

arranging volumetric systems [4] [Programme & Accommodation]

[4.1]

[4.2]

[4.3]

[4.4]

PROGRAMME

PROGRAMME

ACCOMMODATION

VOLUMETRIC

ASSEMBLY

EXPLORATION

ASSEMBLY

ASSEMBLY



Because of the project's unconventional nature, the building's programme cannot just be assembled by looking at a precedent or two, checking the National Building Standards and working out a standard accommodation schedule. First of all the **available technologies and on-site requirements** need to be calculated and investigated in order to establish to which extent the site can be serviced by the Infratecture. What systems are needed, how should they be applied and what other programmatic spaces are needed to manage the Infratecture?

Then the public infrastructure of the building needs to be determined. Thus what are the public facilities, how would the parkade work and **how would one integrate the spaces with the infrastructural systems?** In order to find out what is needed and what is **possible**, product research, technical analysis and a series of precedent studies were done to inform the project programme assembly. The research was organised under the following headings:

- _ Energy supply
- _ Water harvesting
- _ Effluent waste management
- _ Recyclable waste management
- _ Organic waste management

INVESTIGATING AVAILABLE TECHNOLOGIES

As previously stated, the project is focused on serving the site with resources, more specifically; **water, electricity, solid and effluent waste management**. It is the aim to do so in the most sustainable manner, integrating the systems in the project structure, cycling and harvesting the resources on site to whichever extent it is possible.

Thus for every resource management system one needs to know what the capacity should be, what system is needed to manage the resources and **what one can ultimately achieve with current technology**. An investigation was done on each topic to find the most appropriate management strategy.



ENERGY SUPPLY

The on site energy usage is 334 600 kW/h per month, but with current power saving strategies and technologies a building's power usage can be reduced by 15% (Eskom Demand Side Management 2008 : 1). Thus, the on-site energy requirements should be about **284 410 kW/h per month**. Current available sustainable energy generating technologies are:

- _ Solar water heaters
- _ Solar photovoltaics
- _ Hydro-electricity
- _ Tidal power
- _ Wind energy
- _ Geothermal energy
- _ Methane gas harvesting
- _ Nuclear energy

Solar water heaters and solar photovoltaics only **need surface area and sun exposure** to generate energy, the bigger surface area that is used (thus the more panels) the more energy can be generated. Hydroelectricity needs **large volumes of water at extremely high pressure** and is only feasible if these volumes are available. Tidal power is generated by waves, thus one needs to be by the sea. Wind energy requires **strong and constant** winds which we do not have in Pretoria.

Geothermal energy is harvested from heat stored in rock in volcanically active plate margins which also does not occur in Pretoria. Methane gas is **highly explosive** and would present a health and safety risk in the urban setting. Nuclear energy is generated through a very hazardous process and it would be a **safety risk** to operate in a dense urban area (Boyle 1996 : vii).

Thus the only available, economical and practical energy generation technologies are **solar water heaters and solar photovoltaics**. If one considers photovoltaics, the nearest cell supplier is Solar Metrics Ltd. in Johannesburg, Gauteng.

Solar Metrics uses **small cell modules to build custom panels**, but also has a range of standard prefabricated panels. According to their product data, **a 1m²** (1580mm x 808mm x 35mm) **panel generates 0.925kWh per day** (for an average **5 hour sun exposure**) at the optimal angle of 30° north facing. Because the energy produced is used in an off-grid application 28% of the efficiency is lost, to counter this loss 28% more panels are needed. Thus to supply the entire site's energy via photovoltaics, a simple calculation needs to be done:

Entire site's energy requirements:

	= 284 410 kW/h per month
1 panel	= 0.925 kW/h per day X 30 days
	= 27.75 kW/h per month
	= 284 410 / 27.75
	= 10 249 panels.

Thus **10 249m² surface area is needed** to generate the entire site's energy. This is **one third of the site's surface area** and would cost about **R50 million**. Although one could hypothetically attempt to cover a third of the site in photovoltaic panels it would not be possible to do so with a singular central intervention. The technology of alternative energy production is still in an early development stage and although many brilliant advances have been made, large scale energy production remains a mountain yet to be conquered. Unless perhaps thousands of m² is set aside outside the city for a large photovoltaic energy plant.

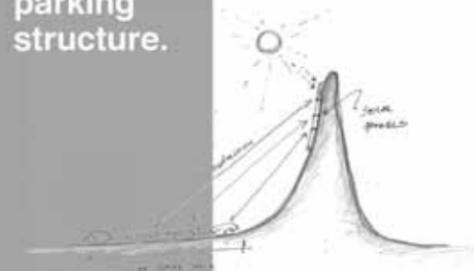
Thus, unfortunately, it would **not be feasible** to attempt to supply alternative energy to the existing structures on site. One can however integrate photovoltaic energy harvesting into the intervention's design to at least generate the building's own energy. A few precedents were consulted to look at the possibilities of **integrated photovoltaic design**.

precedents



Alternative energy harvesting in the high density urban context.

Using solar energy to charge electric cars in a parking structure.

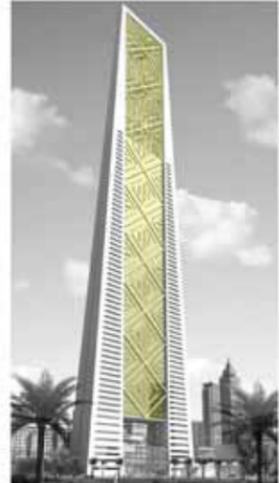


the lighthouse

2010 eVolo skyscraper competition

location: Dubai, 2007
 architect/s: Atkins
 project:

The Lighthouse is another innovative green skyscraper to be constructed in Dubai. For energy generation, it will have three enormous 225 kilowatt wind turbines (29 meters in diameter), and 4000 photovoltaic panels on the south facing façade. To optimize performance and operational periods, the turbines have windward directional wind vanes. The 400-meter office tower aspires to reduce its total energy consumption by up to 65% and water consumption by up to 40%. According to Atkins, this unique building, with a total construction area of 140,000 sq m, will become a working prototype for low carbon towers within the region and a model for more sustainable developments in the future (Thomas 2007).

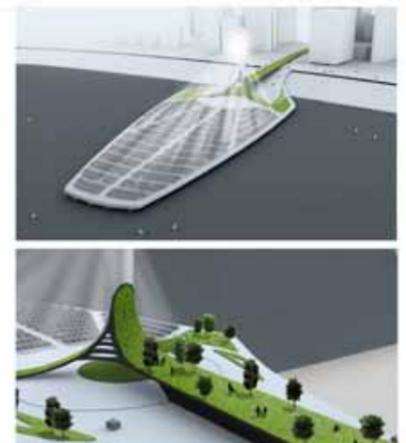


solasis light tower

the future does much more than park cars

location: Design comp, 2010
 architect/s: Designboom, Nissan
 project:

This renewable energy generating parking lot actually uses the cars' windshields to shine sun onto a solar power concentrating tower adding valuable juice to the grid. Cars are parked so that their windshields and hoods face the solar receptor at the front of the parking lot. The designers, Klaud Wasiak and Yongbang Ho focused the concept around the Nissan Qashqai which has mesh made up of photovoltaics and mirrors on the windshield and roof. When parked, the mirrors activate and track the sun and re-direct the beams of light to the solar concentrating power tower. Drivers of cars who park in this offshore parking lot can hop on an underground metro line that will bring them to the city core. Or they may choose to cut through the above-ground park and get exercise by walking into the city (Meinhold 2009).



WATER HARVESTING

The on-site potable water requirements are 663 140L per month. If current water saving technology is implemented on the existing buildings, the water requirements would be 20% less (Tshwane 2004 : 76) thus the site would need 530 512L per month. The best way to harvest rain water on site is to collect water off roofs and tank it. The water needs to be filtered for impurities which might be on the roofs and treated with chlorine to be drinkable. 40% of the water used can also be cycled as grey water which is then used for black water and irrigation purposes (Tshwane 2004 : 78). Thus 40% of the potable water is used for grey water purposes. The total usage is then **318 308L per month.**

If every roof on site is used for water harvesting and one calculates the average monthly rainfall on the **total roof area which is 26 034m²**, there will be an adequate surplus amount to provide enough water for the whole year if the water is collected in a 900KL tank (refer to table below). This implies that it **will be possible for the intervention to provide enough water for the rest of the site.** The following precedents were consulted to investigate how water purification and harvesting was integrated into architectural interventions.

Rain water collection												
Month	DES	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV
Rainfall	0.108	0.135	0.076	0.079	0.054	0.013	0.007	0.003	0.005	0.02	0.007	0.01
Water collected kL	2389.932	2987.415	1681.804	1748.191	1194.966	287.677	154.903	66.387	110.645	442.58	154.903	221.29
Water used kL	318	318	318	318	318	318	318	318	318	318	318	318
Surplus water kL	2071.932	4741.347	6105.151	7535.342	8412.308	8381.985	8218.888	7967.275	7759.92	7884.5	7721.403	7624.693
Total collected kL	2071.932	4741.347	6105.151	7535.342	8412.308	8381.985	8218.888	7967.275	7759.92	7884.5	7721.403	7624.693
Tank size	900	900	900	900	900	900	900	900	900	900	900	900
Water collected kL	2071.932	2669.415	1363.804	1430.191	876.966	-30.323	-163.097	-251.613	-207.355	124.58	-163.097	-96.71
Total collected kL	900	900	900	900	900	869.677	706.58	454.967	247.612	372.192	209.095	112.385

precedents



Alternative water harvesting in the high density urban context.



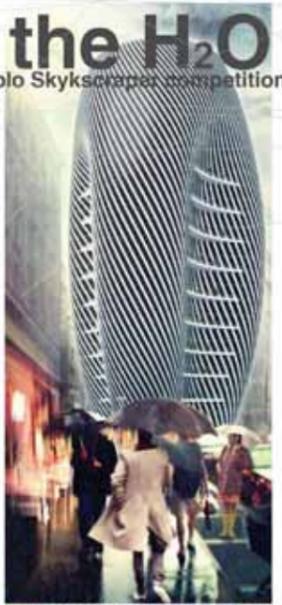
Using a reservoir as a mixed use building & economic aid.



location: New York, 2010
 architect/s: H3AR
 project:

capture the H₂O
 2010 eVolo Skyscraper competition

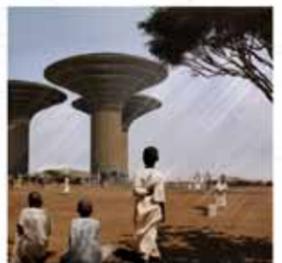
A skyscraper is comprised of a system of gutters to catch as much rainfall as possible. The water captured and processed by the building may be used for flushing toilets, feeding washing machines, watering plants, cleaning floors and other domestic applications. The water collected with the skyscraper will supply 85liters pp of rain water to meet the daily needs of the inhabitants (each user averages a daily consumption of about 150 liters). This is achieved by the development of the skin treatment to make the building transform into a cohesive rain collecting machine. The gutters on the external surfaces of the building capture rainfall flowing down the building. The rainfall is then transmitted to floors and its surplus is stored in a reservoir under the building (Cilento 2010).



location: Sudan, 2010
 architect/s: Hugon Kowalski
 project:

watertower
 skyscraper for Sudan

In 2007 an underground lake in the region of Darfur, Sudan was discovered. The lake is the 10th biggest lake in the world (31, 000 m²). A building that allows access to underground water through the application of water pumps was proposed. The form of the building was inspired by a water tower and also by the symbol of the African savanna – the baobab. The building houses water pumps, a treatment plant and also a hospital, a school and a food storage center. This building is meant to provoke economical development but also to stimulate cultural exchange and the coexistence of the three different religions and languages in Sudan. Two water circulation processes would be in place. The first set of extracted water is meant to heat or cool the building, and is accessible to the users. Second set of extracted water is used for the building itself (i.e. kitchen, toilets) (Sebastian 2010).



EFFLUENT WASTE MANAGEMENT

The site produces **663 140L of effluent waste per month**. Effluent waste is a source of **rich minerals and gasses** which can be used for heat, gas and compost production. It can be processed via

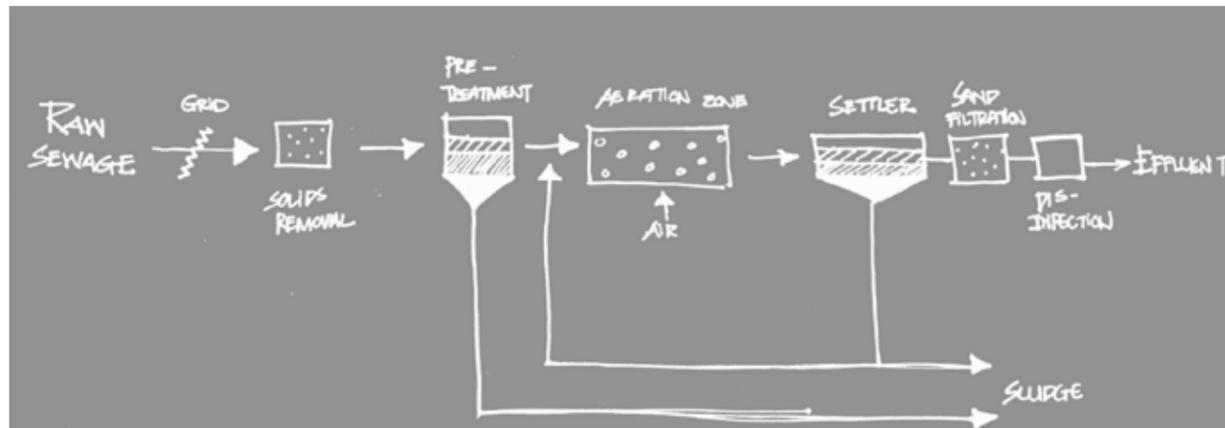
- _ sewage treatment plants
- _ wetlands
- _ septic tanks
- _ methane digesters
- _ membrane bioreactors (MBR).

Sewage treatment plants take up large tracks of land, do not smell very nice and are a health hazard and need large and expensive equipment. A wetland big enough to treat the entire site's sewage would be bigger than the entire site and would smell unpleasant. Septic tanks are only fit for small scale use and require a lot of maintenance to keep them in good functioning condition.

Methane digesters are highly flammable and thus pose a health and safety risk. A membrane bio reactor is a patented machine which can process large amounts of sewage and produce fertile sludge and grey water as by products.

The most practical and compact method to process effluent waste would be to integrate a MBR system into the building's design, which plugs into the existing sewer system.

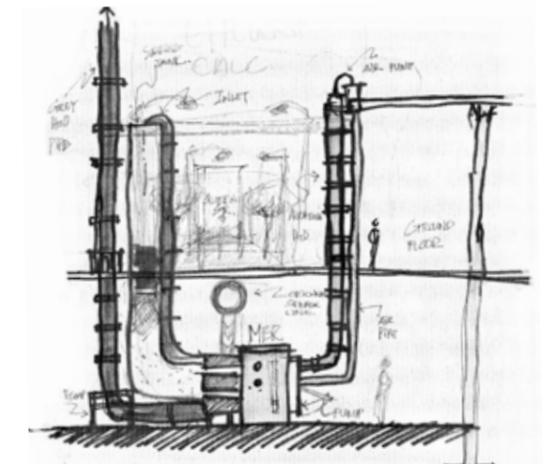
MBR manufacturers Wock Oliver Limited supply different MBR systems which can be bought as a prefabricated product or a custom site specific product. The VOK MBR (2.5 m x 2 m x 2.2 m) would typically be used to process 800 000L of effluent waste per month and would be the applicable product for on-site requirements.



[Figure 4_1.] Membrane bio-reactor process diagram. Sketch by Author, 22 March 2010.



[Figure 4_2.] Wock Oliver model VOK MBR 2.5m X 2m X 2.2m, will be suitable for on site needs.



[Figure 4_3.] MBR under Queen street with extruded process.

Advantages

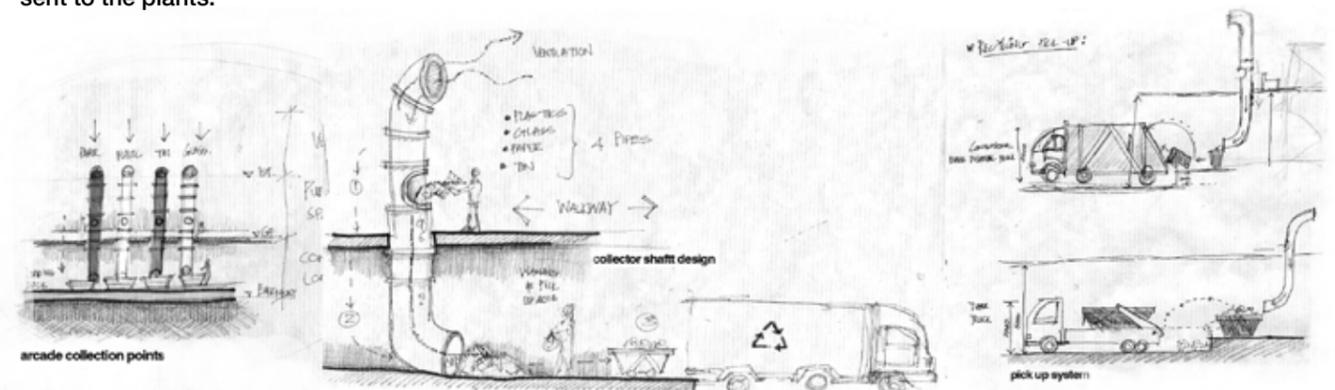
- _ **Reduced plant footprint** as secondary clarifiers and tertiary filtration are eliminated, thus the system can fit into small rooms inside buildings, or as applied in boats, making the machine handling more user friendly and easy to install and transport.
- _ Footprint can be further reduced because other process units (digesters or UV disinfection and aeration basin volume) can also be eliminated/ minimized, in this case **aeration is maximised as an aesthetic and communicative part of the process.**
- _ **Long sludge age**, hence low sludge production, thus the sludge can be tanked on-site and removed systematically.
- _ Produces a MF/UF quality effluent **suitable for reuse applications like flushing WCs and irrigation**, some of the machines used in boats can even produce clean enough water to drink.
- _ Reduced sludge de-watering cost because of an advanced filtering system.

Application

- + Municipal wastewater for high quality outlet water
- + For recycling systems
- + Wastewater from numerous industrial sources such as paper mills, beverage ingredient processors, slaughter houses, food processors, chemical plants, tank truck cleaning operations, etc

RECYCLABLE WASTE MANAGEMENT

The on-site recyclable waste production is **17 855kg per month**. Recyclable waste: paper, glass, tin and plastic needs to be collected, separated and sent to recycle plants. It is not feasible to implement recycling processing systems like melting plastics on-site, it is hazardous and not energy efficient to have many little plants than one large plant. Thus the recyclable wastes are **collected and sent to the plants.**



[Figure 4_4.] Recycle waste management system in basement.

ORGANIC WASTE
MANAGEMENT

The site produces 7 345 kg organic waste per month. Organic waste is a rich source of minerals and gas which can be used for heat and compost production. Organic waste can be processed by using:

- _ Composting
- _ Methane digesters
- _ Incinerators
- _ Earthworm composting

Composting is a slow, smelly and spacious process which one would not necessarily want to combine with public spaces. Methane digesters are highly flammable and are thus a health and safety risk. Incinerators use energy and resources to burn materials which often causes harmful fumes and gases into the atmosphere.



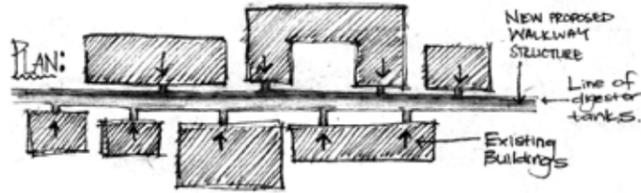
Earthworm composting needs management but is compact, smell free and produces compost much faster than regular composting. Thus the most practical and compact method to process organic waste would be to integrate earthworm digesters in the intervention which can produce compost for on-site use as well as leachate for further cultivation.

[Figure 4_5.] Vertical earthworm composting process.

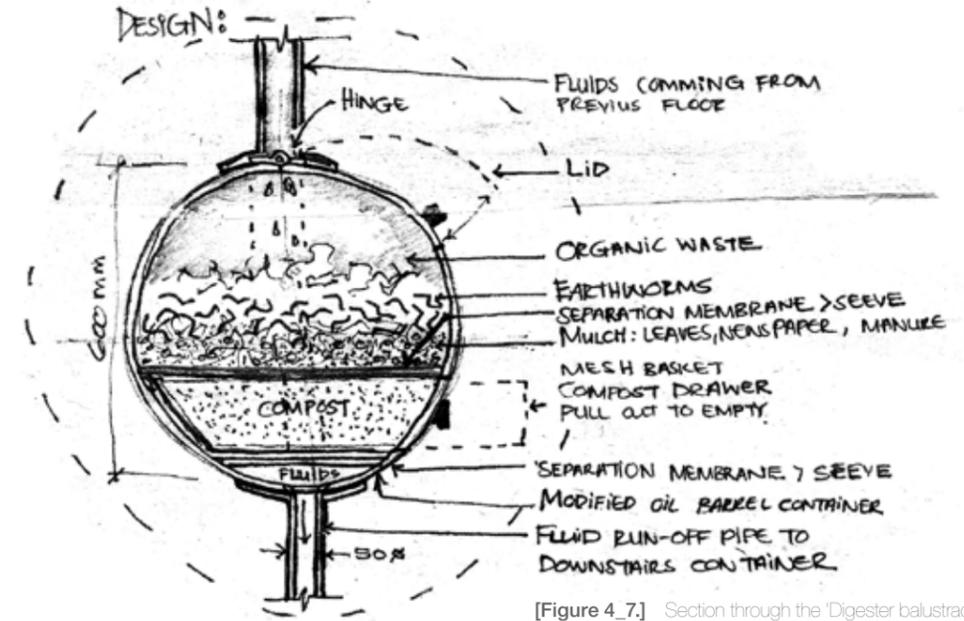
Basic earthworm composting as described by the diagram above is a process where organic matter is fed to earthworms in a secure container. The earthworms eat the organic matter and in the process produce two very valuable by-products. The liquid produced by the worms is called 'leachate', it has a high nutritional value and can be diluted 1/11 to be used as a growth supplement for plants.

The solids produced by the worms also has a high nutritional value and is used as compost to boost plant growth. In the diagram figure 4_5 a strategy is formulated to illustrate how worm composting digesters can be combined with the circulation routes between the buildings in order to reach the user more efficiently.

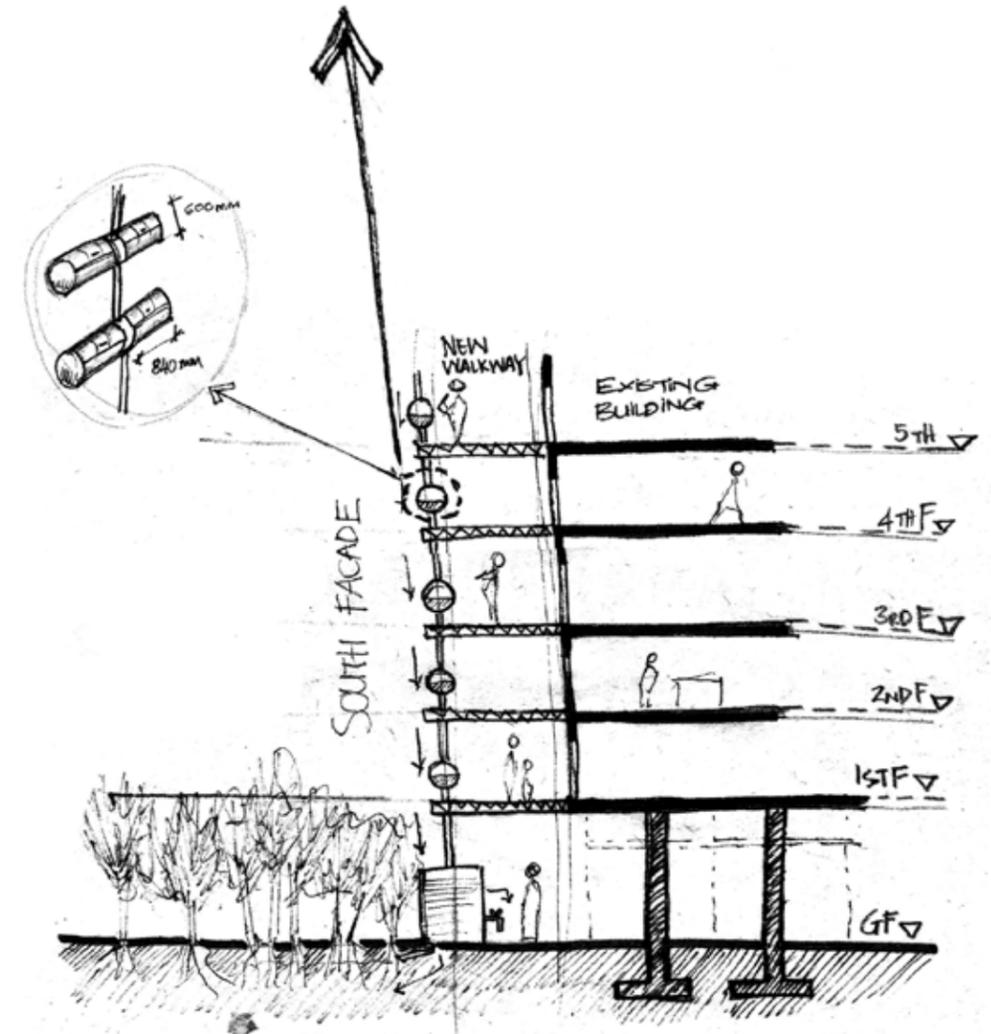
The worm digesters are designed to be integrated with walkways on circulation routes and are intended to act as part of a balustrade system and planter design as well as acting as refuse bins for the organic waste as illustrated in figure 4_6.



[Figure 4_6.] Route between buildings where digesters can be placed.



[Figure 4_7.] Section through the 'Digester balustrade bin'.



[Figure 4_8.] Digester on different levels connected to each other.

The intervention's public facilities are determined by the needs of the users (as discussed in the interviews in chapter 3) and as a response to the site analysis. The needs that were identified are:

- _ Public recreational space
- _ Organised vending
- _ Secure access to buildings
- _ More parking facilities
- _ Better organised loading facilities
- _ Cyclist facilities
- _ Public restrooms

The core mass of the building is the parkade. The lack of public transport is one of the main culprits in urban sustainability, so why should one encourage the use of cars by creating facilities for them? First ignoring a problem does not make it better or disappear, maybe the best way to create awareness and start making a difference is targeting the source of the problem.

Second, the areas with good economic development are those with good access. People would rather go to Menlyn for shopping than the CBD because there is organised, accessible and safe parking.

Third, development of alternative energy sources to replace the use of fossil fuels in cars has increased in the last 20 years. Even in South Africa the first electrical car named 'Joule', envisioned by a company called Optimal Energy, designed by Keith Helfet (designer of the iconic Jaguar XJ-220 supercar - which was for a time the world's fastest car). The first Joule cars will be in showrooms in September 2010.

Sustainable methods of travel are thus encouraged, the parkade will have electric car charging ports (one could make drivers of normal cars pay for parking and the electrical cars can park and charge for free), cyclist parking and public transport facilities to encourage the use of 'greener' transportation. The following precedent illustrates similar intentions to combine an urban regeneration project with infrastructure and public facilities.



Self sufficient skyscraper which provides infrastructure and urban facilities.

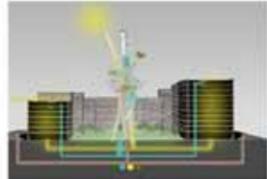
Jaume Canal Parelada

Ecological Skyscraper

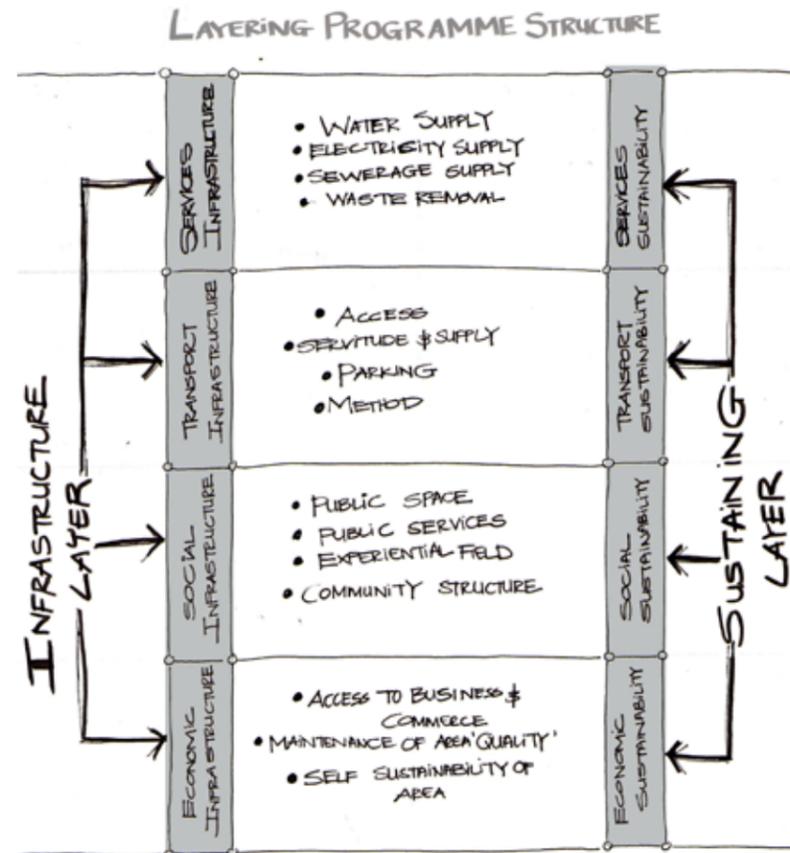
location: Spain, 2008

architect/s: Jonathan Arnabat

project: Jonathan Arnabat designed a building that provides infrastructure, urban facilities, green zone, office and living space. The real challenge of this Mediterranean self-sufficient skyscrapers lies not in their design but in integrating these within congested urban areas. What can be designed without damaging historical centres? Within a well-known base and in the heart of Barcelona, a four million people city-area, the Eixample Quarter, a series of Regenerating Hubs, a 335ft (102m) skyscraper, in essence a mechanism for living, breathing, producing energy, and recycling the huge quantity of waste we produce, for managing scarce resources such as water. Use of clean, non-polluting energies, gathering of organic and inorganic waste, storage and management; centralization of antennae for technology, television, telephony, Internet and radio; collection of resources such as water; attraction and absorption of pollution, creation of large green spaces. The building is structured along a great vertebral column, centre of communication and access areas. A large perimetral structure is created to support the building height. Housing, workspace and facilities are connected and supported by the same structure (Canals 2008).

precedent



[Figure 4_9.] Hierarchy of spaces and functions sprouting from parkade structure.



[Figure 4_10.] Grouping infrastructural and sustaining functions.

After determining the required programmatic systems the assembly of the different components in the programme structure is compiled of different layers of hierarchy which ultimately works together as a 'services' building. The greater part of the building is a parkade which facilitates the other services and enables the manifestation of the symbiotic relationship with the existing

Fig. 4_9 illustrates the different relationships and layers within the intervention programme and fig. X illustrates the functional hierarchy of the different systems. Thus both the diagrams describe how the **infrastructural components coexist to serve one central purpose while maintaining the existing structures and needs on site.**

PARKING STRUCTURES

The challenge of housing a maximum number of cars in a well-designed space is one of the most overlooked aspects of twentieth-century architecture, and yet it has attracted an array of architects throughout the history of its development. From Louis Kahn to Rem Koolhaas, from Paul Rudolph to Zaha Hadid to Kengo Kuma, architects have used the parking garage to experiment with ideas about materiality, form and structure.

The parking structure has captured the imagination of novelists, photographers and film makers, and yet it remains peripheral to our culture, best understood as a forbidding fictional setting or as an often **imposing, silent building that we encounter on the way to work or shop**. We think of these places as dynamic but secret, where the rules do not apply, mysterious, inhumane, born out of an extreme obligation to the car.

J.B. Jackson describes the evolution of the domestic garage by defining the role of the car at the beginning of the twentieth century as that of a **'pleasure vehicle and a toy, costly, exciting and of extraordinary elegance'** (in Henley 2007: 8). Initially the expeditionary nature of motoring was a pastime and an end in itself. This and the low numbers of automobiles limited the impact of the static (parked) vehicle in the city. **But when the vehicle became a tool rather than a toy, the need to park in mass arose.**

Only a few parking structures existed before the 1920's: Auguste Perret's garage in the rue de Ponthieu (1905) in Paris, Marshall & Fox's Chicago Automobile Club (1907), and Marvin & Davis's garage for Palmer & Singer in New York (1908). This generation of buildings had appropriated the warehouse idiom, and indeed Jackson noted that the word 'garage' is derived from the French word for 'storage space', i.e. 'warehouse' (in Henley 2007 : 8).

In the 1990's the carpark made a return as a practical solution to the congested city, particularly in Europe. A new more technically perfect and **mischievous architecture of planes, ramps, spirals, folds and continuous landscapes surfaced**. The sincerity of the 1950's and the 1960's had been replaced by playfulness, or a search for the sublime. A few relevant precedents are consulted for inspiration and guidance.



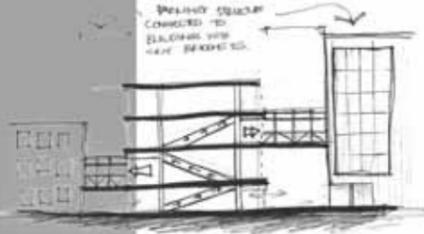
multi-level parking

location: Linz, Austria, 2007 combining scattered parking spaces

architect/s: x Architekten

project:

Due to the location in the city of Linz and restrictions on the premise boundaries, the Voestalpine steel company needs to pursue alternative growth strategies. An important method of achieving this is through the strategic concentration of facilities and processes on the premises. For this reason the idea developed to concentrate the existing scattered parking spaces, which use up a lot of space, to a centrally located car park. Strategically positioning the car park has proved to be a prototypical solution when considering transformational processes of industrial premises. Each level consists of an access and exit ramp as well as three lifts, one of which leads directly to the bus station. The surrounding office buildings can be directly connected to the upper levels of the car park via foot bridges. The daily route of drivers from car to workplace becomes shorter and more convenient and an optimal vertical distribution of the car park's usage is therefore encouraged (Saieh 2009).



Central service parking lot connected to surrounding buildings.

1111 Lincoln Road

location: Miami, USA 2010 mixed use parkade

architect/s: Herzog & de Meuron

project:

Called 1111 Lincoln Road, the building incorporates 300 parking spaces. Eleven shops and three restaurants are located at ground level, with further shopping on the fifth floor and another restaurant on the roof. 1111 Lincoln Road represents the collaboration of renowned architects, landscape architects, artists and designers to create a unique shopping, dining, residential and parking experience for Miami's residents and visitors. Constructed of concrete and glass, 1111 Lincoln Road is described by architect Jacques Herzog as pure Miami Beach – "all muscle without cloth". Each level of the sculptural parking facility is filled with natural light, creating successively striking vistas of the city. At its base, the retail spaces offer unobstructed access to a new, transformed public space (Wennett 2010).



Pedestrian promenade combined with commercial strip and parking.

For each required space and system a number of regulations and volumetric requirements are provided as part of the practical organisation and assembly of form and function. Thus every required space is calculated to ensure it complies to National Building Standards and will be sufficient for the intended function.

Spaces which need to be calculated are:

- _ Parkade size
- _ Water tank size
- _ Photovoltaic surface area
- _ Loading zones
- _ Cyclist parkade
- _ Commercial zone
- _ Change rooms
- _ Waste management areas
- _ Management facilities

PARKADE SIZE

The Tshwane Town Planning Scheme 2008, Clause 28 (1) Table F (TTPS 2008 : 60), states that 1 parking bay is required for every:

- _ 93m² of Flats
- _ 37m² of Residential Buildings
- _ 100m² of Offices
- _ 100m² of a Bank
- _ 100m² of an Industry
- _ per classroom of a Place of instruction
- _ per 5 seats of a Place of Worship
- _ per 2 seats of a Place of Refreshment
- _ 6 bays per 100m² of Commercial space.

There is a total of 830 bays available on site and a shortage of 900 bays needed according to Tshwane Town Planning Scheme. But pedestrianisation, increase in the cycle culture, public transport and surrounding public parkades need to be taken into account in order to make this a realistic number.

Traffic Engineer at the Faculty of Road Engineering and Public Transport, University of Pretoria, Professor Christo Venter was consulted on how to go about adjusting the amount of required parking spaces with regards to the respective influences mentioned above (Venter 2010). After he was advised, the following conclusive calculations were made.

900 bays are reduced by :
Sammy Marks parking = 1179 bays >> 1200
 Divide between 7 user blocks = 1200 ÷ 7
 = 171 bays available.

State Theatre parking = 1000 Bays
 Divide between 7 user blocks = 1000 ÷ 7
 = 142 bays available
 = 900 – (171 + 142)
Total = 587 bays

Public Transport = already calculated into town planning scheme.

Encouraged Cycle culture = 16% residential bikers & pedestrians.
 = 37.
 = 15% office bikers & pedestrians.
 = 67.
 = 12% retail users bikers & pedestrians.
 = 42.
 = 587 – (37 + 67 + 42)
Total = 441 bays

Mixed use cycle = Fatima Centre & Libri Bldg. both residential.
 = 114 extra day bays
 = 441 – 114
Total = 327 bays

Grand Total >>>> 360 bays
1 bay = 12.5m²
= 360 X 12.5m²
=4500m²

Total amount of workers:
 Entrance & boom = 2ppl
 Security = 4ppl
 Cleaning = 2ppl
 Pay points = 2ppl
 1 Charge worker per floor = ±4ppl
Total = 14ppl



WATER TANK SIZE

As previously mentioned, average of **900KL potable water can be harvested and stored for on-site use**. The water is harvested from the existing roof areas only and not from the ground level surfaces because of various pollutants on the ground surface that would complicate the water treatment process.

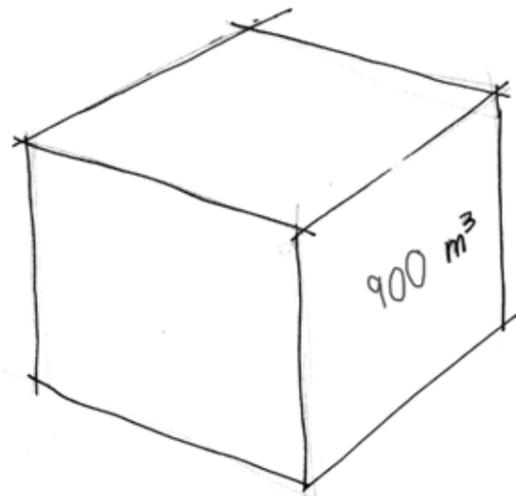
$$\begin{aligned} 1\text{m}^3 &= 1000\text{L} = 1\text{KL} \\ &= 900\,000 \div 1000 \\ &= \underline{900\text{m}^3} \end{aligned}$$

NB. A concrete tank must be **circular** in plan (cylindrical) in order to resist the horizontal force created under the pressure of the water.

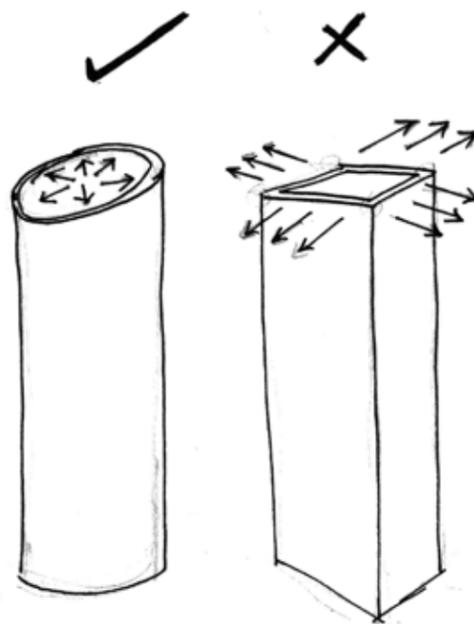
A steel tank may also be considered but will have to be divided in to smaller compartments because one big steel tank will also give way under the force of the water.

Total amount of workers:

Cleaning	= 1ppl
Collector	= 1ppl
Manager	= 1ppl
Total	= 3ppl



[Figure 4_12.] Volume of water mass.



[Figure 4_13.] Tank must be cylindrical.

PHOTOVOLTAIC SURFACE AREA

Photovoltaic technology is not yet advanced enough to generate enough energy for the entire site. Thus the energy generated by photovoltaic panels will only be used to run the entire **building's lighting and the charging of electrical cars.**

According to Reinart Moraal, Electrical Engineer at solar cell dealers and design company Solar Metrics Africa, by the year 2020 approximately 15% of all cars on the road will be electrical cars. Thus if the parkade has space for 360 cars, 54 cars will be electrical cars (Moraal 2010).

One car battery takes 8 hours to charge and will use 36kWh (R 26.00 as per current Eskom rates) but if the car charges during a business hour average of 5 hours only two thirds of the energy will be used thus 24kWh (Moraal 2010).

$$\begin{aligned} &= 24 \times 54 \\ &= 1\,296 \text{ kWh} \\ \text{One } 1\text{m}^2 \text{ panel generates} &= 0.925 \text{ kWh per day} \\ &= 1\,296 \div 0.925 \\ &= 1\,401 \text{ panels} \\ &= \underline{1\,401\text{m}^2} \end{aligned}$$

In order to run the entire building's lighting, the optimal lighting rates needs to be applied. The SABS 204-1 states that for a covered parking area 100 Lux is required per every 1m² (SABS 2008 : 28). If, for example, standard Osram LUMILUX® T8 (L 58 W/840) fluorescent lamps are used for the parkade area, the 5200 lumen/m² lamps will use 58 Watt per hour. Thus to service the entire surface area of the building:

$$\begin{aligned} \text{lux} &= \text{Lumen/m}^2 \\ &= (12.5 \times 1\,000) / 300 \\ &= 375\,000 / 5200 \\ &= 72 \times 58 \text{ Watts} \\ &= \underline{4.176\text{kW/h}} \end{aligned}$$

If natural lighting is efficient enough during the day, the lights will be switched on for an average of 10 hours. If 2/3 of the building is completely empty during the night the lights will be switched off and thus only 1/3 will be on for 10 hours.

$$\begin{aligned} &= (1/3) \times 4.2 + (2/3) \times 4.2 \\ &= 5.88 + 11.76 \\ &= 17.64 \text{ kW/h is required.} \\ &= 17.64 \div 0.925 \\ &= 20 \text{ pannels @ } 1\text{m}^2 \\ &= \underline{20\text{m}^2} \end{aligned}$$

Thus the total photovoltaic surface needed for lighting and charging of the car batteries are:

$$\begin{aligned} &= 20 + 1\,401 \\ &= \underline{1\,421\text{m}^2} \end{aligned}$$

A battery bank is needed to store the energy for use.

$$\begin{aligned} 1 \text{ battery bank} &= 1 \text{ battery} = 1.1\text{m}^2 \\ &= 54 \text{ batteries needed} \\ &= 54 \times 1.1 \\ &= \underline{60\text{m}^2} \end{aligned}$$

Total amount of workers:

Cleaning	= 1ppl
Maintenance	= 1ppl
Manager	= 1ppl
Total	= 3ppl

LOADING ZONES

Because of the traffic jams and congestion on site, alternative loading zone areas are proposed. These zones are incorporated with the super basement where the **goods can be safely off-loaded and directly transported into the appropriate storage spaces.**

New rentable storage space as well as loading zones are proposed to serve the main goods handling buildings as well as a general loading area for smaller goods services.

Requirements:

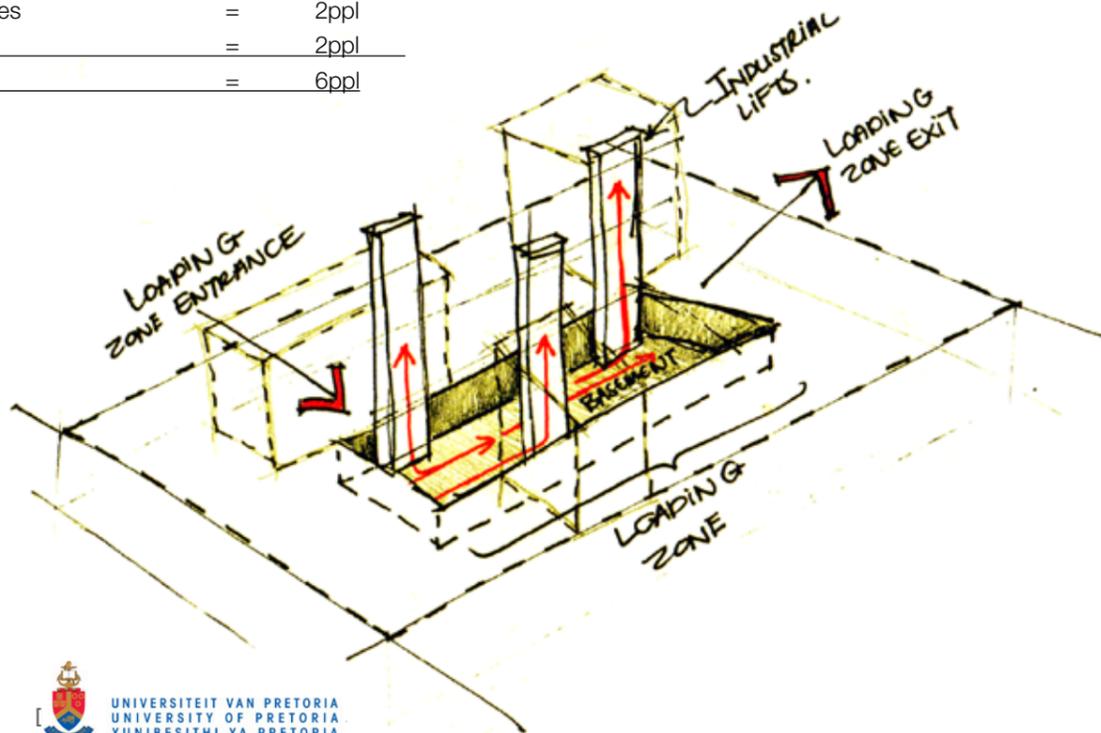
Loading dock width	=	3500mm
Road width for one way truck circulation	=	3500mm
Provisional space for truck length with back to dock	=	min. 14 000mm
Min. floor to ceiling height	=	4500mm

Areas:

Four rentable storage rooms	=	4(100)
	=	400m ²
New Shoprite Storage	=	250m ²
Five new loading docks	=	5(32)
	=	160m ²
Total loading zone area	=	400 + 250 + 160
	=	810m²

Total amount of workers:

Entry & exit security	=	2ppl
Manage offices	=	2ppl
Loading staff	=	2ppl
Total	=	6ppl



CYCLIST PARKADE

Cyclist parking is provided as part of public facilities and to encourage a cycling culture. The facilities go hand in hand with public change rooms. If a bicycle is stored vertically it will need 0.5m² storage space.

300 Stands are needed to serve each building on site according to Green star rating regulations (Green Star 2008 : 173).

1 bay	=	0.5m ²
300 X 0.5	=	150m ² parking space
Lanes (2 way lane)	=	3000mm
Bicycle service area:	=	25m ²
Total area required	=	150m ² + 25m ²
	=	175m²

Total amount of workers:

Entrance	=	1ppl
Security	=	2ppl
Cleaning	=	1ppl
Workshop	=	1ppl
Total	=	5ppl



COMMERCIAL ZONE

Commercial activity on the ground floor is pulled onto the periphery of the central core, framing the square and activating the arcade. Commercial businesses which are incorporated into the design are planned to **further serve different aspects of the site's on site social needs.** These businesses include:

_ Bakery	=	250m ²	=	5 staff
_ Take away (2)	=	150m ² (each)	=	10 staff
_ Tavern	=	140m ²	=	4 staff
_ Bookshop	=	100m ²	=	3 staff
_ Hair Salon	=	250m ²	=	5 staff
_ Joule Show room	=	900m ²	=	8 staff

Total commercial area	=	1790m²
Total amount of workers	=	35ppl

CHANGE ROOMS

Change rooms for cyclists, commuters and workers in the surrounding buildings are needed where people can store belongings and for **refreshment between commuting**. According to Green star rating regulations (Green Star 2008 : 173) the following requirements should be met:

28 total shower, basin, WC facilities needed
 1 restroom footprint = 4.8m²
 = 28 X 4.8
 = 134.4m² gross
 rest room area

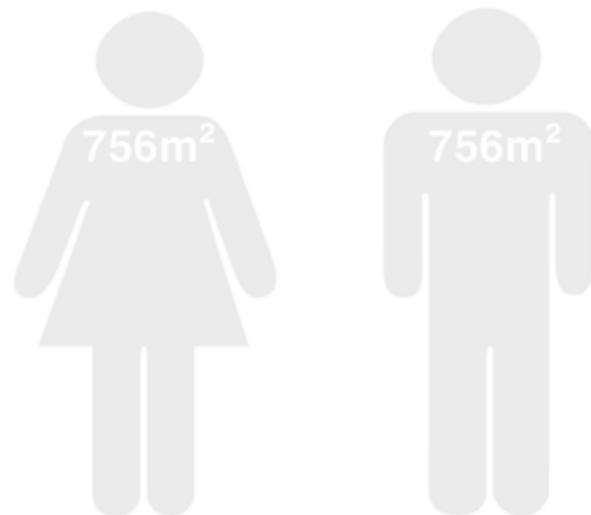
168 total lockers needed
 1 locker = 0.8m² (including dressing space)
 = 168 X 0.8
 = 134m²

Total change room facilities = 134 + 134 = 268m²
 = 268 ÷ 2
 = 134m²

Ladies = 134m²
Gents = 134m²

Total amount of workers:

Cleaning = 2ppl X 2
 Total = 4ppl



WASTE MANAGEMENT

Recycle area:

The recycle sorting and pick up area is connected to the loading zone in the basement, large pipes on ground floor which go all the way down to the basement act as 'bins' into which public can come and throw their recyclables.

Total area needed for all 24 buildings:
 = 326m² (as specified by Green star rating handbook)

Sorting space = Bin + area
 = 3 X 4m
 = 12m²

Loading space = Single dock
 = 3.5 X 3m
 = 10m² (X3)

Cleaning space = 6m²

Pick up bins = 1.2 x 1.3m
 = 1.56m² (X3)

Total space required = 12 + 10(3) + 6 + 1.56(3)
 = 12 + 30 + 6 + 4.68
 = 52.68m²
 >> **53m²**

Total amount of workers:

Cleaning = 1ppl
 Collector = 1ppl
 Manager = 1ppl
 Total = 3ppl

Membrane bio-reactor:

Sewage = 663 140L per month
 Product = VOK MBR by Wock-Oliver
 Capacity = 29 062 L per day
 Area needed = 2.2 X 2 X 2.5
 = **11m³**

Excess sludge = ±30 kL per day
 Filtered water = ±30 kL per day

Total amount of workers:

Sludge removal = 1ppl
 Maintenance = 1ppl
 Manager = 1ppl
 Total = 3ppl



Composting:

Organic waste & sludge = 7 345 kg p/m
 Volume needed = 1kg waste
 = 2kg worms
 = 1m² X 0,5m tray
 = **0.5m³**

2 digesters per building = 25 X 2
 = 50 X 0.5
 = **25m² (area)**

Total amount of workers:

Compost removal = 1ppl
 Maintenance = 1ppl
 Manager = 1ppl
 Total = 3ppl

MANAGEMENT FACILITIES

Management offices are needed for the overall building management serving the individual systems and building maintenance. Offices are needed for the:

Facilities manager	=	25m ²
Loading zone	=	25m ²
Parkade management	=	25m ²
Commercial & marketing management offices	=	25m ²
Total offices needed	=	100m²

SUMMARY: TOTAL AREA AND ACCOMMODATION

Building total area:

Parkade	=	4500m ²
Cyclist facilities	=	175m ²
Change rooms	=	1512m ²
Loading zone	=	810m ²
Recycle area	=	53m ²
Solar collection	=	60m ² (battery bank only)
MBR	=	11m ²
Commercial	=	1790m ²
Management	=	100m ²
Water tanks	=	150m ² (excluding existing rooftops, only footprint area)
TOTAL	=	18 322m²

Total accommodation:

Parkade	=	14ppl
Cyclist facilities	=	5ppl
Change rooms	=	4ppl
Loading zone	=	6ppl
Recycle area	=	3ppl
Solar collection	=	3ppl
MBR	=	3ppl
Commercial	=	35ppl
Water tanks	=	3ppl
Composting	=	3ppl
TOTAL	=	79ppl



consumption design supply contribution

An investigation was done of the site's current usage and demand, as well as interviews with the users to determine what their needs are in the immediate area. After determining what the on-site waste produce, sanitary run-off, water usage and electricity consumption is, the alternative systems which could replace these infrastructural systems were explored.

Decided systems which aid and ultimately form the 'Infrastructure' space are as follows;

- A rain water harvesting, chemical treatment and tanking system which provides water for the entire site.
- A Membrane Bio-reactor system which treats the entire site's sewage and produces gray water and sludge.
- A solid waste recycling and pick up system.
- An organic waste earth worm digester system combined with a vegetation system.
- A Photovoltaic solar screen system to provide energy for a portion of the intervention's electrical requirements.

The interviews held with the users revealed that on site problems included bad access systems to the buildings, lack of recreational public space and public change rooms, a congested servitude system and not enough parking. The project programme thus becomes a combination of these public and infrastructural needs. The inter-

SITE CONSUMPTION & REQUIREMENTS	INTERVENTION SUPPLY	% DELIVERED OF REQUIRED AMOUNT	DESIGN & SPATIAL CONTRIBUTION
WATER 320 kL p/m	TANKED ± 480 kL p/m	110%	> 3 X 300 kL TANKS > STRUCTURE BRACING > COOLING SPACES > FOUNTAINS > COLLECTION POINTS
ELECTRICITY 2 844 100 kWh p/m	1420m² PV PANELS 39 432 kWh p/m	5%	> ROOF STRUCTURE > NORTHERN SHADING > BALUSTRADE > SCREENING
SOLID WASTE 17 800 kg p/m	RECYCLING 17 800 kg p/m	100%	> RECYCLE TUBES > EDUCATIONAL / INFORM > FRAME ARCADE > CIRCULATION THRESHOLD
ORGANIC WASTE 7 300 kg p/m	50 DIGESTERS 7300 kg p/m	100%	> EARTH WORM DIGESTER > SEATING > PLANTERS > COMPOSTING > SCREENING
SEWAGE 663 kL p/m	MBR 800 kL p/m	120%	> MBR EXTRUDED SYSTEM > PRODUCE GREY WATER > PRODUCE SLUDGE > EDUCATE / INFORM > QS PORTAL
PARKING 360 BAYS	BASEMENT = 100 DESIGN = 180	75%	> SKY STREETS > VERTICAL CONNECTIONS > ALTERNATIVE ACCESS > FRAME RAMP

services building
services building
services building
services building

The available volume in the block core where some existing open spaces are optimised, buildings are demolished or buildings are incorporated with the project is **12 000m³**. Thus the surface areas stated in the previous section need to be **organised vertically** to fit into the available space. In order to start visualising areas as volumes some typical heights need to be estimated. For the trucks to move with ease through the basement, the floor to ceiling height would be about 5000mm. The ground floor to ceiling height which is mostly commercial space is about 4000mm which is the approximate height of the existing building's ground floors. The rest of the typical floors would be at a floor to ceiling height of about 3000mm.

One parking bay takes up an area of 12.5m² (excluding structure). **160 of the total 360 parking bays area integrated into the super basement.** Thus the building mass only houses 200 bays, which is 2 500m². The parking space will be from the 4th floor upwards with a typical floor to ceiling height of 3m, thus the total parking volume would be 7 500m³. The cyclist facilities would either be in one collective controlled space or be spread out along circulation routes on typical floors throughout the building. An area of 175m² would then give a volume of 525m³.

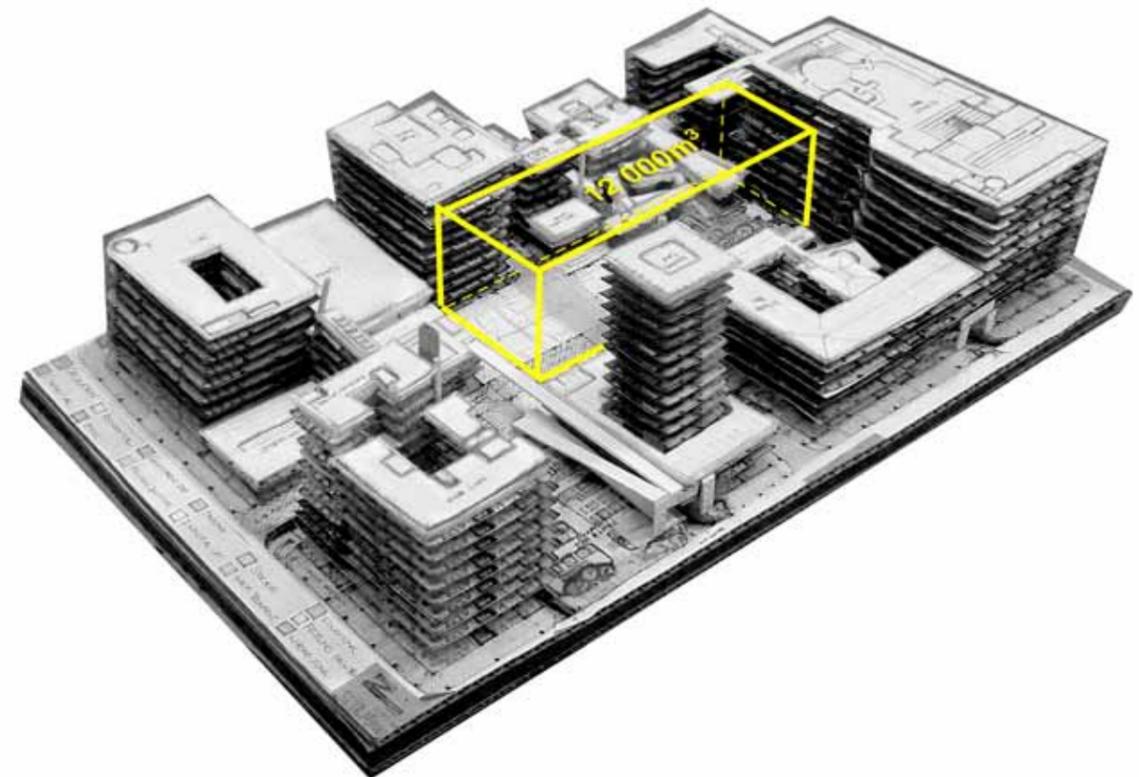
The change rooms would either be split into two separate floors or one big rest room floor and would have a volume of (1 512m² X 3m) 4 536m³. The loading zone is situated in the basement and would thus have a volume of (810m² X 5m) 4050m³. The recycle area is situated in the basement and has a volume of 265m³. The battery room for the photovoltaic solar energy collection has a volume of 180m³. The MBR will be situated in the basement and will have a volume of 55m³. The commercial area on the ground floor will have a volume of 7 160m³.

The water tank is divided into 3 separate tanks which are connected to the surrounding roof tops and buildings.

Each tank has a diameter of 8m and a footprint area of 50m² and is 34m high with an overall collective volume of 5 310m³. The management office will be scattered all over the site and will have an overall volume of 300m³. The composting area and services distribution will be integrated with the circulation.

Thus the overall intervention mass will be a total of 28 881m³. But the building mass will be a total of 18 171m³.

[Figure 4_15.] Open space volume in block core.



[Figure 4_16.] Total project volume in block core.

