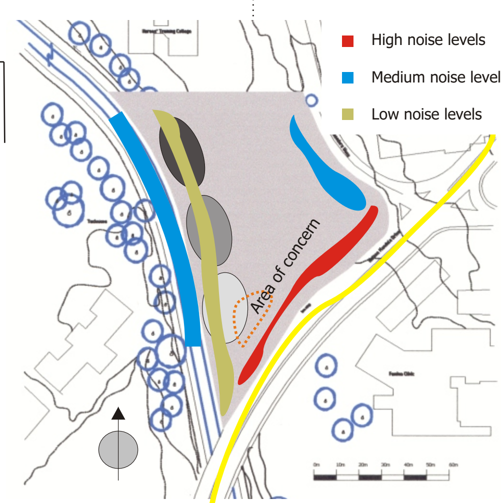


Fig 154. Noise levels on site

Inclusive Environments
This buildings is designed to accommodate disabled persons.

Public Transport
The building is located no further away than 400m from **disabled-accessible public transport**. The centre has a mini- bus that provides a service of collecting and dropping off, of disabled people at the nearest public transport node. Arrangements are made in advance by the person needing the service to avoid unnecessary trips.

Routes
All routes between and within buildings are of a **smooth and even** surface to be easily navigable by wheelchair.

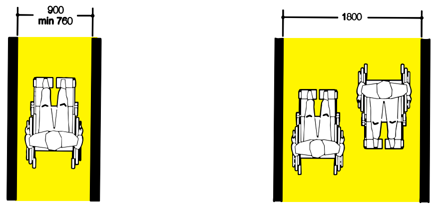


Fig 155. Comfortable widths of aisles for disabled users

Changes in level
All changes in level are catered for with appropriate **ramps of 1:12 fall**.

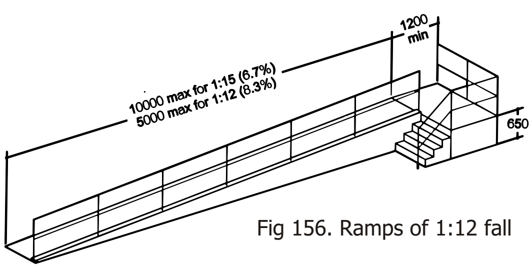


Fig 156. Ramps of 1:12 fall

Edges
All edges between walls, and floors and stair nosings are **clearly distinguished** through the use of contrasting colour, to aid the visually impaired.

Toilets
A **minimum of one** disabled toilet is provided in each of the men's and ladies' toilets.

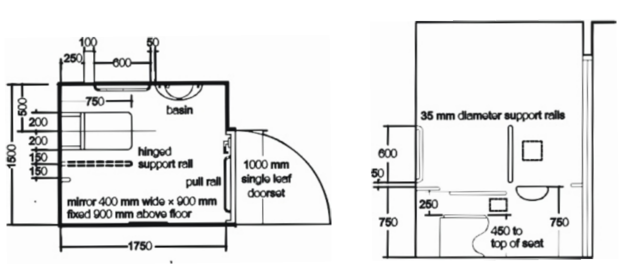


Fig 157. Layout of sanitary facility for disabled people

SOCIAL


Fig 158. Inclusive environments

Access to Facilities
Conventional living and working patterns require regular access to a range of services. Ensuring that these services can be accessed easily and in environmentally friendly ways supports sustainability by increasing efficiency and reducing environmental impact.

Childcare
Childcare will not be provided in the building, due to the small number of permanent staff working in the building. There are adequate childcare facilities located **within 3km** of the site.

Banking
Banking services such as an ATM are located **within 3km** of the building.

Retail
Grocery, items required on a day to day basis are available **within 3km** from the building.

Communication
Postal, telephone or e-mail facilities are provided by the **information centre** within the building.

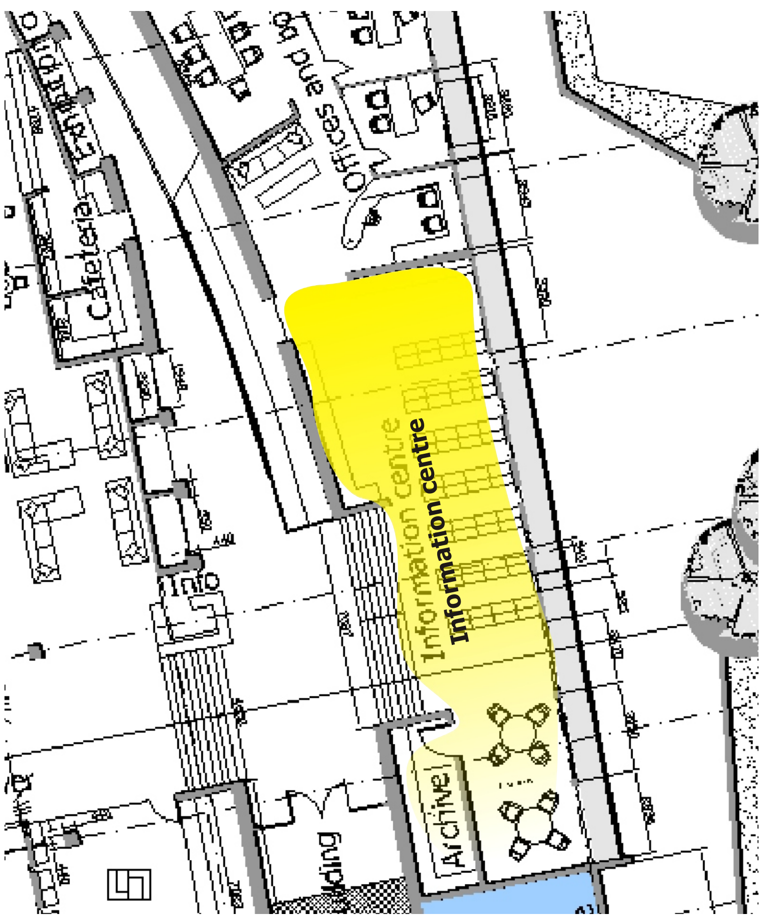


Fig 159. Information centre

SOCIAL


Fig 160. Access to facilities

Participation & Control
Ensuring that users participate in decisions about their environment helps to ensure that they care for and manage it this properly. Control over aspects of their local environment enhances personal satisfaction and comfort. Both these aspects support sustainability by promoting proper management of buildings and increasing productivity.

Environmental control
The users of the building have reasonable **control** over their environmental conditions. This includes openable windows and adjustable blinds.

User adaptation
Furniture and fittings, tables, chairs, and internal partitions are designed or specified to allow for **arrangement/rearrangement** by the user. Provision is made for **personalisation** of spaces. This includes the provision of pin boards, a choice of colours, places for plants and personal storage.

Social spaces
There are spaces for easy informal / formal **social interaction** in the building. A tea room with comfortable seating and en suite kitchenette is provided for this function. The spaces that will be shared between occupants/users, such as the photocopying rooms, are large enough to allow for comfortable social interaction. The dining area and foyer on the ground floor are the main areas for social gathering.

Amenity
Easy access to the refreshment facilities such as the tea room, kitchenette or even vending machines and water closets is provided for all users of the building.

Community involvement
Spaces and services of this building should be shared and made available to the **local community** for its **use**. This includes access to the information centre, and thus to the computers, the teaching and learning spaces, the leisure facilities, as well as the auditorium for community theatre.

SOCIAL

Education, Health and Safety

Buildings need to cater for the wellbeing, development and safety of the people that use them. Awareness and environments that promote health can help reduce the incidence of diseases such as AIDS. Safe environments and first aid can help limit the incidence of accidents and their effect. Learning and access to information is increasingly seen as a requirement of a competitive work force. All of these factors contribute to sustainability by helping to ensure that people remain healthy and economically active, thus reducing the 'costs' (to society, the environment and the economy) of unemployment and ill health.

Education

Access to support learning is provided by the information centre. This takes the form of Internet access, structured courses, learning materials such as books, journals and newspapers.

Security

Measures are taken to ensure that all areas of the buildings and routes to and from the **building are safe**, and feel safe. This entails well-lit routes, routes and spaces overlooked by occupied areas, and clear visual links between spaces.

Health

A **first aid kit** is provided in a central location, and is effectively handled by one of the permanent staff that has undergone a first aid course. **Information** is readily available on health, education, and career development issues. This takes the form of a well serviced notice board located in a central position.

Smoking

No smoking is allowed in public spaces. Spaces **allocated** for smoking are placed where other users will not be affected by it, thus away from the building's air intakes.

Safety

The building complies with all health and safety **requirements** set by the **NBR**. The user had a policy in place, and regular checks will be made to ensure that these are complied with.

SOCIAL

Fig 161. Education

Structure

Decisions related to the structure and sizes of elements in the building, were made in consultation with Mr. Pieter Strobos of PSBK consulting Engineers, Pretoria. Structural tables set up by Mr. Johan Smit, lecturer, University of Pretoria were also used for the necessary calculations.

The bulk structure of the building consists of reinforced concrete, if possible - recycled bricks, wood and steel. These materials are logical choices as construction materials in South Africa since skilled workers in all the different fields are readily available. Not only does the use of concrete have its advantages as far as thermal mass in concerned, but the plasticity of the material also allows moulding of intricate forms. Such forms and shapes are apparent in the two high curving walls forming the back-bone of the main structure.

STRUCTURE

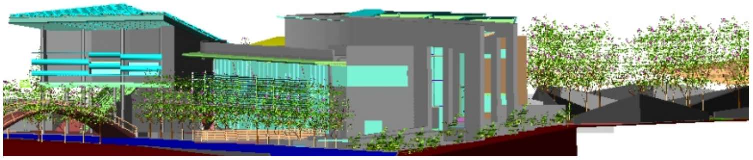


Fig 162. View showing prominent concrete construction

The following images show the concrete structure that forms the greater part of the buildings structure.

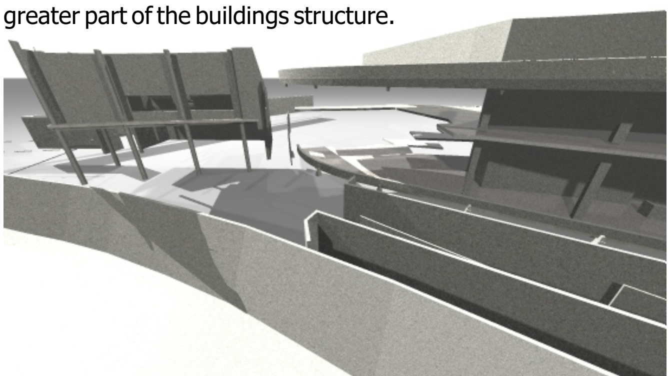


Fig 163. Concrete structure

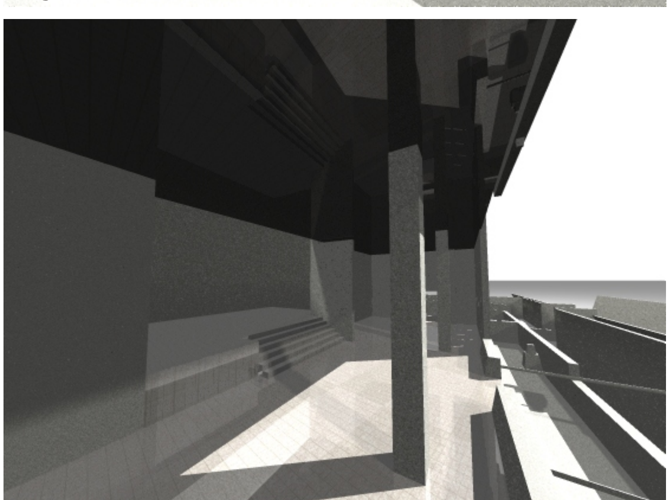


Fig 164. Concrete structure

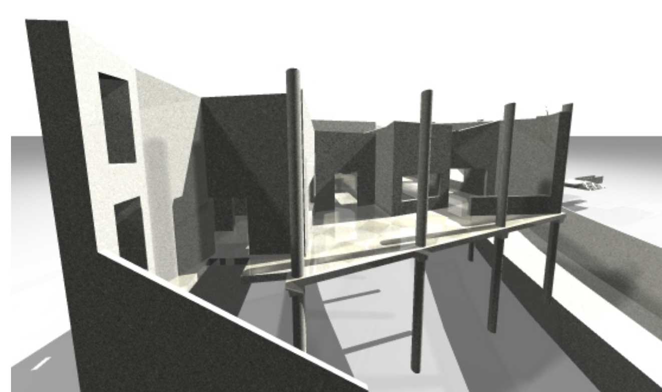


Fig 165. Concrete structure

Foundations

After discussions with Mr. Strobos the assumption was made that the soil conditions next to the Apies River might consist mainly of clay. Therefore a piling system should be used. The piling should be driven in to a depth where a stable substrate is found. A regular strip foundation could be used on top of the piling system. A size of 900x400 was adopted for the strip footings. A typical load for one story of height - 3.5m is roughly 10KN/m^2.

STRUCTURE

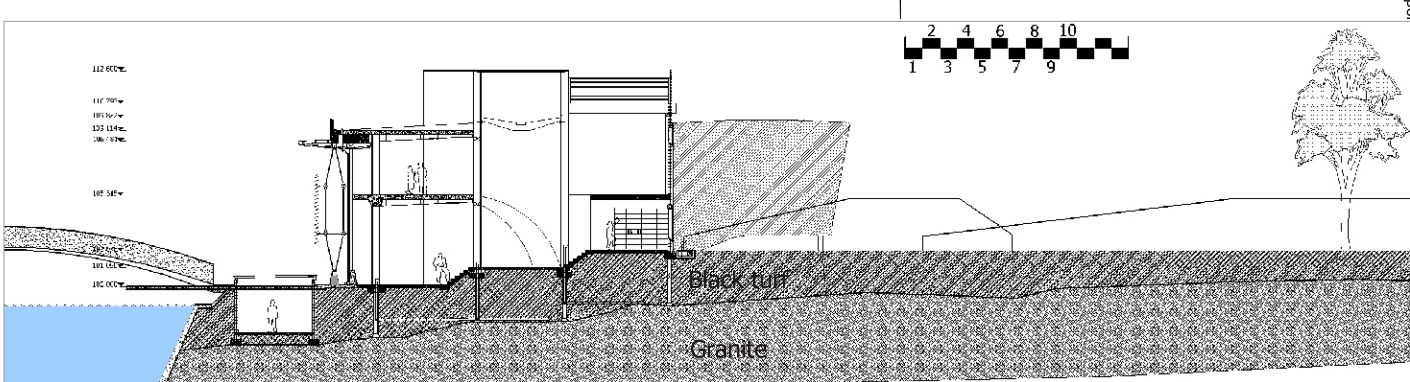


Fig 166. Piling for strip foundation

Floor slabs

On ground floor level the floor slabs are reinforced concrete slabs and span a maximum of 6 metres in one direction. The height of a story varies from 3 metres upwards. The roof slabs of the western wing are 5000x1200x250 precast concrete slabs, supported by 400x400 reinforced concrete columns on the one end, and built in, in a 440 reinforced concrete wall on the other.
The decision to use precast elements for the roof is both practical and economical.
All precast elements are to be fabricated and erected according to SABS 12 GE - 1984 standards. Ease and speed of construction is insured.

The roof slab of the theatre also consist of precast elements, as shown on drawing. It is topped with a structural concrete finish of 100mm.

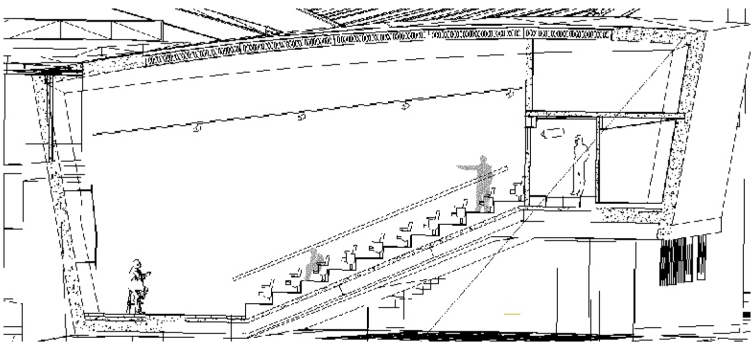


Fig 167. Structure of the theatre

STRUCTURE

Atrium

The atrium is planned mainly as circulation space, an intermediate between the three main areas of each floor. Since the inhabitants of the building seldom spend long hours in this space one can afford to have less thermal mass in this part of the building, in contrast to to other parts that require a greater level of thermal comfort. It was therefore decided to use a glass and steel skylight system for this space. The skylight / atrium also operates as a stack system, providing the highest point for heated air to escape the building. A profiled I-section beam bolted into the 440 reinforced concrete wall at both ends is used for the main structure of the skylight. 10mm safety glass panels are fastened to the flanges of the I-beams with structural silicone.

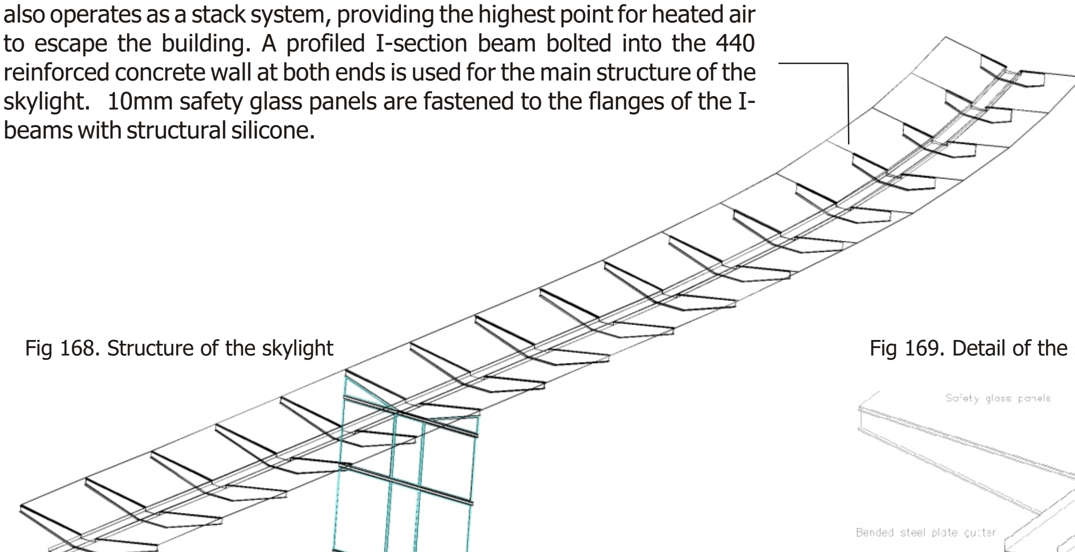
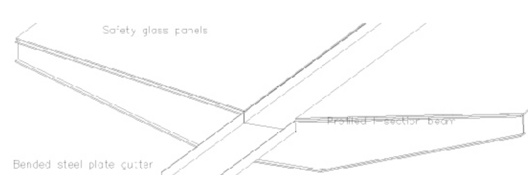


Fig 168. Structure of the skylight

Fig 169. Detail of the skylight



Access and security

Access to the site
There is one permanent vehicular entrance to the site: the main entrance on Oumas Hoop Steet. Visitors use this entrance and park in the parking lot on the northern side of the building. Pedestrians enter the site via the route along the Apies River, linking the site with the public transport node. Visitors follow the route past the western facade of the building, all the way down to the entrance located on the southern end of the building.

The existing footpath running along the Apies River along the western boundary of the site is kept open to the public.

Access to offices
The offices in the main building are accessed through the same route, visitors take during the day, or they can access the building from the staff entrance on the eastern side of the building. The offices on the northern sector of the building can be accessed via the fire stair located on the northern end of the building or via the main route followed by visitors.

ACCESS AND SECURITY

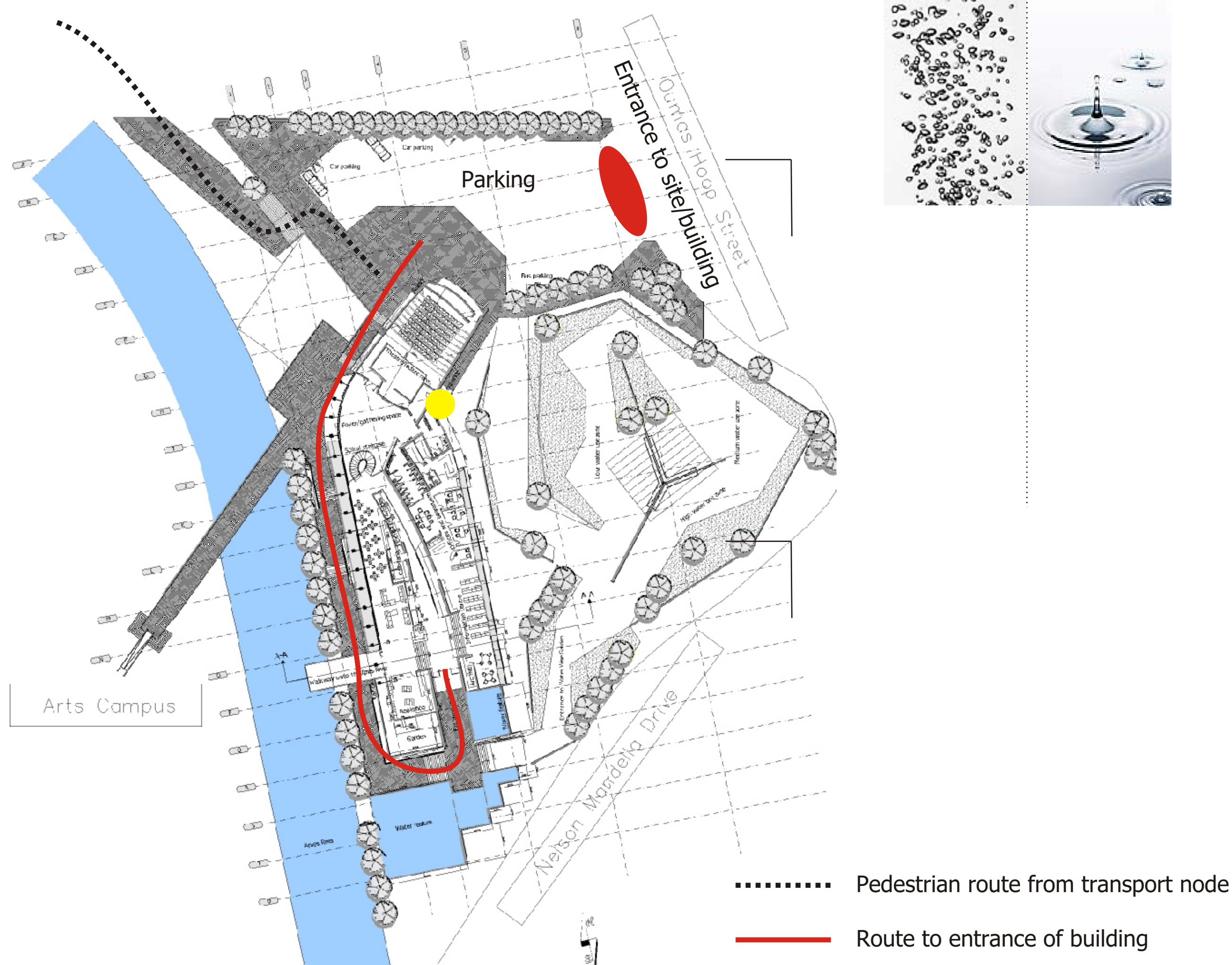


Fig 170. Access to the site/building

Water

The objective is to provide water for the user for drinking, washing etc. At a comfortable pressure and flow rate. Acceptable flow rates are 1-2m/s inside a building to 3m/s externally. It is also assumed that water is provided to the site at a pressure of 250-600kPa.

The municipal water connection is on Oumas Hoop Street. A valve box with pressure control valve and a water meter with stopcock and in line filter is provided. This is accessible from street level. A valve box with pressure control valve is also provided for each wing.

Water is reticulated on site through a ring system. The system makes isolation possible when conducting maintenance or repairs.

Electricity

Main supply
A standard electrical service consisting of mains supply, reticulation and sub distribution is installed.

Reticulation
The following wire was are required:

- Sleeves cast into slabs or in access floor void
- 500x500 riser shafts
- Trenches with covers for external lighting

Sub distribution
Second stage wiring originates from distribution boards, typically 1800x800, at central points in the building. One located on the inside of the building, at the service entrance and one at the offices in the northern block. Services branching from here are small power systems, security systems, smoke detection units and lighting.

Emergency power
An automatic start diesel generator provides back up to normal electricity supply. The unit is situated underneath the northern office block. Ventilation and room for diesel storage tanks are provided.
Electricity generated by the photovoltaic cells can be used to back up small electrical systems such as external lights or even computer stations.

Load estimations
Main supply
Load,500 VA (0-3000m^2)- Low voltage (400Volts)

Lighting	20 VA/m^2
Normal power	10 VA/m^2
IT Equipment	30 VA/m^2
Auxiliary	5 VA/m^2
Total	65 VA/m^2

SERVICES

Internal finishes

Walls
The following images give and idea of the durability, quality and texture of the internal finishes applied.

Fig 171. Internal finishes

Fig 172. Internal finishes

Floors
Floors are covered with a pigmented epoxy finish on top of the concrete screed. Therefore, no tiling of the floors needed. In the laboratory the screed is power floated to give an extra smooth floor finish. In the offices an additional carpet can be used to soften and personalise the space.

Lighting
Offices are provided with fluorescent uplighters. Fluorescent lamps produce less heat then tungsten lamps and use up to five times less electricity. By making use of reflective luminaries the harsh light quality normally associated with fluorescent tubes is softened. Desks are also provided with standards for individual task lighting.

INTERNAL FINISHES

Fig 173. Fluorescent uplighter

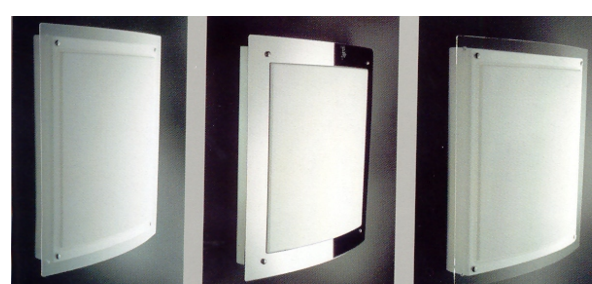


Fig 174. Fluorescent uplighter - different types

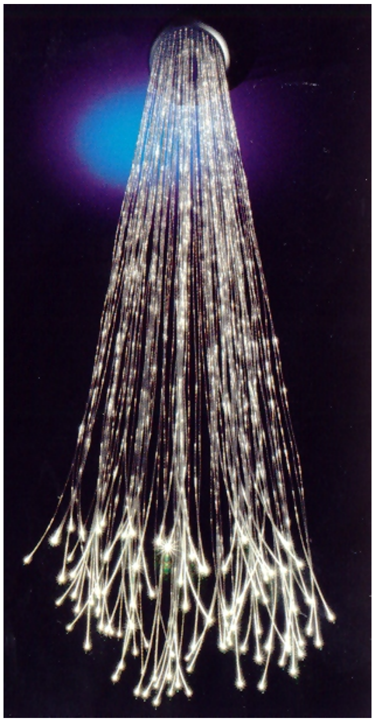


Fig 175. Lighting for foyer

Fig 176. Corridors lighting on floor level

INTERNAL FINISHES

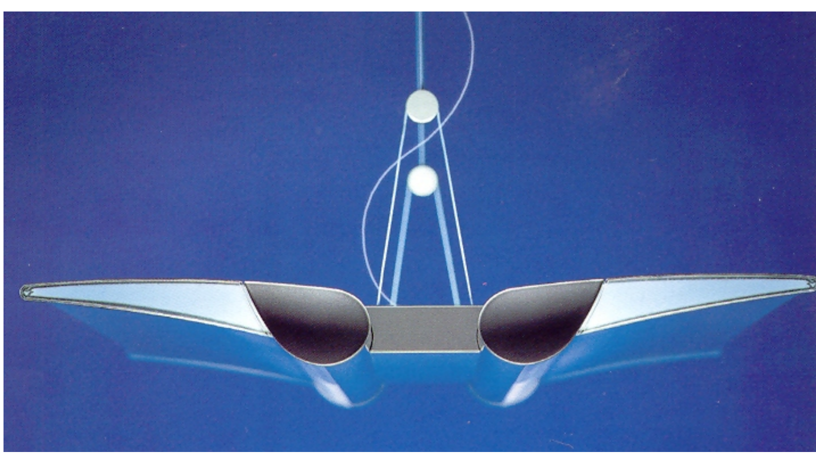


Fig 177. Boardrooms and reception desks are fitted with low energy use fluorescent lamps. The exhibition areas are fitted with lows voltage halogenlamps.

Fig 178. Individual task lighting

Fig 179. Individual task lighting

Ceilings

Patent suspended ceilings are fitted in the offices and conference venue as well as the exhibition spaces. These consist of a typical grid system of hangers fixed to the underside of the concrete slabs. The ceiling panels are 600dx600 perforated metal panels fitted with acoustic panel absorbers. They have a sound absorption coefficient of 0.7 and class O fire rating. The ceiling void of 475mm is adequate for electrical service pipes.

External finishes

Most of the external walls are left with an off shutter concrete finish.
The recycled bricks of the eastern wing are left exposed en thus a rough irregular pattern of colour will immerge. The western facade will consist mainly of steel and glass. Some of the walls in the Water Wise Garden are gabions.

EXTERNAL FINISHES

Fig 180. Off-shutter concrete finish

Fig 181. Gabions / Stone walls

Fig 182. Off-shutter concrete finish

Rational fire design

General aspects

Generally speaking the building can be regarded as a double story building. As far as fire design is concerned there are considerable differences between two and three story buildings. Above three storeys one is for example limited to materials with specific fire ratings. Multi-storey open volumes inside a building such as atriums can also affect fire design.

Cement flooring is used throughout. These have a better fire rating than plastic coated floors. Metal ceiling panels also have a better rating as opposed to panels made from synthetic materials.

Fire hose reels and sprinkler systems

In general, sprinkler systems are not required for a two-storey building. Sprinkler systems have proven to fail under fire conditions. Firstly smoke tends to accumulate at floor level where sprinklers are activated. Secondly structural elements such as steel beams that fail under high temperature cut off ceiling mounted fire water pies and consequently jeopardise the system. A possible solution is to keep fire water pipes at floor level and to supply vertical pipes to the ceiling at regular intervals. This ideal may however influence space planning to a great extend and it is hence not always possible to implement a system in this manner.

Fire hose reels and extinguishers are marked clearly with appropriate signage. Fire hose reels are provided at 30m intervals.

Fire escape routes

Escape routes are in accordance with part T of the National Building Regulations. This means that no escape route may exceed a length of 15m in one direction.

Emergency routes

Once entering an emergency route there are two escape options. The total length of an escape route plus the emergency route up to a safe oint outside the building does not exceed 45m.

RATIONAL FIRE DESIGN

Fig 183. Fire escapes

Design Analysis

Design Analysis

The aim of this design scheme was to create a educational facility which conveys the principles of Water Wise living methods to it's surrounding community without compromising on the principles.
The following design issues will be addressed:

- **PHILOSOPHY**
- **METAPHORS**
- **LINEARITY**
- **SITE CONTEXT**
- **RESPONSE TO CONTOURS**
- **TOPOGRAPHY**
- **CREATING AN EDGE**
- **NOISE BUFFER**
- **ENTRANCE**
- **CONTRAST**
- **TRANSITIONAL SPACE**
- **CONCEPTUALISING**
- **VENTILATION**
- **ROOFING**
- **PEDESTRIAN ROUTE**
- **ROOFING**
- **INFORMAL LABORATORY**
- **LAYOUTS**
- **LANDSCAPE**
- **CIRCULATION AN**
- **EMOTIONAL EXPERIENCE**

PHILOSOPHY

Through the ages, WATER has been seen as maybe the most important resource available to man. In Africa, and more specifically South Africa, we have limited water resources.
This leads to the universal issue of resource management, to prevent the depletion of our water sources. Educating the community in the essential techniques and methods of working wisely with water is becoming more imperative as time passes.

Rand Water - the main water management body in South Africa - expressed their increasing need for a facility to address these issues. In concurrence with the Department of Education, it is apparent that a centre, purposely designed for this need, would be indispensable. This Water Wise Centre will accommodate the activities needed to achieve the goal of educating the community.

Buildings have become more multi-functional. Buildings have started to act as living organisms. With this in mind, the Water Wise Centre can not house only one function, i.e. administration, but it should be an interactive, living organism which will serve the community in a linear learning process. This learning process teaches people how little water we have, how to gather additional water, and how to purify water for their own use, or to redistribute it for use in the bulk water network of Rand Water.

The three phases of water, liquid, gas and solids play an intricate philosophical part in the design process. Knit together with this, three other aspects of water:

- Dirty undrinkable water
- Cleaner water
- Drinkable water

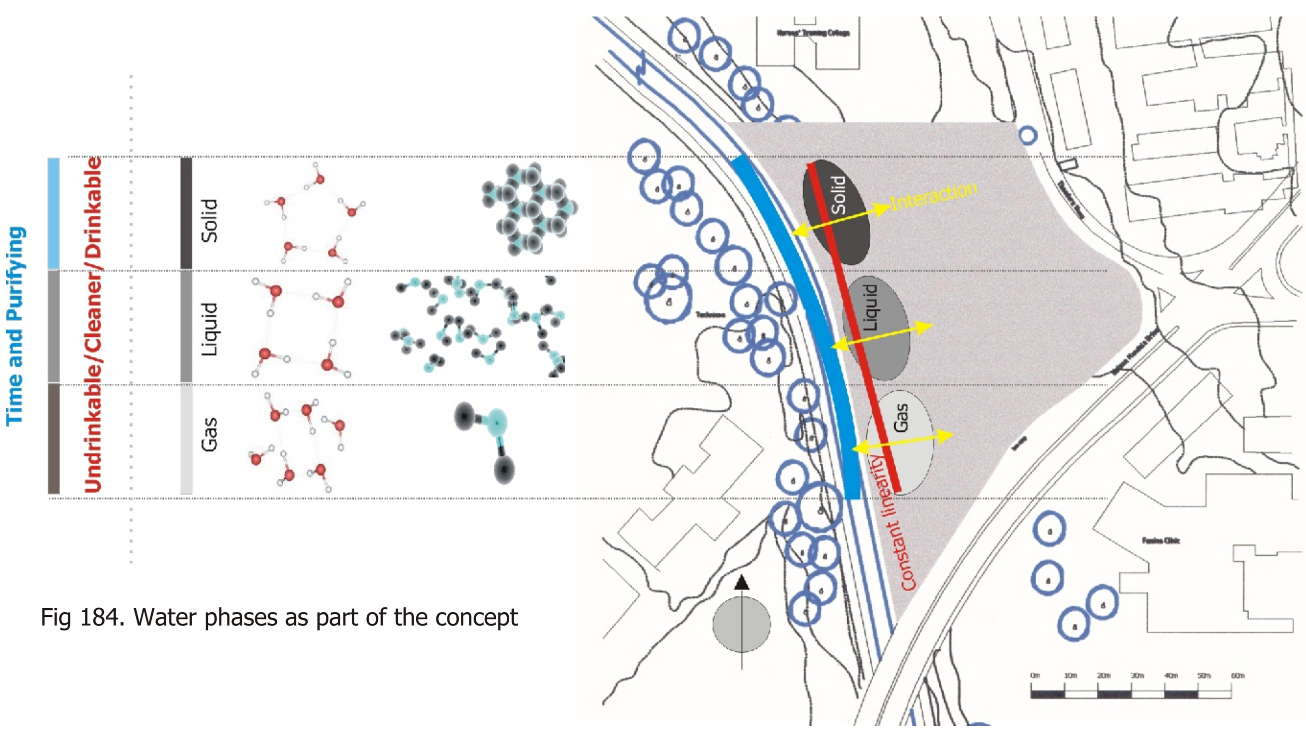


Fig 184. Water phases as part of the concept

In the end, water, in its guises of ice and steam as well as its liquid state, tantalises in its potential as a building component or element and is a reminder of its undeniable presence in the life of each living being.

Architecture, in response to these issues, should create the space for experiencing water.
It is necessary to differentiate between a Water Wise centre, and a building that focuses on water technologies available in the building industry. The challenge in this project is to provide an experience of water, without compromising on Water Wise principles.

A problem concerning urban sustainability arises here. A building that facilitates the functioning of education in water wise living methods, cannot be designed without focussing on sustainable design. In order to achieve this, issues concerning a civil society, improvements in social equity, diversity, opportunities and 'quality of life' need to be addressed. Physical development cannot be dealt with in isolation from the dynamics of the prevailing political and economic environment. The overriding aim of the project is to create an urban educational environment that facilitates and enriches the daily activities of human life. The SBAT/ Sustainable Building Assessment Tool was used in depicting these points of concern.

METAPHORS

Where the individual is concerned, education of any learner runs parallel to a line which starts at a zero/basic point of knowledge and runs through the stages of obtaining knowledge, to reach an end point where one could say the learner is adequately equipped to make his own inductive vs. deductive decisions concerning what is best for humankind as a whole.

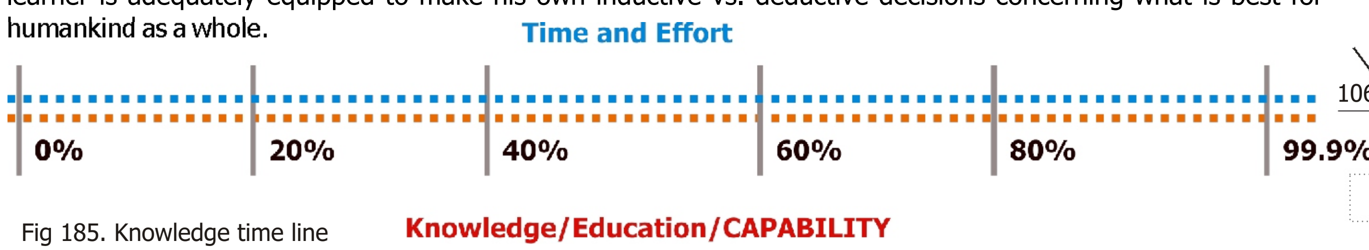


Fig 185. Knowledge time line

The line above shows the natural growth of any person when it comes to obtaining knowledge. Different people arrive at the different stages at different times. This is fortunately not the crux of the problem. If more people can be brought to the capability side of the graph - no matter how long it takes - many more people could be influenced.

Directly linked to the above is the process of cleaning dirty water that has been extracted from a source. This process also follows a linear process of treatments to change water from an undrinkable state into purified drinkable water.

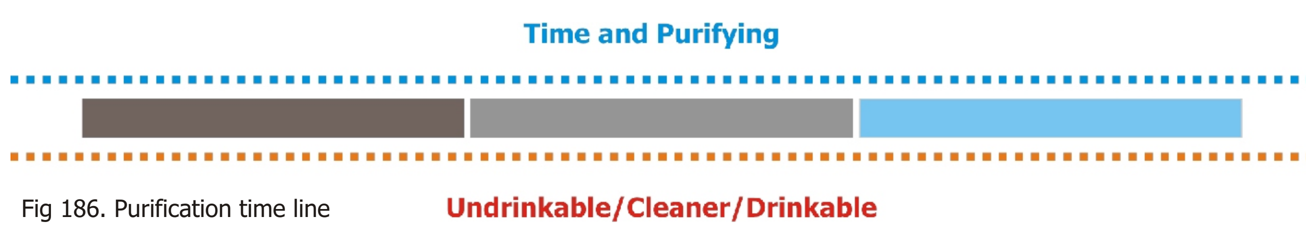


Fig 186. Purification time line

LINEARITY

Architecture is much more than physical form created by wall, roof and floor. Buildings are living organisms. Being alive means to interact with things or elements around and within one. It is with this knowledge that this Water Wise Centre should be a linear vessel for any learner or visitor to further their path and quest on the time line of knowledge/education/capability. To assist in this process the building should be an interactive, living organism. The linearity of this building takes learners step by step through a learning process. The term linear must not be associated with a straight line with a start and an end point, where the one has no relation to the other.

Site: 8894.3m^2
Building: Maximum footprint 5300m^2

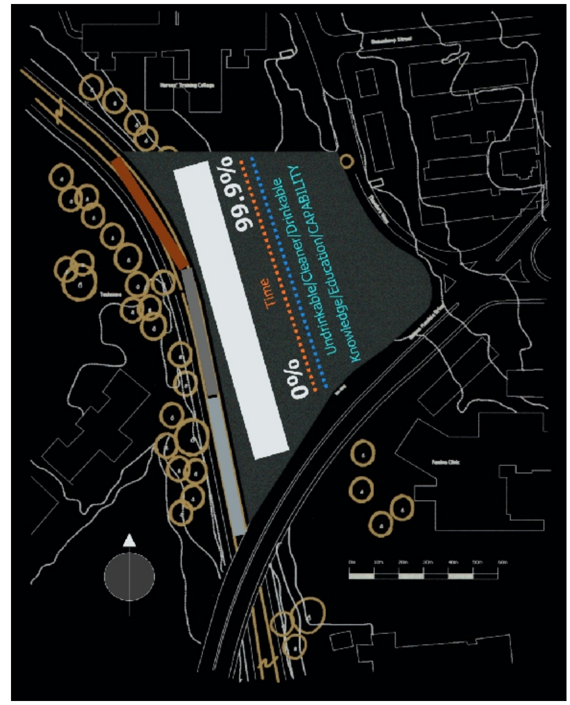


Fig 187. Linearity of the site

SITE CONTEXT

The diagram shows the relationship of the existing buildings relative to the site of the Water Wise Centre.

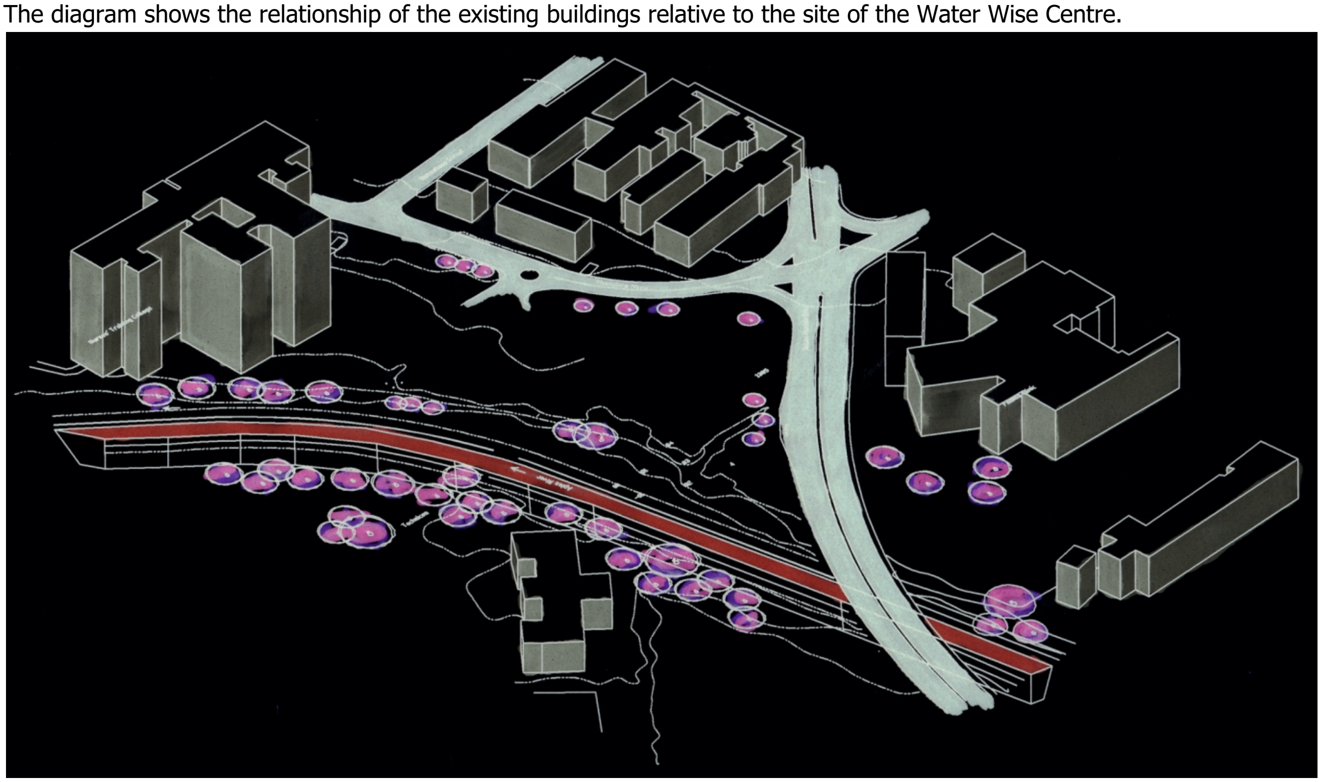


Fig 188. Existing buildings relative to the site

RESPONSE TO CONTOURS

The following diagram shows the contour lines present on the site. Take note how the contours are concentrated on the western part of the site. The greater part of the site, are very flat in comparison.

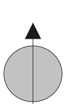


Fig 189. Contours on site - Proposal of city council for the extension of Nelson Mandela Drive

TOPOGRAPHY

The shape and form of the Water Wise Centre generates from physical conditions on site. The most prominent changes in level on site is on the wester side with each one increasing in height at 1m intervals as one grogressess.The education philosophy, as mentioned above, also plays a part. See section of the topography of the site below.

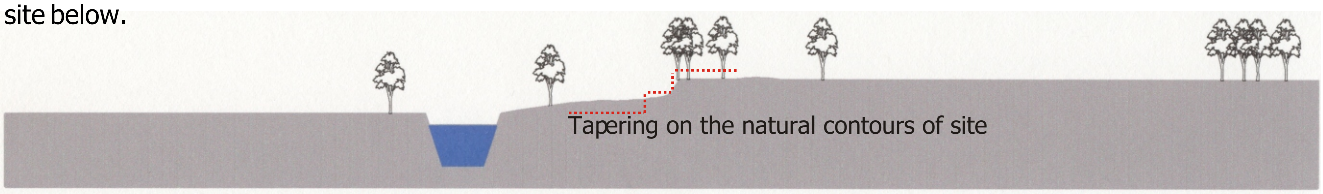


Fig 190. Proposed levels for building floors

The greater part of the site slopes evenly from east to west. The position of the contours on the western side of the site, the traffic concerns on the eastern end of the site, and the dominantly high building on the northern façade had a critical impact on the placement of the building on site.

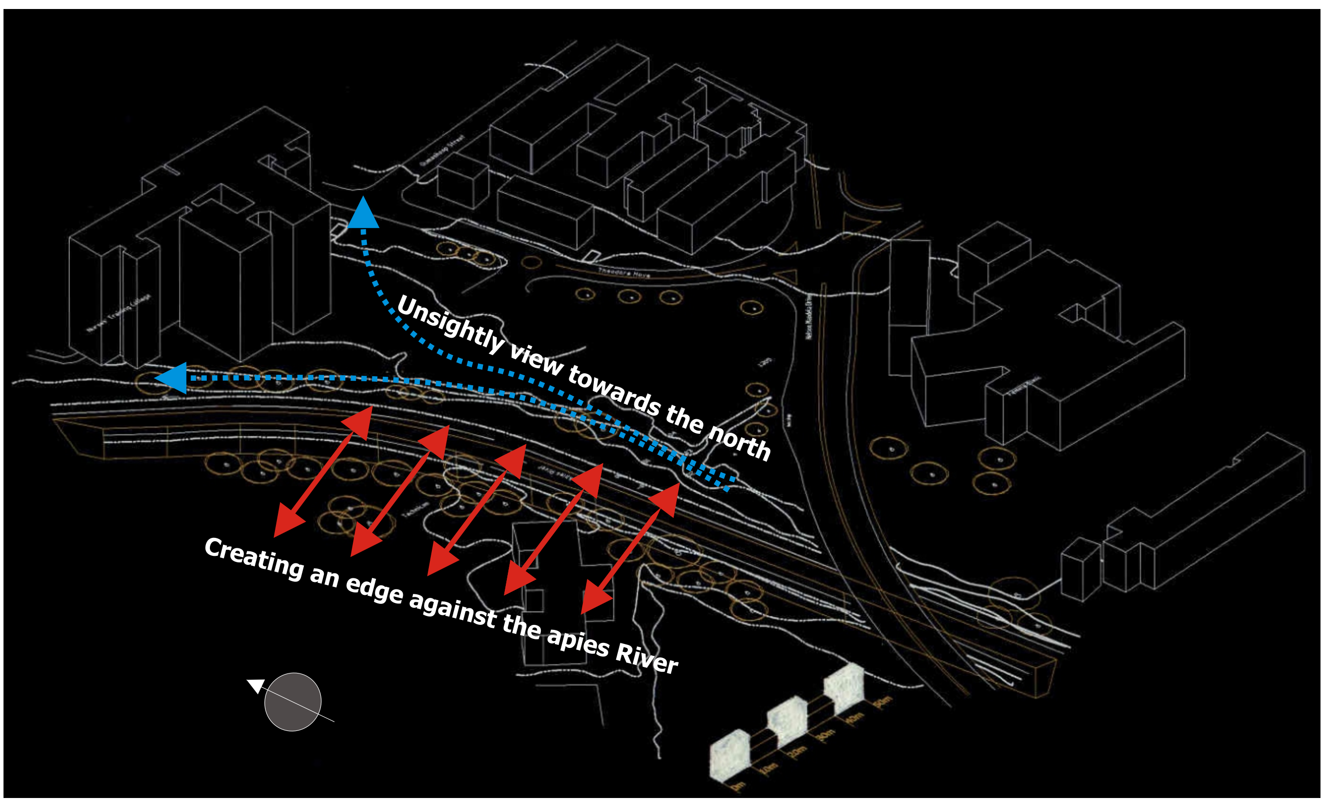


Fig 191. Unsightly views to the north

Making use of the natural fall on the western side of the site, level changes in the building where not only possible, but also much more cost effective, due to the limited excavations needed to achieve these changes in level.

CREATING AN EDGE

It made it much easier to define the edge along the Apies River. This edge forces one to be close to the water, and therefore one is confronted by the presence of water as an entity. The more spaces face onto this edge, the more psychological awareness of water is created in the mind of the visitor. As we all know, water has the tendency to make one reflect on one's own life, very much like the gripping power of a camping fire has on one. This is exactly what the aim of this building is, to make people reflect on their ways of using and sometimes abusing water.

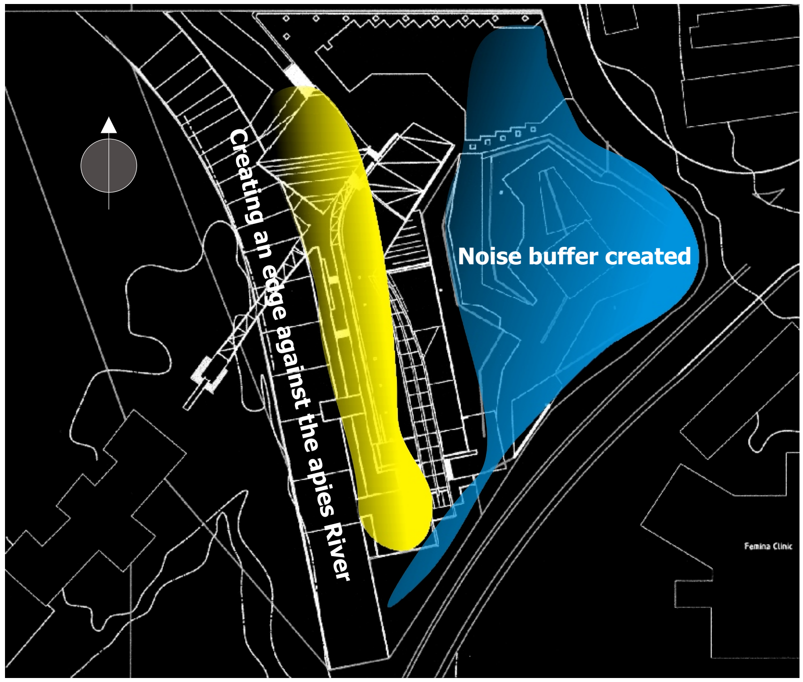


Fig 192. Edge along the Apies River

NOISE BUFFER

The concentration of the greater part of the building is along the western side of the site, running parallel to the Apies River. On the eastern side of the site, a noise buffer zone is created, by means of a garden with stone walls. This buffer zone minimises the high noise levels that originate from the new intersection at Nelson Mandela Drive and Oumas Hoop Street. It has a dual purpose. A communal space is created that can be used for a multiple of options. Apart from its main purpose of being an educational space, this area serves as a communal and social

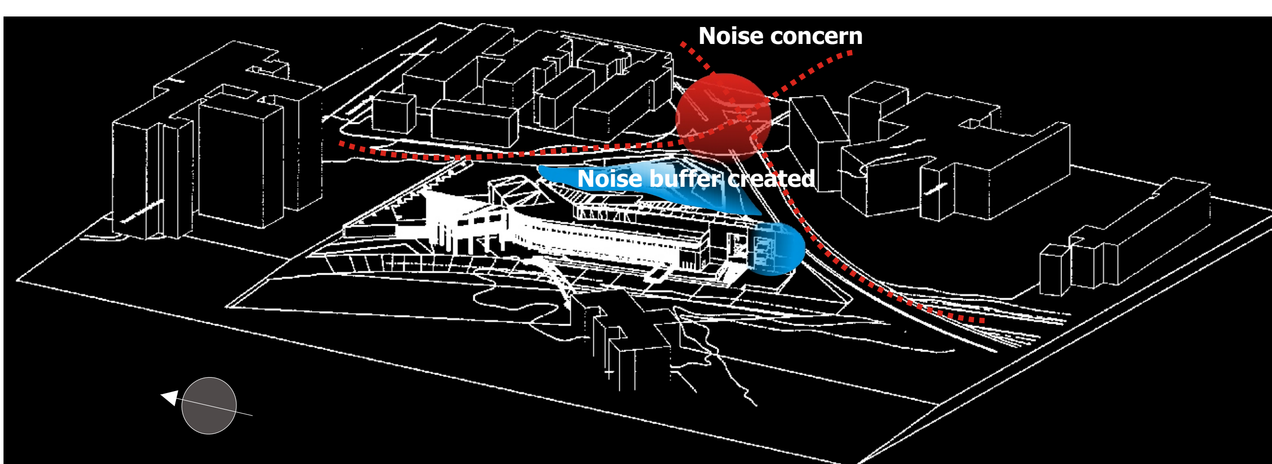


Fig 193. Edge and noise buffer zones

ENTRANCE

Pointers as to where the entrances to the site would be were taken from the existing traffic routes, and proposed new routes. A vehicular entrance originated from Oumas Hoop Street. This was apparent due to restrictions and frameworks given by the City Council of Tshwane. An entrance close so close to an intersection is not advisable and it is provisioned that Nelson Mandela Drive would have a high volume of traffic. Therefore, the entrance to the site

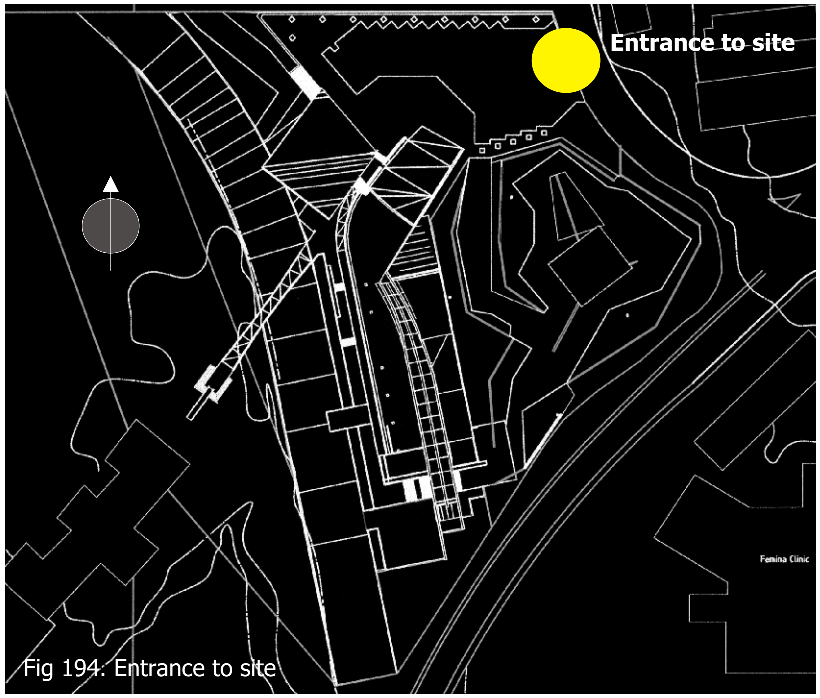


Fig 194. Entrance to site

CONTRAST

Several critical points were identified after evaluation of the concept. Firstly, Oumas Hoop Street is already well defined as a space by the flanking trees and existing buildings, and therefore the introduction of a street edge is not essential. Accommodating a vehicular entrance at the marked position has practical implications: An entrance from the busy Nelson Mandela Drive is undesirable and it has to be a reasonable distance from the proposed new intersection at the corner of Nelson Mandela Drive and Oumas Hoop Street. This helps preventing traffic congestion at the intersection.

The new development stands in contrast to the surrounding architecture, mainly because its function and status is inherently different to that of the surrounding flats, hospitals and office buildings.

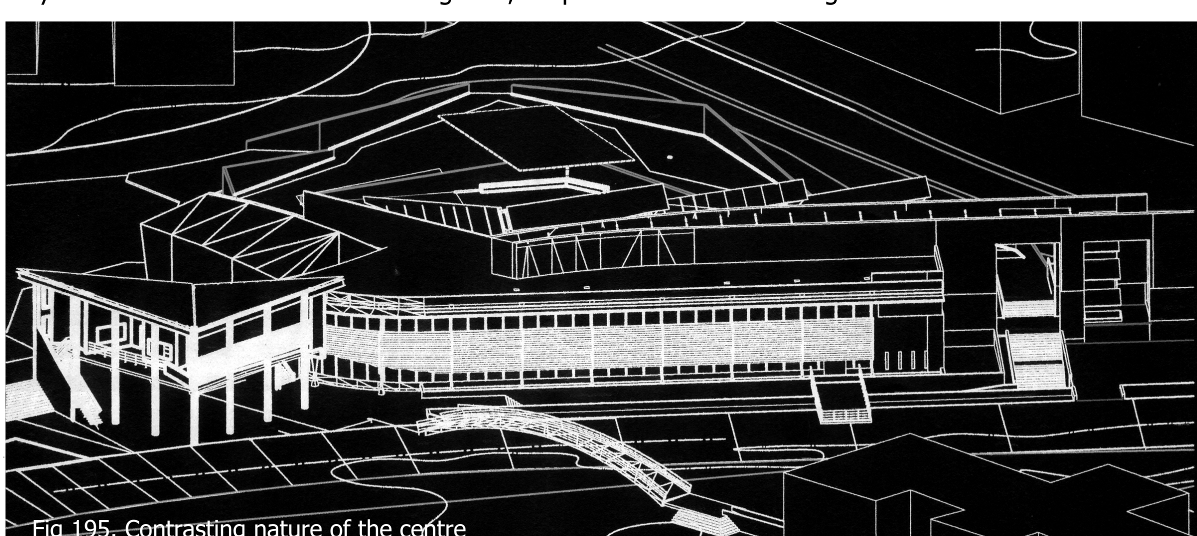


Fig 195. Contrasting nature of the centre

TRANSITIONAL SPACE

The site functions as a transitional space between the Hospital precinct and the inner city. There is a transition from dense urban fabric to 'natural' landscape. The entire site is not covered but instead the development is a freestanding element in a natural setting. These points of view should already be manifested in the footprint of the building.

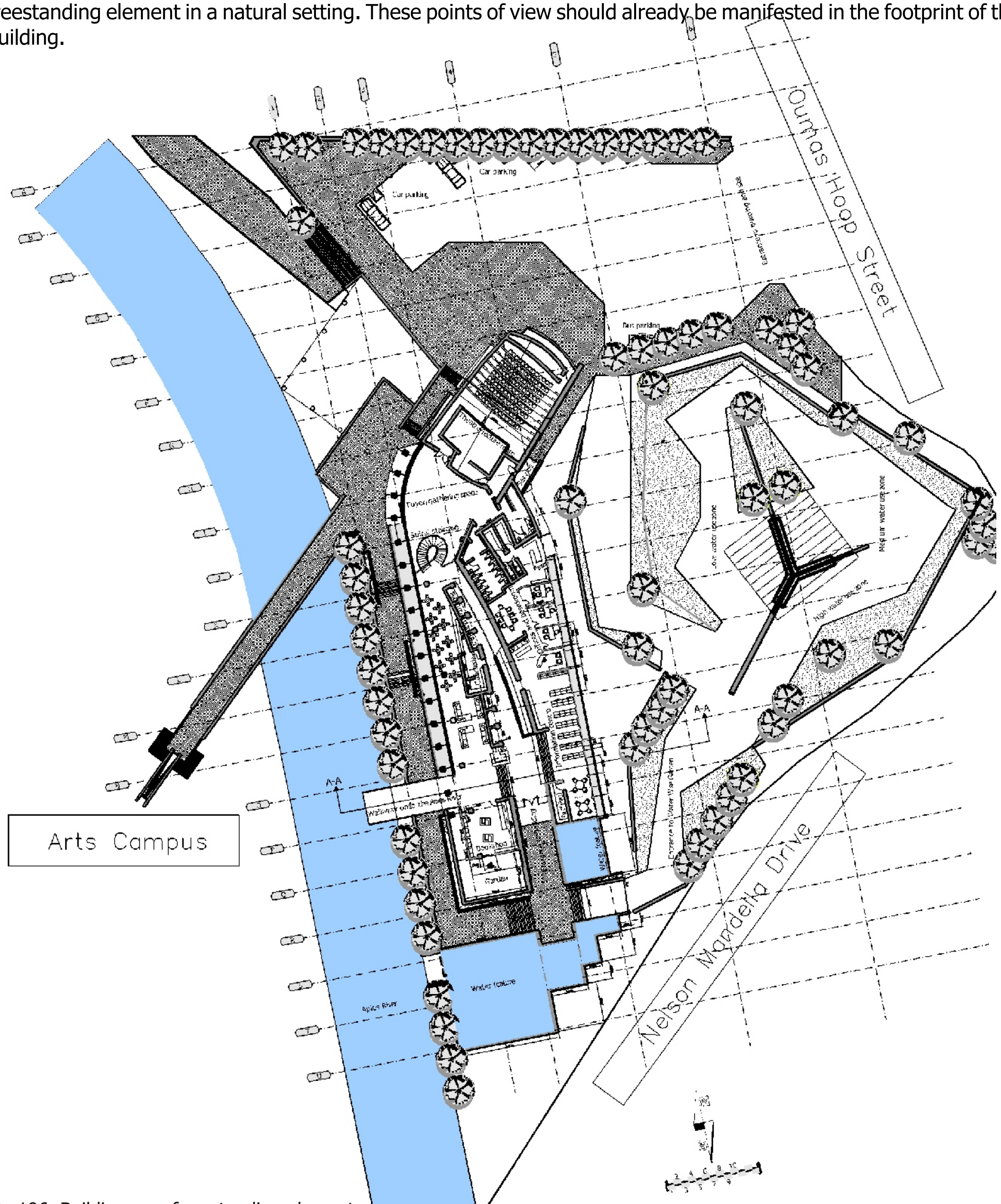


Fig 196. Building as a free standing element

CONCEPTUALISING

The resulting concept introduced curved shapes to the footprint of the design. These shapes not only give the design a unique quality in contrast to the direct physical context, but it also conceptualise the design with regard to the flexibility of water as an entity. The idea arose to extend the embankment along the Apies River into the site, transforming itself gradually into the hard fibre of the building. Taking this into consideration, it was decided to turn the building "upside down", meaning that the conventional approach was turned around so that the building is entered from the 'back end'. From the parking area the route follows a path running through a gateway, formed by the theatre on the left and the office block on the right. A pedestrian bridge lingers right in front, and when this is reached the route suddenly swerves to the left. The route leads to a path descending to a point below the water level of the river. The river is now out of sight, but a lively reflection of the water, is always visible on the western glass façade on the left. This keeps one attend on the constant presence of water in one's life.
Water cascades down the changes in levels as one proceeds. Water runs across glass panels into a shallow pool, which run the full length of the route. Following this route one is at different intervals exposed to yet another guise of water.

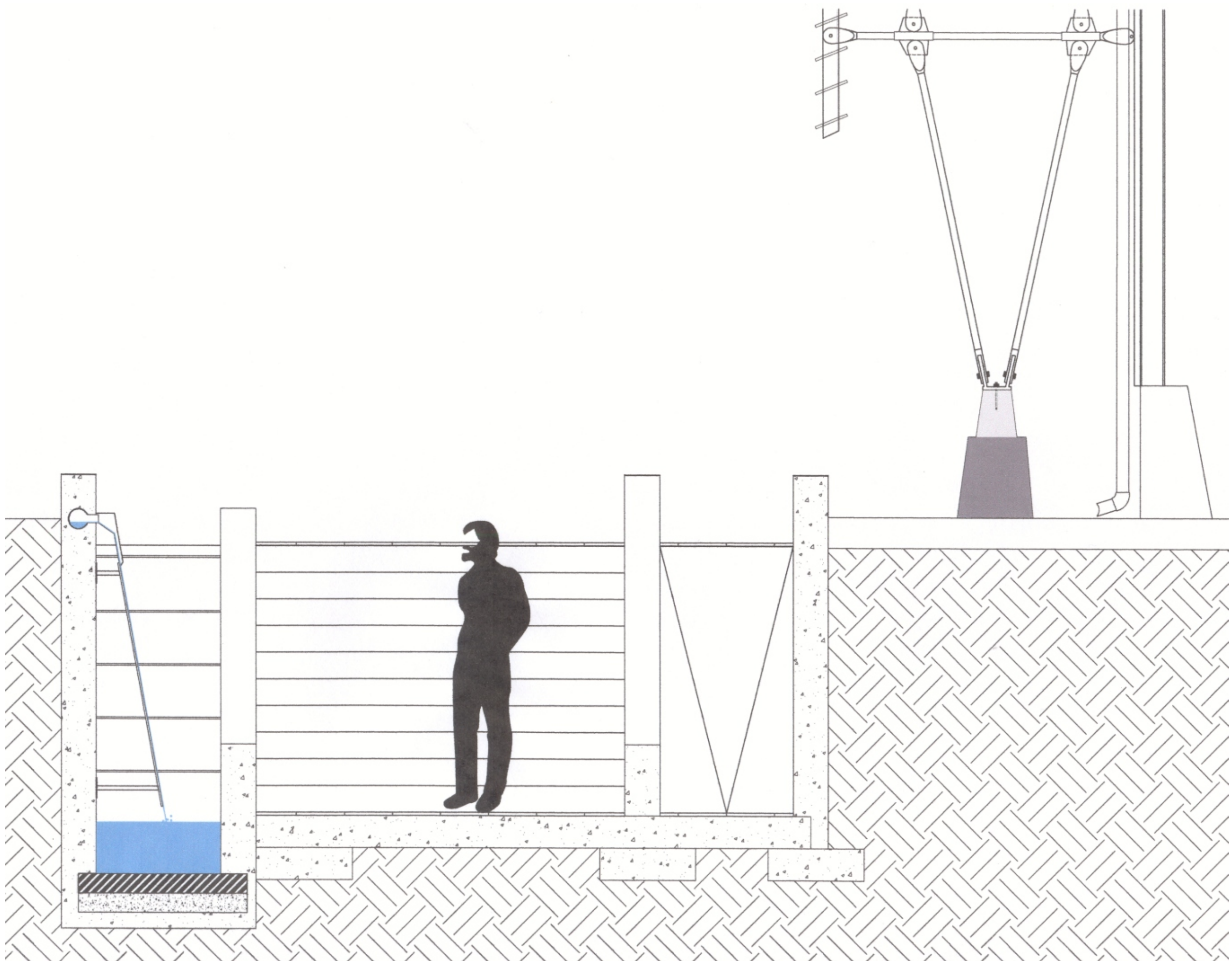


Fig 197. Section through walkway, showing water running over glass panels

Just as one passes the cascading water, one steps into an area covered with a simple glass and steel rooftop. Suddenly one finds oneself in a misty cloud. Nozzles, located in the walls on either side of the walkway, release a fine water mist. The roof covering the space, together with the slope of the floor, encapsulates the water, keeping it in a closed system. This prevents the water/steam from evaporating.
Underneath the pedestrian walkway a space with a lower roof and a different light quality is entered. Cold mist is blown over the body by overhead nozzles. This might take one to the point of discomfort, but just before this point is reached, one exits from underneath the walkway into a space that opens up clear skies. Here ,the reflection of the river is still visible on the glass facade.
The next part of the route has no roof. Next to one, four streams of water are shot from nozzles located in the shallow pool. At this point the rumble of cascading water, more forceful than the limpid ripples of the overflowing pool, can be heard. This is the kind of noise generated when water has been provoked. All that can be seen at this stage is a large glass panel located in a blunt concrete wall right in front. This panel reveals the water mass that lies behind, seemingly quiet. The origin of the rumbling water reveals itself only gradually as one walks towards the end of the route. The last few metres lead up a large staircase through a slot cut into the concrete. When this point is reached, one is again above the water level of the river, at the source of the rumbling 'waterfall' and on the threshold of the entrance of the building.
From here one can walk up to the waterfall to experience the sensory pallette, provoked by, sight, smell, hearing, touch, and even taste, for if one looks towards the back, a large sand filter is located within the concrete wall. This sand filter is used to clean the water running through the water feature system. It is also part of the educational exhibition, where one can physically see how dirty water is added to the system and clean drinkable water exits the filter. The clean water falls into a metal basin located at the bottom of the filter. From there it fills up, and the overflow falls into the first pool of the water feature. One can even be so bold as to make a bucket with one's hands and drink some of the water in this basin. The proof lies in the tasting!

The next images explain the route mentioned above, running to the reception level within the building.

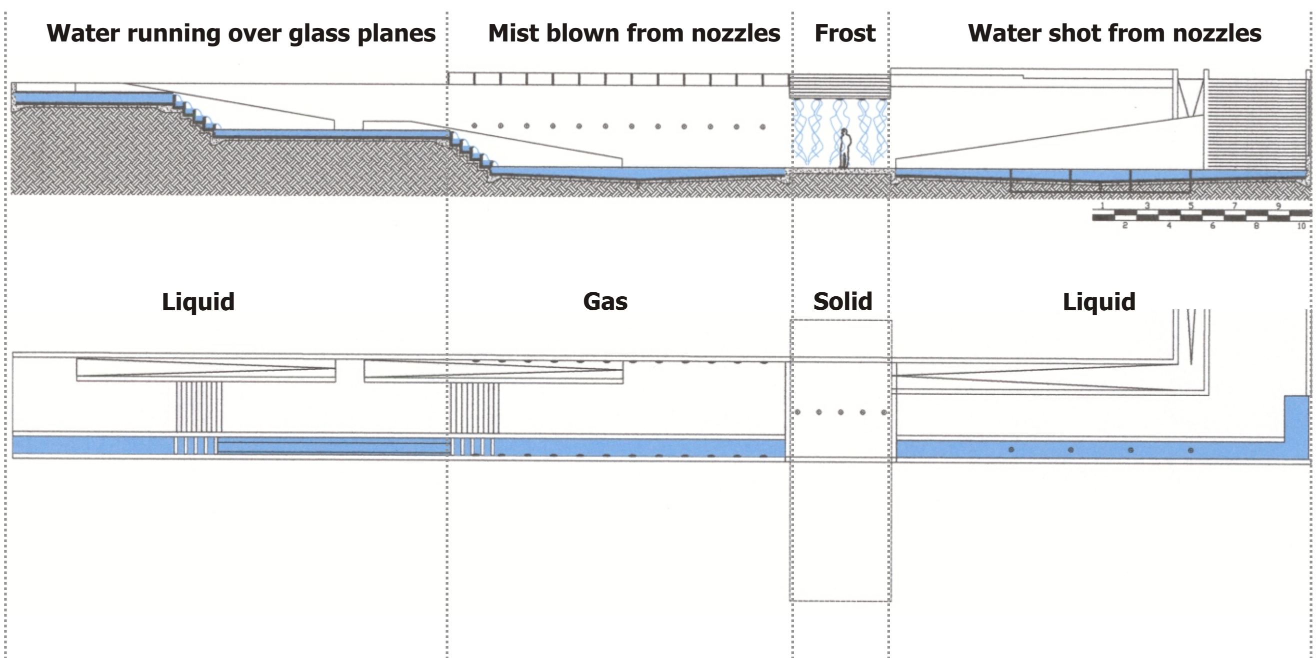


Fig 198. Section through the walkway, showing different guise zones

At this point in the design development the circulation within the building is addressed. The first proposal was to have the exhibition areas one after the other, but this meant that there would have to be an exit on the northern end of the building. This would have had a dramatic impact on the 'forced' route that the visitor is supposed to take. It also would have meant that one will have to backtrack at some stage on the same route followed earlier. A circular route within the exhibition spaces was adapted. After entering the building, an extended ramp within the atrium leads towards the exhibition spaces. On turning left, one follows the circular route down to ground level again. The formal functions are located on the ground level, where the formal functions are located. These functions include theatre/lecture room (for lectures, puppet shows and further educational media), the information centre (including archive, library, reading/study room, and computer station), offices, book and tuck shop, and the dining area. The pedestrian bridge extends over the river, and there one can find time to reflect quietly on what was learned during the visit.

The office block on the northern end of the building is mainly administrative and the laboratory lends the opportunity for doing experiments under strict safety conditions.

The space underneath the office block provides the opportunity for more relaxed interaction with water.

After the functions within the building have been completed, one may exit the building and follow the route through the Water Wise garden. The garden consists of three zones, which represent plant types that are adaptable in their zones: low water use, medium water use, and high water use. The garden serves as an educational tool. The plants are used as props to explain further principles on how to adapt to the three zones of water availability.

If one chooses not to walk through the garden, one can directly follow the route towards the parking area.

This will conclude one's visit to the centre.

Fig 199. Circulation routes

VENTILATION

The building is dependent on a natural ventilation system. 20% Openable windows on all facades enhance this system. To ensure the constant inflow of cool air and escape of warm air, an air displacement system is introduced to the building. The three-dimensional quality of the atrium was determined and fixed by thermal considerations. The atrium serves as a stack system, with very high walls that are exposed to direct sunlight. All the adjacent areas are linked to the atrium. The skylight runs at a slope and the atrium is the highest point for warm air to escape from the building.

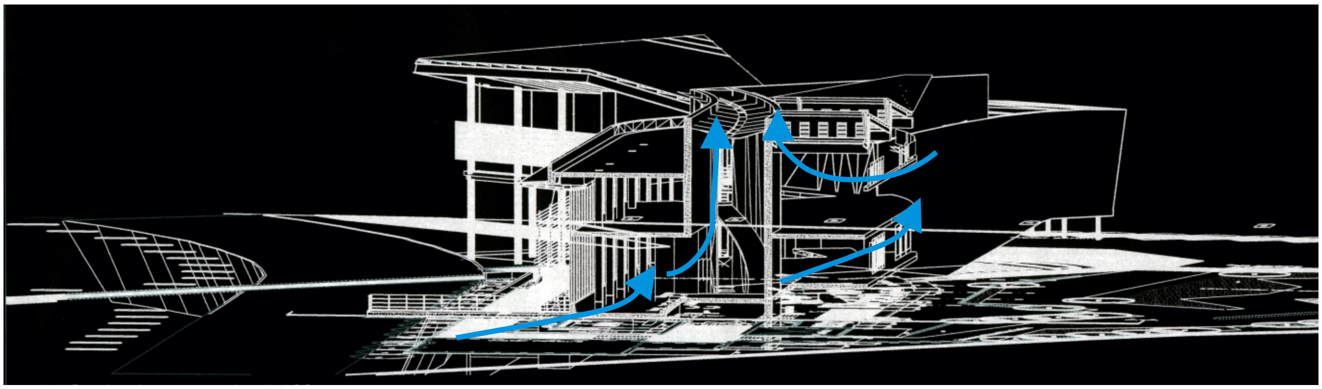


Fig 200. Natural ventilation

ROOFING

The exhibition areas on the second level of the building need natural light. A system of I-section beams and lipped channel beams create a roof system, which introduces ample southern light to these exhibition areas. Brownbuilt sheeting was implemented at a slope of 6 degrees. It is important to note that the contrasting featrues of the building emerged as a result of a reaction to the context. This creates variety and tension within the building, while the organic shapes become more striking against an orthogonal backdrop. It was subsequently decided to emphasize the contrast but to refine it to a point where the building expresses unity and variety simultaneously.

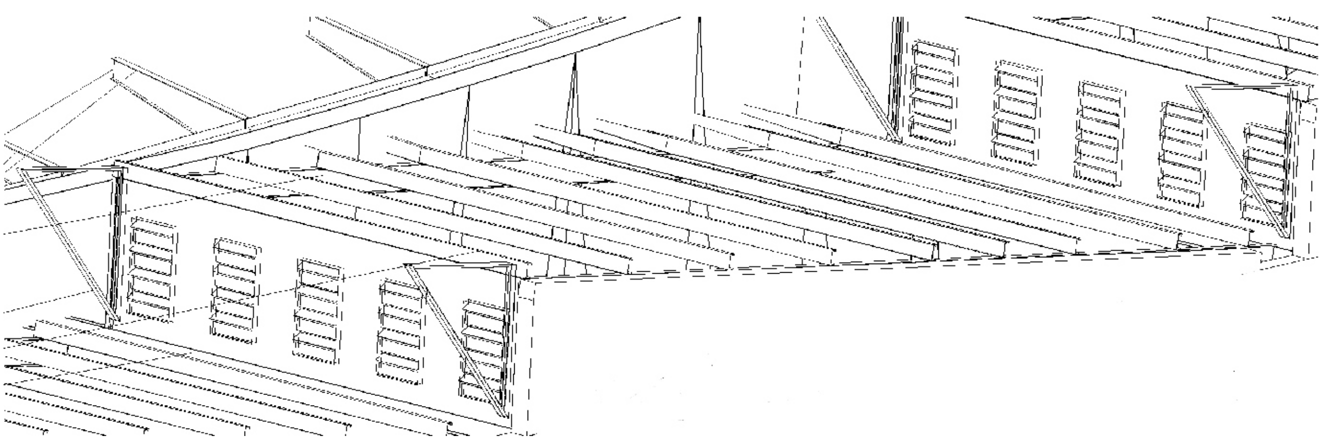


Fig 201. Steel roof structure

PEDESTRIAN ROUTE

The prospect of a pedestrian entrance directly from the north, from the public transport node, was also considered. However, it was decided that this configuration was too conventional in the sense that it left little opportunity for creating a sense of expectation in the visitor and that the address and the function of the building called for an appealing entrance on a grander scale. Thus, access from the north was given, but it flows into the 'forced' route that takes one to the entrance of the building.
The option of a second access route into the building, for staff only, was already apparent. The entrance on the southern side of the theatre gives direct access to the parking area, and is close enough to the important areas of the building for deliveries, etc.

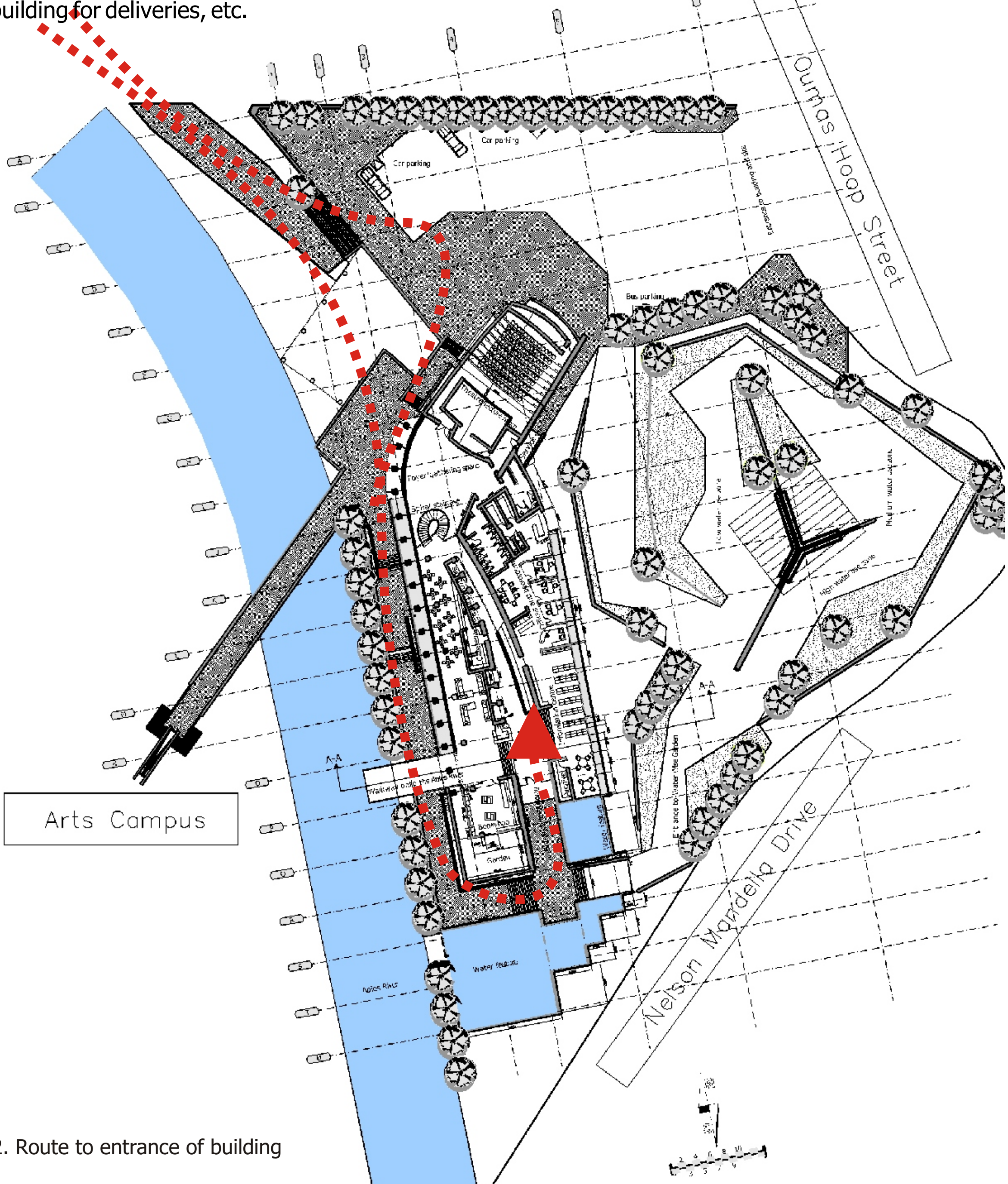


Fig 202. Route to entrance of building

ROOFING

The roof structure of the northern office block is solely used for the catchment of rainwater. This system consists of a catchment area, a roof-washing system, a rainwater conveyance system, a cistern or storage container, a delivery system, and a water treatment system. The system works on the following principle - the roof-washing system captures the first 70 to 80 litres of water in a separate pipe that removes the first flush, allowing the heavier solids to sink to the base so that the water flowing into the collection system is relatively free of particulates. The water is purified by a simple sand filter system. The roof covering consists of galvanised steel sheeting with a baked-on enamel, lead-free finish.

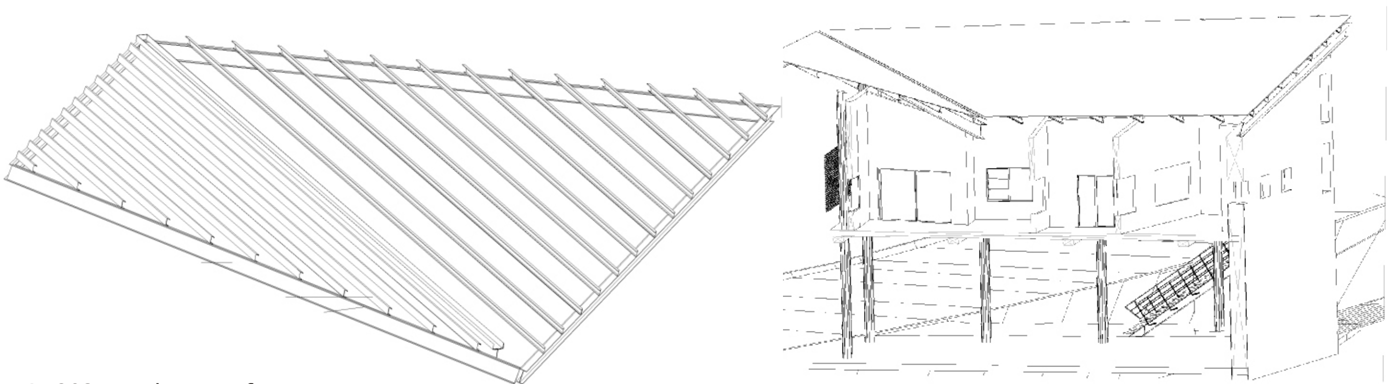


Fig 203. Northern roof structure

INFORMAL LABORATORY

The collected rainwater will be used for experiments in the laboratory that forms part of the office block. This decision was made due to the fact that there should at all times be supervision close by, when and if children are doing experiments in the laboratory. The indoor laboratory is a formal space with all the safety regulations in place. If one descends down the staircase running from the laboratory, one finds an informal 'laboratory'. The floor of the office block forms the roof for this area. This area has direct access to the river. The central open space has

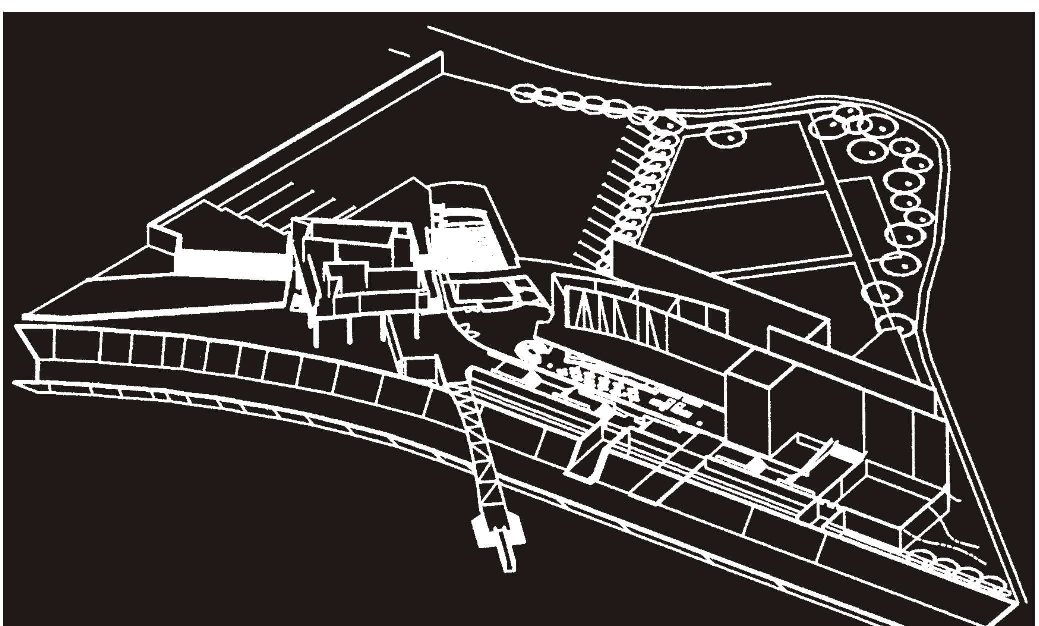


Fig 204. Laboratory and office block

LAYOUTS

The client requires very little office space, due to the fact that a small amount of permanent staff is necessary to run a facility of this kind. Most of the people participating in the educational programmes are privately contracted. There are only 4 offices on ground level, near to the information centre, since here would be the place where most assistance would be needed. The other offices are located in the northern block due to reasons already mentioned. The yellow hatching indicates the location of the offices.

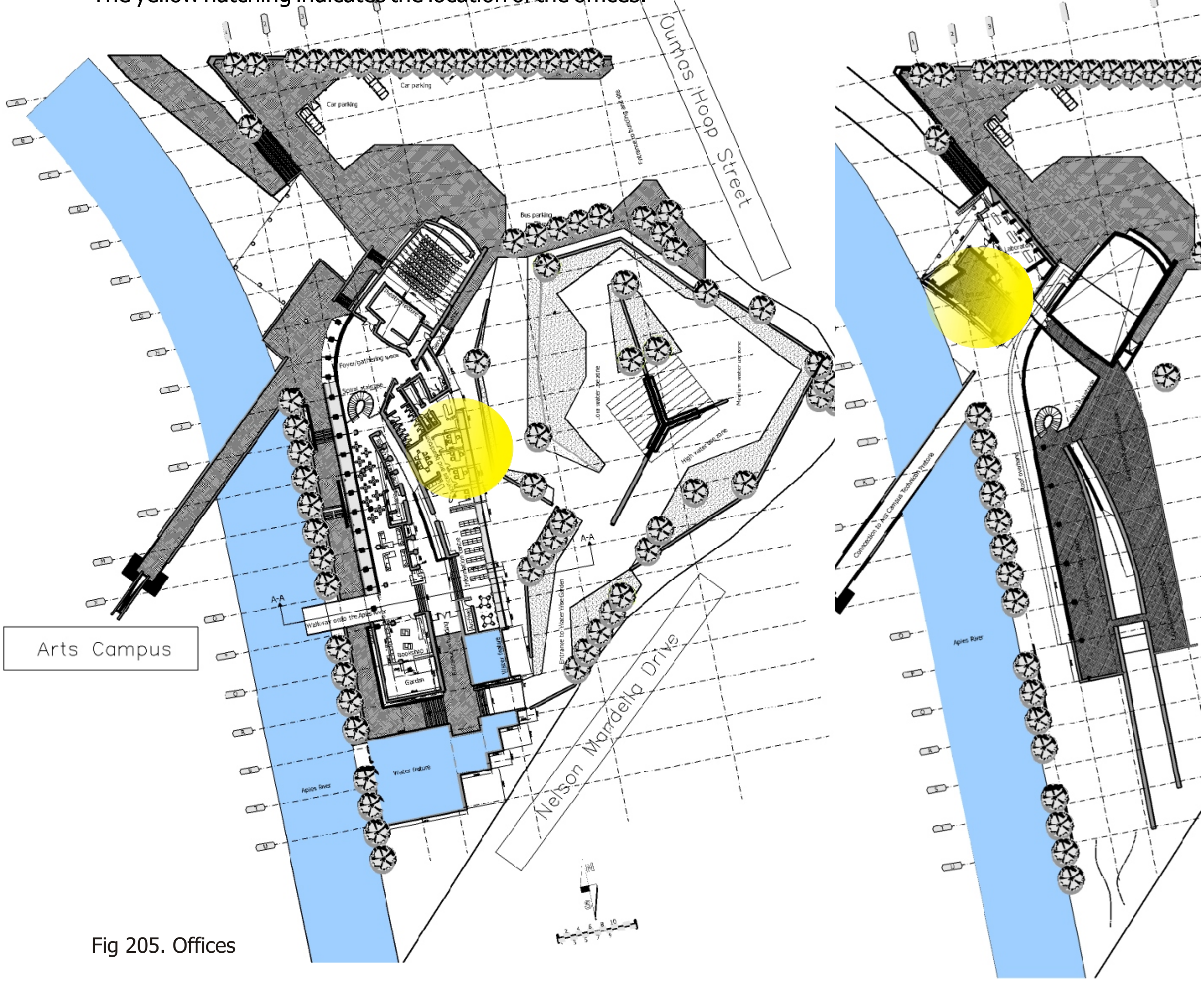


Fig 205. Offices

The building footprint was by now established. The generous floor to ceiling space answers the question concerning its potential for extension. In two of the exhibition areas, there is ample space to add additional mezzanine floor levels. Even within the offices in the northern block, space is provided generously. These offices don't have a fixed layout and can be determined by the clients themselves.

Once the footprint was established, scaling and arranging of the different spaces for the needed functions followed. This process was mainly influenced by the accommodation schedule and the grid dictated by the structure of the columns. The form and shape of the theatre were modified for acoustic reasons. Proportionally the new shape is better suited to the rest of the building's form. The objective was to create an architecture which was honest, unambiguous and to the point.

The order inherent in the architecture has a subconscious effect on the inhabitants' common knowledge that human needs can be categorised into two groups: physical and psychological. Physical needs include shelter, food and protection against the elements, whereas basic psychological needs include the desire to create order. Where there is order in a space, man achieves a certain level of "psychological comfort". In this building, these two needs are played against one another. Whilst one experiences the building as being organised and that there is a strong order within it, one's physical comfort is constantly challenged, due to the exposure to water in all its guises. Therefore, the exposure and discomfort one might experience at times are limited to specified areas. On the other hand, the formal areas where one should feel the potential of being productive and efficient are structured and ordered.

Too much order in a space can cause that space to become sterile and monotonous. Too much variety, on the other hand, could result in chaos. Thus there has to be a balance between order and variety, in order to create a healthy environment. This is not so easy to achieve. The exhibition spaces provided are very much ordered, but with carefully planned exhibitions in place the balance between order and chaos will be achieved.

LANDSCAPE

The Water Wise garden is a space not only for outdoor activities, but also becomes an element that is responsible for the "well-being" of the building through the presence of nature. The proximity of nature to the workspace creates a tranquil effect within. It has been proven that nature slows people down, whether they pass through it or whether they observe it passively. All the offices have views either of the Water Wise garden or of the natural surroundings. This puts the occupants of the building in contact with the natural surroundings. Opposed to controlled static spaces, such as vast areas of harsh landscape commonly found in highly populated areas of modernist cities, these spaces are dynamic. The diversity provided to the natural landscape by seasonal changes, texture and colour is visually stimulating and keeps the occupants of the building alert. This alertness stimulates productivity.


Fig 206. View to Water Wise garden from parking


Fig 207. View to parking from garden

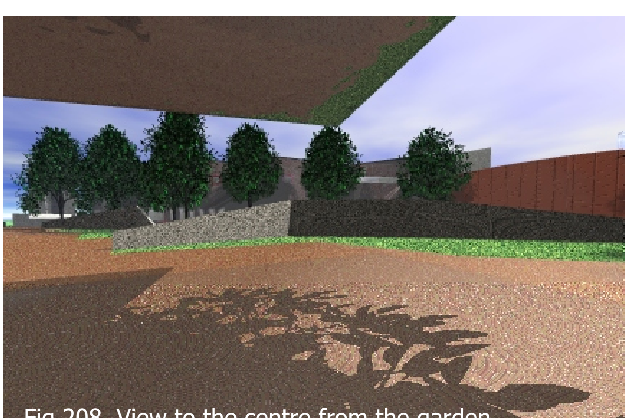


Fig 208. View to the centre from the garden

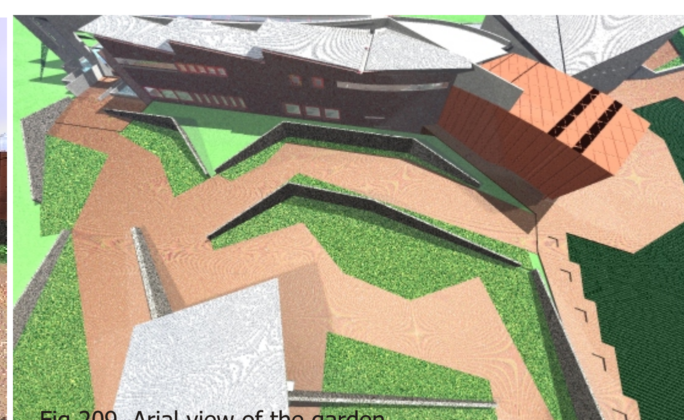


Fig 209. Arial view of the garden

CIRCULATION

The public spaces of the building are arranged at logical positions along circulation routes. The conference venue/theatre, atrium and cafeteria are all located on the ground floor of the building, enabling the natural flow of movement.

The atrium, which lies at the centre of the building, becomes a binding element in the building. Upon arrival, the visitor, having passed the walkway, enters the building via the stairs leading one to the information desk and straight to the ramp in the atrium. Either way, the atrium is a concourse and main point of orientation of the building, since all public spaces are accessed via the atrium. It is also within the atrium that smaller exhibition spaces are located. These spaces can either be used as part of the client's exhibition spaces, or for example, for advertising by sponsors.

This space act as an extension to the adjacent spaces during official gatherings, or when the client houses larger exhibitions. It is also suitable for catering activities due to its proximity to the kitchen.

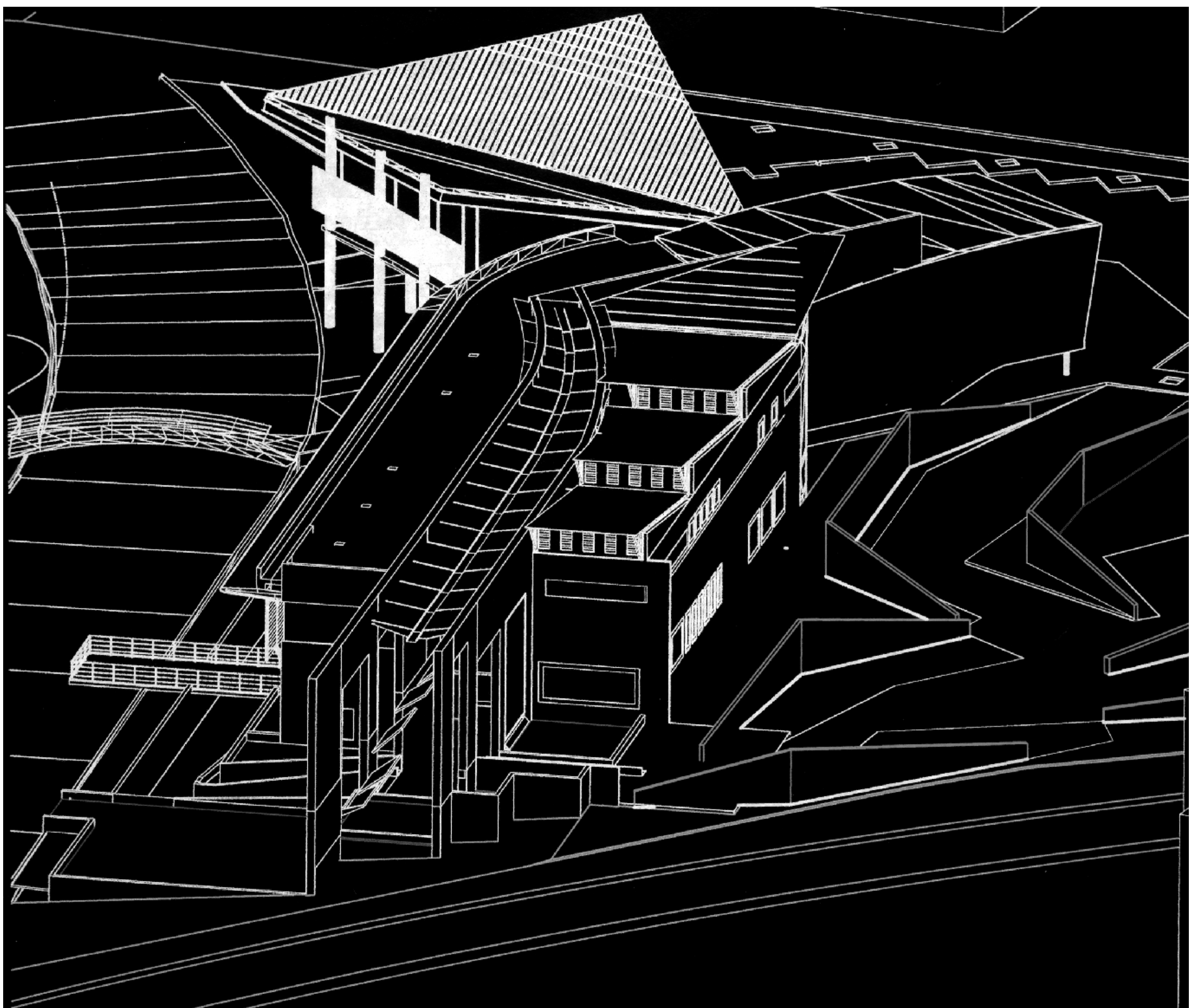


Fig 210.Arial view of the Water Wise centre

EMOTIONAL EXPERIENCE

The architectural language and the pursuit of geometry has had to accommodate the reality of an excavated site and a series of hydraulic installations that have been used to control the waterways of the area.

A complex architectural landscape has been created rather than a discrete, individual building. Approached from the parking area, the building is like a cliff that must be scaled. When one arrives at the beginning of the route, one suddenly finds oneself at the edge of the cliff looking down into the abyss of a walkway and route. The landscape is permeable and one can walk around and through, disappear inside at one level and emerge again at another.

Concrete, rough recycled bricks and glass form the surfaces of the centre. These have an intrusive effect on the visitors' pristine world. The real energies were channelled into making the entire building a symbolic demonstration of humanity's ability to manage water as a life-giving resource. The heart of the project is not only the internal exhibition hall, but rather the building and its landscape as a whole. One senses the presence of the spaces long before they are seen. As you progress along the route you gradually become aware of the sound of cascading water. This is the kind of noise you get when water has been provoked. But it's origin reveals itself only gradually as you descend a staircase through a slot cut into the concrete wall.

The curved lines of the concrete walls and the water features has the effect of softening the impact of the concrete that has been used. It is in the reflective quality of the glass used on the western facade that one is gradually taken to a point of self-reflection. The glass reflects the landscape playfully and is visible through the louvres protecting the building against western sun. Standing at the centre of what seems like a gigantic water machine is a hypnotic experience and it serves as an appropriate reminder of jus how strong the presence of water is in the life of every human being.

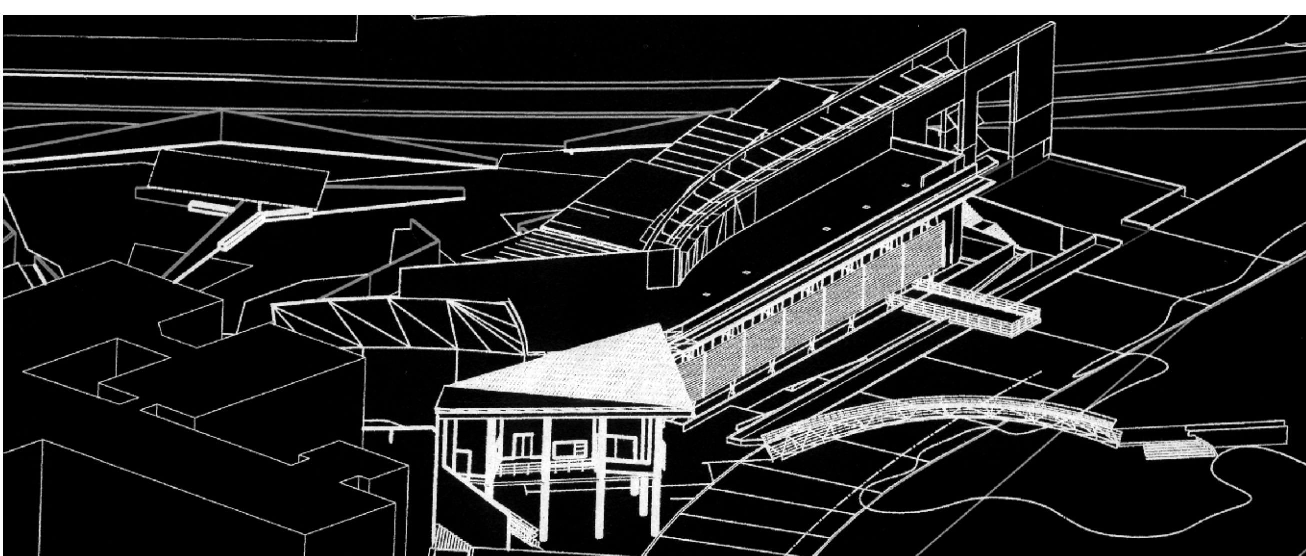


Fig 211. Curved concrete walls

DESIGN ASSESSMENT

Any design regardless of the quality thereof can be refined and improved. A designer can recognise points of improvement through a process of self reelection and criticism from others.

In retrospect, the orientation of the building was generated by contour lines, and visual focal points. This created an inconventional shape for the building. The exposed east and west facades created a challenging design for external shading and methods of achieving natural ventilation. Although basic intelligent and responsible design as far as climate and choice of materials was applied, the designer feels that the footprint, and orientation of the building could have been investigated further. On the other hand, this would have a negative impact on the edge created next to the Apies River.

Further investigation on water technology that could be used in buildings that concur with the principles of Water Wise living methods would have been a great challenge and very rewarding. This topic is so comprehensive that it could become the subject of and entire thesis. The designer whishes to make a thorough investigation of this field of study in the future.

The design has achieved the following:

- It is site specific and sensitive to the physical and social context
- The design is sustainable
- Circulation routes are clearly legible
- It is naturally responsive to climatic conditions
- Spaces have an emotive quality, achieved by the use of natural light, scale and through materiality

It adheres to the client's design criteria with regard to:

- Providing an educational centre which is robust and 'fun'
- Providing functional accommodation which is robust
- The spaces can be extended internally, due to the ample space between floor and ceiling
- Creating a healthy working environment
- Providing a building that uplifts the image of the inner city
- A building that is divided in, private and public areas
- Low maintenance
- Durability of finishes

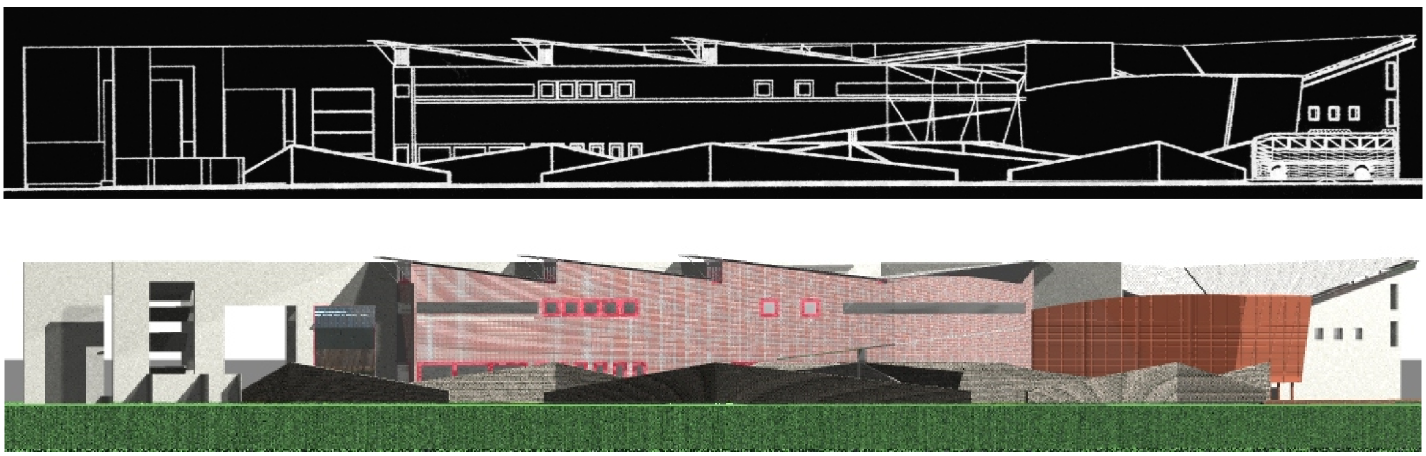


Fig 212. Eastern Elevation

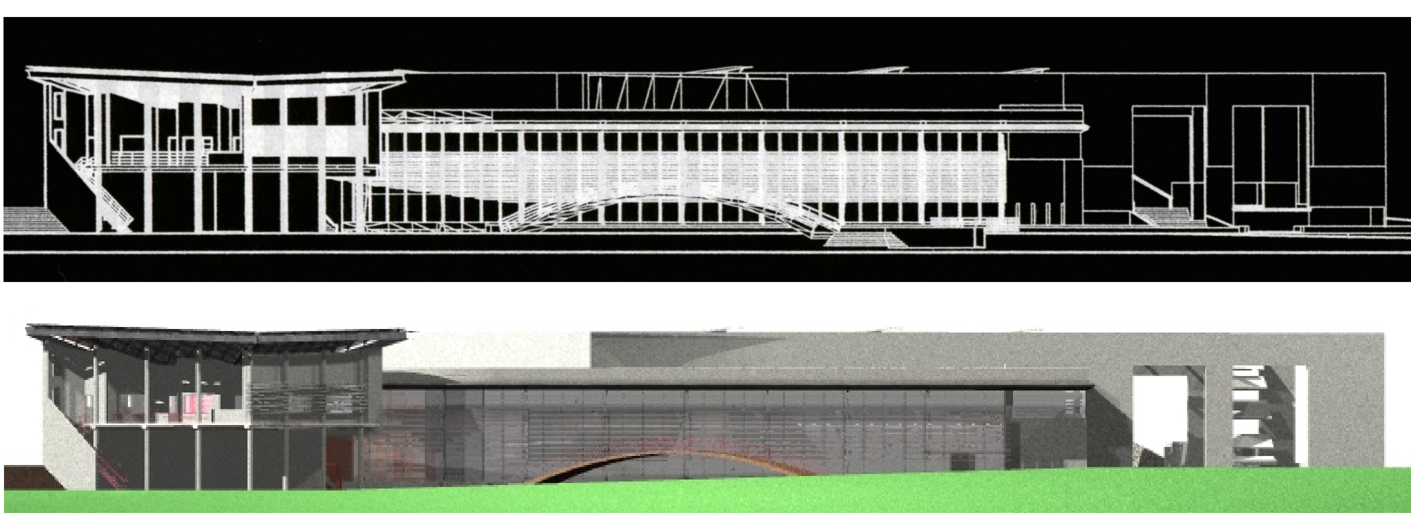


Fig 213. Western Elevation

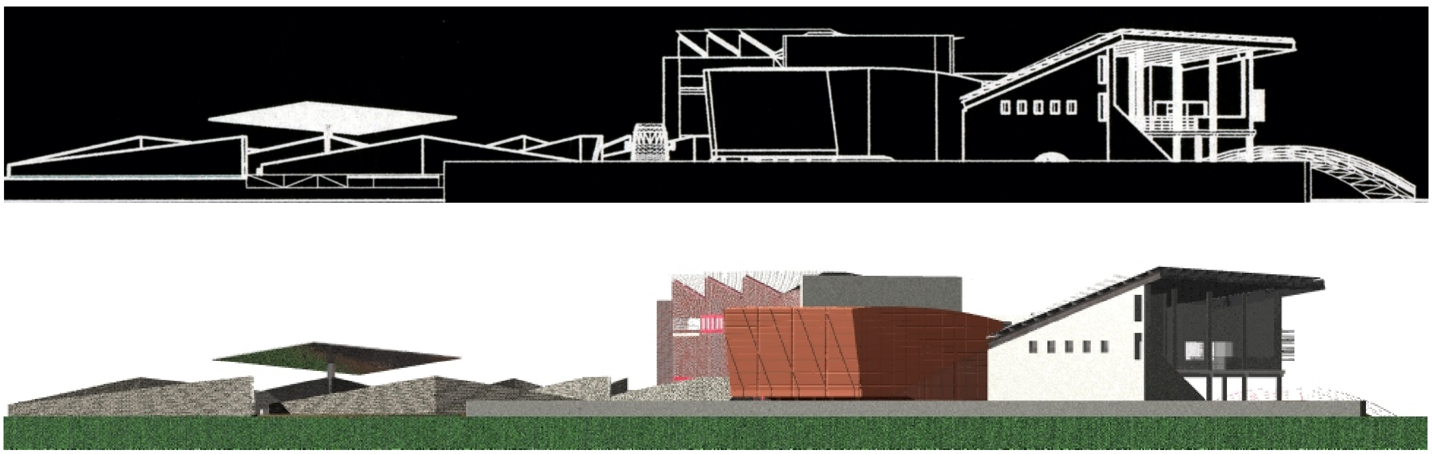


Fig 214. Northern Elevation

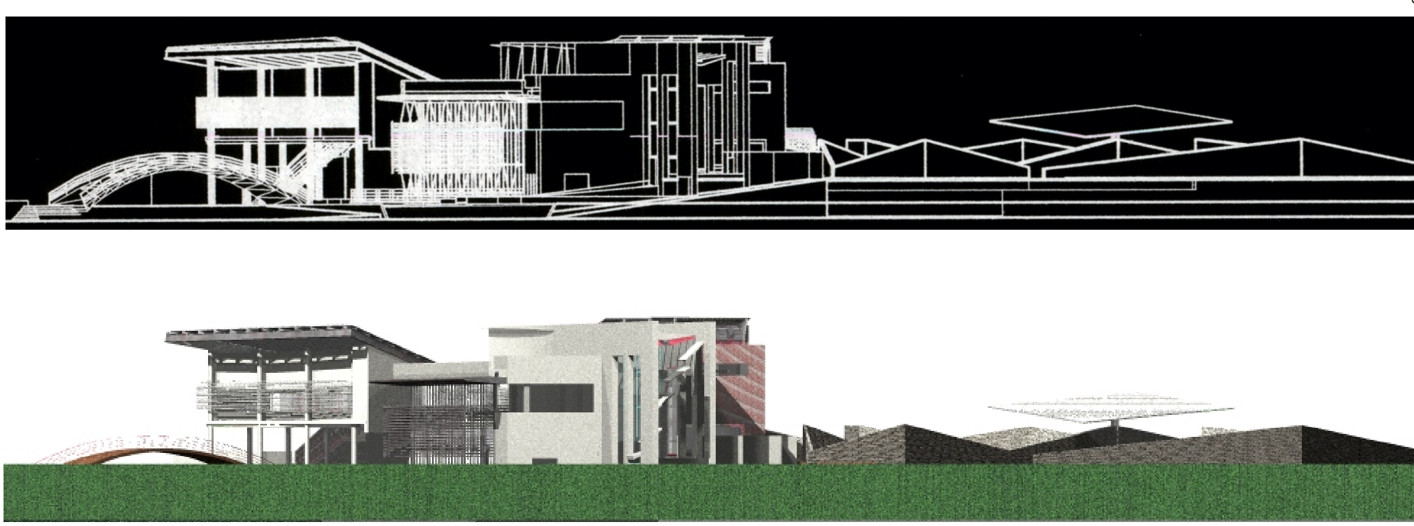


Fig 215. Soutthern Elevation

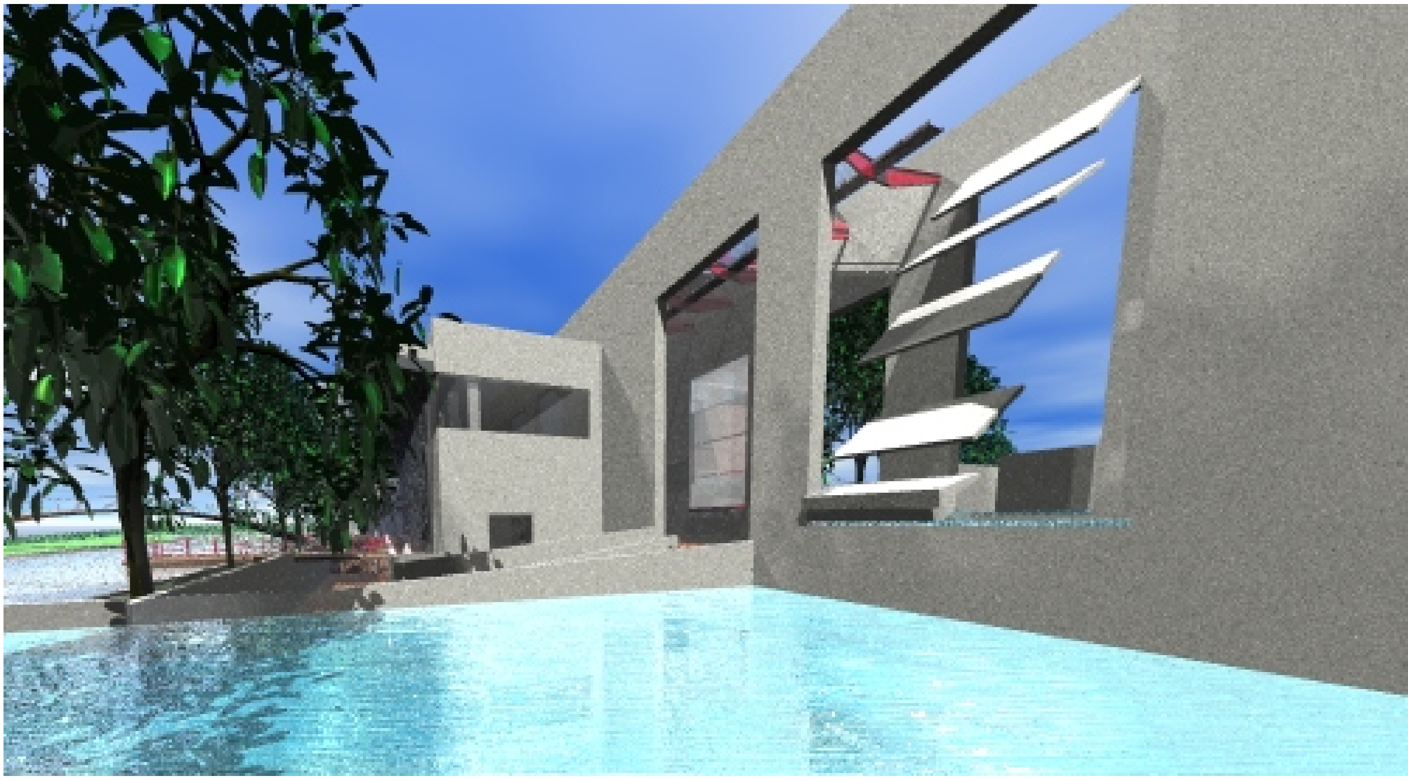


Fig 216. Waterfall at entrance of the building

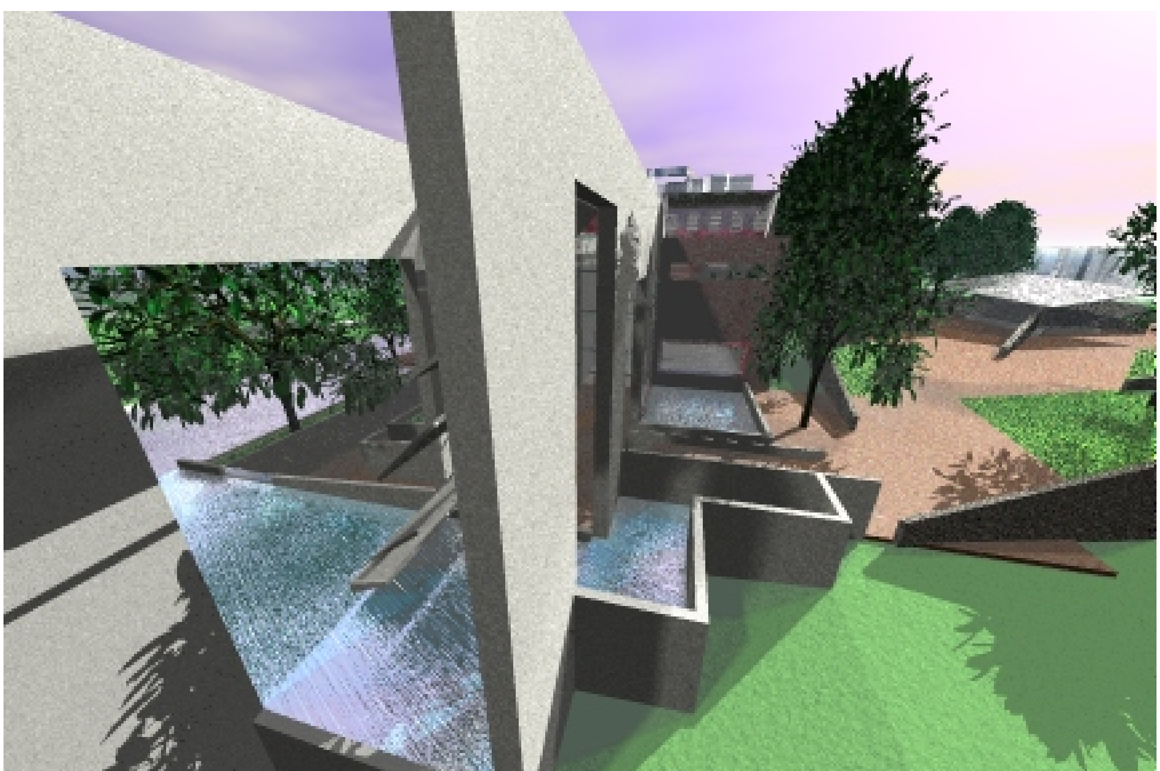


Fig 217. Water feature at entrance of the building

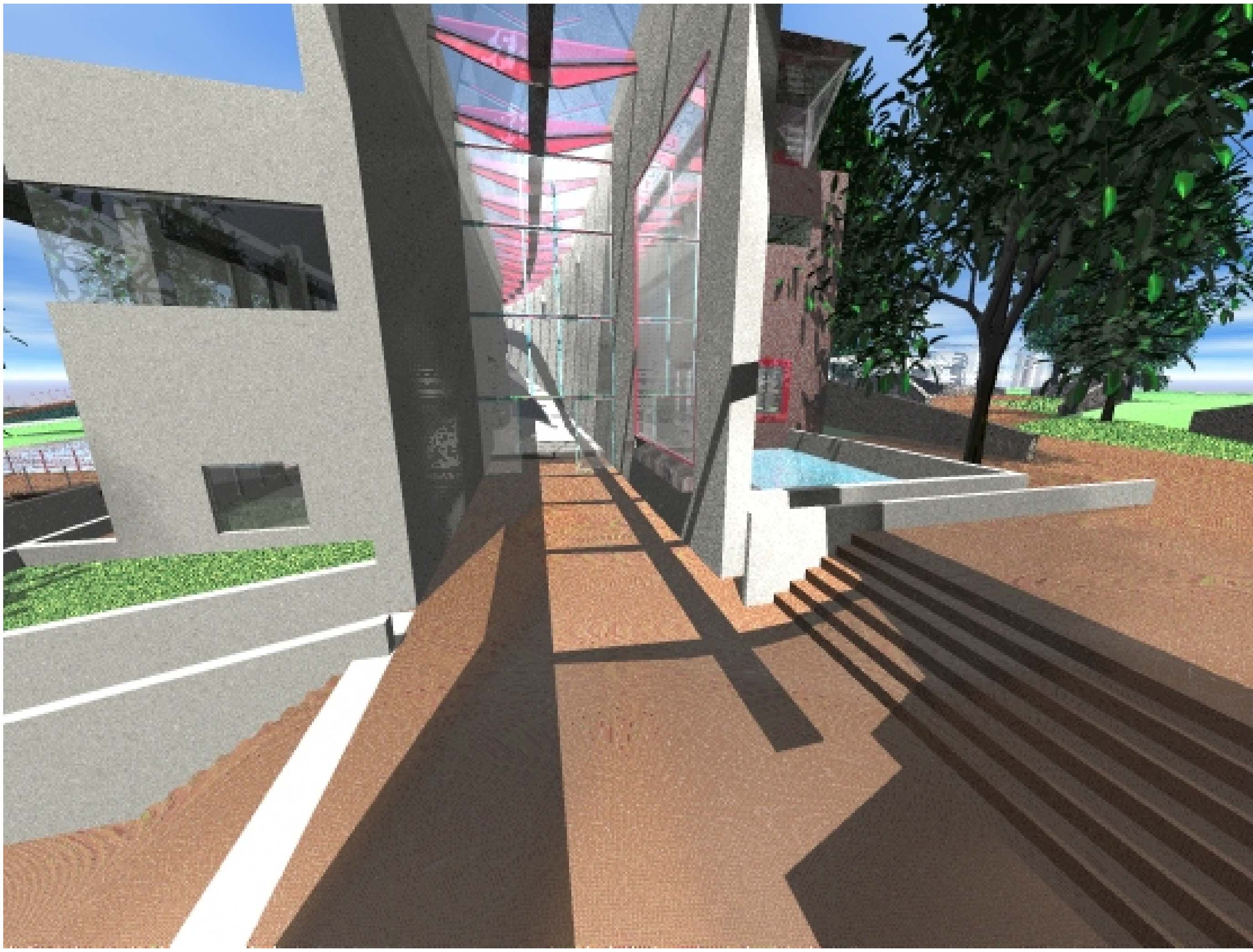


Fig 218. Entrance to the building

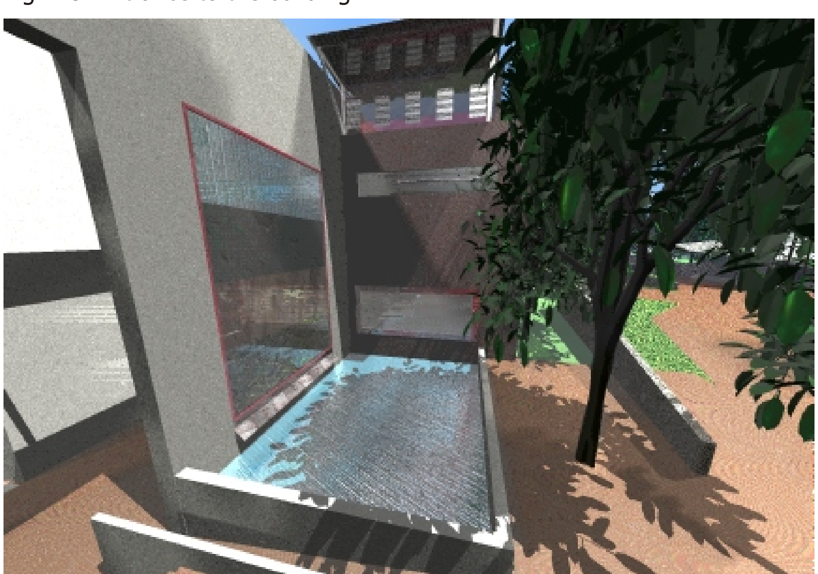


Fig 219. Sand filter in concrete wall

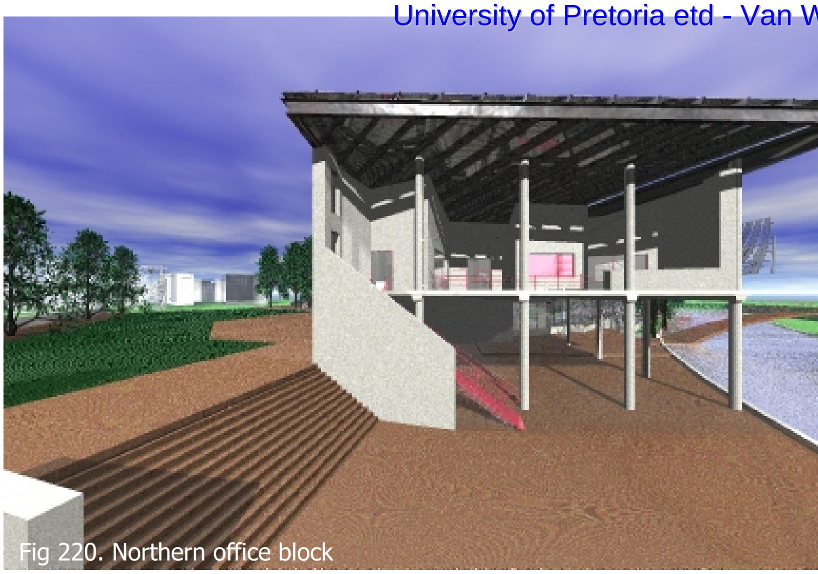


Fig 220. Northern office block

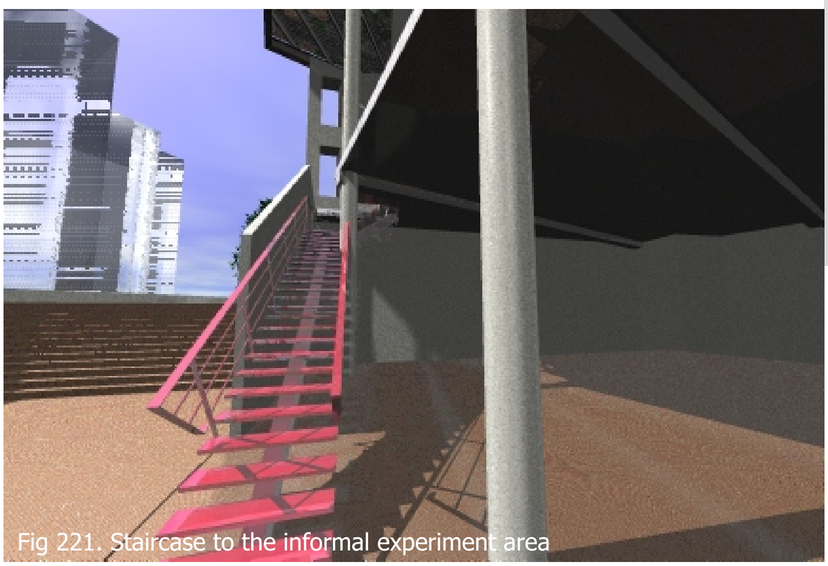


Fig 221. Staircase to the informal experiment area

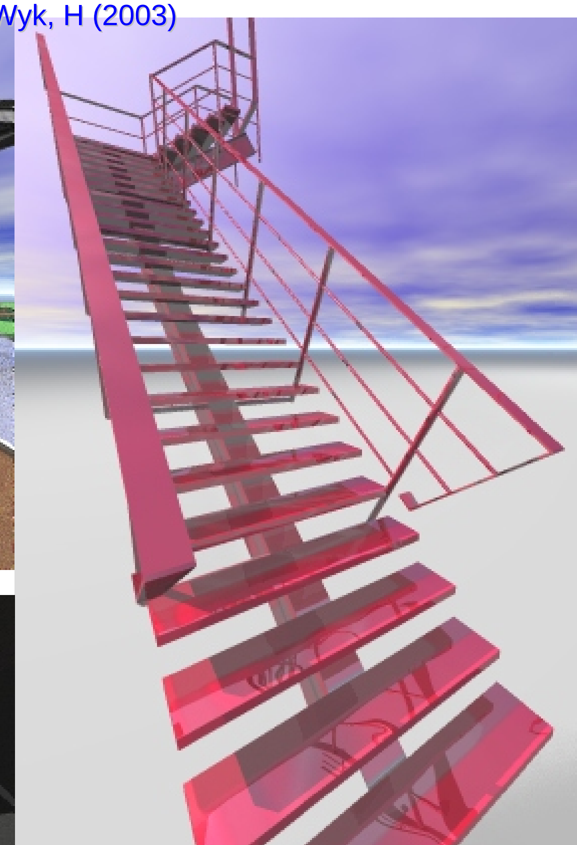


Fig 223. Staircase

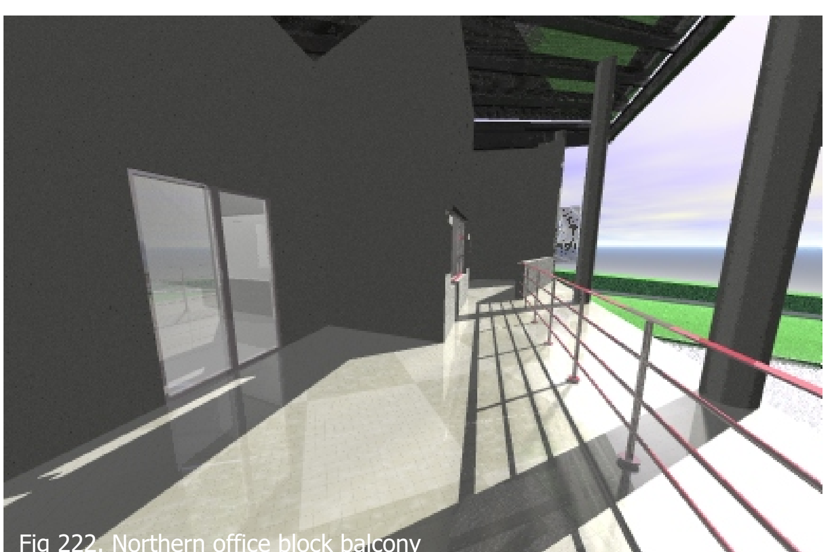


Fig 222. Northern office block balcony

Fig 224. Interior of the office

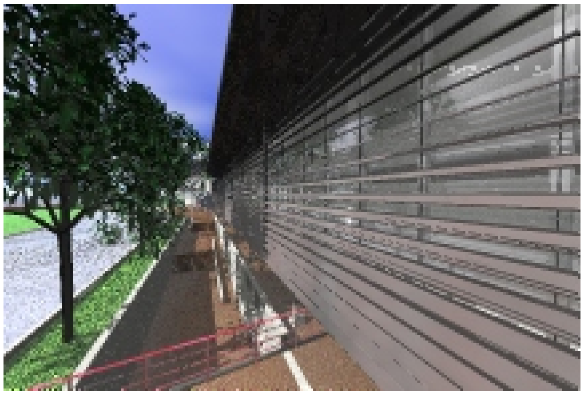


Fig 225. Louvre system on the western facade

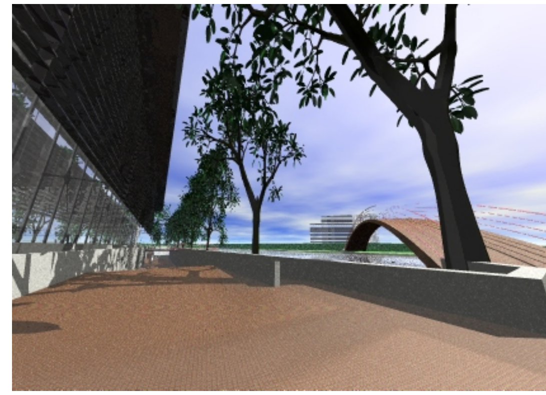


Fig 226. Pedestrian bridge to the Technikon

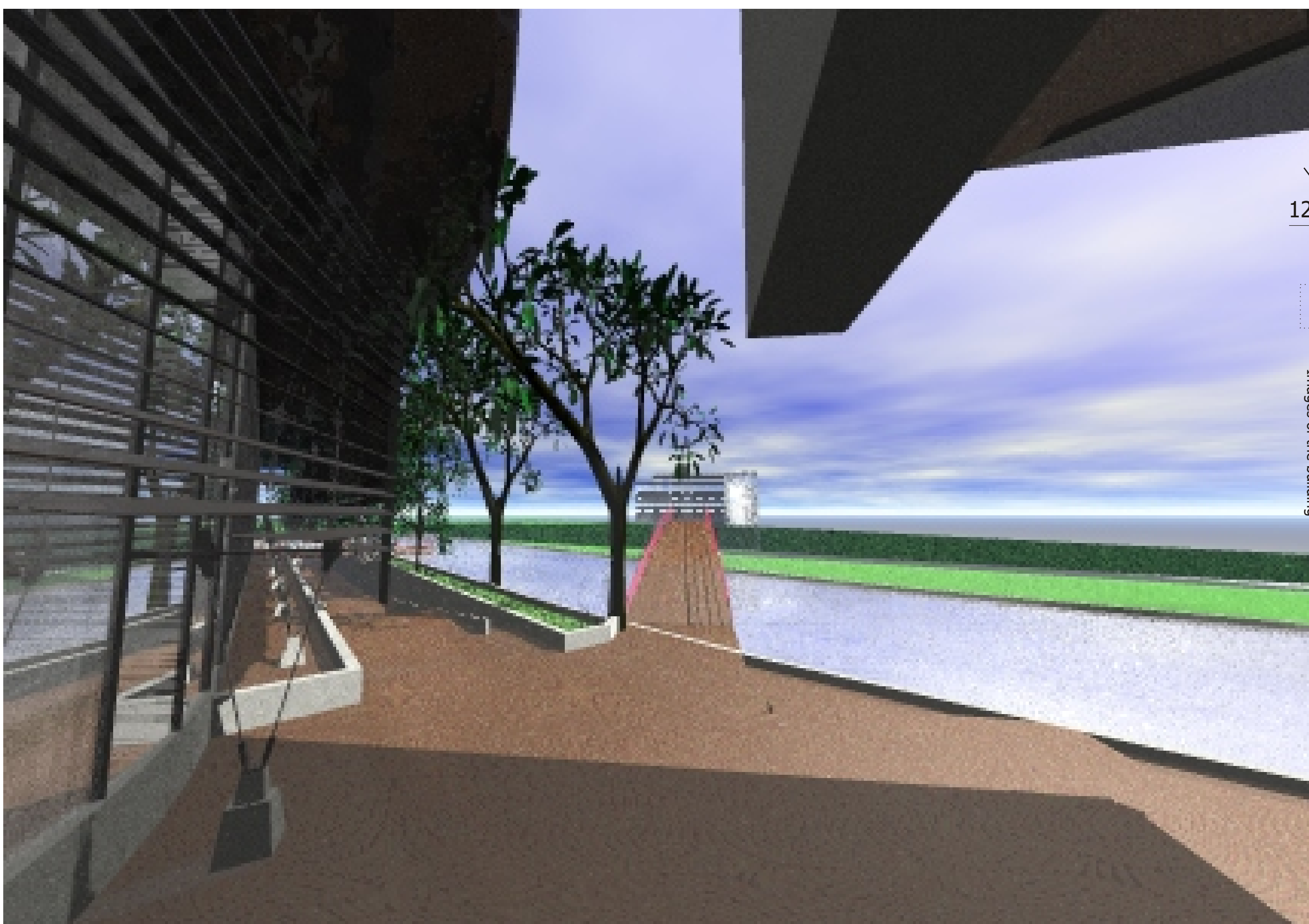


Fig 227. Beginning of route to the entrance of the building

Fig 228. Staircase to entrance of the building

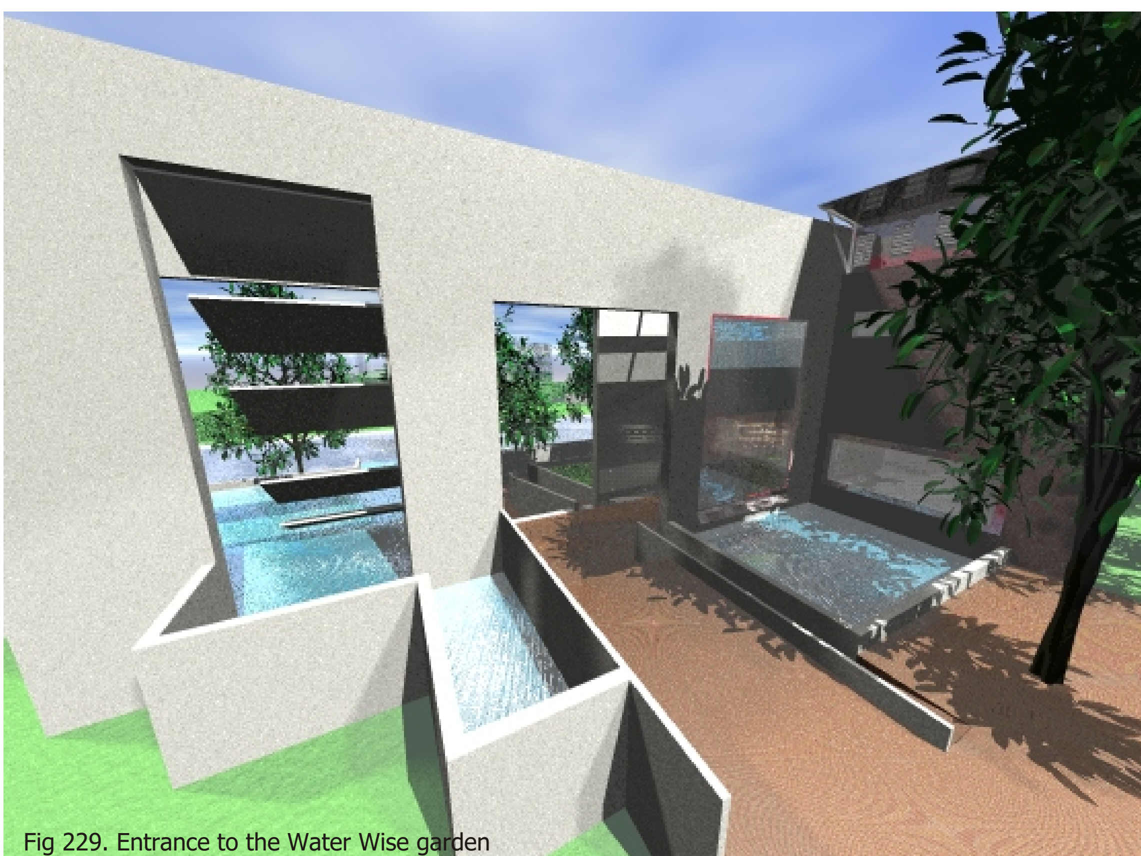
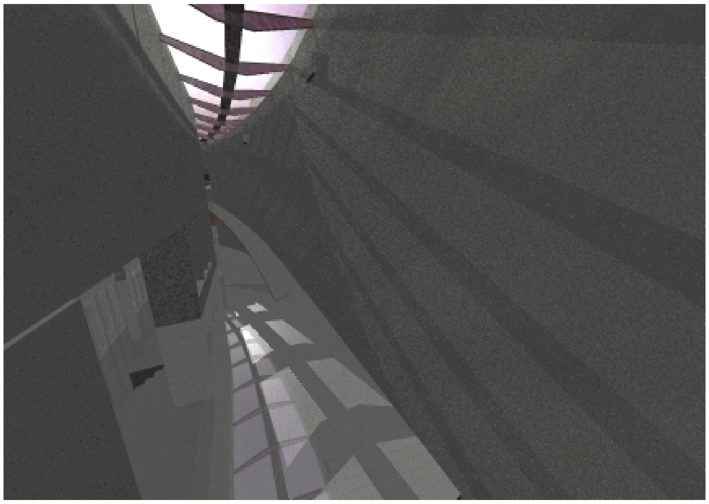


Fig 229. Entrance to the Water Wise garden



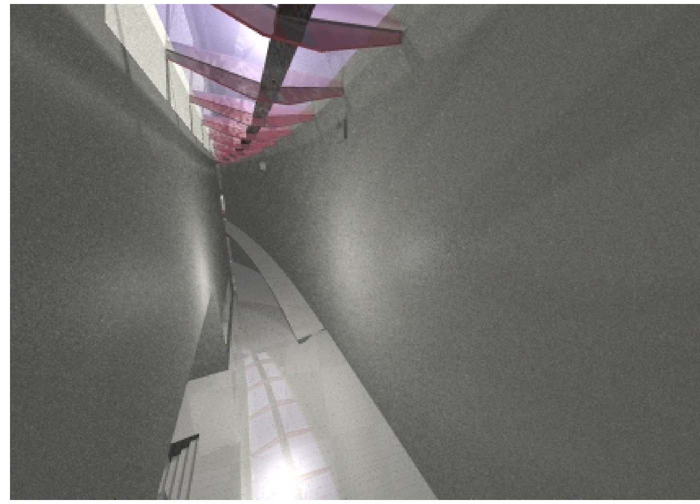


Fig 230. Atrium

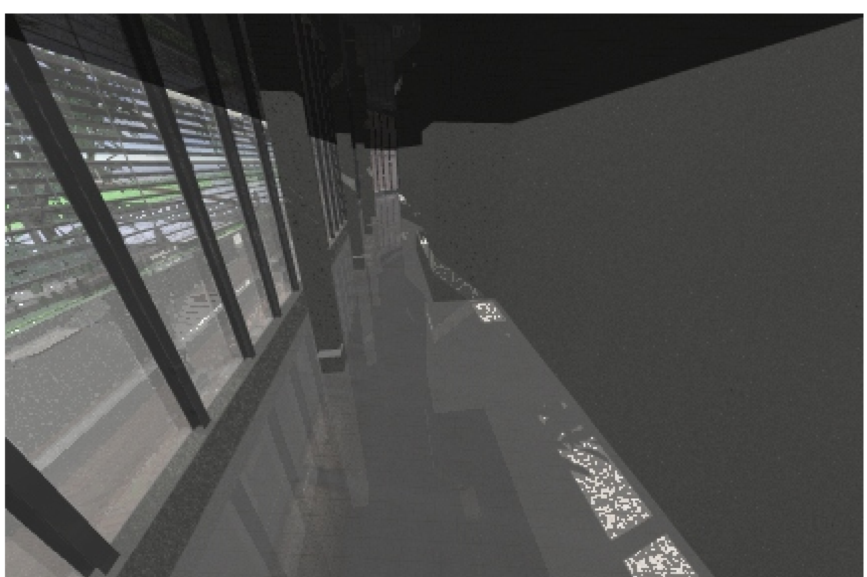


Fig 230. Interior of ground level

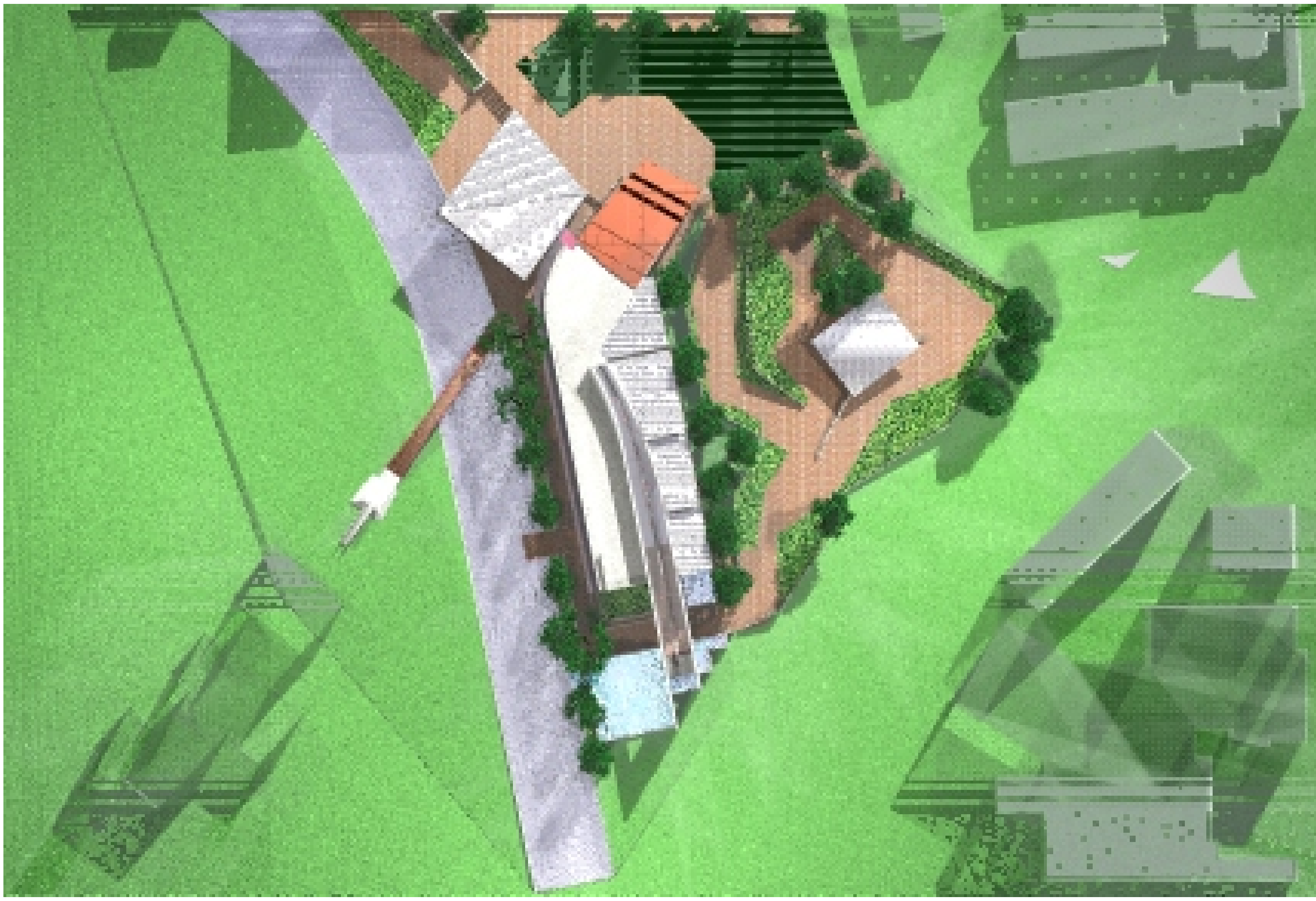


Fig 231. Plan

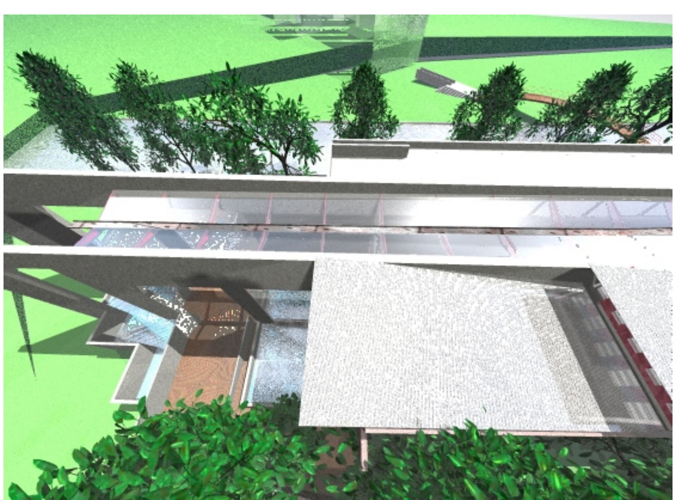


Fig 232. Eastern roof and skylight

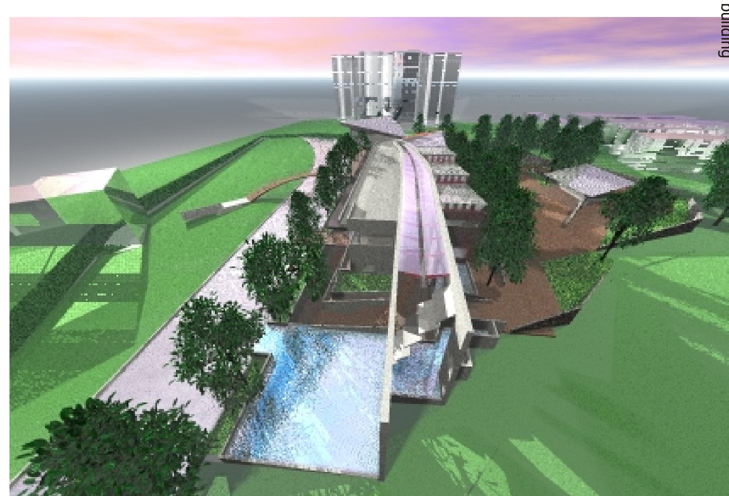


Fig 233. Curved concrete walls

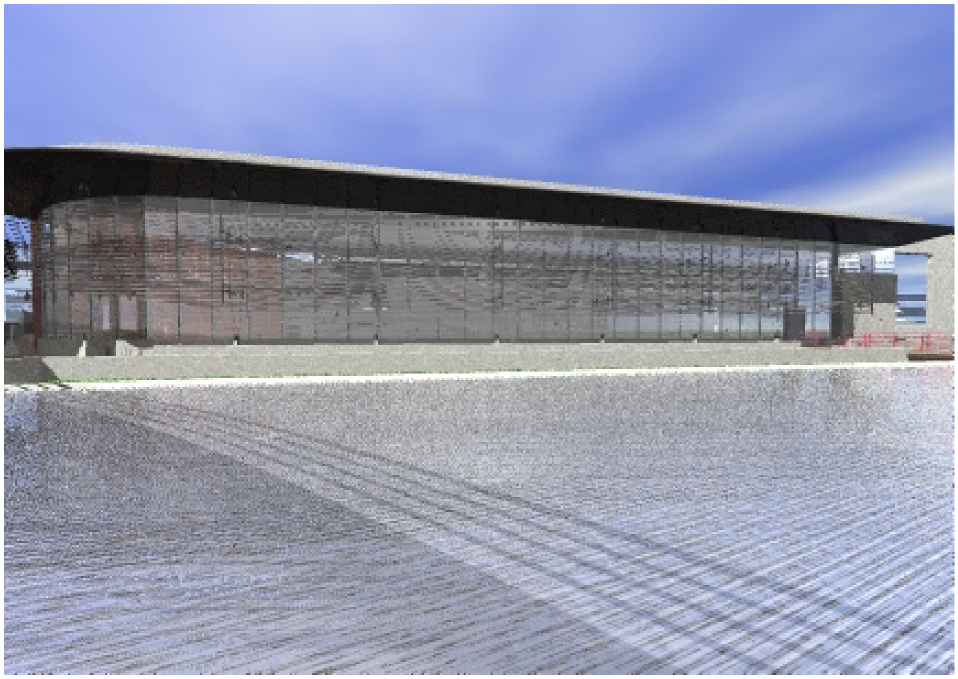


Fig 234. View of the western facade, without trees

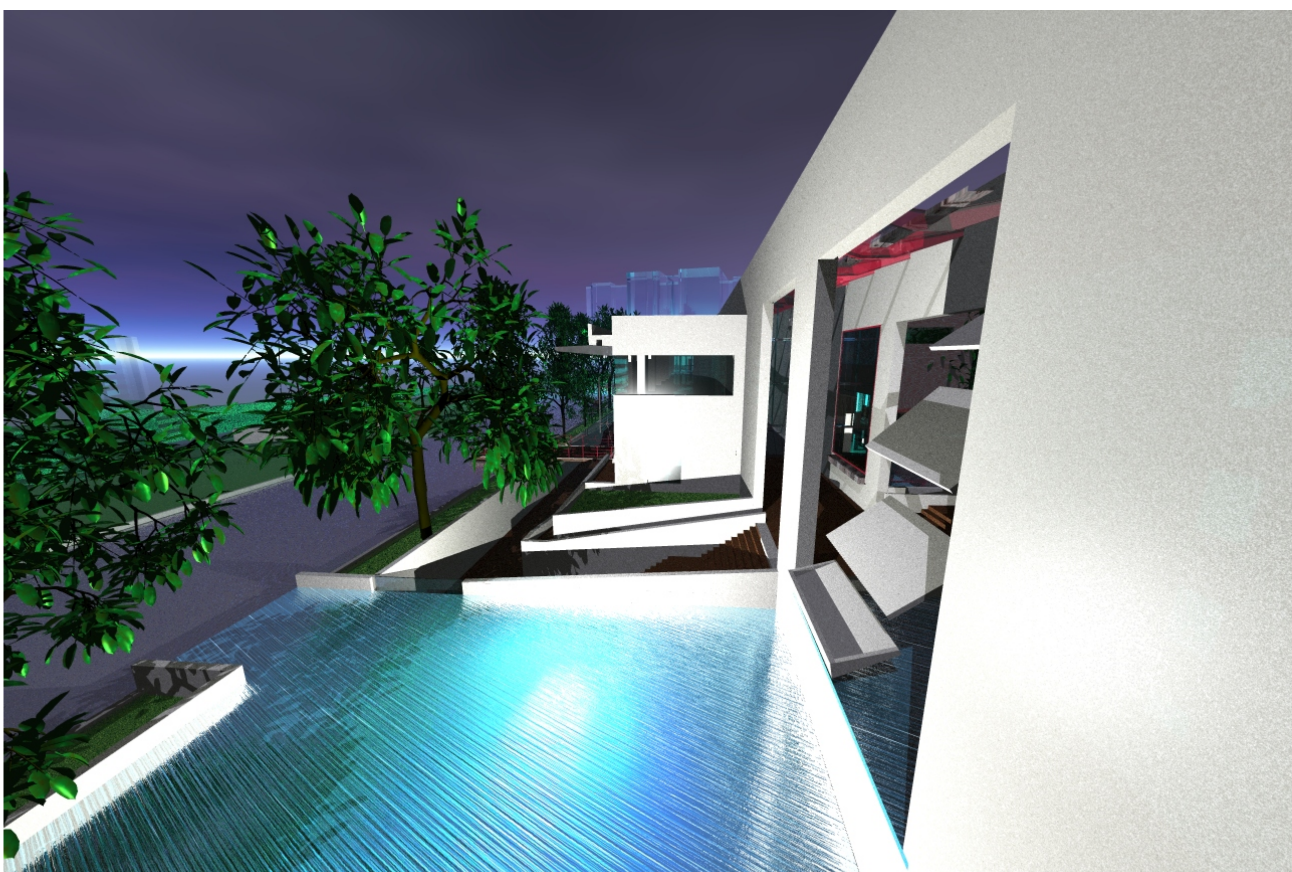


Fig 235. Night view of the waterfall

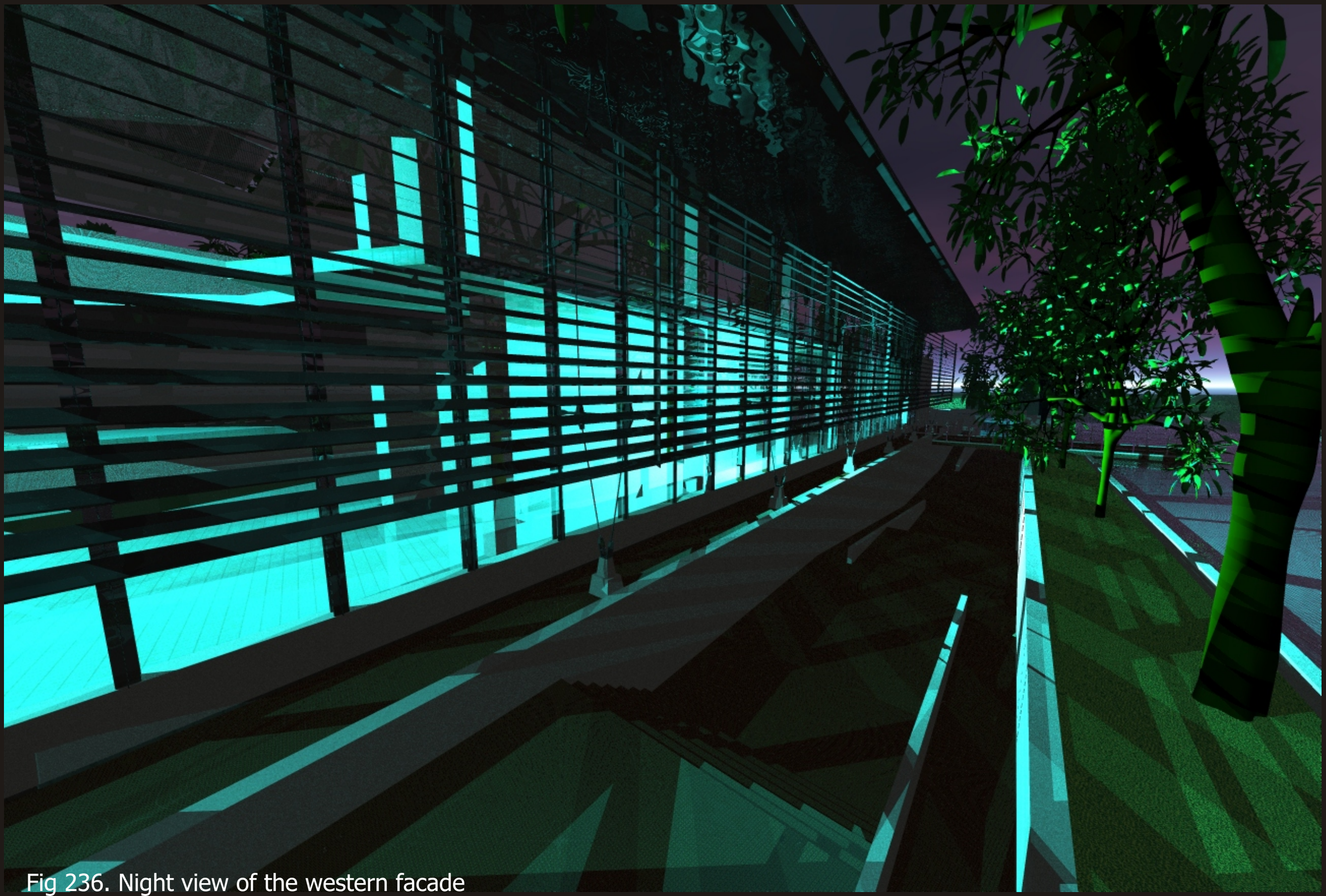


Fig 236. Night view of the western facade

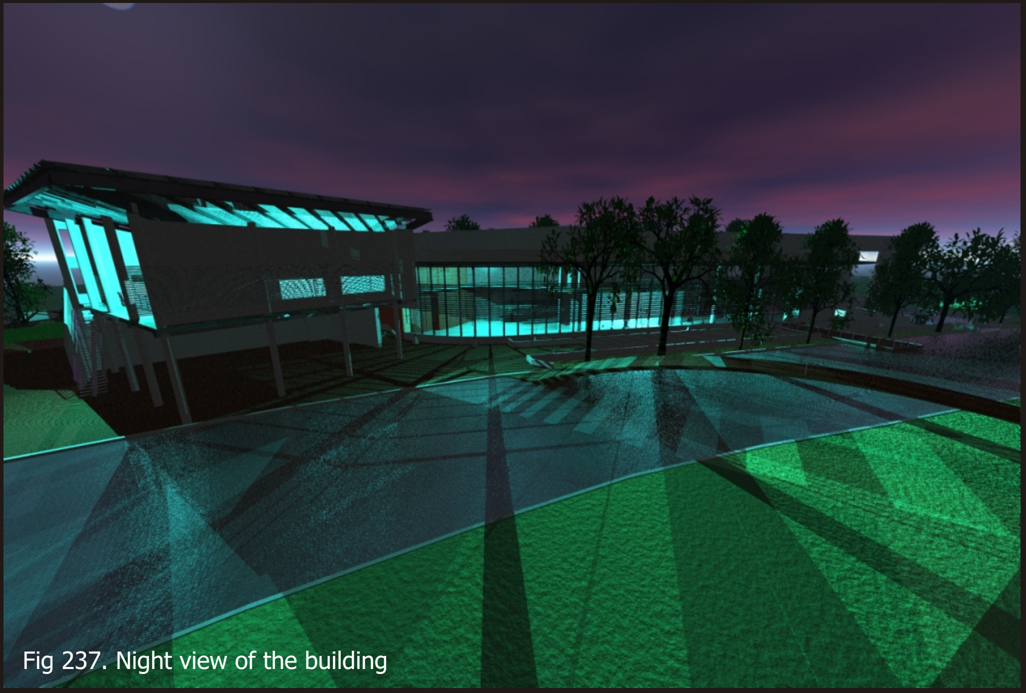
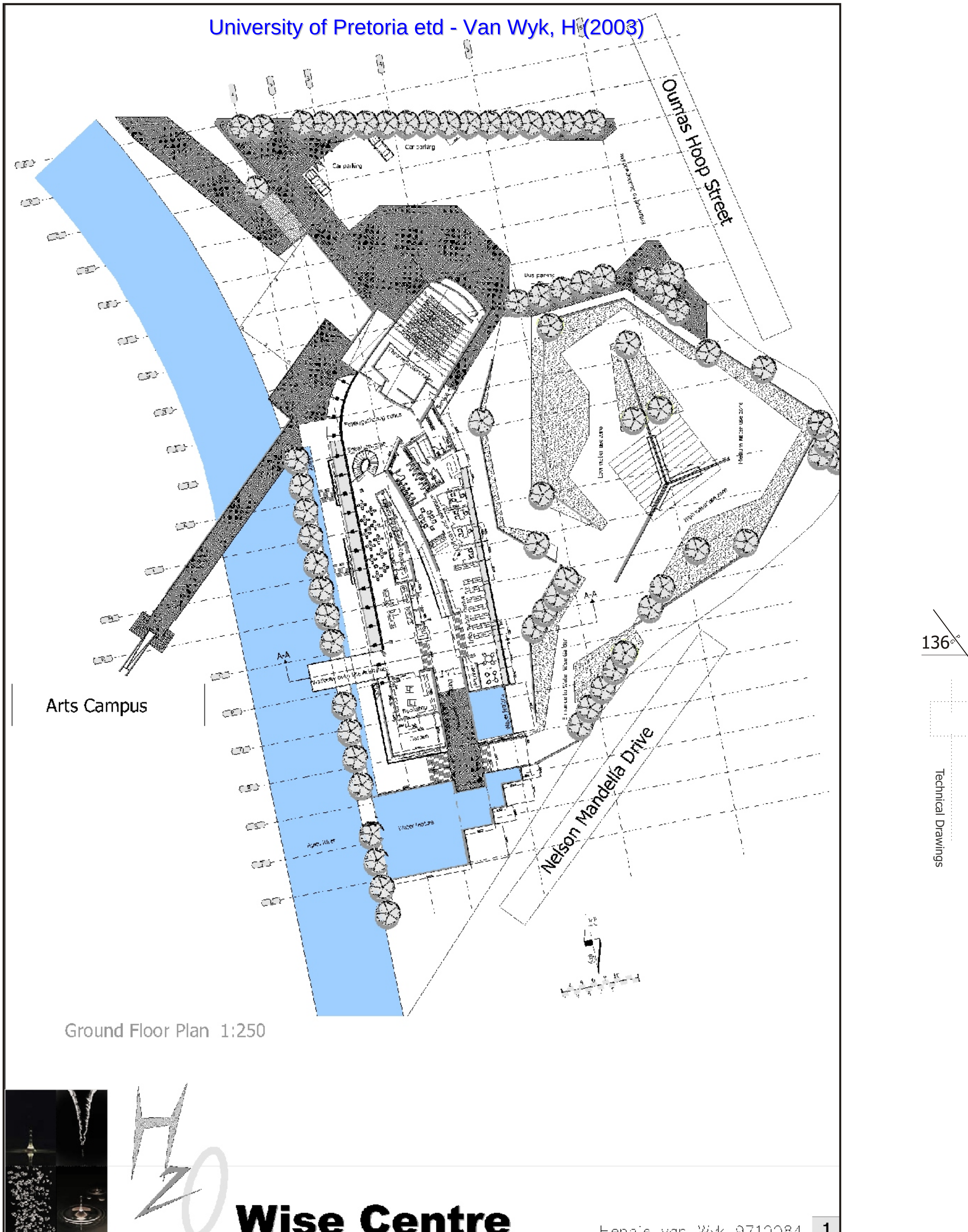
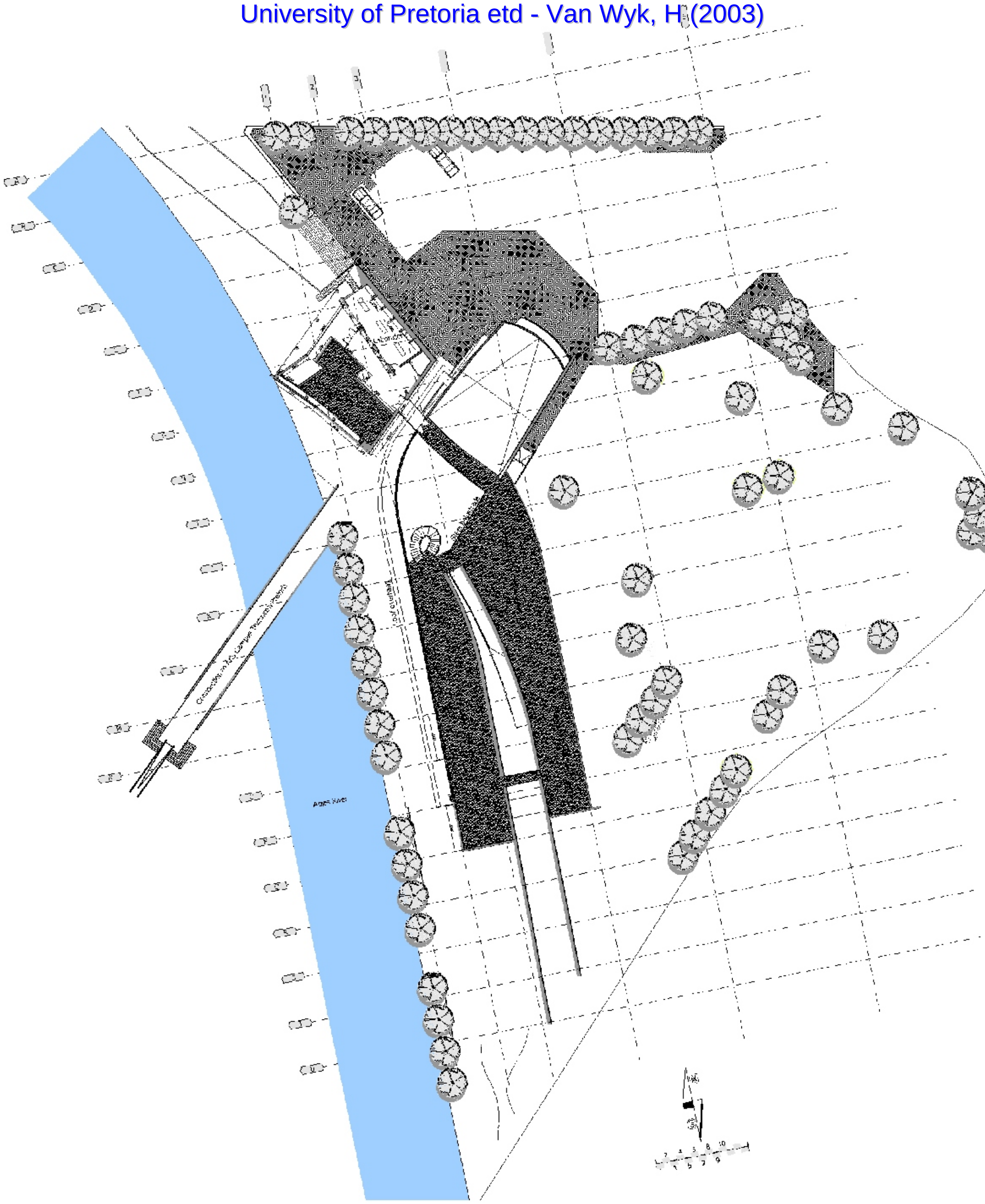


Fig 237. Night view of the building

Technical Drawings

Technical drawings

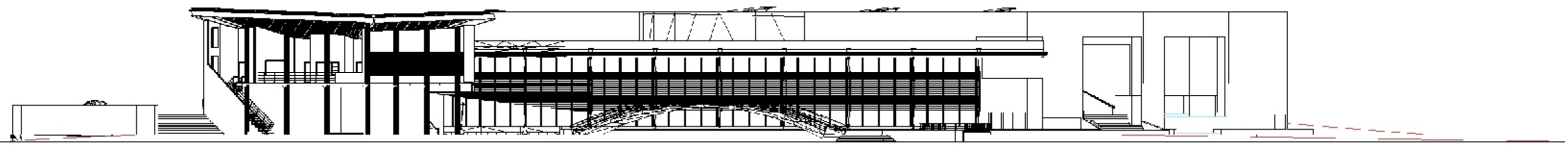

Oumas Hoop Street
Arts Campus
Nelson Mandella Drive
Ground Floor Plan 1:250
Wise Centre
Henrie van Wyk 9710084
136°
Technical Drawings

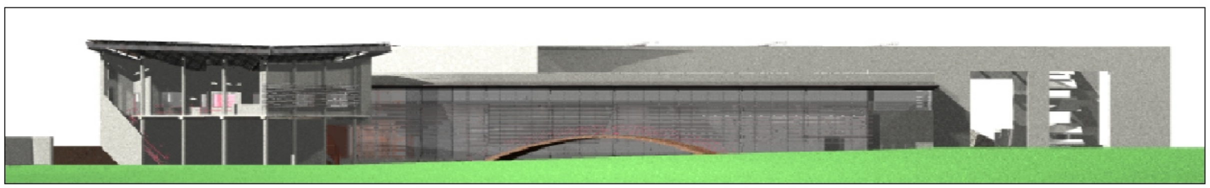


First Floor Plan 1:250

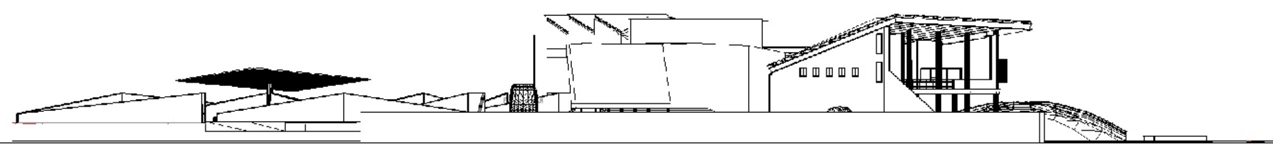
Wise Centre

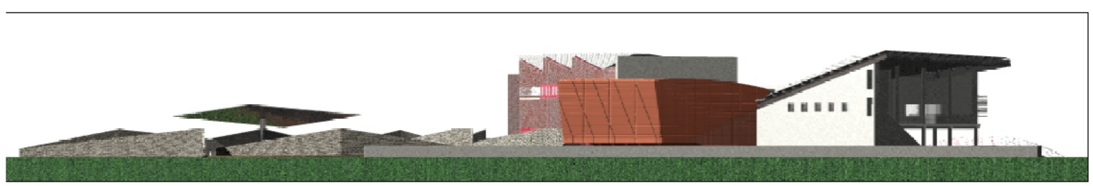
Hennie van Wyk 9710084





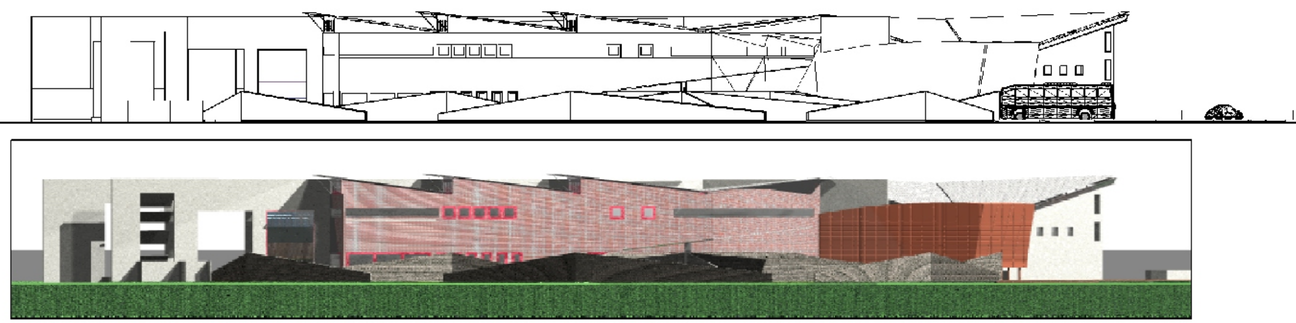
Western Facade 1:200



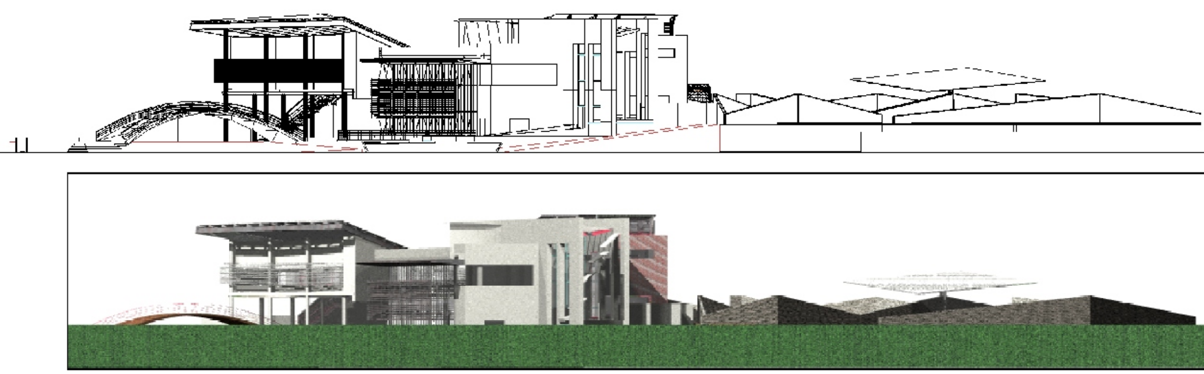


Northern Facade 1:200

H2O Wise Centre



Eastern Facade 1:200



Southern Facade 1:200

H2O Wise Centre

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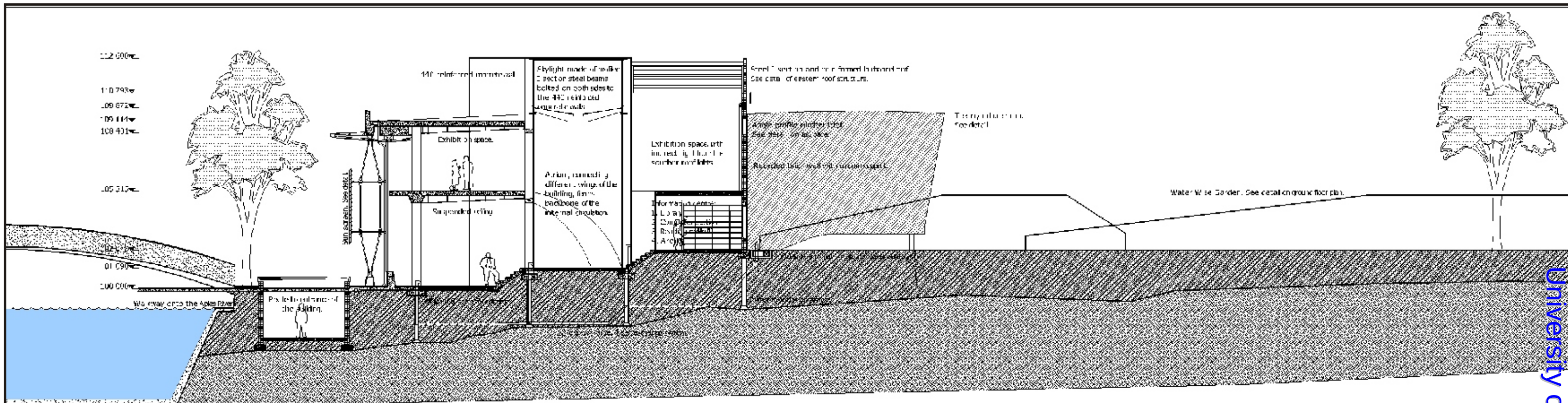
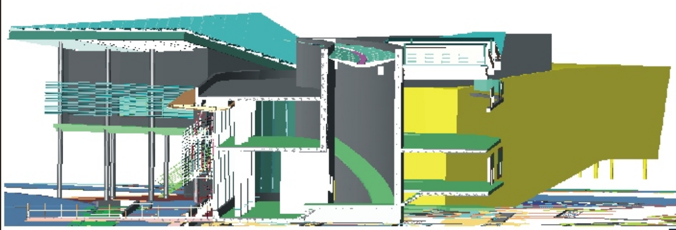
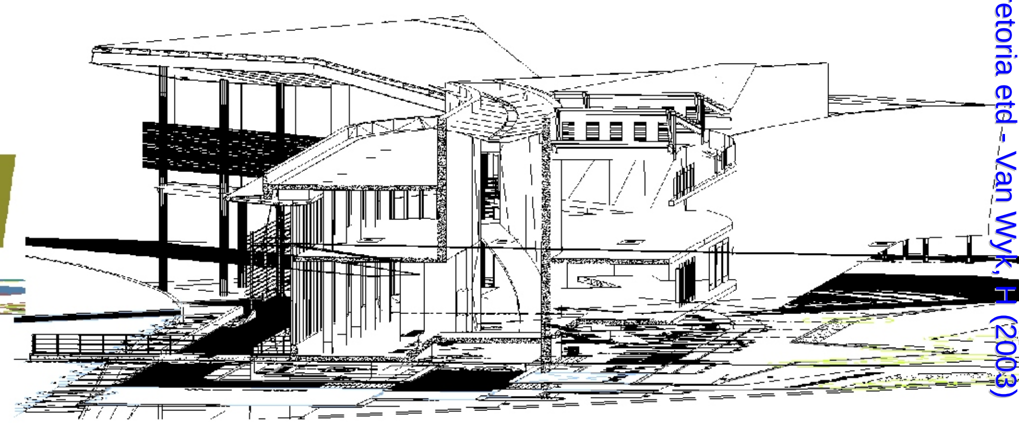


Section A/A 1:100





Section in perspective 1:100

H2O Wise Centre

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Detail of theatre 1:100
East-western section through offices 1:100
Plan of offices 1:100
Detail of fire ascape at offices 1:25
North-southern section through offices 1:100
Roof structure 1:100
Wise Centre
Hennie van Wyk 9710084
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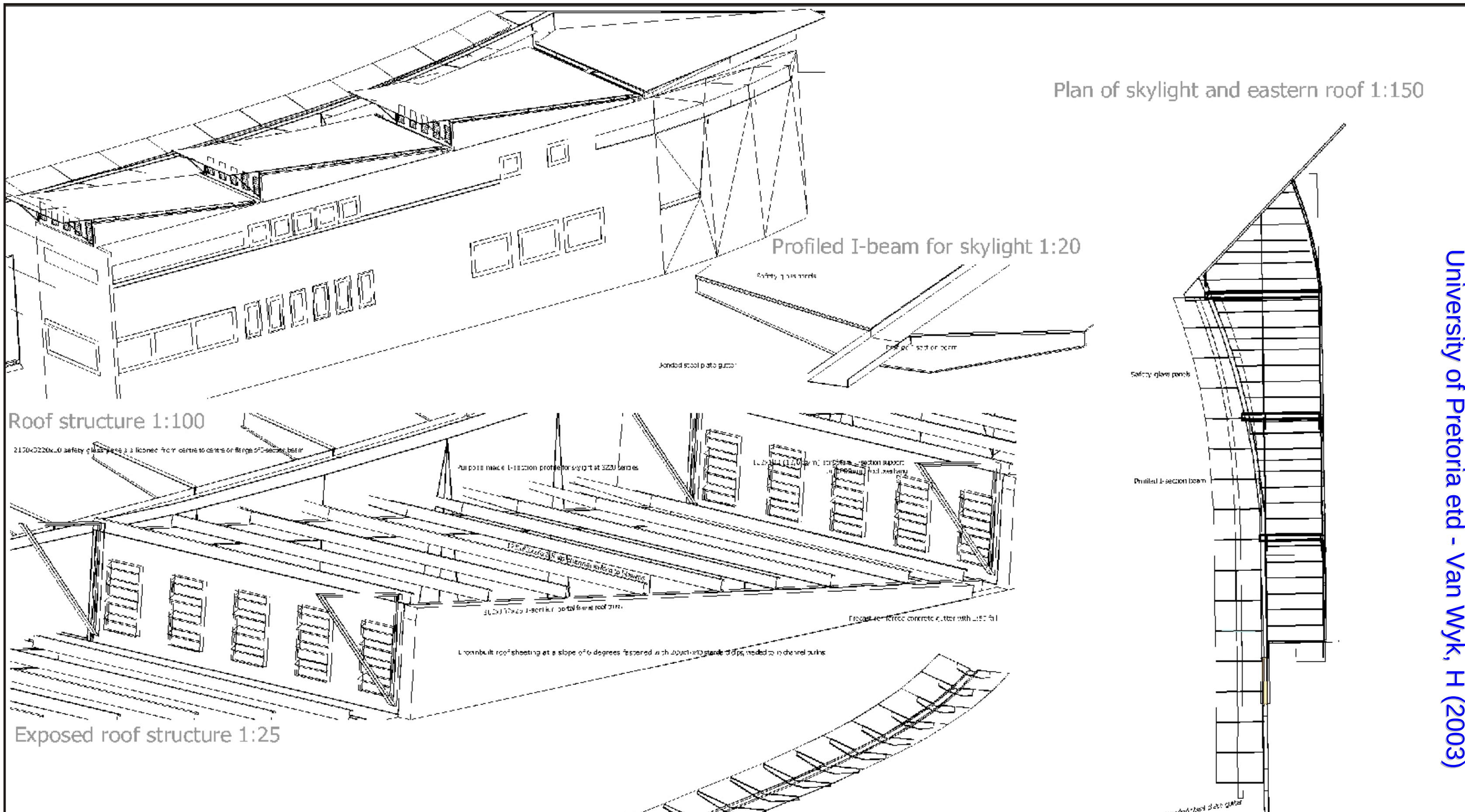

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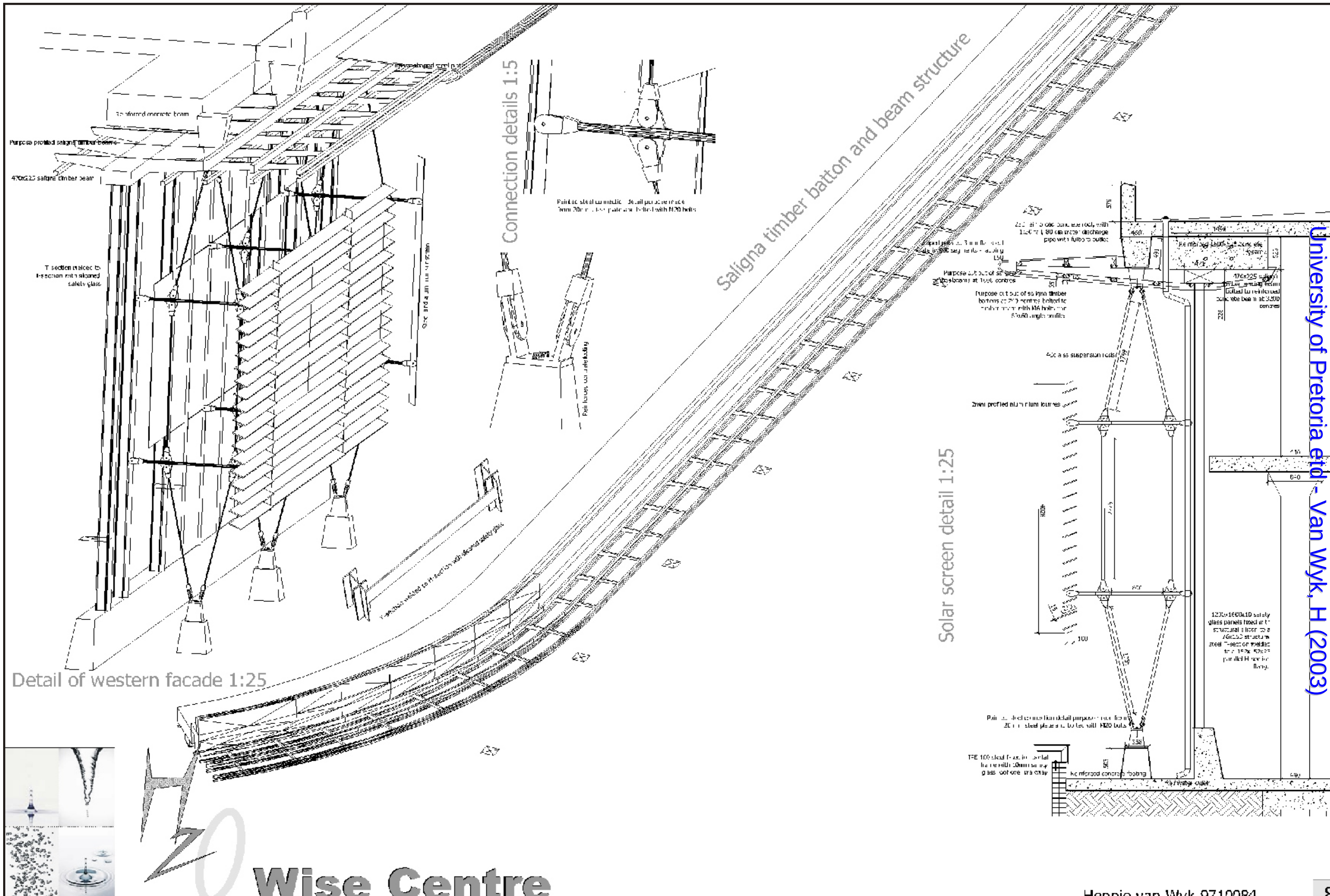
Connection details 1:5
Saligna timber batton and beam structure
Solar screen detail 1:25
Detail of western facade 1:25
Wise Centre
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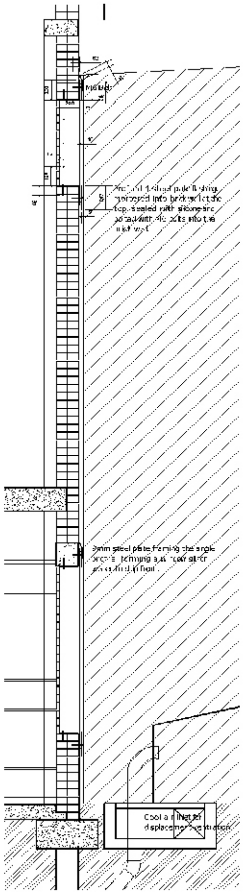
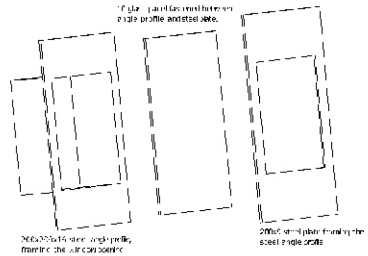
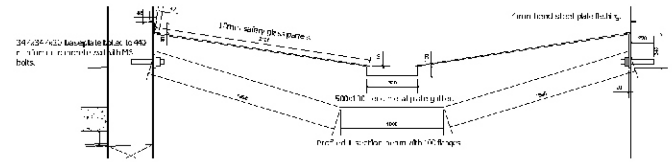


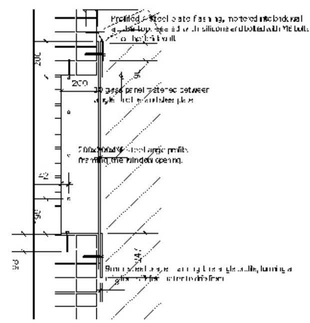
Detail - Eastern recycled brick wall1:20



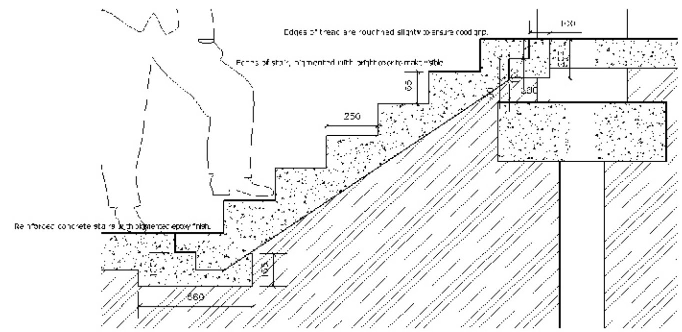
3D detail - Window frame 1:10



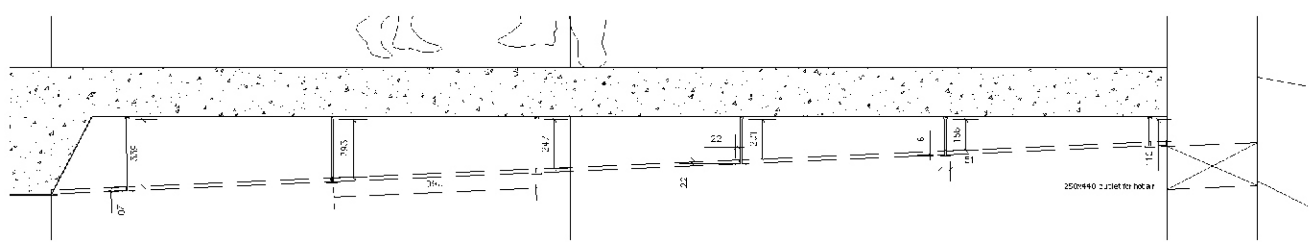
Detail - I-section skylight beam 1:20



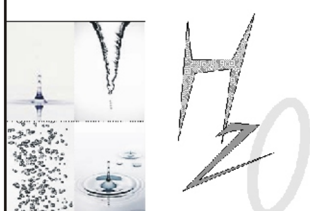
Detail - Window frame 1:10



Detail - Typical concrete staircase 1:10



Detail - Suspended ceiling 1:10



Wise Centre

Hennie van Wyk 9710084

Photos of model

Fig. M1

Fig. M2

Fig. M3

Fig. M4


Fig. M5


Fig. M6


Fig. M7

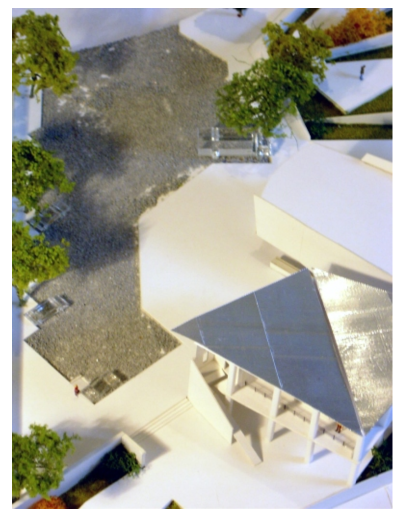
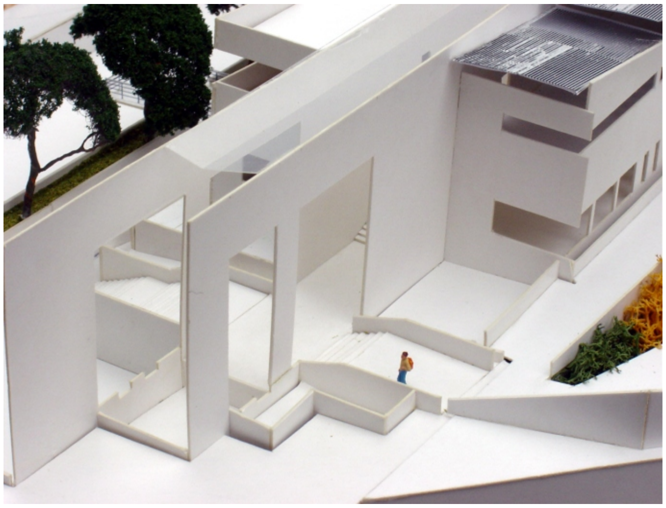


Fig. M8


Fig. M9


Fig. M10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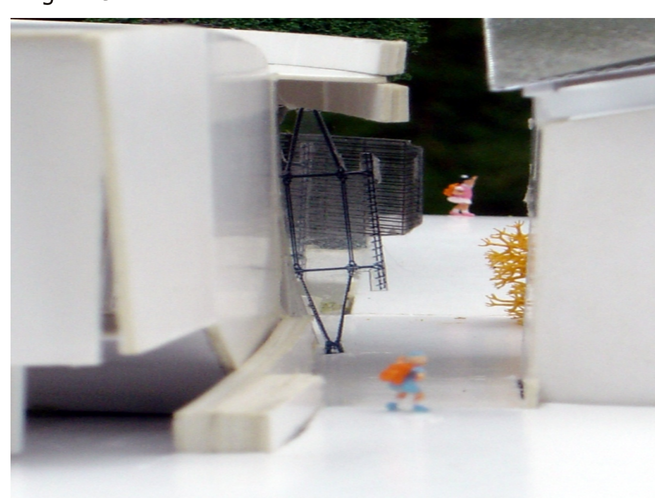

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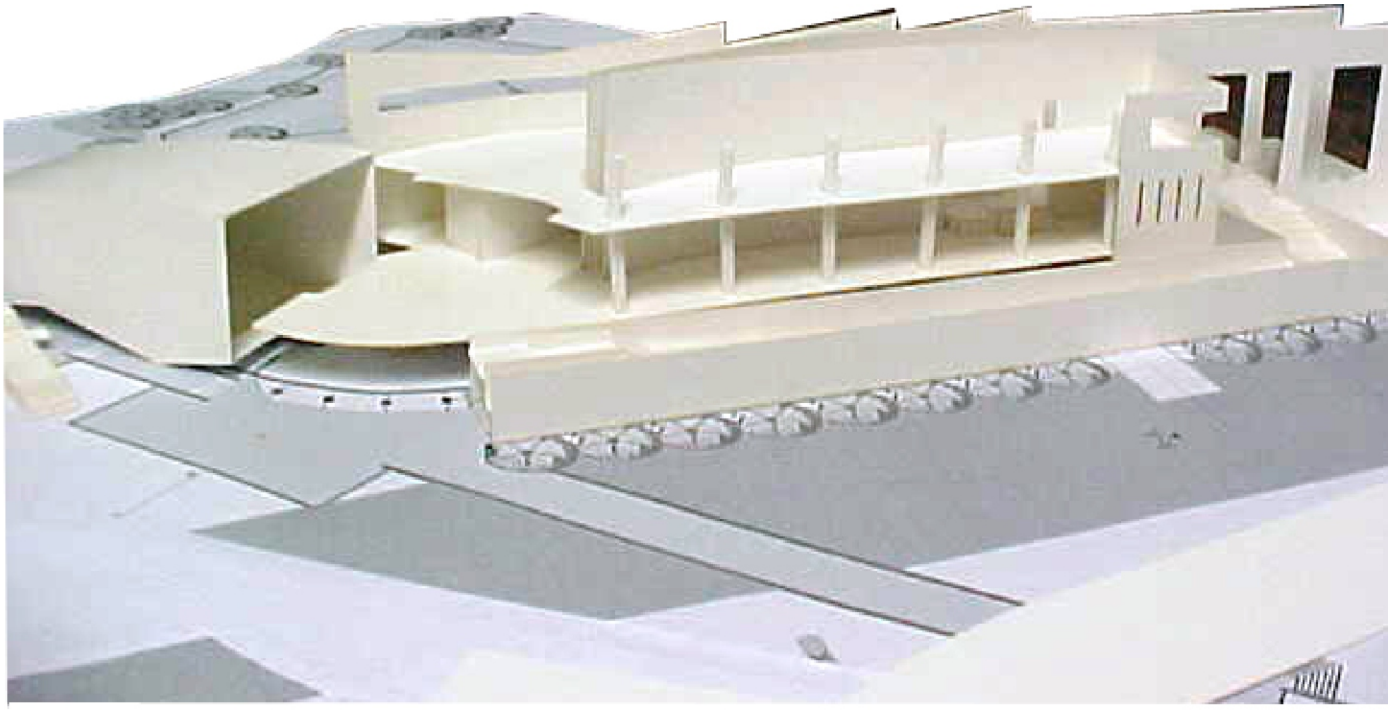

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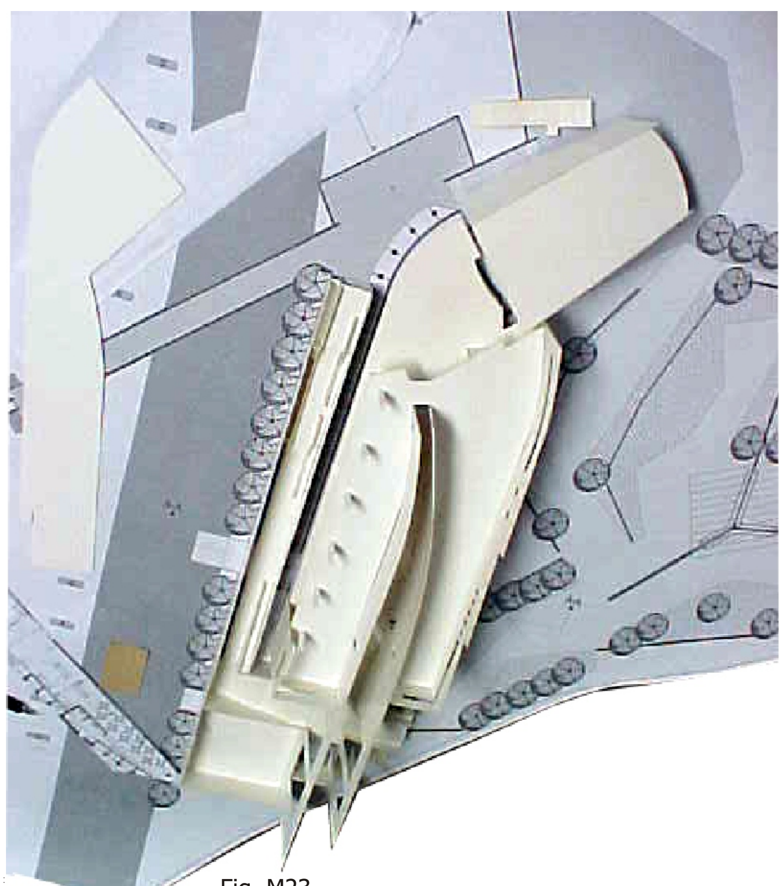

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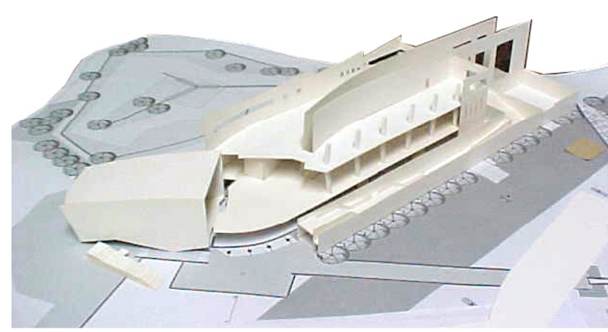

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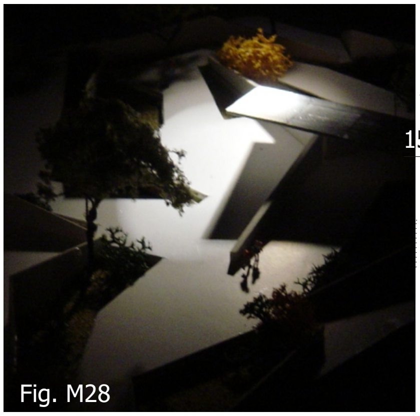

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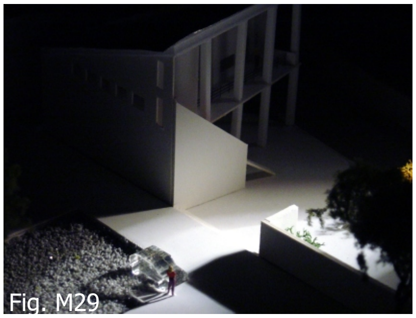
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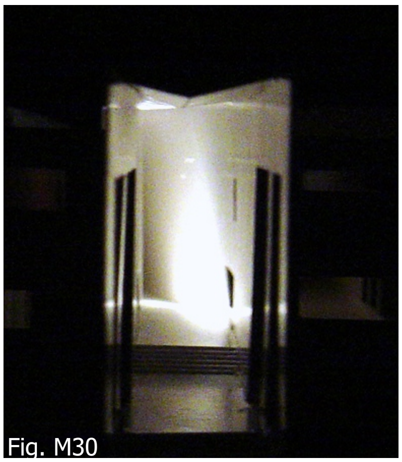
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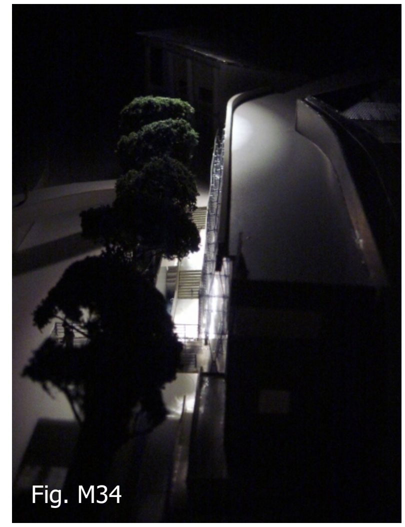
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Fig. M37


Fig. M40


Fig. M41

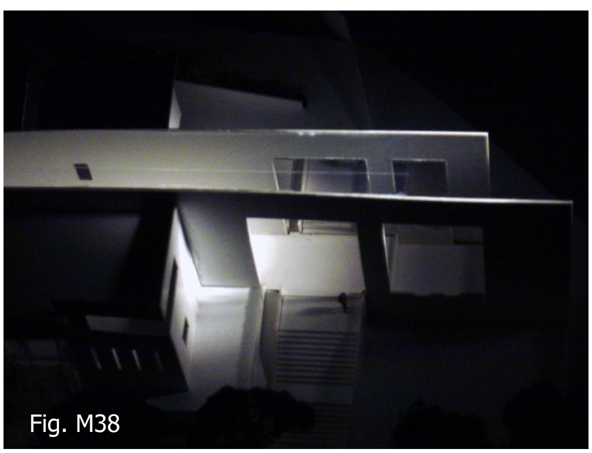


Fig. M38


Fig. M39


Fig. M42

Risk Identification and Assessment

Building costs

BUILDING COSTS

(Overall rates per m2 excl. VAT)

Current Quarter - Gauteng Region

The following information is provided to indicate the current square metre costs of a range of basic or common buildings in the industry. The rates are approximate and can vary according to the circumstances of the project. Rates should be used with extreme caution. Descriptions are abbreviated and if information is not stated specifically, the lowest industry standard The rates include preliminaries but exclude external works (indicated separately), escalation to start and during construction, professional fees and finance costs.

ONLY TO BE USED FOR MPROF 2 PROJECT

		R/m2			RANGE LOW 2003: R/m2	RANGE HIGH 2003: R/m2
Landscaping for low rise developments	R 250 - 450	6794.3	250	450	1,698,575.00	3,057,435.00
External works paving and services	R 250 - 400	882	250	400	220,500.00	352,800.00
Attached office buildings (no AC)	R 1 450 - 1 650	190.5	1450	1650	276,225.00	314,325.00
Ablution	R 3 400 - 3 800	64.2	3400	3800	218,280.00	243,960.00
Kitchen and dining facilities	R 2 800 - 3 050	130	2800	3050	364,000.00	396,500.00
Exhibition areas	R 2 550 - 2 950	561	2550	2950	1,430,550.00	1,654,950.00
Laboratory	R 4000	91		4000		364,000.00
Theatre	R 5000 per seat	117		5000		585,000.00
Skylight		202.8		5000		1,014,000.00
440 Concrete walls		1446.77		320		462,966.40
220 Concrete walls		1184.1		350		414,435.00
220 Recycled bricks		531.5		80		42,520.00
220 Brick walls		239		150		35,850.00
Steel I-beam and lipped channel roof system		300		300		90,000.00
440x440 reinforced concrete columns		98.2		200		19,640.00
300 dia reinforced concrete columns		11.2		250		2,800.00
Aluminium louver system with steel cable		231.4		500		115,700.00
Glass curtain wall		374.4		800		299,520.00
250 concrete roof		639.7		400		255,880.00
250 concrete floor slabs (precast)		922		500		461,000.00
Stone walls		511.3		120		61,356.00
Galvanised steel sheeting baked-on enamel, lead free finish roof sheeting		300		180		54,000.00
Brownbuilt roof sheeting		345.5		150		51,825.00
Toilet Ventilation		64.2		162		10,400.40
Sprinklers		500		56		28,000.00
Fire extinguishers	each	12		672		8,064.00
Hose reels	eash	5		1600		8,000.00
Total						**10,404,926.80**

ESCALATION FORECASTING		
Pre-contract escalation		
This is escalation prior to the start of a building on site. It is related to competitive building rates and monitored nationally by		
Monthly projected pre-building cost escalations	0.08	0.09
Escalation during construction		
This is escalation during the construction period and usually monitored by the BCAC Haylett indices published by JBCC		
Monthly projected during building cost escalations	0.06	0.08

Fig 238. Building cost

Analysing stakeholder influence

Stakeholder Group	Power			Level of concern		
	Influence on others	Direct control of resources	Y-Axis Score	Technical	Social	X-Axis Score
	0.35	0.65		0.2	0.8	
A - Neibouring buidings	2	1	1.35	1	3	2.6
B - Rand Water	4	5	4.65	4	4	4
C - Department of Education	4	2	2.7	3	4	3.8
D - Schools	3	1	1.7	2	3	2.8
E - Government	5	5	5	3	2	2.2
F - Community	2	0	0.7	1	5	4.2

Fig 239. Stakeholder analysis

Plot results

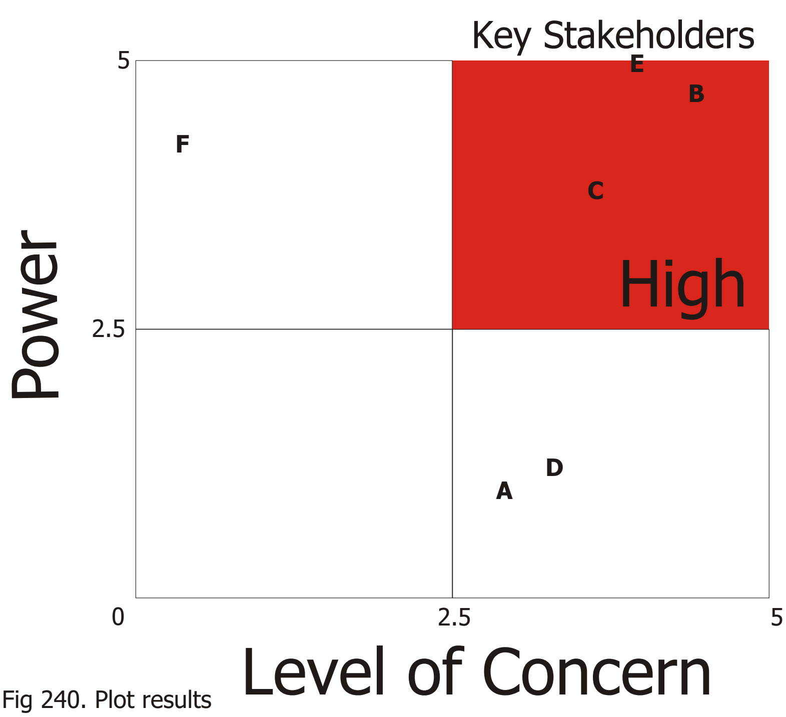


Fig 240. Plot results

In the above plot result it is evident that the Government, Rand Water and the Department of Education are the key stakeholders concerning this project. Their influence, control and level of concern should be taken in consideration from the conceptual phase till the end of the termination phase.

Probability/Impact risk rating matrix				
Risk description	**Consequence measure**	**Likelyhood measure**	**Numeric Ranking**	**Category Ranking (Companies threshold levels)**
Not enough time	4	2	8	Medium
Insufficient budget	4	3	12	Medium
Insufficient resources	4	1	4	Low
Management	4	4	16	High
Cash flow	4	3	12	Medium
Contractual	3	1	3	Low
Legislation	3	1	3	Low
Poor quality production	5	3	15	High
Design	4	2	8	Medium
Weather interference	3	3	9	Medium
Material costs	3	1	3	Medium
Insufficient users	4	3	12	Medium
Government	5	3	15	High
Inflation & escalation	3	2	6	Low

Fig 241. Stakeholder analysis

Risk uncertainty

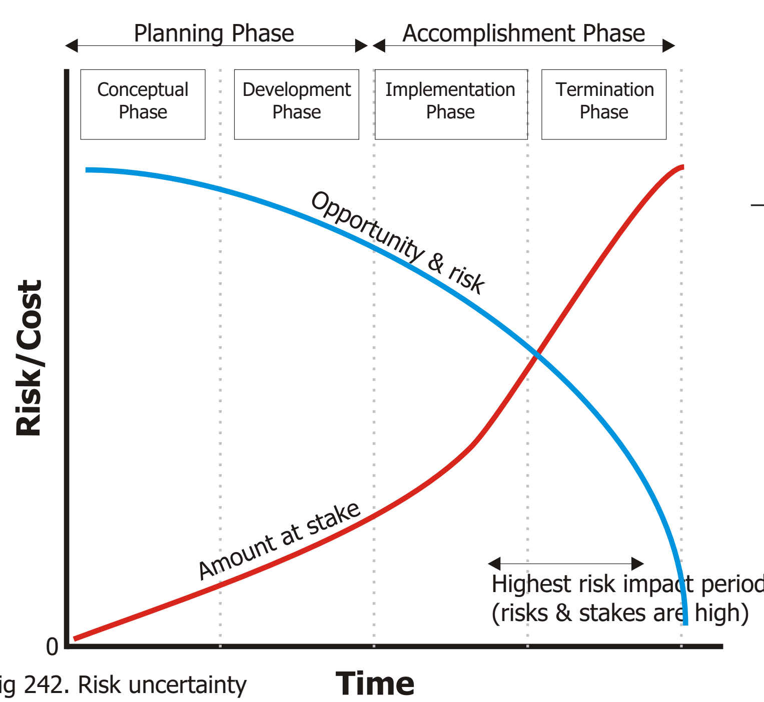


Fig 242. Risk uncertainty

Mitigation measures

The greatest degree of uncertainty exists at the conceptual phase of a project, but the amount at stake is low. As the project progresses the risk become less, but the amount at stake becomes higher.

When looking at the risk rating matrix, those risks with the greatest impact and the most likely possibility of occurring i.e. with the highest ranking, should be addressed. Close attention should be given to each of these risks.

For each one of these risks a detailed system should be in place to minimise the risk factor during each phase of the building process.

Management:
Management of the scheme as a whole, should be planned very carefully. Matrixes and diagrams should be in place to ensure that planning, construction and termination takes place within the time framework set up at the beginning of the scheme. A penalty system should be implemented for any one who exceeds beyond the time frame given for a specific part of the project.
Management is the key factor to a successful or failed project. Good management and planning can eliminate the risks on the lists mentioned above or extend on them greatly.

Poor quality production:
To prevent ending up with poor quality workmanship, and to maximise the quality of the end product, mitigation measures should be set up very early within the conceptual phase. This is a technical risk. To prevent this, the designer should, with the input of the client specify the exact building materials required for the clients need. Technical drawings should be flawless. All of this should concur with the necessary SABS standards. Local contractors should be used, but the quality of work done on previous projects should be inspected before the constructing phase start. Regular quality checks should be performed during the construction phase to ensure that construction takes place according to the given specifications.

Government:
The input and involvement of Government and more specifically the Department of Education, will have a big impact on the feasability of the whole project. The structuring of the educational system and the current curriculum, are the generators of the amount of people visiting the centre. Any changes in the educational system or curriculum might effect the feasability of the building to a great extend.

Appendixes

RAND WATER

THE FULL SERVICE WATER UTILITY

Rand Water was appointed as the sole bulk water supplier to Gauteng in 1903, and has never totally failed to supply its customers with water. As times have changed, Rand Water has evolved to meet the progressive requirements of a growing population and expanding economy. It has been a key partner in the development of Gauteng, South Africa's industrial powerhouse and is well positioned to play and even more strategic role in the future.

The enactment of the Water Services Act in 1997 has allowed Rand Water to expand its activities into the field of sanitation and so manage a more complete portion of the water cycle. Another major change is license to engage in other water related services such as providing engineering expertise, undertaking water and sanitation contract in the municipal sphere, and offering consulting services for the institutional development of new water boards.

In the spirit of the new regulatory framework, Rand Water is proud to offer a full range of water services. It is directly involved in uplifting and empowering previously neglected areas and communities. The organisation embraces the vision of the Minister of Water Affairs and Forestry. This is to ensure that all people in South Africa have access to clean drinking water as well as adequate sanitation and refuse removal. Rand Water also assists communities, in its area of authority, to create and develop water management structures by transferring skills, expertise and resources.

Through living the values embodied in the spirit of partnership, integrity, equity, excellence and caring, Rand Water will continue to actively participate in programmes and initiatives aimed at providing and improving basic services to all south Africans. This includes helping to develop capacity at all level of the water supply industry and channelling concerted efforts into educating the public on the wise use of water as a scarce and essential resource.

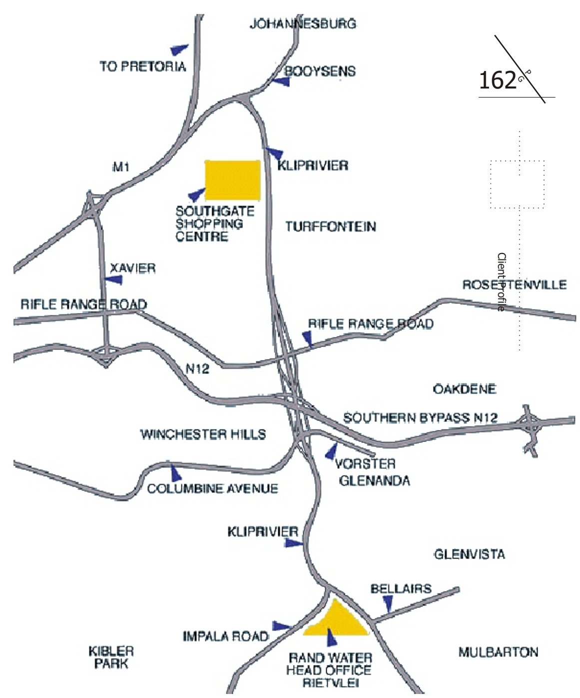


Fig a1. Road Map (RAND WATER Corporate Profile, 2002) (not to scale)

THE PEOPLE AT RAND WATER

Rand Water is a multi-disciplinary organisation possessing all the financial, managerial, technical and operational skills required to supply water services and drinking water in bulk services to the 10 million people living within its service area of supply by the beginning of the new millennium. It is also rapidly developing skills in the field of bulk sanitation.

Rand Water is now governed in terms of the Water Services Act, 108 of 1997. The board of Rand Water is appointed by, and responsible, to the Minister of Water Affairs and Forestry for the financial and operational performance of the organisation. Ultimate management authority for Rand Water lies with the members of its Board. The Board comprises representatives from commerce and industry, the mining sector, local and middle tier government, the Department of Water Affairs and Forestry, and members of Rand Water's executive management committee. Day-to-day management is in the hands of the Chief Executive and the General Managers of the main functional activities of the organisation.

Fig a2.

Rand Water remains a public utility that is run on strict business lines. It finances its capital infrastructure by issuing long term loan stock and taking up institutional loans, while daily operational expenditure is financed by the sale of water.

Fig a3.

ONE OF THE WORLD'S LARGES WATER UTILITIES
WIDE AREA OF SUPPLY

Rand Water supplies all the drinking water consumed by people, communities, businesses and industries across a vast area in South Africa, which stretches over 18 000 square km. On average, almost 3 000 millions litres are pumped every day to consumers throughout the Gauteng Province and as far a field as Rustenburg and Carletonville in the North West Province, Bethal in Mpumalanga and Heilbron in the Free State. The magnitude of this quantity of water is significant as it makes Rand Water one of the larges water utilities in the world.

The area supplied by Rand Water with drinking water, houses the provides employment for about a quarter of South Africa's population, some 10 million people, it includes the metropolitan areas of Greater Johannesburg and Pretoria. Overall the area is the central nerve of South Africa's economic activities accounting for about 50 % of the countries industrial turnover.

Fig a4.

RAND WATER AND THE ENVIRONMENT

Rand Water's business is in every way tied to the environment. Water is a scarce natural resource and Rand Water gives equal weighting to the legal requirements and ethical obligations posed by Environmental Management. Rand Water has formalised the value it places on caring for the environment in a Corporate Environmental Policy, which has, as its key priorities, performance with regard to the core elements of environmental management and facilitation of employee environmental awareness, which includes stakeholders and research activities.

Environmental Management has become integral to Rand Water's overall management strategy. It has been entrenched into the overall management function and in this way; Rand Water strives to influence environmental performance in an organised, systematic and meaningful manner.

THE WATER SUPPLY CHAIN

The water supply chain in Rand Water's supply area is made up of three parties who are, in essence, the suppliers, wholesalers and retailers of water in these areas.

Beginning with the suppliers of the raw water, the Department of Water Affairs and Forestry are responsible for building and maintaining the dams, and then storing the raw or unpurified water. The water is then sold to Rand Water who, as a bulk supplier or wholesaler, purifies and treats the raw water. It is then distributed and sold as drinking water to the municipalities that store in reservoirs and sell the water to residents and businesses. Other major customers of Rand Water are mines and large industrial concerns.

Rand Water is responsible for the infrastructure and reticulation system from the start of the purification process to delivering drinking water to the retailers' supply points. From this point, the municipalities, as the water retailers, take over responsibility for the provision, operation and maintenance of the intricate pipe reticulation networks winding through the cities, towns, and villages which end at the supply points of thousands of businesses and individual yards.

SOURCE OF SUPPLY

The Department of Water Affairs and forestry (DWAF) are responsible for the management of all water resources in South Africa. With the exception of Vaal River Barrage Reservoir, DWAF acts as the custodian of the nation's water resources including all storage dams in the Vaal Rivers system.

The Vaal Dam has a capacity of 2.6 million mega litres of which 234 362 million litres are reserved for the sole use of Rand Water. The organisation draws about 99% of its water for purification from the dam and is the single largest consumer of water from the Vaal River system.

Rand Water's overriding concern is to supply clean water that is safe to drink, colourless, odour free and pleasant tasting. The key to maintaining cost effective high quality raw water is good catchment management. Rand water has for many years run a resource protection programme in the catchments areas of the Vaal Dam and the Vaal River Barrage, and area totalling some 500 000 square km. With the development of the Lesotho Highlands Water Scheme and the reliance on the Tugela-Vaal Transfer Scheme, this programme now includes the Katse Dam in Lesotho as well as the catchments of the Kilburn, Woodstock and Spioenkop Dams in KwaZulu Natal.

SOURCE WATER PROTECTION

The single largest cost incurred by Rand Water each year is the purchase of raw water from the Department of Water Affairs and forestry with expenditure on the resource amounting to some 43% of the total annual budget.

Rand Water maintains an extensive source water quality-monitoring programme as the consequences of deteriorating raw water have a major impact on both water purification costs and the quality of drinking water. This programme is couples to and advanced information management and decision support system, which allows Rand Water to keep abreast of changes that may impact on the drinking water quality and, if necessary, proactively intervene to avert potential problems.

The organisation's source water management programme also extends to water conservation. Here, Rand Water is managing several Working for Water projects, which aim to increase the Yield of specific catchments through the removal of alien invasive vegetation. Wetlands are also rehabilitated as part of this programme to gain the most possible benefit from the natural purification and water storage capabilities of these systems.
The working for Water initiative has assisted in creating more than 2 000 job opportunities in areas where unemployment is rife.

Fig a5.

165°

Client Profile

CATCHMENTS

Over 99% of the water abstracted and treated by Rand Water in recent years is surface water taken from the Vaal Dam, fed by the Vaal and Wilge Rivers. This surface water is generally of good quality and relatively unpolluted as id drains from a catchment area, which is mainly rural, with agriculture being the main activity. It consists of both the mixed farming areas of Mpumalanga and the eastern Free State, and the Drakensberg area where stock farming predominates. In stark contrast, the catchment of the Vaal River Barrage Reservoir, downstream from the Vaal Dam, shows the destructive effects on the water quality of urbanisation and intensive industrial activity. This catchment is characterised by various central business districts surrounded by high-density urban development including formal, semi-formal and informal sectors. Sixty wastewater treatment plants generating approximately 900 million litres per day of effluent serve these sectors. Also in this catchment are countless industries, and numerous operating and disbanded mines which all bring their own pollution problems.

Rand Water no longer draws water from the Vaal River Barrage Reservoir, other than in emergencies, as the Suikerbosrand and Klip Rivers plus tributaries such as Taaibosspruit, Rietspruit and Leeuspruit, which drain the formal and informal areas of Gauteng, have adversely influenced the quality of the water. However, should Rand Water ever be required in the future to draw water from these river systems, the present purification processes would need to be modified to ensure we meet the demand for high quality drinking water.


Fig a6.


Fig a7.

THE VAAL RIVER BARRAGE RESERVOIR

Located 80 km downstream from the Vaal Dam, the Vaal River Barrage Reservoir, with a capacity of 54 211 million litres, belongs to Rand Water. It is the hub of water sport and recreation in Gauteng, and Rand Water has put into place a comprehensive management programme to protect it from urban development, industrial pollution and recreational use, Measures in place include riparian development control and protection of aquatic life. An intensive monitoring programme routinely gives the public information on any health risks related to the various uses of the water and is available via the Internet as well as through pamphlets and on the notice boards at the various public resorts along the river.

TUGELA-VAAL AND DRAKENSBERG PUMPED STORAGE SHCEMES

Growing demand and the threat of drought has necessitated the development of back-up schemes. Since 1974, the water in the Vaal Rivers has been supplemented by the Tugela-Vaal scheme, through the inter-basin transfer of water form the Tugela River in KwaZulu Natal. The inflow rate was substantially increased in 1982 by the commissioning of the Drakensberg pumped storage scheme.

Water is released as required from Sterkfontein Dam into the Vaal River system via the Nuwejaar Spruit and the Wilge River. The availability of water from the Tugela-Vaal scheme enabled Rand Water to maintain restricted but adequate water supplies to consumers during the drought of 1983 and 1995.

LESOTHO HIGHLANDS WATER PROJECT

In 1986, the governments of the Kingdom of Lesotho and South Africa signed a treating sealing the Lesotho Highlands Water Project (LHWP) for the transfer of water from Lesotho to supplement the Vaal Dam. The treaty specified that South Africa was responsible for paying all water transfer related costs and Lesotho was to foot the bill for hydroelectric power and ancillary development projects within the country. In South Africa, the project has been partly funded by a levy charged to consumers within Rand Water's service area, which, together with the water tariff, contributes towards enabling South Africa to meet its loan repayment liabilities.

The entire project comprises six dams and three pumping stations that will divert the flow of the Orange River via tunnels through the Maluti Mountains, and channel the water to the eastern Free State and on to the Vaal Dam. Once complete, it should substantially augment the water resources available to the ever-growing population of Gauteng, and those residing and working the vast area supplied with drinking water by Rand Water.

The first phase of the ambitious Lesotho Highlands water Project to meet the expected demand of water in the Gauteng province up to the year 2020 was completed in 1998. This phase of the project included the construction of the Katse Dam and an underground power station.


Fig a8.

ABSTRACTION AND PURIFICATION

Rand Water abstracts its raw water from the Vaal Dam via a canal and gravity pipeline, and by pumping from the Vaal River Barrage Reservoir at Lethabo, Zuikerbosch and Vereeniging. A small quantity of water is also abstracted from underground sources at Zuurbekom. After abstraction, the water undergoes a complex purification process to ensure it meets the stringent standards set for drinking water. Conventional treatment processes remove the suspended material and disinfect the water prior to pumping to the local authorities, the mining industry and other large industrial concerns. Each stage in the purification process is accompanied by changes in the physical and chemical composition of the water. These changes are constantly monitored and corrective action is taken to prevent the water quality from dviating from the prescribed limits.

The process involves seven stages, which are: coagulation, flocculation, sedimentation, stabilisation, filtration, disinfection and chloramination.

SLUDGE DISPOSAL

Between 500 and 1 300 tons of dry sludge are produced each day during the purification process. This is removed from the sedimentation tanks at Zuikerbosch and Vereeniging in thin slurry containing 3% mass by volume of dry sludge.

The sludge is pumped to Rand Water's sludge disposal site at Panfontein. Here it is dosed with an organic flocculent in gravity thickened plants to aid the separation of the solids from the liquid. The thickened sludge is pumped onto drying beds where it is dried by evaporation and the clear supernatant fluid is drawn off and returned to the purification system.

PUMPING TO GAUTENG AND ELSEWHERE

Rand Water is the only bulk water supplier in the world that provides water to a metropolitan centre that is not situated on a large waterway. With Johannesburg some 70 km away from the Vaal River, and ranging between 375 and 400 metres higher in altitude, Rand Water's pumping and infrastructure costs to deliver drinking water to its customers from the Zuikerbosch and Vereeniging purification stations are a major expense.

DELIVERY AND DISTRIBUTION OF WATER

Rand Water has the capacity to supply 5 184 million litres per day although the average daily demand is far less ranging, for example in 1998/1999, from a low of 2 399 million litres per day to a record breaking high of 3 745 million litres per day.
Rand Water's infrastructure includes two main water treatment plants where raw water is purified. Rand Water operates and maintains 10 primary pumping systems as 11 booster-pumping systems throughout its area of supply. In addition, it owns and operates 53 bulk storage reservoirs that form an integral part of the distribution system and allow for variations in the daily and weekly demands while maintaining relatively uniform pumping rates. They also provide reserve storage in the event of scheduled or unscheduled interruption in supply over the widespread system. The largest reservoir has the capacity of 652 00CM.

Fig a9.

Ninety five percent of the treated water pumped from Zuikerbosch and Vereeniging is pumped onwards via Zwartkopjes, Palmiet, Eikenhof and Mapleton booster pumping stations through some 2 800 km of large diameter pipeline to 53 strategically located service reservoirs. The pipe network comprises 2 800 km of which 1 272 km are pumping mains and 1 557 km are gravity mains. The diameters of the pipes vary between 300 mm and 3 523 mm. 789 isolating valves, 3 014 air valves, 1 315 scour valves and measure by 1 468 consumer meters control water distribution.

Fig a10.

The water is delivered in bulk from reservoirs to Rand Water's customers. These customers are the final link in the chain and, in turn, supply the drinking water to the general population and businesses.

RESERVOIR TECHNOLOGY

In 1997, Rand Water completed building the Klipriviersberg Reservoir south of Johannesburg. To achieve economies of scale and to meet its current and projected requirements in the Gauteng area, Rand Water built one large reservoir rather than several smaller ones. This presented unique design and construction challenges, as the requirement capacity was 650 mega-litre. (A reservoir with a capacity of 200 mega-litres is generally considered to be large.) Making this the largest covered concrete potable water reservoir in the Southern hemisphere and possible in the world. Its area is equivalent to about eight rugby fields, with a depth of 13m.

Fig a11.

Rand Water has long been recognised as a leader in reinforced concrete water retaining structures. Years of experience enabled the utility to design and build a reservoir of this capacity such that the various structural elements not only contain the 650 000 tonnes of water but also accommodate soil movements. In order to comply with Rand Water's environmental protection philosophy, the reservoir was built into the side of the Klipriviersberg hills, making it as inconspicuous as possible. Most of the rock excavated from the hill was crushed and used to make concrete, from which the reservoir was constructed.

On completion of the reservoir, the construction site was completely rehabilitated. The reservoir has since won a Fulton Award for excellence in the use of concrete.

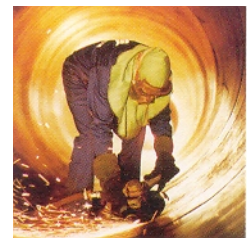


Fig a12.

EXCELLENCE IN TECHNOLOGY THROUGH INNOVATION

Rand Water has to provide water in such complex conditions as the altitude and distances from the major waterways. This means that pumping and infrastructure costs for the 2 800 km of piping required are usually a major cost consideration. Rand Water has thus become an innovator, by necessity, in large diameter high-pressure pipe technology. Rand Water has developed technology that allows it to use thin walled pipes that are expected to last at least 75 years. Two of these technologies include pipe stiffening and corrosion protection.

PIPE STIFFENER TECHNOLOGY

Rand Water uses trapezoidable stiffeners o stop the pipes buckling under the external soil loads and internal vacuum pressure. Large diameter thin wall steel pipes would normally require flat ring stiffeners at close spacing to avoid buckling. The use of trapezo8idal stiffeners has allowed the spacing to be increased up to 6 meters. The main advantage of this technology is a significant cost saving as thinner pipe wall steel and fewer stiffeners are used.

CORROSION PROTECTION

The organisation has perfected and effective method for the lining of large diameter pipes, using in-situ cement mortar. This has a life span of up to 100 years and, for environmental reasons, is preferable to bitumen. The cement mortar is put in place using a spray method and smooth steel troweling after the pipes are laid and buried in the ground. This is effec8ient and quick, allowing more effective pipe laying and alignment.

ZONE METERING

The objectives of this project include conducting a more accurate water balance, monitoring draw-off patterns, determining water leaks and monitoring the conditions of pipes.

ENGINEERING SERVICES

Rand Water's Engineering Division is able to provide a wide range of Engineering services:

- Planning: Planning and provision of bulk water supply infrastructure to meet future demands. Integration of information and planning methods with suppliers and clients. The primary function of the Planning Department is to recommend and support the most cost effective and efficient use of existing and new infrastructures to meet customer d3emands. They do demand forecasting, hydraulic water quality analysis, infrastructure analysis, including financial viability calculations and financial optimisation; manage customers' water point connections and upgrades.
- Survey: Rand Water has an entire department dedicated to deliver the finest quality surveying, draughting and topographical plans, enabling engineering project design to be accurate and hence more const effective.
- Geographical Information System: Approximately 80% of all date has a spatial connotation. Rand Water uses the GIS to link data or information to and object to which it is associated. Clients can then view images (photographs), documents, spreadsheets, database files and reports through and intranet viewer that make decision making easier.
- Design: This service forms part of all engineering projects in all the various disciplines. It is generally the theoretical process, which will be used to achieve the objective of the project. This includes an analysis of technical details, calculations, validation and verification, modelling and testing preceding implementation.
- Project Management: This involves a time and cost analysis, overseeing the project from the conception of the project until the end of the project. Rand Water has a project management department, which is able to provide fully inclusive project management services.
- Quality Management: This is the continual monitoring of the quality of materials used in the project and the workmanship of work done. Ensuring that the customer gets the best quality of work at a cost effective rate.
- Construction Supervision: Supervising all construction involved in the project. The structure must meet international standards and it is constantly monitored and controlled.

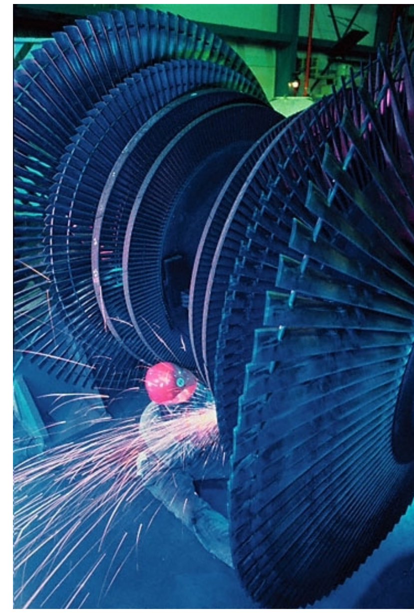


Fig a13. Engineering skills

- Installation Supervision: Supervising all installations of equipment needed.
- Commissioning: Rand Water will commission the project and monitor the working solution.
- Training: Training is provided on all equipment processes involved in the project, ensuring that the solution is operated efficiently.
- Pipeline renovations: Rand Water is fully capacitated to restore existing pipelines and fixing pipe leaks. Considering how much money can be saved by making sure that pipelines are in good condition and that future leaks can be avoided, it is an activity both beneficial for Rand Water and external customers (a service currently provided to external customers). Existing leaks can be identified and repaired with the most cost effective pipeline engineering solutions.
- Infrastructure refurbishment: This service includes restoring existing structures and processes already in use by the customer. Utilizing the existing infrastructure and saving the customer money.

These services span all the Water Engineering related disciplines namely:

1. Survey
2. Pipelines
3. Mechanical
4. Electrical
5. Instrumentation
6. Automation
7. Process/Chemical

It is this kind of knowledge and expertise that ensures healthy and clean drinking water every day to millions op people. Having said this, Rand Water believes that their greatest achievements are the services and dedication they give to their customers.

MEETING THE WATER DEMANDS

Rand Water is responsible for the infrastructure necessary to supply water to meet the projected demand. And ongoing programme of proper refurbishment, renovation and replacement of pipelines is on of Rand Water's priorities.

With more than 2 800 km of pipelines in service with diameters ranging from 300 too 3 500 mm, both proactive and reactive maintenance are a necessity.

Leaks are proactively kept to and absolute minimum through the use of protective coatings and cathodic protection of the pipeline network. Reactive maintenance takes the form of repairing leaks found by pipeline patrols or pinpointed from reports by the public.

Fig a14.

In 1999 the projected demand for drinking water was, on average, 69% of Rand Water's capacity. This is equivalent, each day, to 36 000 average sized home pools and is, by world standards, a very large quantity of water. By 2005, Rand Water estimates that consumers will use an annual average of 3 677 million litres of drinking water per day and an average daily quantity of 4 500 million litres over any peak seven day period.

THE QUEST FOR PURITY

Rand Water has supplied high quality tap water, meeting the requirements of the world's leading developed nation, to its consumer since 1903. Critical to this delivery are Rand Water's scientific services staff that are engaged in a ceaseless quest to improve water quality and protect the raw water at its source. The division is responsible for operational audits, applied research and resource protection. It also provides a water quality information service to Rand Water's customers, which includes handling consumer complaints linked to water quality.

QUALITY AUDITING

Stringent guidelines are set for the quality of drinking water through all stages of the purification process and throughout the distribution system to ensure that the water reaching Rand Water's customers meets the required standards. Guidelines for the quality of the water supplied by Rand Water were compiled using international and national drinking water quality criteria including those prescribed by the World Health Organisation (WHO), the South African Bureau of Standards (SABS) and relevant government departments.

Rand Water's chemical and microbiological laboratories carry out over 250 000 analyses every year on water samples form 200 pints in rivers, factories and sewage effluents in the catchment area and over 1.2 million analyses each year on the purification process. Chemical, physical and hydro biological tests are also continuously conducted on samples of potable water in the distribution system.

WATER QUALITY RESEARCH

Rand Water is engaged in ongoing research to develop new techniques of water purification and make existing methods more cost effective.

It has one of the best-equipped water laboratories in South Africa, which have been awarded accreditation by the National Calibration Service, and boasts world-class technical expertise and analytical capability.


Fig a15.

WATER QUALITY CUSTOMER SERVICE

Concern over the quality of tap water has become a topical issue worldwide. Now more than ever, people's acceptance of the quality of their tap water has become a measure of Rand Water's success.

Rand Water has launched a concerted educational campaign over the past years to make consumers aware that the tap water being supplied to Gauteng rates among the best in the world. The Tap Analysis Programme (TAP) offers a service testing water samples from people's homes on an ongoing basis to monitor quality trend.


Fig a16.

REACHING OUT TO THE BROADER COMMUNITY

Since 1994 Rand Water has become more and more involved in the total water cycle to improve service to the end customers who actually use the water. The organisation fully supports and is committed to furthering the government's Water Supply and Sanitation Policy. Emphasis is given to community based; people-driven projects, which build capacity within previously, disadvantaged communities and empower them to manage water supplies efficiently and effectively.

In 1994 Rand Water established its Community Support Services Division, which is actively involved in offering assistance to support and strengthen the capacity of water service authorities and promote water conservation. The main responsibilities of the division cover communications, marketing, community projects and retail water.

Actively involved in creating solution to water and sanitation service problems in communities and local authorities, Rand Water's Community Based Projects has a practical and developmental approach to solving seemingly intractable problems. It is a leader in its dealings with informal settlements. The use of its comprehensive database to manage information about the settlements in partnership with the Department of Water Affairs and Forestry, municipalities and the provinces is vital asset in helping communities most in need of lifeline assistance.

The purpose of the Community Based Projects Department is to provide a centralised community development support services chain, and in so doing, assist Rand Water in fulfilling its commitment to meeting the aspirations of the previously disadvantaged communities and the needs of all relevant stakeholders.

The Department has a proud history of making a difference in the communities that they work in. The department is involved in cost-recoverable, institutional development, corporate social responsibilities, SMME development, non-recoverable and Rand Water investment projects. The cost-recoverable projects have been funded by external sources like the Department of Water Affairs and Forestry.]

The Water Wise Centre in Pretoria would fall under this Department of Rand Water. It will be part of the outreach to the broader community, thus the community of Pretoria. It will be a community project in the sense of the word that educators, scholars and anyone from the surrounding area could be educated at this centre.

In its approach to its work, the Community Based Projects Department seeks:

- To maximise economic and employment opportunities through the development of emerging contractors and the use of labour construction methodologies
- To build the capacity of community and newly created local government structures to ensure the sustainable management of water and sanitation systems
- To promote the integration of water and sanitation projects into borader development initiatives
- To act a Implementation Agent for the Rand Water Foundation
- To strive for sustainable water service delivery
- To focus on underprivileged communities and under-serviced areas giving priority to Rand Water's area of supply

The department has a core of skilled and experienced staff from a number of disciplines. The services include:

- Project management
- Participatory and community development
- Institutional and social development
- Facilitation of community based water and sanitation services
- Community guidelines
- Generic training plan
- Implementation agent
- Site tours

COMMUNITY BASED PROJECTS

Mnweni Trust:
The Mnweni Trust was launched in 1999 and is the culmination of years of work resulting from a close association between Rand Water, the wildlife Environment Society of South Africa, Bergwatch, and the communities of the amaNgwane in the Upper Mnweni Valley of the Drakensberg. The objective of the trust is to manage and promote the protection, conservation and restoration of the Upper Mnweni Catchment area through education, appropriate local economic development and the development of a conservation-based ethic amongst the people of the amaNgwane.

Winterveldt Water Supply Projects:
This project was identified as a Presidential leak Project in 1994. The Department of Water Affairs and Forestry appointed Rand Water as the Implementing Agent for the project. The objectives of this project is to provide water to all the people of Winterveldt with a least minimum standard of water supply, 25 litres per capita per day and to create employment opportunities for the local community.

Winterveldt Eco-Circle Vegetable Garden project:
The aim of the project is to provide unemployed community members with skills and knowledge to improve their health, quality of life and the environment. It will also empower individuals and communities to become self-reliant in food production and within a short period help generate small businesses. The Kromkuil Nutritional Centre consists of about 30 40 households that will be trained to develop these vegetable gardens.

Fig a17.

Bushbuckridge Infrastructure project:
The project entrails the provision of bulk water infrastructure through the application of RDP principles including labour intensive construction, contractor development and community involvement and capacitation.

Ten Morgan Rural Community Sanitation project:
The project was established to achieve health improvements in the community by changing poor hygiene behaviour practices and improving sanitation facilities such that they are sustainable in the long term. The project is being implemented using DWAF's A/B approach to rural sanitation projects that involves funding of improved sanitation facilities through household subsidies.

Fig a18.

DACE Alien Vegetation Eradication project:
The main focus of this project is the eradiation of seedlings and coppice of the Blue Gum and Wattle tree, which consumes lots of water around the water catchment areas. The project objectives is to protect and restore biological diversity by reducing the competition by invading alien plants, enhance water security through regaining control over alien plants, improve the ecological integrity of the natural systems, and to develop and maximise social and economic benefits through the training and employment of local community on the project.

Informal Settlement Encroachment project:
This project aims to ensure that all informal settlement communities who have potential to use Rand Water's properties (land, pipeline and servitude to the future) are stopped from achieving such potentiality, and the reactive is to ensure that all informal settlement communities who are currently using Rand Water's properties are removed from the properties with immediate effect.

Leak Repair project:
Rand Water, in partnership with the Department of Public Works, is providing funding to complete a free one-off community project in Daveyton to repair consumer water installations that have leaks and retrofit houses with dual flush cisterns as a further means to reduce water consumption. People from the area are employed on a contract basis to fill various positions on the project which reduce costs and empowers the communities by providing additional job opportunities and facilitating the development of skills, as well as maximising the retention of funds within the community.

EDUCATION AND TRAINING

Besides visibility in national conservation efforts such as the National Water Week, Rand Water is also deeply involved in a wide range of educational programmes, which focus on promoting water conservation and demand management. These programmes take the form of organised site visits, television programs, school workshops, road shows, TV and printed media advertisements.

SALES AND CUSTOMER SERVICES

The whole way Rand Water approaches its business has been restructured to serve the needs of its customers. The changing political, economic and social environment has meant that the responsibilities of municipalities to communities have increased enormously. Never before in the history of South Africa has there been so much pressure on the public sector to deliver services to improve the health, safety and quality of life on the people it serves.

Rand Water regards its re-invention as growth for both the organisation and its customers. For customers, the re-invention means that Rand Water will direct far more energy at understanding the needs of its customers and matching services to those needed by its customers. Rand Water is able to offer the following services to ensure that the operations of its customers remain sustainable:

- Engineering
- Water treatment
- Institutional
- Retail water
- Bulk water
- Water Cycle management
- Training and capacity development
- Sanitation
- Communication and education programmes

CUSTOMER INTERACTION

Customers have easy access to the one-stop public service utility through a 24 hour Customer Services Centre and through other customer interaction mechanisms. These mechanisms include the role of the regional account executives and industry account executives that are the direct interface between Rand Water and customers; and numerous Forums that are held on a regular basis with customers and other key stakeholders.

Fig a19. Water drop

Vegetation

KAREE

BOTANICAL NAME **RHUS LANCEA**
MANGO FAMILY **(ANACARDIACEAE)**

Description

An evergreen tree with a loose, rounded crown up to 9 m tall. **Bark** on young branches smooth and reddish brown but rough and dark brown on older branches and stems. **Leaves** drooping, with three leathery, glossy and dark green leaflets up to 150 mm long, middle leaflet the longest, leaf stalk up to 50 mm long. **A flower small, up to 3 mm in diameter, yellow-green, in much-branched sprays at ends of branch lets**, with male and female flowers on different trees. **Fruit** round and slightly flattened, up to 5 mm in diameter, with a thin layer of flesh, glossy brown when ripe. **Wood** reddish brown, hard, tough, close-grained and heavy (air-dry 1 040 kg/m^3).

Fig a20

Diagnostic features

Bark rough and dark brown; leaves leathery, with three glossy leaflets up to 150 mm long; small greenish yellow flowers, male and female flowers on different trees; fruit round and slightly flattened.

Fig a21

Habitat

Mostly in woodland or along drainage lines. Grows in practically any soil type. Thrives in poorly drained soils, i.e. black cotton soil.

Cultivation

Grows easily from seed, cuttings or layers. There are approximately 30 000 seed per kilogram. Sow ripe seed in flat seedling trays in a mixture of river sand and compost (8:1). Cover seed with a 5 mm layer of pure river sand. Seedlings can be planted out into black plastic nursery bags when they have reached the 2-leaf stage. Transplant into the veldt or garden when ± 300 mm tall. Cuttings must be made from young branches from September to October. Transplant as for seedlings from December to January. Can be grown from truncheons but they do not strike easily. Fairly fast growing, up to 800 mm per year. The karee is drought and frost-resistant.
A protected tree in the Northern Cape and the Jacobsdal district in the Free State.

Fig a22

Fig a23

Fig a24

FEVER TREE

BOTANICAL NAME **ACACIA XANTHOPHLOEA**
FAMILY **POD-BEARING FAMILY**
(FABACEAE)

Description
A semi-deciduous to deciduous tree up to 30 m tall with an open, rounded to spreading crown. **Bark** lemon- to greenish yellow, becoming powdery. **Stipules** spinescent and in pairs, white and straight, 1085 mm long. **Leaves** twice compound, with 37 pairs of pinnae each with 820 pairs of leaflets, glands present at bases of upper pinnae pairs. **Inflorescence** round, bright yellow and sweetly scented, borne on shortened side shoots represented by clustered scales. **Fruit** a thin non-splitting yellowish brown-to-brown pod slightly constricted between the seeds, breaking transversely into segments. **Wood** pale brown with a reddish tinge, hard and heavy (air-dry 910 kg/m^3).

Habitat
The fever tree occurs in low-lying swampy areas, margins of lakes and pans and along riverbanks. Often form dense stands in seasonally flooded areas.

Cultivation
Easily grown from seed. Despite the production of a large number of flowers, often only a few pods develop. Seeds are therefore generally not easy to come by. Soak seeds in hot water, leave overnight and sow the next morning in seedling trays filled with a mixture of river sand and compost (3:1). Cover the seeds with a thin layer of sand and keep moist. Transplant the seedlings into nursery bags filled with a mixture of river sand and compost (5:1) when they reach the 2-leaf stage. Be careful not to damage the long taproot in the process of transplanting. Seedlings and young trees transplant well. One of the fastest growing thorn tree species in southern Africa with a growth rate of 11.5 m per year. It can withstand cold but no cold winds or frost.

Fig a25

Fig a26

Fig a27

Fig a28

Fig a29

MOUNTAIN KAREE

BOTANICAL NAME *Rhus leptodictya*
FAMILY **MANGO FAMILY**
(ANACARDIACEAE)

Fig a30

Description

An evergreen tree with drooping branches, up to 8 m tall, with a dense crown. **Bark** on young branches reddish brown, but dark brown and rough on older branches and stems. **Leaves** with three dull green sessile leaflets, the middle leaflet the longest, up to 95 x 25 mm, midrib prominent above and below, margin mostly toothed. Leaf stalk up to 50 mm long. **Flowers** in many-branched sprays at tips of branches, flowers small and light yellow, male and female flowers on separate trees. **Fruit** flattened, glossy, light yellowish brown, up to 6 mm in diameter. **Wood** reddish brown, hard and heavy (air-dry 1 010 kg/m^3).

Fig a31

Diagnostic features

Branches drooping; bark rough and dark brown, with reddish brown young branches; leaves with three leaflets, leaf margin mostly toothed, leaf stalk up to 50 mm long; flowers in sprays at tips of branches; male and female trees; fruit flattened.

Habitat

Occupies most habitat types but shows a preference for rocky slopes.

Fig a32

Cultivation

Sow seed during December to March in seedling trays filled with river sand. Soak the seed overnight in water for the best results. Cover the seed only slightly with sand and keep moist. Germination is relatively quick, 68 days with a 80100% success. Seedlings can be transplanted into nursery bags when they reach the 2-leaf stage. The mountain karee is frost- (up to -7°C) and drought-resistant and grows in any type of soil. It grows best in full sun but also does well in light shade. The growth rate is fast, up to 1 m per year. Young plants should be pruned to form a single-stemmed tree.

Fig a33

Fig a34

SWEET THORN

BOTANICAL NAME **ACACIA KAROO**
FAMILY **POD-BEARING FAMILY**
(FABACEAE)


Fig a35.

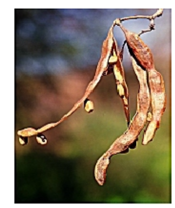


Fig a36.


Fig a37


Fig a38


Fig a39

Description
An evergreen tree up to 20 m. **Bark** rough and fissured on older branches and stems. **Thorns** elongated and abundant on young trees, 30250 mm long. **Leaves** in axils of thorns, twice compound with 26 pairs of pinnae each with 527 pairs of leaflets. **Flowers** sweetly scented, 1013 mm in diameter. **Fruit** a brown sickle-shaped splitting pod up to 160 x 10 mm. **Wood** with a light brown to yellowish sapwood with prominent annual rings and a reddish brown hard and moderately heavy (air-dry 800 kg/m^3) heartwood.

Diagnostic features
Young branches reddish brown; thorns in pairs and straight; gland on leaf stalk large; flowers deep yellow and in round inflorescences grouped towards tips of branches; splitting sickle-shaped pod.

Habitat
Occupy most habitat types. Adapted to various climatic and moisture regimes. Most frequently in wooded grassland and on the margins of marshy areas. Not restricted to any specific soil type.

Cultivation
Grows easily from seed. Seed must be soaked in hot water, left overnight and then sown the next morning. Plant seed either directly into small black nursery bags or in flat seedling trays filled with seedling mix obtainable at any nursery. Cover the seed lightly with sand and keep moist. Seeds usually germinate 312 days after being sown. Transplant from the trays when the seedlings unfold their second leaves. In spite of the long taproot, seedlings transplant well. The sweet thorn is frost- and drought-resistant, with a fast growth rate, up to 1 m or more per year being normal. A protected tree in the Northern Cape and Free State.


Fig a40

WHITE STINKWOOD

BOTANICAL NAME **CELTIS AFRICANA**
FAMILY **E L M F A M I L Y**
(ULMACEAE)

Fig a41

Description
A large deciduous (semi-deciduous in forests) tree up to 40 m tall. **Bark** on young branches hairy but smooth, pale grey, sometimes with horizontal ridges on older branches and stems. **Leaves** alternate, simple and light green when young but dark green when mature, with a drip-tip, margin toothed for upper two-thirds, Leaf stalk up to 35 mm long. **Flowers** appearing at the same time as leaves, yellowish green, male flowers sessile and in dense bundles at base of new branchlets and female flowers single or a few together, on long flower stalks. **Fruit** a small yellowish drupe on 2025 mm long fruit stalk. **Wood** moderately hard and moderately heavy (air-dry 750 kg/m^3), very flexible, pale lemon yellow with nearly no distinction between sapwood and heartwood.

Fig a42

Diagnostic features
Bark smooth and grey; leaves with three main veins from the leaf base, base asymmetrical; male flowers sessile and in bundles, female flowers on long flower stalks, single or a few together.

Habitat
In high rainfall areas in forests and along streams but in the lower rainfall areas in woodland or wooded grassland, on termite mounds or on rock outcrops. Not restricted to a specific type of soil.

Vegetation

Fig a43

Cultivation
Fresh seed must be collected on the tree as insects invariably infest seeds lying on the ground. Approximately 10 000 seeds weigh 1 kg. Seed collected from frost-hardy trees should be sown if the seedlings are to be planted in areas that experience frost as trees from such areas are genetically adapted to the cold conditions. Sow seed in seedling trays filled with river sand and compost (5:1). Cover the seed with a thin layer of river sand and keep moist. Germination usually takes place within 830 days if the trays are kept in a hot but shady area. The germination percentage is usually 5070%. A fast growing species, usually 2 m per year if planted in deep soil and given enough water. The white stinkwood is drought and frost-resistant. A protected tree in South Africa.

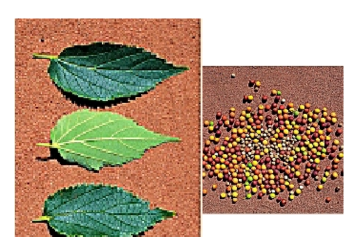
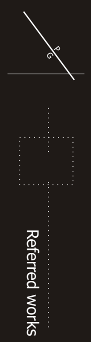


Fig a44

Fig a45

Referred works



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