design development

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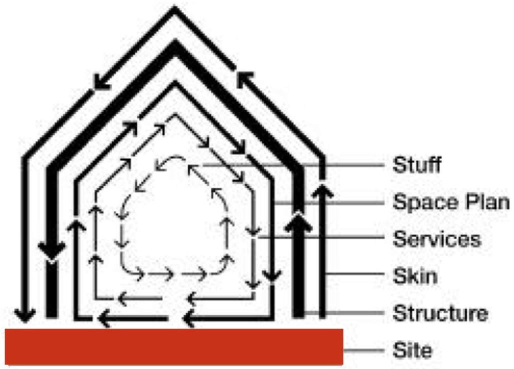
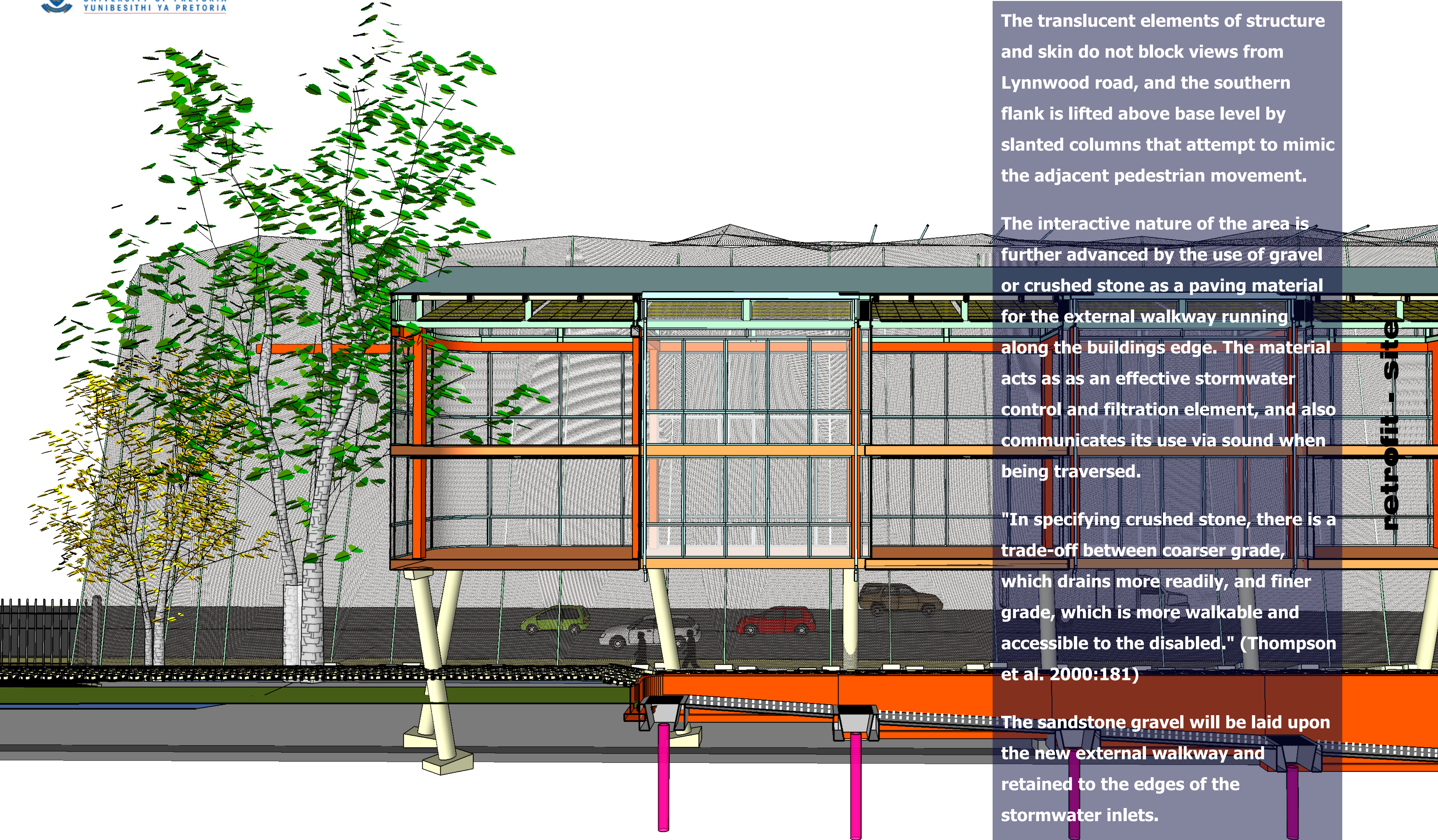


retrofit : site

The once insular orientation has now been exposed to the west, south & east - offering a greater degree of connectivity to the campus surrounds.

Figure 63 : Aerial View over BOUKUNDE (Google Earth)



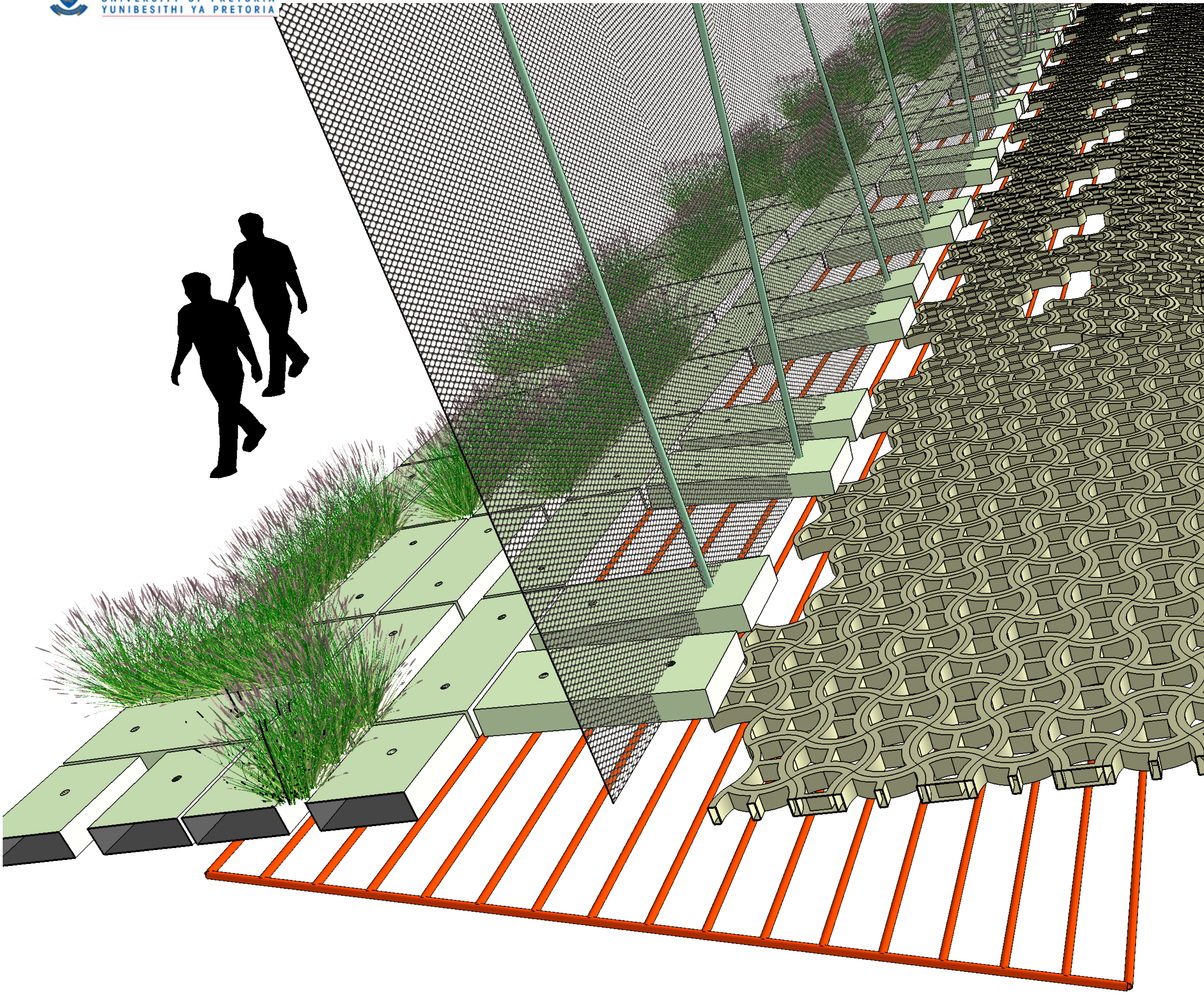
The translucent elements of structure and skin do not block views from Lynnwood road, and the southern flank is lifted above base level by slanted columns that attempt to mimic the adjacent pedestrian movement.

The interactive nature of the area is further advanced by the use of gravel or crushed stone as a paving material for the external walkway running along the buildings edge. The material acts as as an effective stormwater control and filtration element, and also communicates its use via sound when being traversed.

"In specifying crushed stone, there is a trade-off between coarser grade, which drains more readily, and finer grade, which is more walkable and accessible to the disabled." (Thompson et al. 2000:181)

The sandstone gravel will be laid upon the new external walkway and retained to the edges of the stormwater inlets.

Figure 64 : Section view through structure towards Lynnwood Road



"Transporting soil is costly, both in money and in energy. Balancing cut and fill so that no soil needs to be trucked in or carted off the site, is standard practice for large engineering projects. This concept can contribute to sustainibility and should be considered in the design and construction of all sites." (Thompson et al. 2000:78)

The excavated material from internal alteration works will be re-used to profile the southern boundary verge.

"From a sustainibility perspective, the fact that interlocking pavers can be pulled up and replaced repeatedly (or reused elsewhere) means that almost no material waste is involved." (Thompson et al. 2000:39)

The new embankment is held in place by a new concrete retaining wall running parallel to the building facade, and stabilised by a combination of 'recovered' concrete blocks and new concrete erosion control pavers.

Figure 65 : Section view over new landscaping elements - facing west

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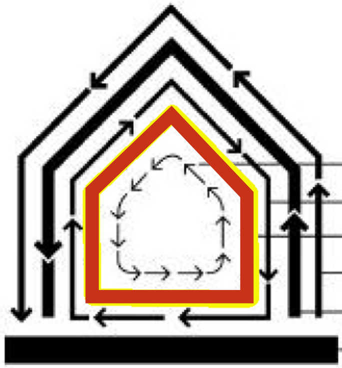


retrofit : services

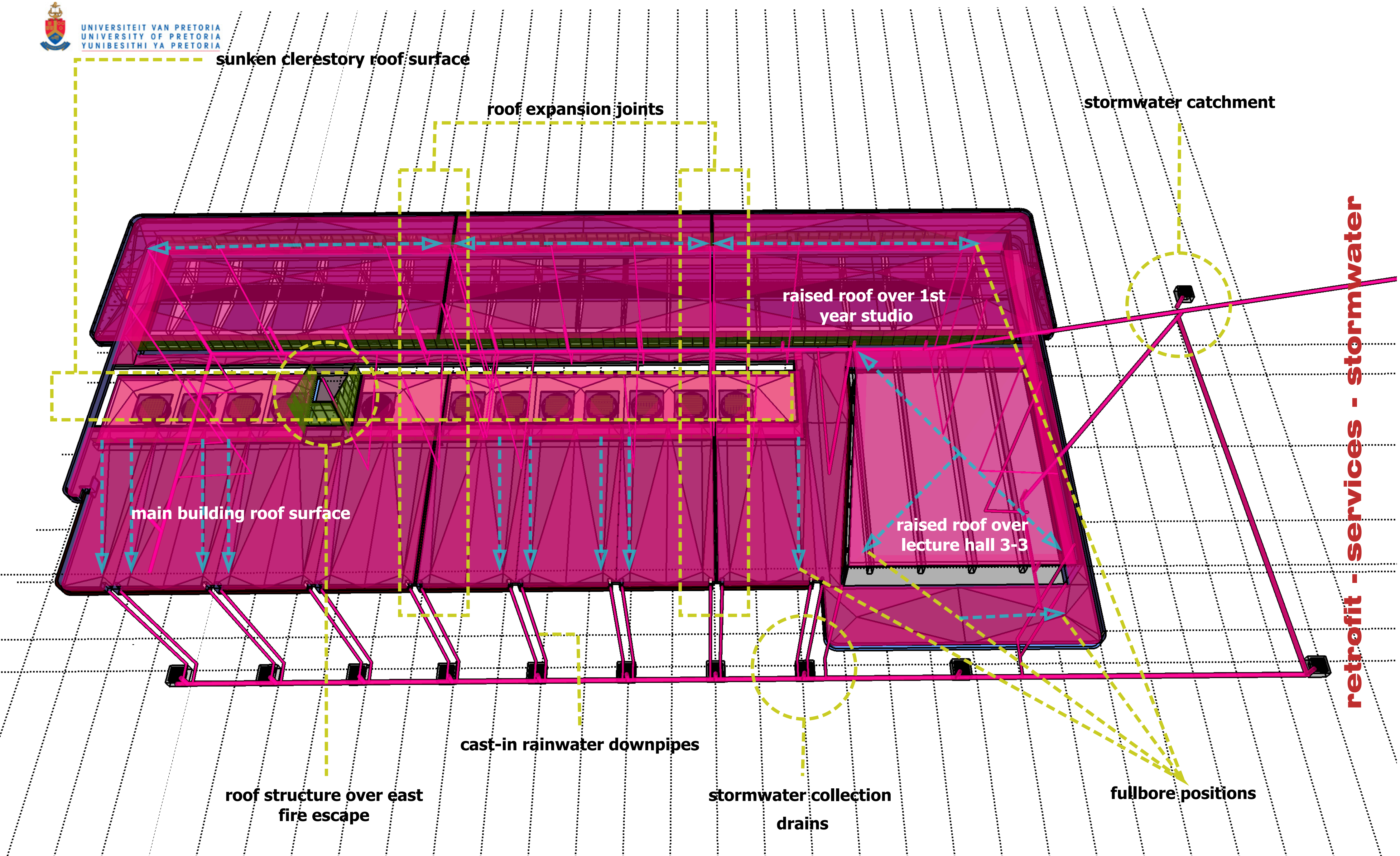


Figure 66 : Boukunde II - Perspective view from north - stormwater

Currently, rain water is collected on the concrete roofs and dispatched via fullbore outlets through the stucture to stormwater drains located on the buildings perimeter, and then brought to a catchment point at the site's south-west corner from where it is delivered into the municipal sewer. The downpipes are cast into the main structural components of the building (perimeter columns and internal concrete structural walls) and as such, cannot be modified or diverted throughout their vertical travel. The rainwater catchment proposal that follows, attempts to circumvent most of the existing stormwater infrastructure.

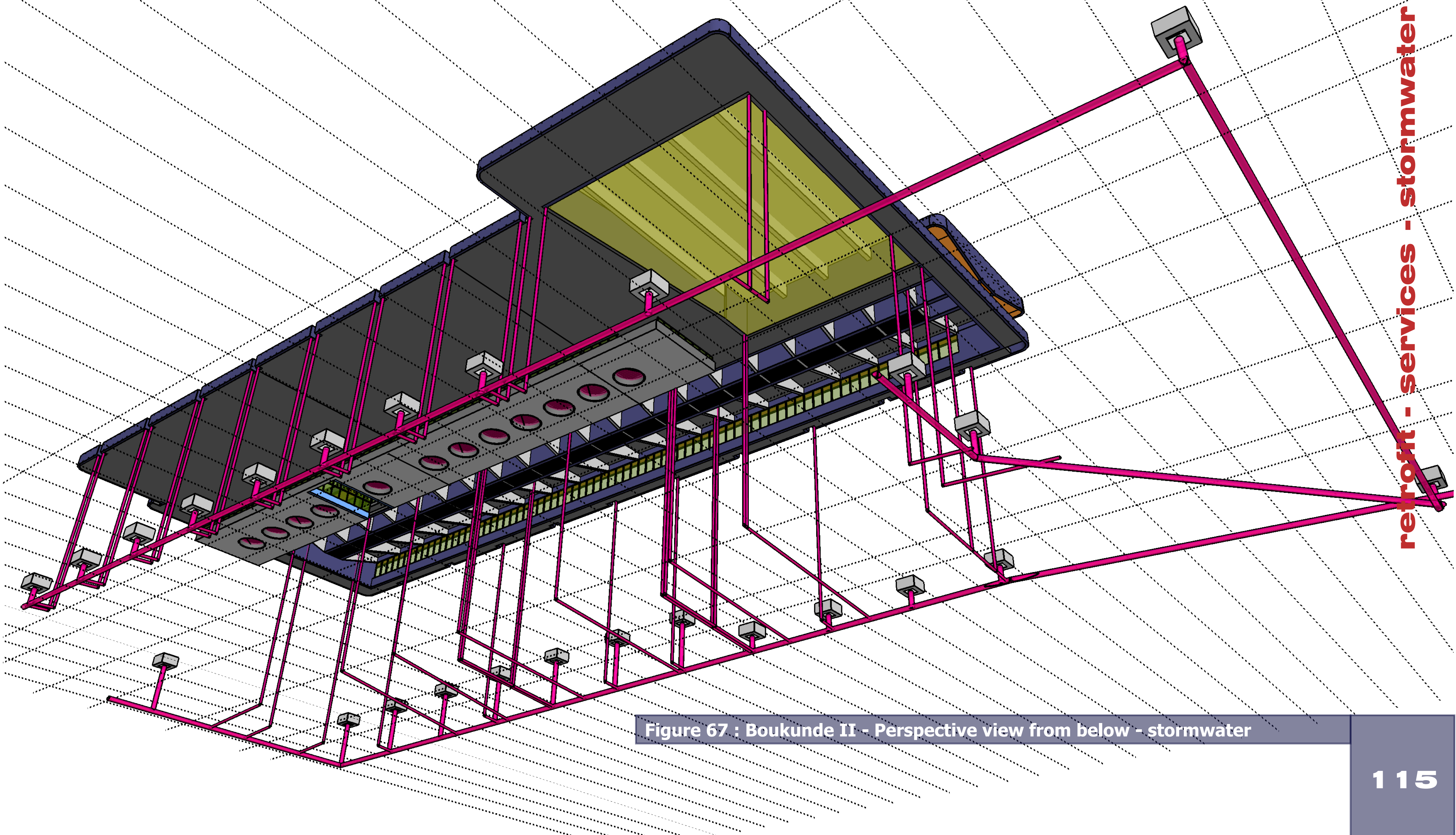
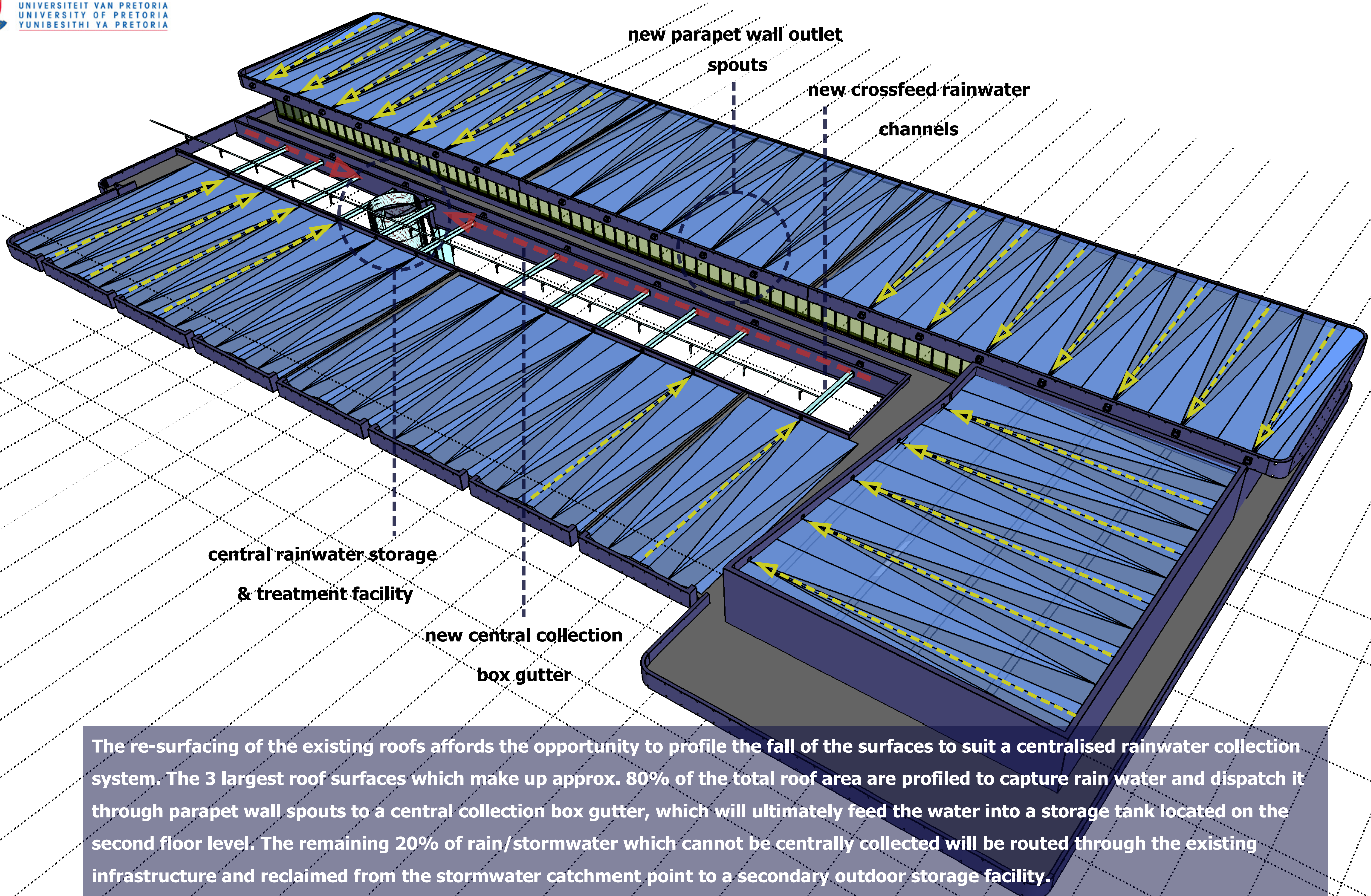


Figure 67 : Boukunde II - Perspective view from below - stormwater



The re-surfacing of the existing roofs affords the opportunity to profile the fall of the surfaces to suit a centralised rainwater collection system. The 3 largest roof surfaces which make up approx. 80% of the total roof area are profiled to capture rain water and dispatch it through parapet wall spouts to a central collection box gutter, which will ultimately feed the water into a storage tank located on the second floor level. The remaining 20% of rain/stormwater which cannot be centrally collected will be routed through the existing infrastructure and reclaimed from the stormwater catchment point to a secondary outdoor storage facility.

Figure 68 : Boukunde II - Perspective view from north west - stormwater

The existing sunken clerestory roof structure is removed to free up the central volume . The largest components of the rainwater treatment & storage system are the header tank where the filtered water is stored for distribution, and the filtration tanks which will remove debris and large waste particles first, and then chemically treat the water for removal of toxins. The system is fed directly from the collection infrastructure, with a first flush bypass channel to avoid overburdening the filtration system with the first wave of rainwater that essentially serves to clean the roofs and flush the feed- & collection channels.

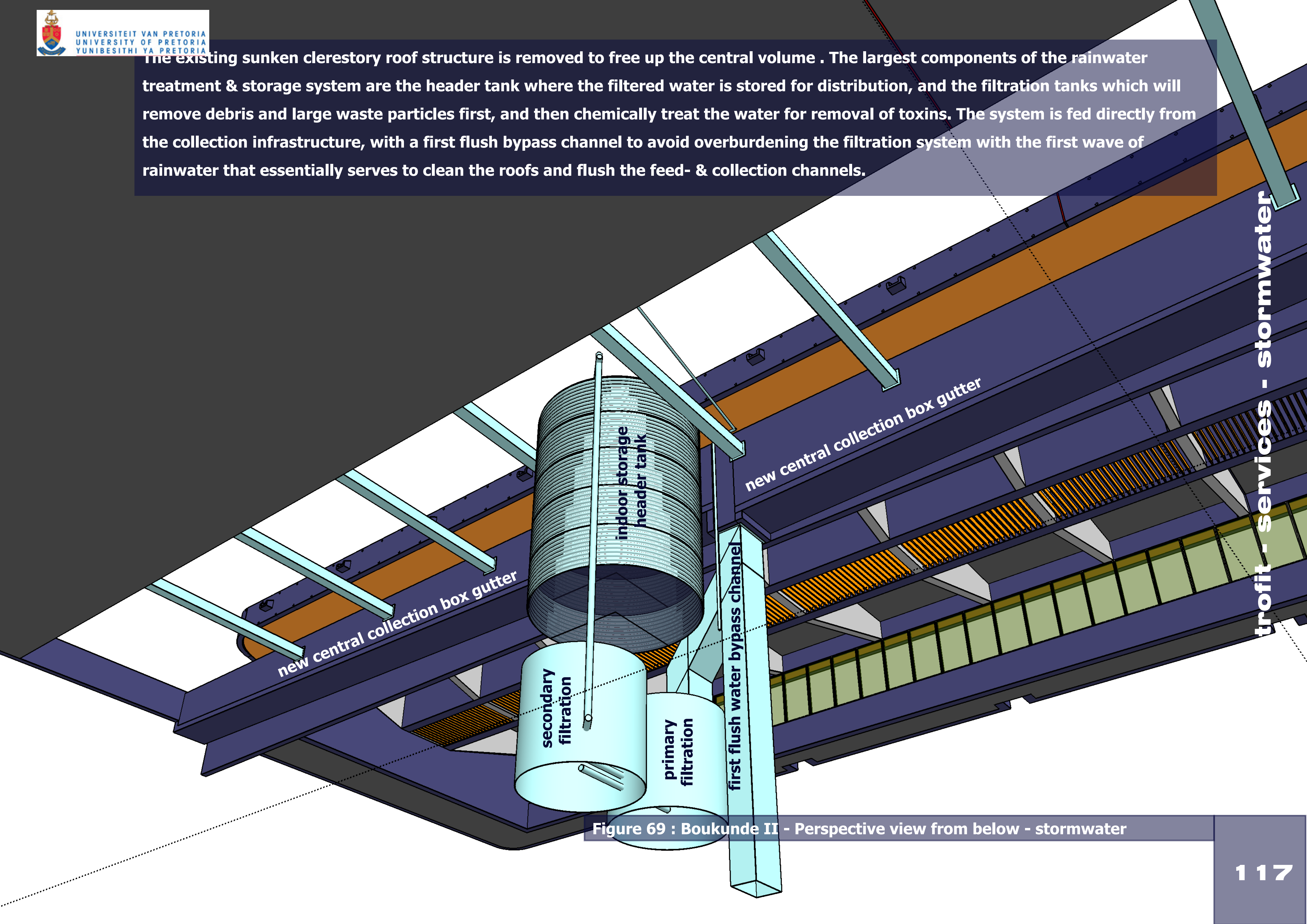


Figure 69 : Boukunde II - Perspective view from below - stormwater

"Evaporation and precipitation 'distill' rainwater, so it is free of many of the pollutants found in surface water. It holds few minerals, making it 'soft' water, and escapes the chlorine and fluorine of municipal systems. Unless it is contaminated by materials on the collecting surface, its purity makes it desirable drinking water and also ideal for many species of plants." (Thompson et al. 2000:155)

Although the ultimate intended purpose of the rainwater harvesting is to supplement / replace tapped water feed - further investigation is required as to the extent of filtration systems to render the water 'fit for human consumption'. For the moment though, the rainwater that is collected will be used primarily to flush the existing ablution drainage and to cycle through the new evaporative cooling system. The drainage function will be gravity fed from the header tank and the cooling system will be pressurised via an independent pump and pipework.

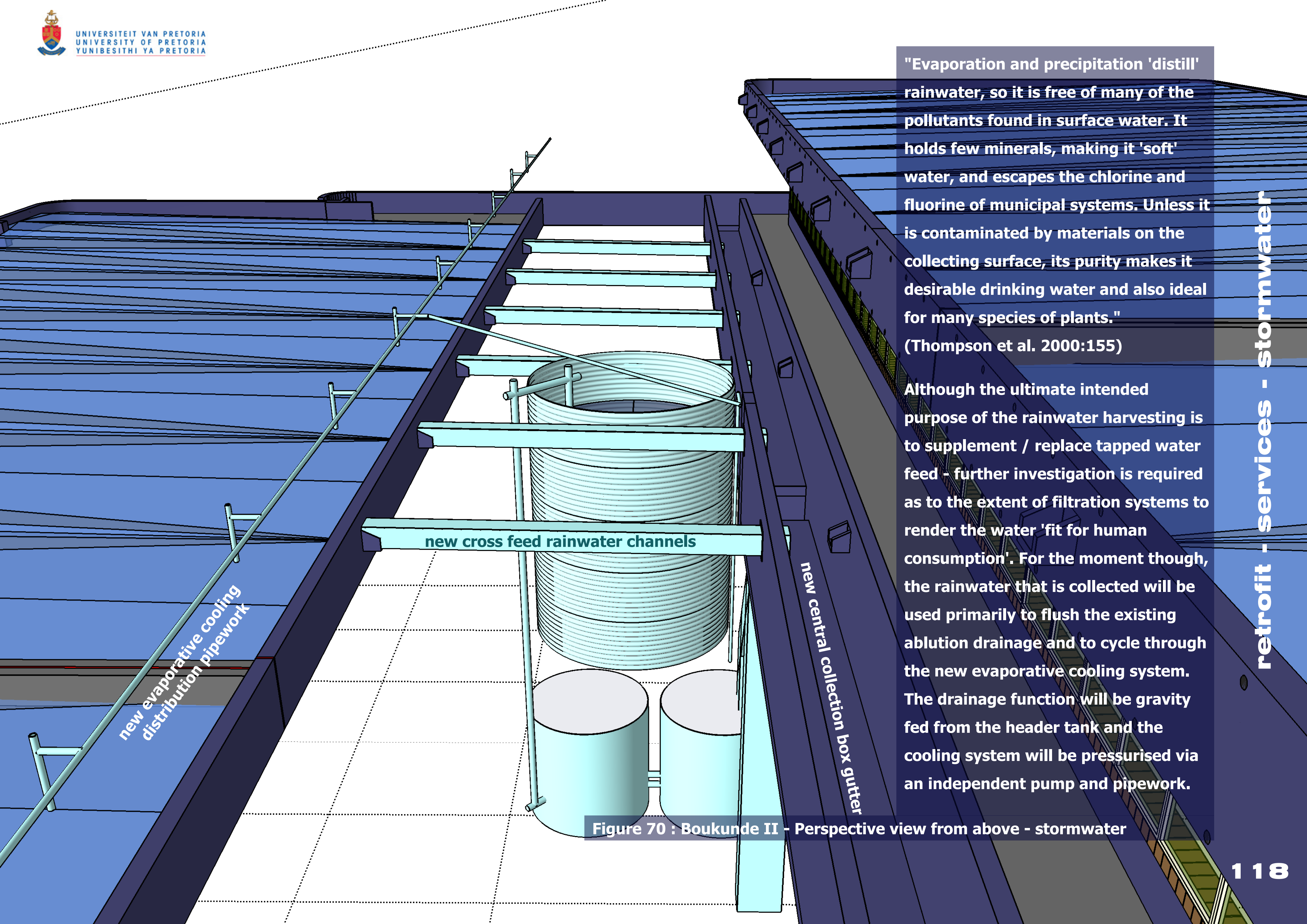
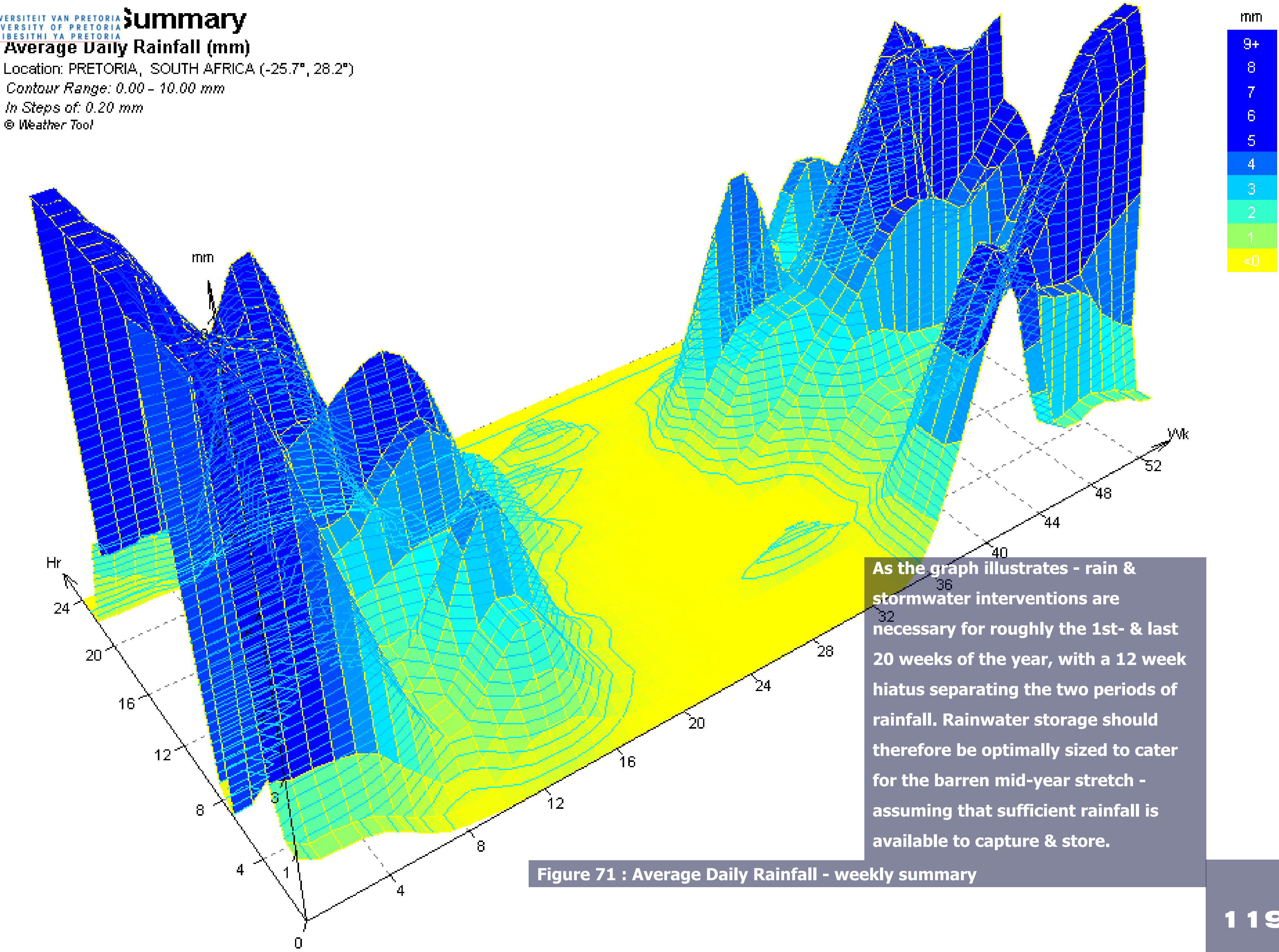


Figure 70 : Boukunde II - Perspective view from above - stormwater



As the graph illustrates - rain & stormwater interventions are necessary for roughly the 1st- & last 20 weeks of the year, with a 12 week hiatus separating the two periods of rainfall. Rainwater storage should therefore be optimally sized to cater for the barren mid-year stretch - assuming that sufficient rainfall is available to capture & store.

Figure 71 : Average Daily Rainfall - weekly summary

average annual rainfall : 674mm

existing roof surface area : 1968.35m^2

new roof surface area : 1256.40m^2

total roof surface area : 3224.75m^2

rainfall to indoor storage:

2374.35m^2 x 674mm = 1600.31m^3

= 1600.31 kilolitres / year

storage tank capacity : approx. 30kL

rainfall to outdoor storage:

850.4m^2 x 674mm = 573.17m^3

= 573.17 kilolitres / year

stormwater to outdoor storage:

734.2m^2 x 674mm = 494.85m^3

= 494.85 kilolitres / year

average consumption = 1.125 kL/m^2/year

highest 24 hour rainfall = 160mm

***the highest rainfall incidence needs to be factored in for system overflow requirements**

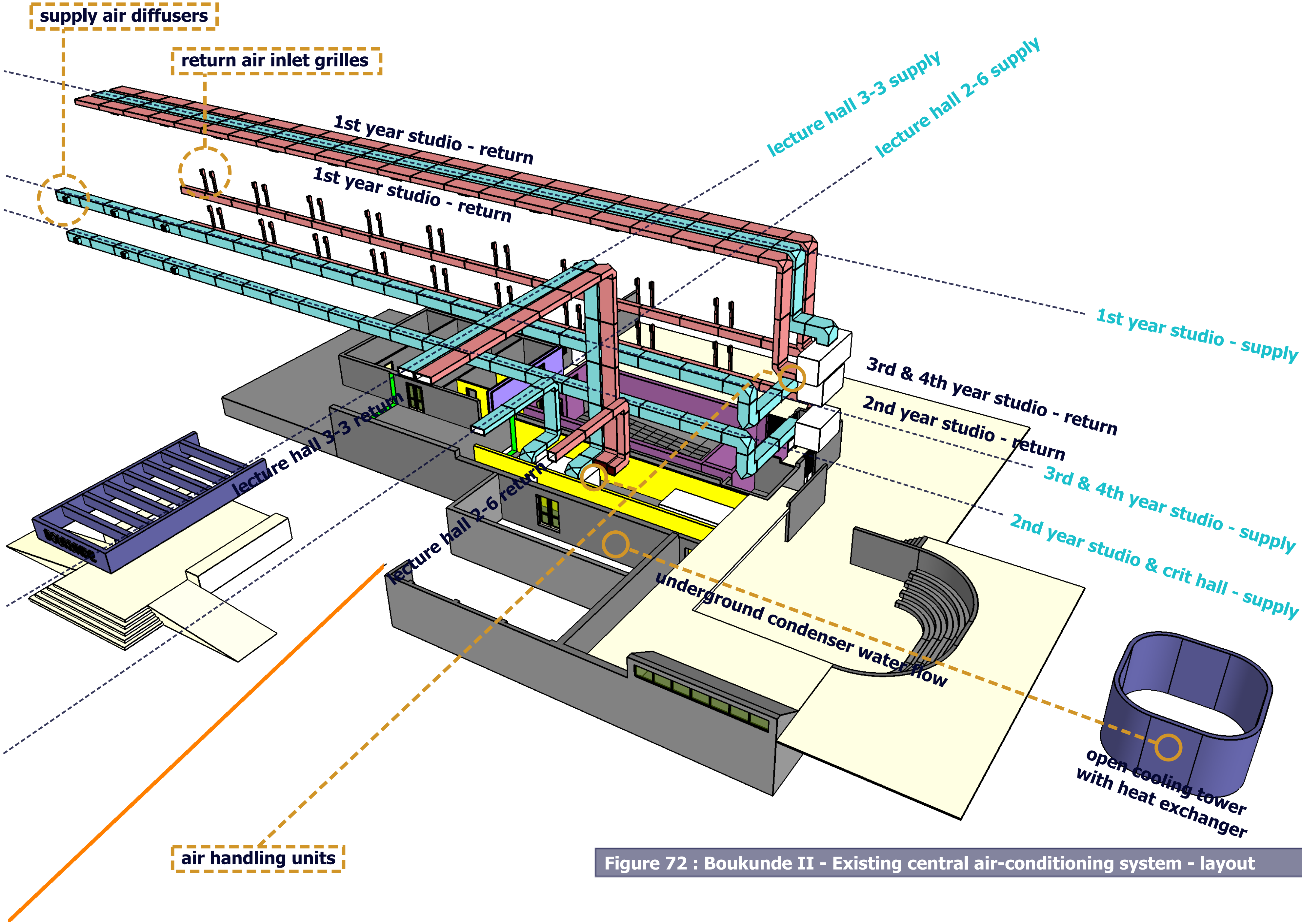
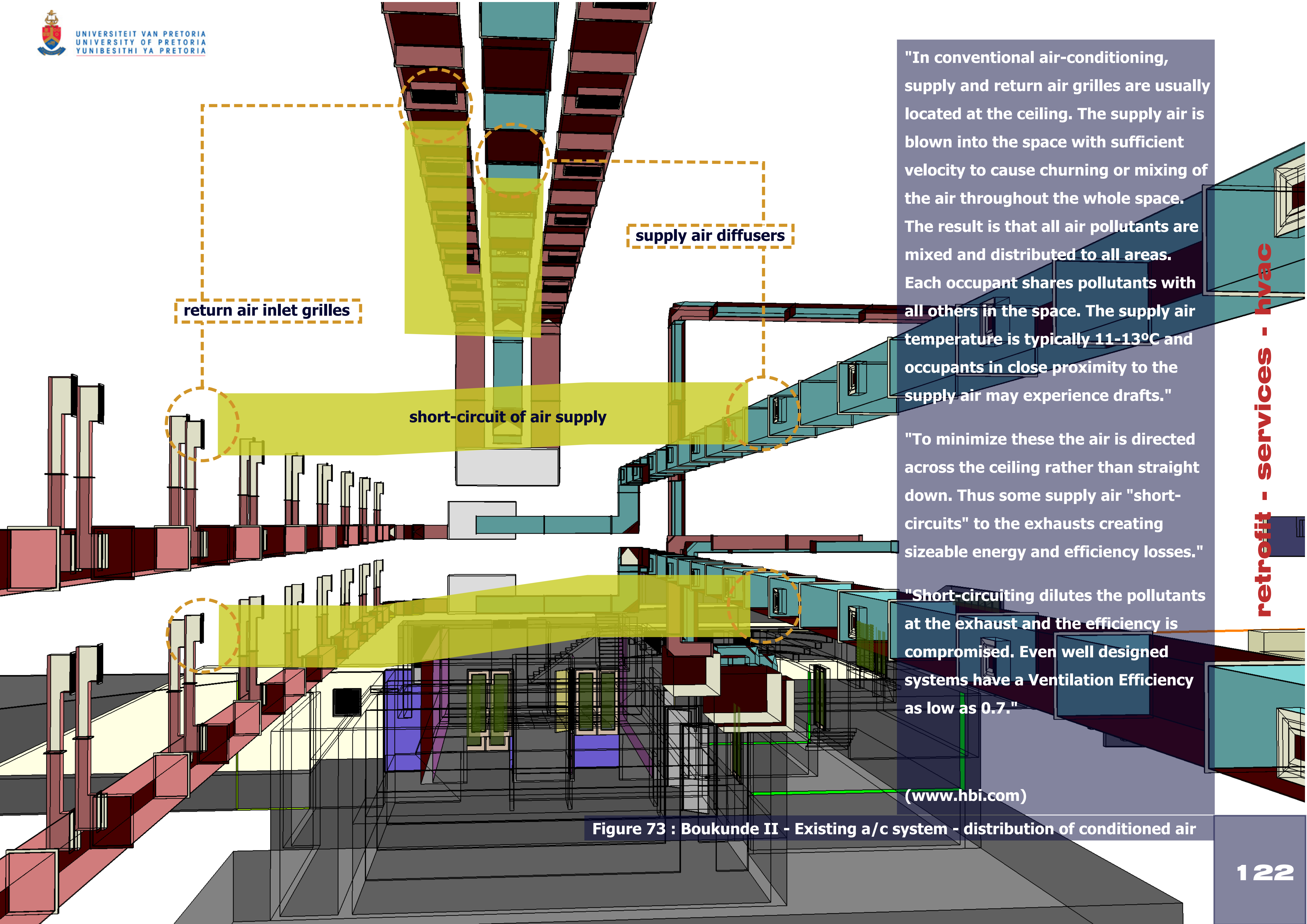


Figure 72 : Boukunde II - Existing central air-conditioning system - layout



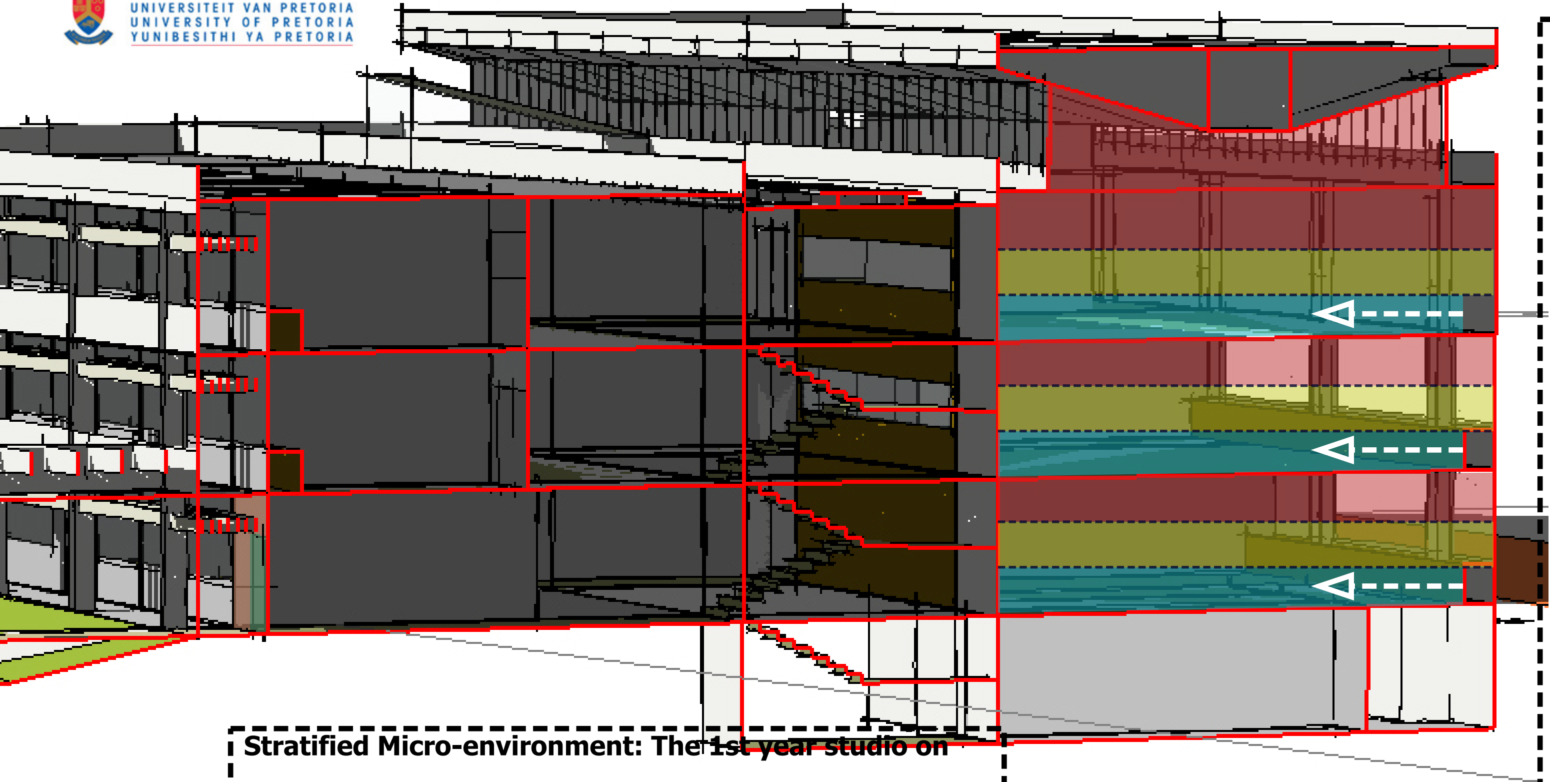
"In conventional air-conditioning, supply and return air grilles are usually located at the ceiling. The supply air is blown into the space with sufficient velocity to cause churning or mixing of the air throughout the whole space. The result is that all air pollutants are mixed and distributed to all areas. Each occupant shares pollutants with all others in the space. The supply air temperature is typically 11-13ºC and occupants in close proximity to the supply air may experience drafts."

"To minimize these the air is directed across the ceiling rather than straight down. Thus some supply air "short-circuits" to the exhausts creating sizeable energy and efficiency losses."

"Short-circuiting dilutes the pollutants at the exhaust and the efficiency is compromised. Even well designed systems have a Ventilation Efficiency as low as 0.7."

(www.hbi.com)

Figure 73 : Boukunde II - Existing a/c system - distribution of conditioned air



"With displacement air-conditioning, cool air is supplied at a low level and at a low velocity into the space. Gravity holds the cooler air down and it spreads across the floor in a "pool".

"At heat sources (people, computers, equipment, etc) the heat warms the surrounding air which rises in a plume and "draws" the cool air at floor level to the heat source. Because the heat sources in a space are usually the contaminant sources, the vertical air flow conveys those contaminants above the sources directly to the exhausts."

"The objective is to separate the room into a stratified micro-environment, with a warm polluted region above the occupants and a cooler, cleaner region around the occupants."

(www.hbi.com)

Stratified Micro-environment: The 1st year studio on the uppermost level places an enormous burden on the existing air-conditioning unit due to the mixed-air principle, which requires that the full volumetric extent of the studio's air be 'turned-over' via overhead intake- & return ducting. The displacement principle would result in this large volume being theoretically considered the same as the 2 studios below by virtue of the fact that the warm, 'used' air above approx. 2m height is left to rise of it's own accord. Also, any internal heat loads located above 2m height don't impact upon the system's design load, unless they are significant sources of radiant heat transfer to objects below 2m.

Figure 74 : Displacement a/c & stratified micro-environment

The intake ducting located in the roof structure of the 1st year studio on the uppermost level will be rendered obsolete with intake ducting to be placed at floor level to match the air-conditioning profile of the 2 lower levels. The proposal for a conversion of the central a/c system to a hybrid - begins with a reversal of the of the air intake lines for the 2nd & 3rd year studios. The position of the existing return ducting remains as is, but is now used for air intake to facilitate a floor level infeed which is more suited to the displacement air-conditioning principle. The existing 'periscope' return air grilles will be removed and existing diffuser sections will be fitted to the ducting run at floor level.

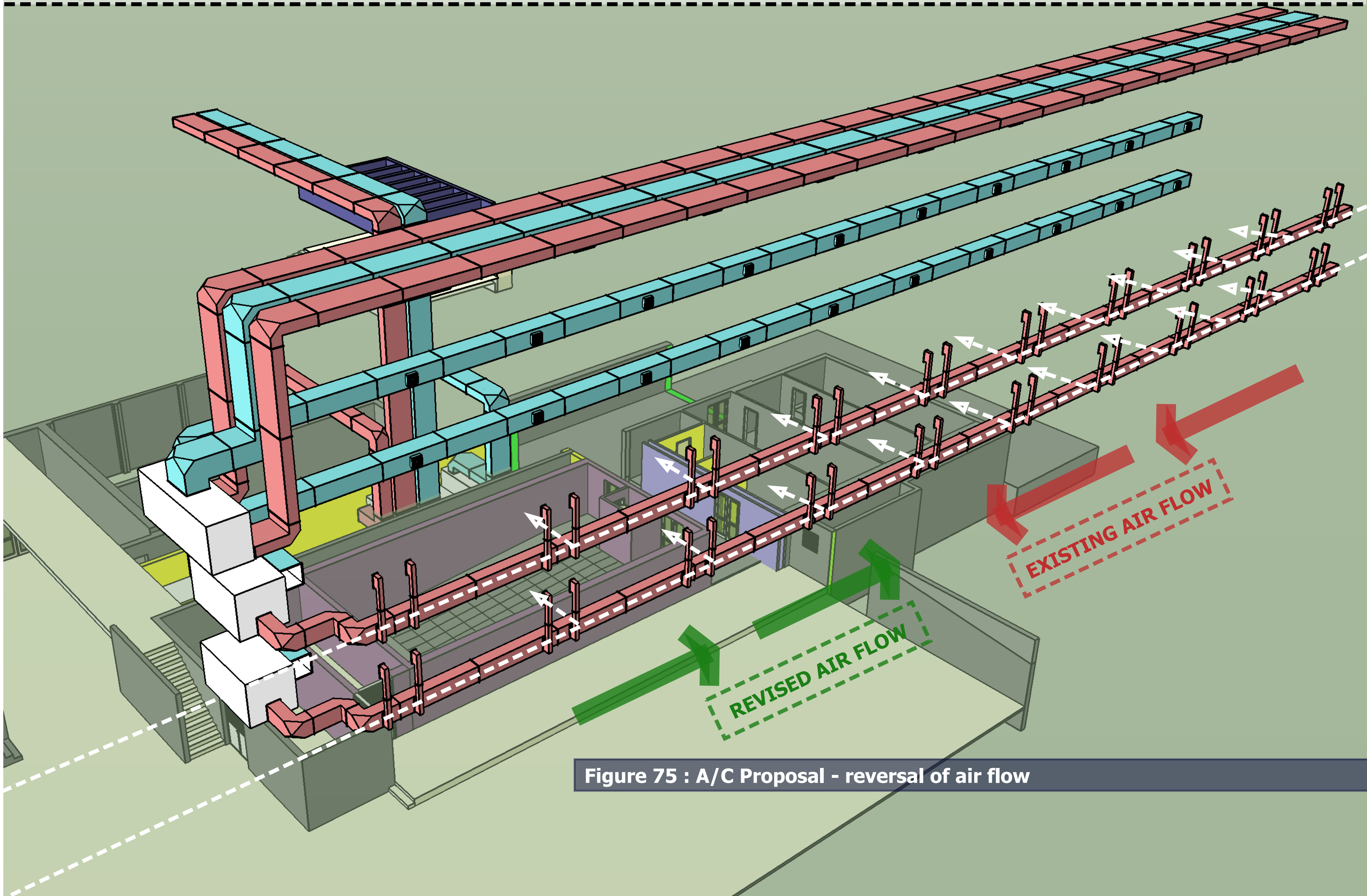
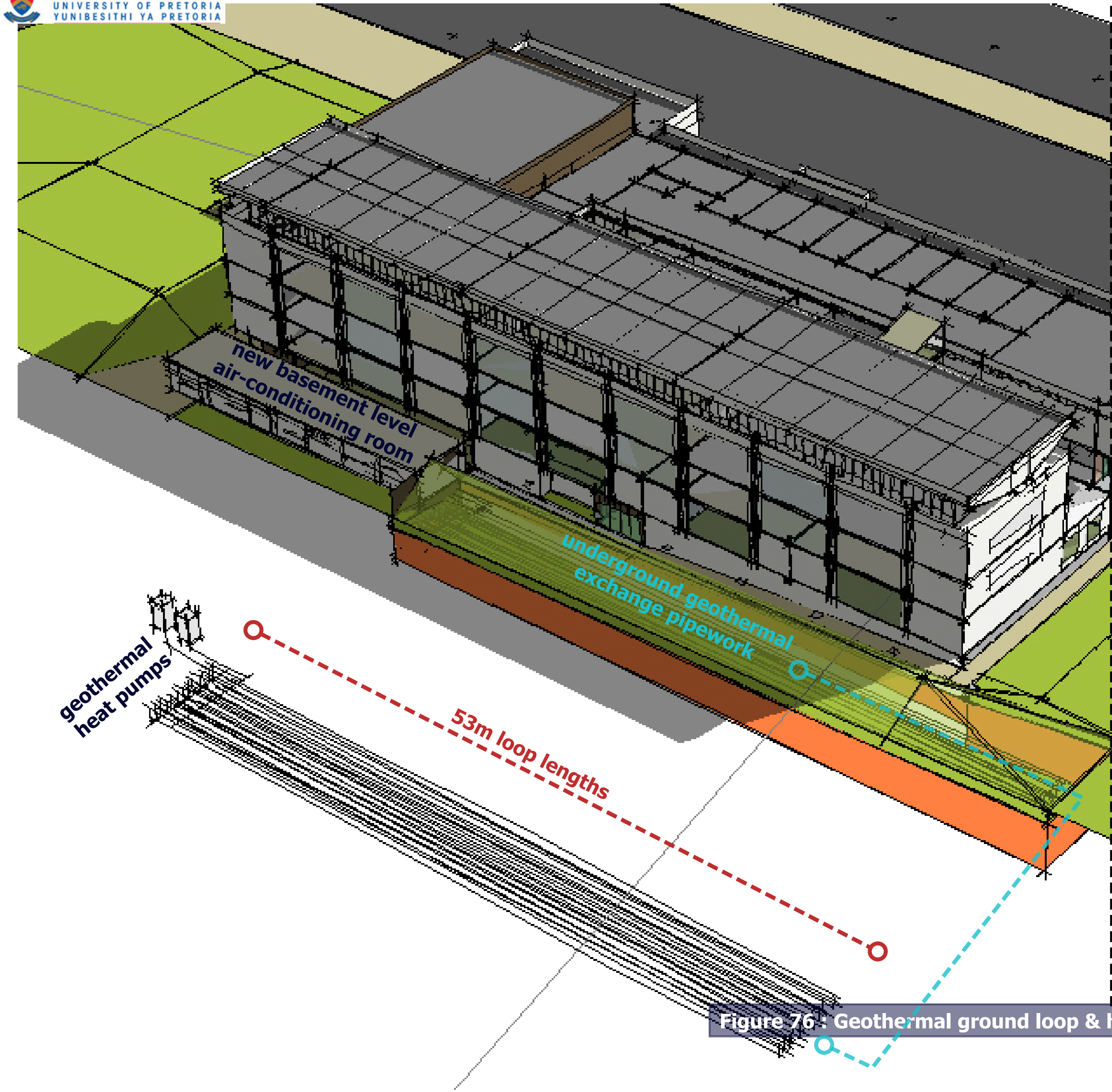


Figure 75 : A/C Proposal - reversal of air flow



The second element of the hybrid air-conditioning system is a closed loop horizontal geothermal unit.

The system design is based upon the following parameters:

- ground temperature = 16ºC (at 2m+)
- total loop length = 1380m
- total loop capacity = 23tons (heating / cooling) @ approx. 1 ton/60 running metres loop length
- loop arrangement in 13 pipe runs @ 0.5m centres

The loop pipework will feed through the existing retaining wall into the new air-conditioning room where the geothermal heat pumps will be located.

"A ground loop is a heat exchanger that either extracts or adds heat to the ground."

source : geothermal heat pump - design manual - application guide AG31-008 - McQuay Airconditioning

Figure 76 : Geothermal ground loop & heat pump layout

The HDPE pipework of the geothermal system will be buried in trenches running parallel to the building's southern facade. Extra depth is created by the 'cut & fill' of soil to be excavated from the basement level to accommodate a personnel elevator - which renders approx. 580m3 of soil and extends the basement footprint to the edge of the existing triple volume internal gallery. The footprint is further extended under the 3rd year studio between gridlines 15 & 17.

The horizontal loop pipework must be located at a min. 2m depth below the natural ground level to be effectively beyond the influence of ambient temperature fluctuations. The excavated soil used as pipework cover negates the requirement to transport this material away from site.

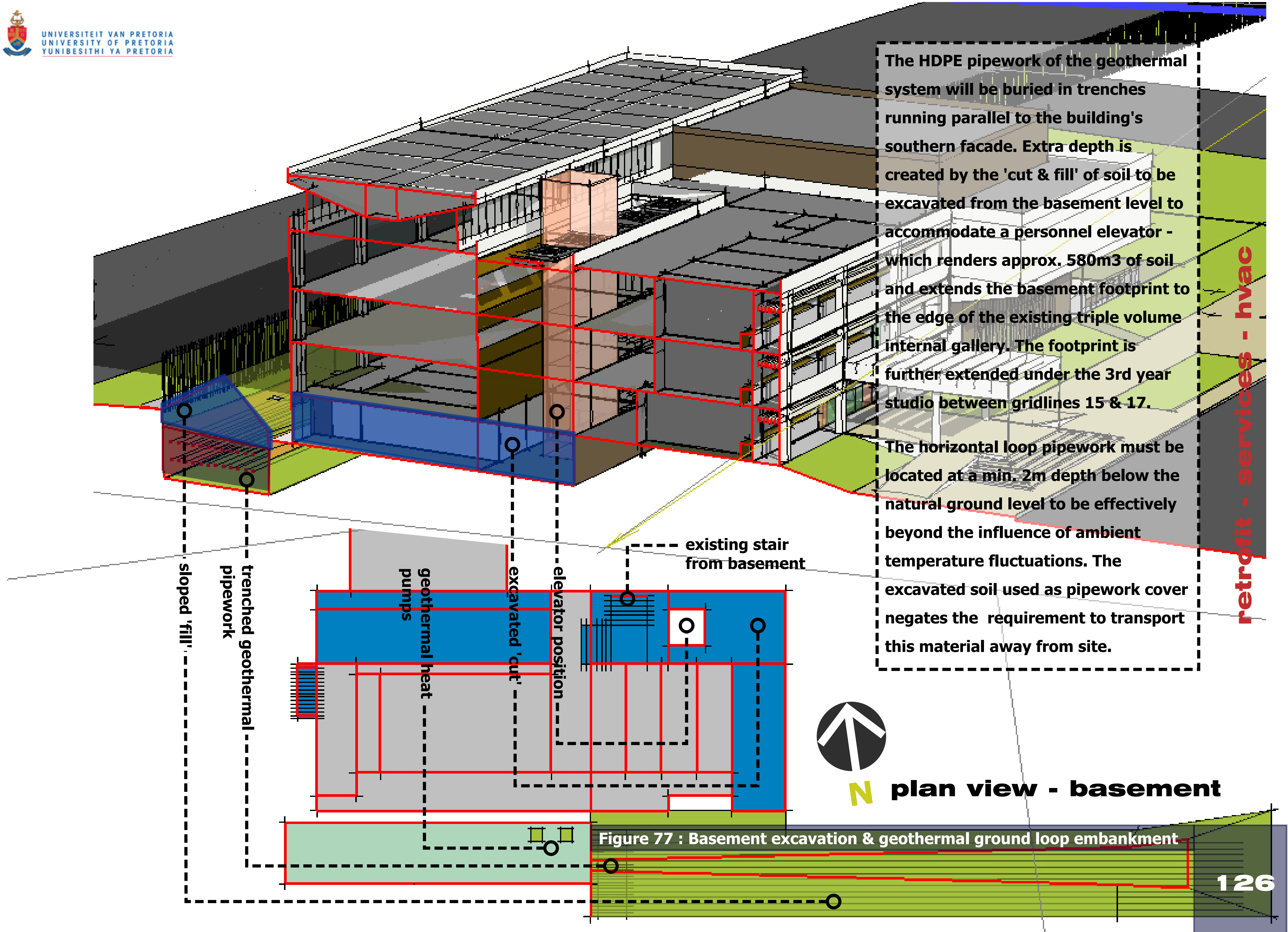


Figure 77 : Basement excavation & geothermal ground loop embankment

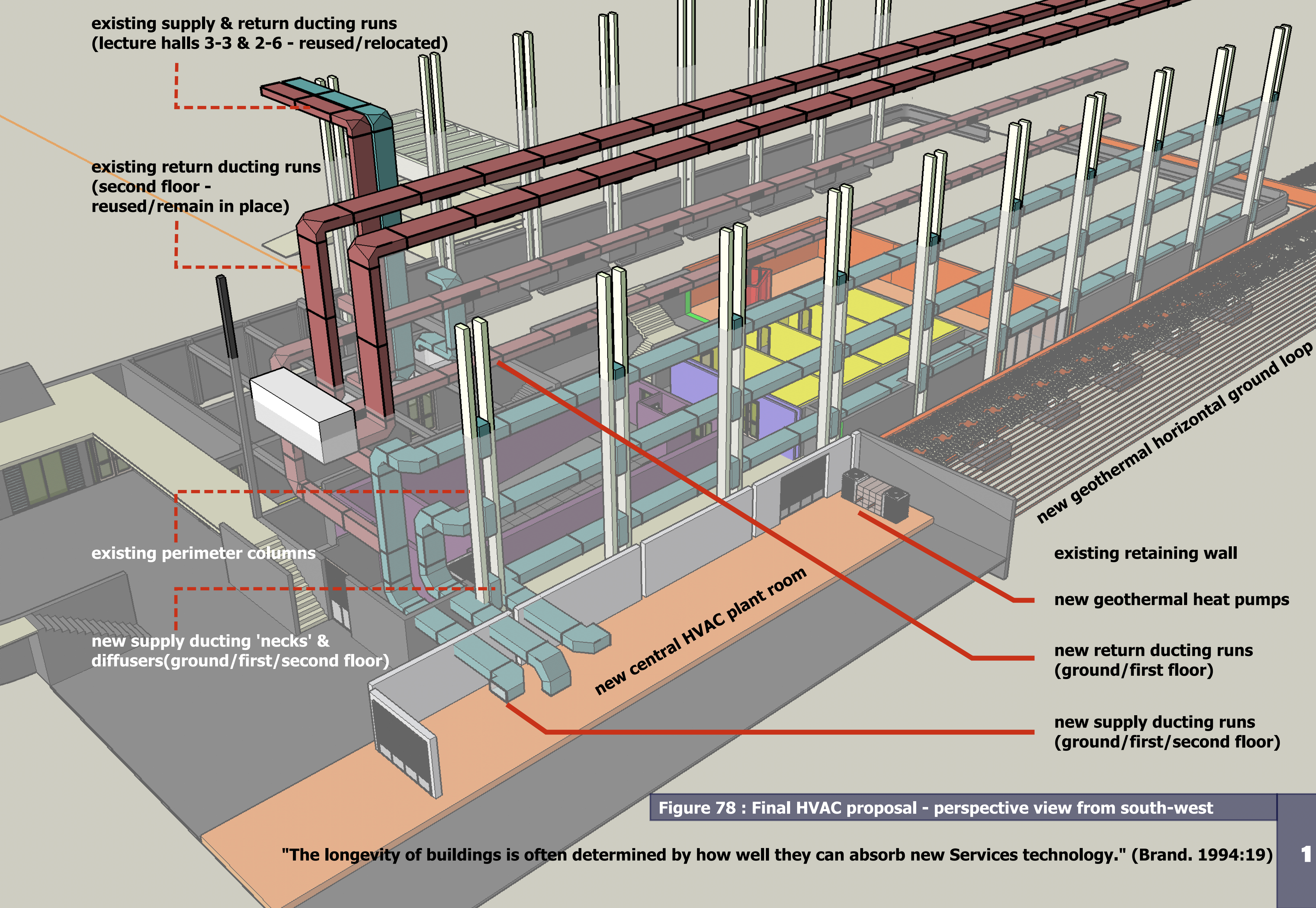


Figure 78 : Final HVAC proposal - perspective view from south-west

"The longevity of buildings is often determined by how well they can absorb new Services technology." (Brand. 1994:19)