design development

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

The garden : Kit of Parts

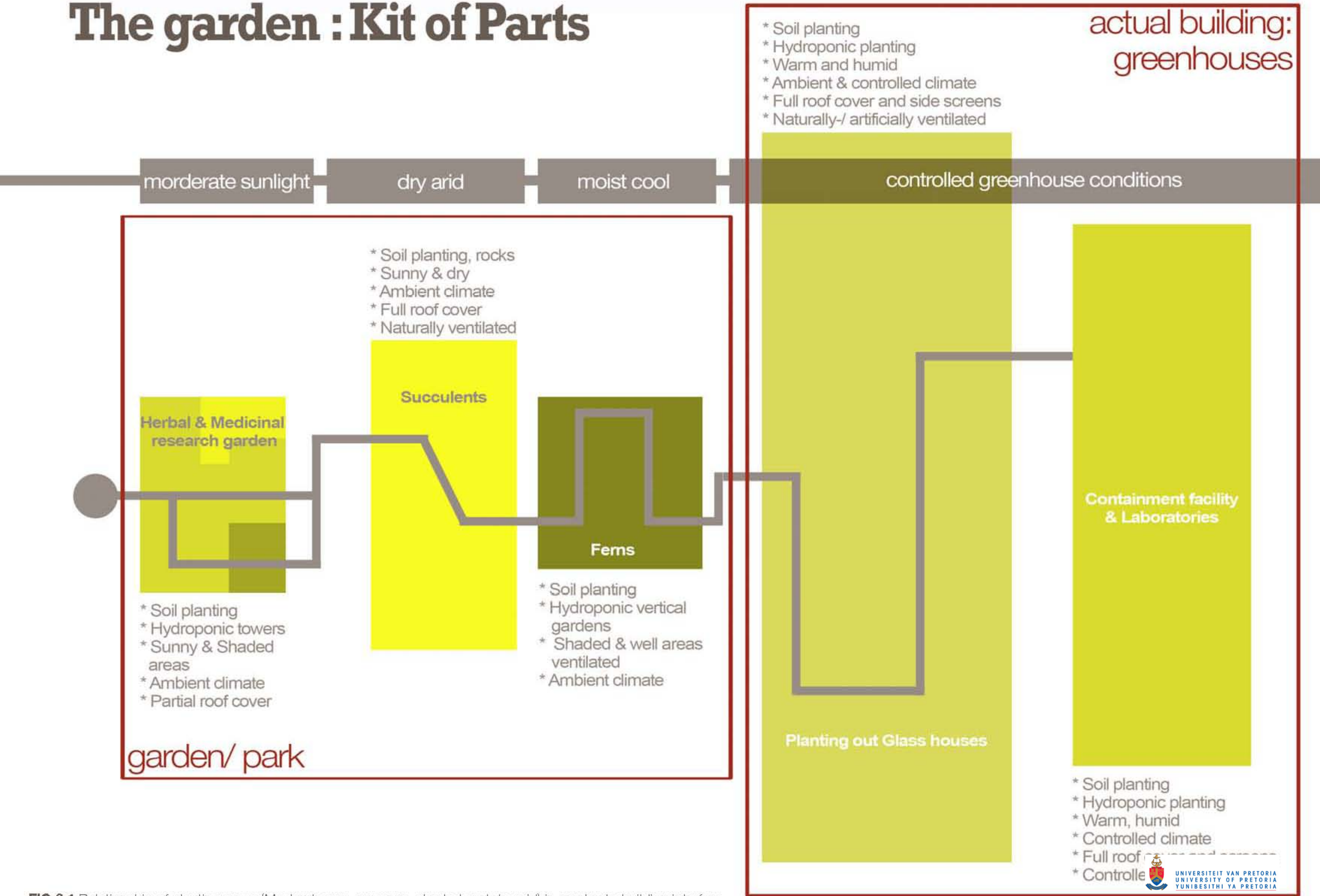


FIG 6.1 Relationship of planting areas (Moderate sun exposure, shaded and dry arid) in garden to building interface

6.1 The Garden:

6.1.1 Ferns:
The growing of ferns can facilitate the collection of medical or food production research data.

Light requirements:
- Like all plants, ferns need a light ray spectrum of blue, red and violet to fuse carbon dioxide with water in order to produce sugar.
- Ferns prefer some level of shading to carry out the process of photosynthesis.
- Too strong light for a significant part of the day can drastically alter the appearance of a fern plant.
- Too little light exposure will inhibit photosynthesis.
- Older fern plants require more light exposure as apposed to the limited light exposure that young plants need.

Atmosphere:
- Ferns require a moist atmosphere of 60-80% relative humidity during the day.
- Low humidity inhibits new growth.

Air:
- Ferns must have fresh air.
- Oxygen is needed for respiration and this is a continual 24 hour process.

Ferns in glasshouses:
- Control of relative humidity and protection against frost can be achieved.
- The roof and exposed sides of the greenhouse must be shaded (dappled shading).
- It must be well ventilated. Top ventilation is preferable in order to get rid of warm air. Down draughts must be prevented.
- Optimal air quality is obtained by vents that open in the morning and close in the early afternoon.
- Stagnant, non-circulated air encourages frost damage and the growth of moulds or bacteria.

6.1.2 Succulents:
For a detailed investigation of the growth requirements of succulent plants, please refer to the Kirstenbosch succulent conservatory discussed in Chapter 5.1.

6.2 Building : Glasshouses and Plant containment facility

These types of facilities are used to safeguard plants and to grow them under quarantine and controlled conditions:

The objective of introducing containment facilities is to manage the risks associated with exotic plants and other foreign organisms. Quarantine and associated research services implement activities to reduce these risks to acceptable or tolerable levels (Kahn and Mathur, 1999:1).

According to Kahn and Mathur (1999:82-97), exotic plant species are quarantine significant if:
- They do not occur naturally in the given country.
- They can place domestic species under severe strain.
- They are subject to a national containment, suppression or eradication programme.
- They can cause economical damage.

Design:
In South Africa the importation of plant species is not regulated by the South African National Biodiversity Institute (SANBI), but rather by the National Department of Agriculture (NDA). Regulations such as the Agricultural Pests Act 36 of 1983 are issued by the National Plant Protection Organization of South Africa (NPPOSA).

The management of risks associated with pests and foreign organisms
Low risk containment: **Open access**
Minimized climate and access control.

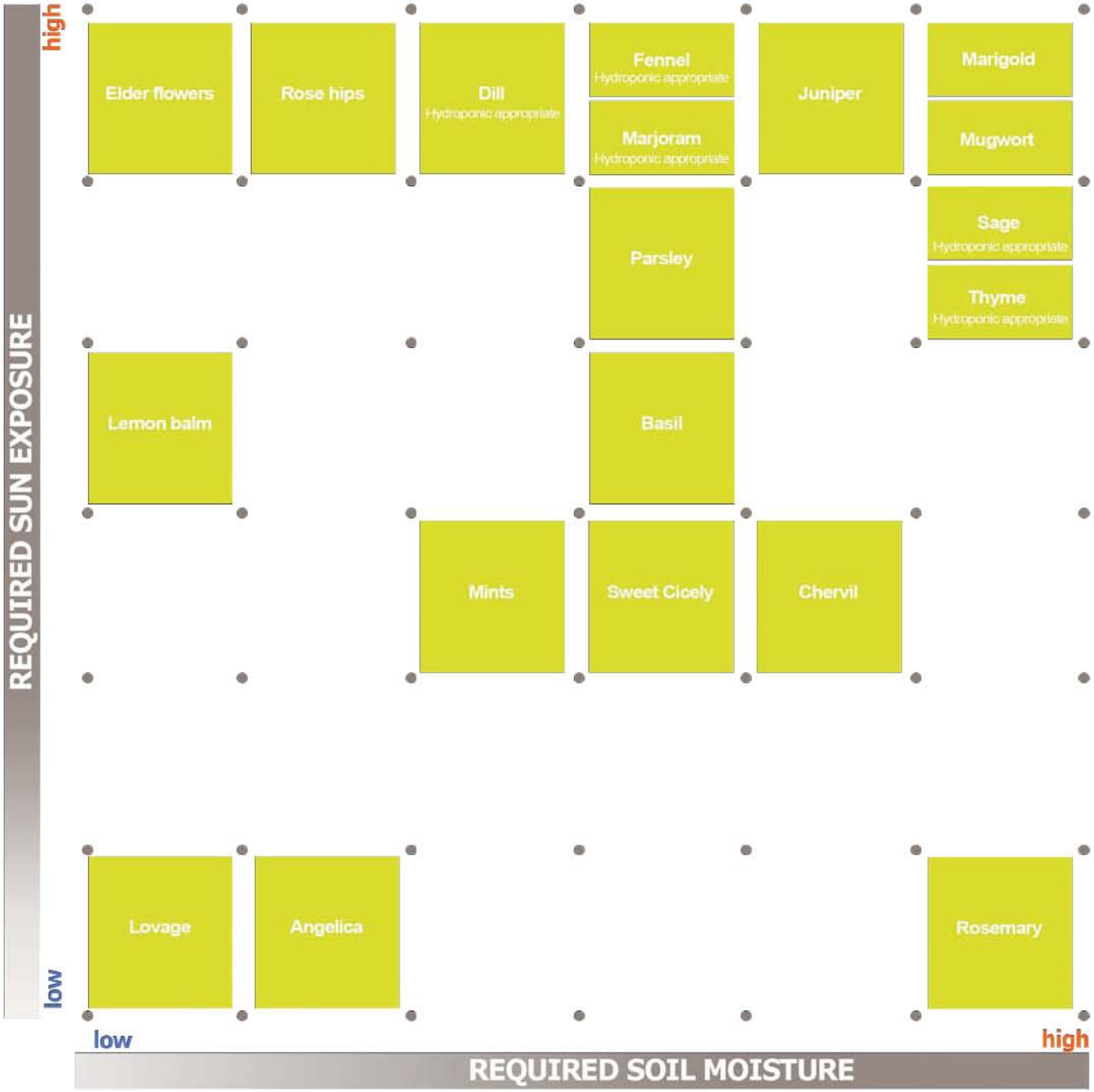


FIG 6.2 Graphical representation of sun/soil-moisture requirements for Herbs planted for medicinal research purposes. Image by author, adapted from Loewenfeld (1967:234-243)

Type	Soil moisture requirements	Sun exposure	Planting season	Culinary attributes	Medicinal attributes
Angelica	Damp rich	Shaded	Autumn	Removing tartness from food	Blood cleansing Diuretic tea
Basil	Well drained, moist, heavy and sand mix	Sunny sheltered	Autumn	Flavoring to dairy, fish and vegetable dishes	Constipation
Chervil	Well drained, light, sandy	Semi shaded	All year	Soups and sauces	Blood cleansing Muscle injuries Diuretic qualities
Dill	Well drained, moist, heavy and sand mix	Sunny	All year	Sweet flavoring for fish and vegetables	Insomnia Vomiting
Elder flowers	Damp rich	Sunny	All year	Fritters	Eye skin lotion Sciatica
Fennel	Deeply dug, rich, chalky	Sunny	Spring	Chicken, fish and egg dishes	Indigestion Cosmetic creams
Juniper	Chalky	Sunny	All year	Flavoring to game, meat, stew, poultry	Blood cleansing Indigestion Rheumatism
Lemon Balm	Damp rich	Sunny sheltered	Spring, Autumn	Flavoring for fish, lamb and vegetables	Relaxation Migraine Palpitations
Lovage	Damp rich, deeply dug	Damp	Spring, Autumn	Flavoring for all meat and vegetables	Milk production for mothers
Marigold	Any soil	Full sun	Spring, Autumn	Flavoring to breads	Skin treatment
Marjoram	Medium rich	Sunny	Spring, Autumn	Tomato and mushroom dishes Meat flavoring	Hay fever Skin treatment
...ts	Moist, rich	Semi shaded	All year	Sweets and Sauces	Mouthwash Toothpaste Headaches
...gwort	Any soil	Sunny	All year	Beer, meat, fish and duck	Chronic diarrhea
...sley	Chalky, dry, well drained	Sunny	All year	Garnish and flavoring for all appropriate dishes	Diuretic tea Rheumatism
...e hips	Clay soil	Sunny	All year	Tea and sauces	Kidney and bladder
...emary	Light, sandy, dry, chalky	Sheltered	Spring	Meat, poultry, egg and vegetable dishes	Heart stimulant Indigestion Skin supplant
...e	Light, sandy, dry, chalky	Sunny, dry	Spring	Meat and fish dishes, cheese making	Sore throats
...et Cicely	Medium rich, well drained, mo	Partial shade	Spring	Added to tart fruit, organic sugar, Vegetables	Perfume
...me	Chalky, dry, well drained	Dry sunny	Spring	Shell fish, mutton and pork, cheeses	Bronchitis Disinfectants Mouth washes

TABLE 6.1 Research value of most com... ...age by author, adapted from Loewenfeld (1967:234-243)

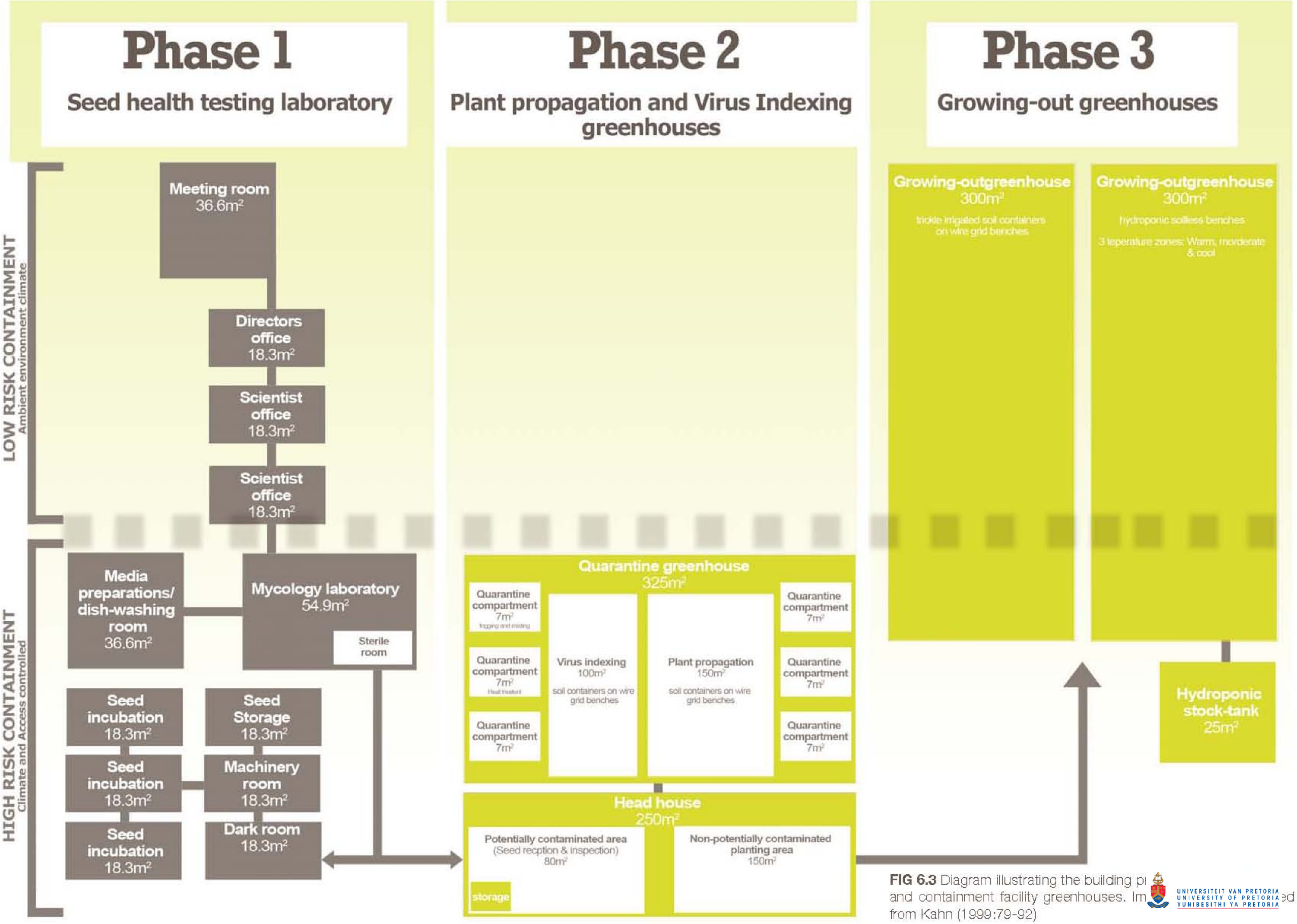


FIG 6.3 Diagram illustrating the building pr[...] and containment facility greenhouses. Im[...]ed from Kahn (1999:79-92)

Used for areas in the greenhouse complex where plant specimens have been immobilized from posing viral or bacterial threats to other plant specimens. Administrative areas and growing-out greenhouses are considered facilities for low-risk containment.

Medium-risk containment: **Single door entry**

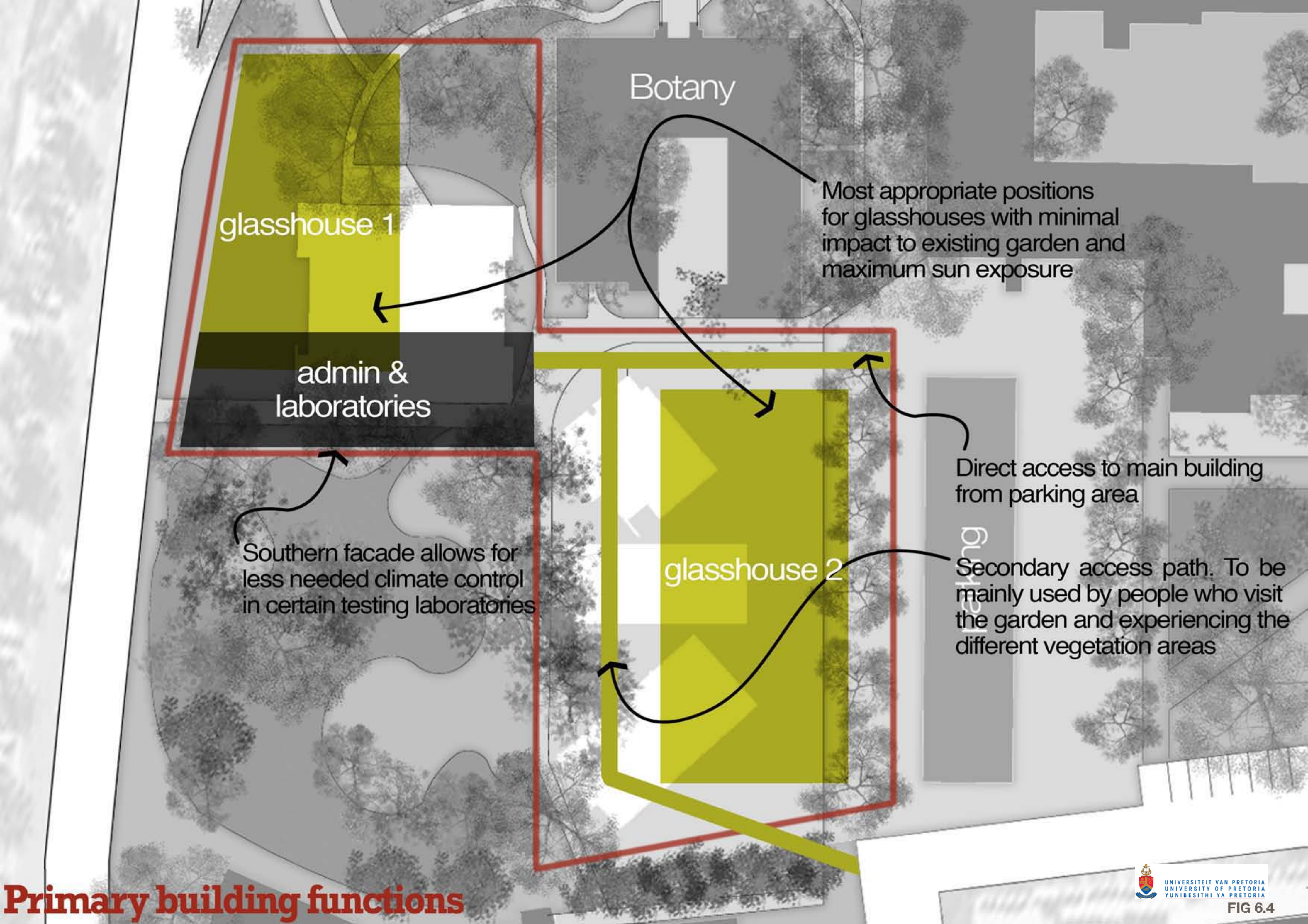
High-risk containment: **Double door entry**
Maximum climate, humidity, ventilation and access control.

A high-risk containment facility is required when a wide spectrum of species with diverse life cycles and characteristics need to be dealt with and hosted, and because the identities of the organisms needing to be hosted are unknown.

Containment greenhouses for research purposes:
A three-phase process

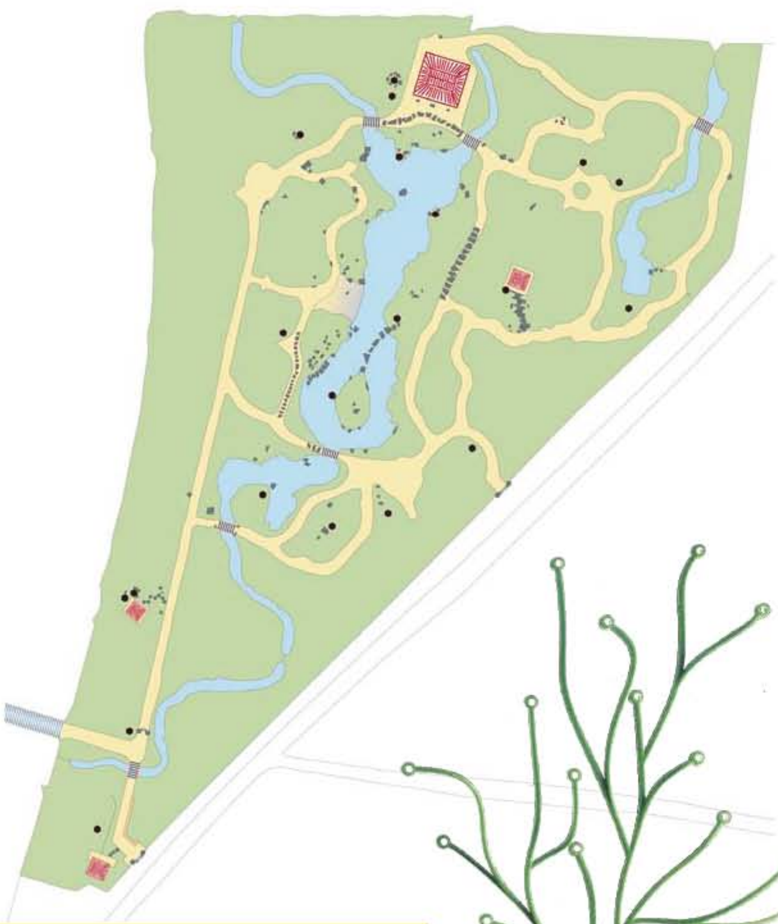
Function	Risk	Design considerations
PHASE 1		
Offices Meeting rooms	Low	▪ Infrequent use: Functions can be located in one area ▪ Can be constructed to connect with laboratories and other facilities
Mycology laboratory & Media preparation	Medium	▪ With supporting Media preparation and dishwashing facility that supports the laboratory. ▪ Modular furniture fittings ▪ Approx. 2.7m floor to ceiling height. ▪ Direct sunlight shouldn't fall on laboratory equipment.
Dark room Machinery room Seed incubation Seed storage (Cold room)	High	▪ Can be in the basement level in order to reduce the heat load. ▪ Carefully regulated interior temperature and humidity for each room. ▪ Façade surfaces should either be white or reflective if it is not positioned in the basement to reduce heat absorption. Alternatively tree shading. Insulation on warmer side of the structure together with a vapor barrier to ward of condensation moisture. ▪ Module must be sealed off from other modules by double doors. Each room must be protected by a double door entry. ▪ Air conditioning equipment and power generators are housed in the insulated machinery room to reduce noise and vibrations.
PHASE 2		
Head house	Medium to High	▪ Connects with a main corridor to all other greenhouses. ▪ Utility ducts and pipes can be routed through corridors. ▪ Seed reception and inspection.double doors. Each room must be protected by a double door entry. ▪ Air conditioning equipment and power generators are housed in the insulated machinery room to reduce noise and vibrations. ▪ Cold room temperatures 6-8°C
Quarantine greenhouse	Medium to High	▪ The individual greenhouses are divided up into compartments connected by a corridor leading to the main corridor. Double door entry at each compartment and a door at the connection between corridors.
Plant propagation	Medium	▪ To grow virus indicator plants. ▪ Units must be protected against the egress and ingress of insects and mites. ▪ Growing occurs in containers on wire grid benches. ▪ Double door entry ▪ Evaporative cooling and shading techniques: 30°C daytime maximum; 15°C nighttime minimum.
Plant Quarantine	High	▪ Screened against egress and ingress of insects and mites. ▪ Double door entry ▪ Floor drainage, shading and evaporative cooling. ▪ Growing occurs in containers on wire grid benches. ▪ 30°C daytime maximum; 15°C nighttime minimum. ▪ Mechanically air-conditioned. Negative pressure relative to corridor by exhausting air from each chamber through HEPA filters which discharge in the corridor. ▪ One compartment with 40°C day/night temperatures for heat treatment of virus infected plants. ▪ One compartment with independently controlled fogging and misting system. ▪ Specialized compartments can also be used for general purpose.
Virus indexing/ Seed health testing	Medium	▪ Floor drainage and double door entry. ▪ Growing occurs in containers on wire grid benches. ▪ 2 Movable internal shading areas. 30 and 50% respectively and 65% if used in tandem. This is to remove heat stress and to promote symptom expression in virus indexing. ▪ 25°C daytime maximum; 20°C nighttime minimum. ▪ Fog and shading systems should eliminate the need for mechanical refrigeration.
PHASE 3		
Planting out greenhouses	Low	▪ Specimens are planted in growing out greenhouses when seeds have been inspected and incubated for at least 7 days. Much of the risk was eliminated during this process and the main requirement for these greenhouses are to be insect proof. ▪ Glasshouse temperatures can be equal to the ambient temperature ▪ Due to the high solar radiation in South Africa, not all walls need to be screened as this also enhances natural convection. ▪ Evaporative- or fog cooling is optional. ▪ Concrete floors or similar to avoid contamination of floor for both soil-bench container growing and hydroponic waterborne fertilization.

TABLE 6.2 Detailed summary of the 3 phases of containment and risk levels within the containment facility. ...apted from Kahn (1999:79-92)



Primary building functions

FIG 6.4



Influences

FIG 6.5 Kennet, William Morris,1883 (Sachs, 2007:83)

FIG 6.6 Japanese garden in Clingendel (Gieskes 2006:4)
Note the meandering pathways everytime creating new vistas until you reach the pavilion with its very geometric plan contrasting the natural forms and lines of the garden.

FIG 6.7 Algue, Ronan & Erwan Bouroullec (Sachs 2007:62)

FIG 6.5 FIG 6.6 FIG 6.7

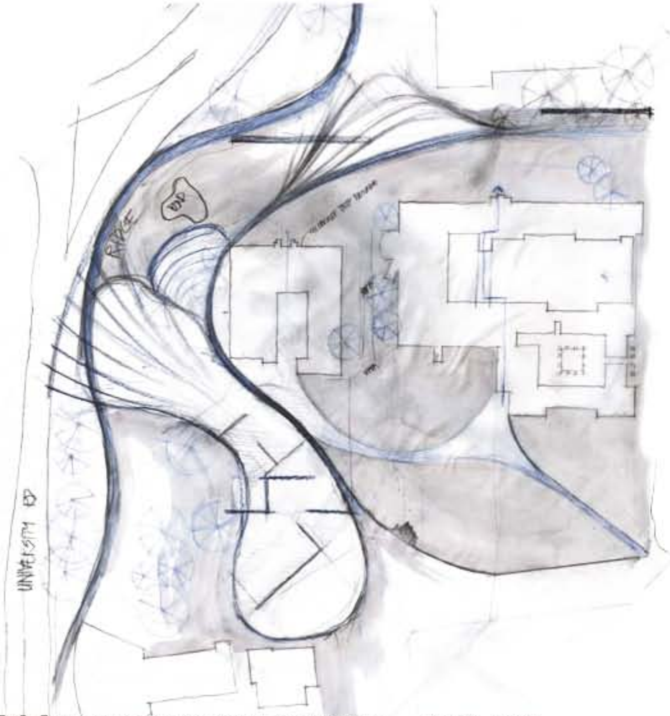


FIG 6.8 2D Building footprint exploration - March 2008

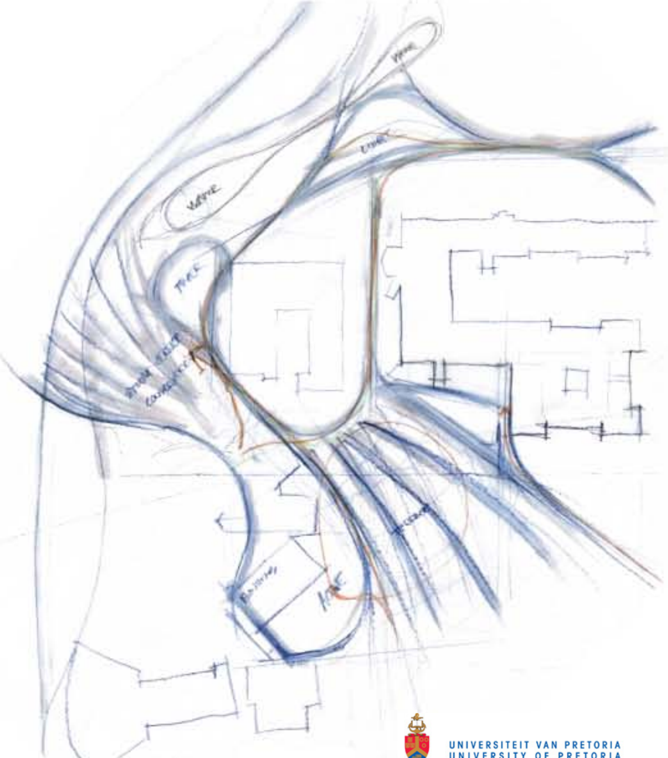


FIG 6.9 2D Building footprint exploration - March 2008

6.2.1 Footprint:

The building footprint is mainly governed by the following factors:

- Growing-out **glasshouses** for plant propagation (largest footprint) need maximum exposure to **sunlight.**
- **Laboratories** require **less sunlight** and lower levels of heat gain.
- **The botanical garden** forms part of the research area and contains many rare species of plants. Optimal sensitivity to the existing vegetation should be maintained.
- Most users **access** the site from the adjacent parking area or the southern entrance to the garden.

The design of the glasshouses and laboratory calls for a regulated and parametric approach to their layout. Most of the furniture units that will occupy these spaces are modular, with fairly rigid plan shapes that will allow for a more logical and effective use of the spaces.

FIG 6.10 3D Clay model building form language exploration. Experimentation with terracing and organic facade shapes - April 2008

FIG 6.11 3D Clay model building form language exploration. Experimentation with terracing and organic facade shapes - April 2008

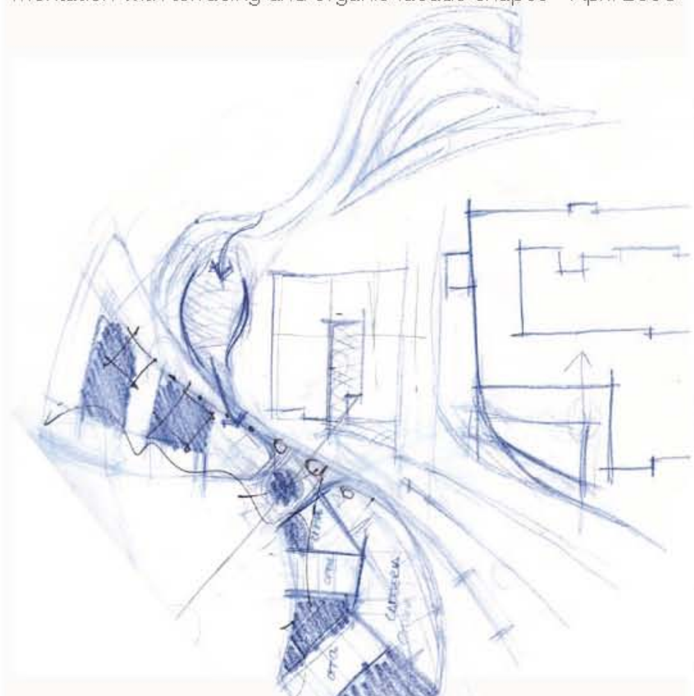


FIG 6.12 Creating "pockets" within the form

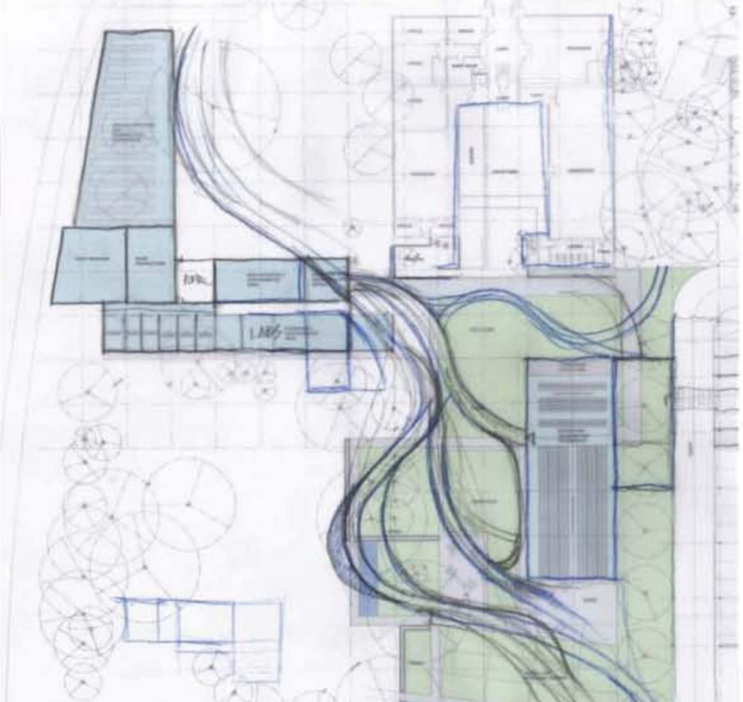


FIG 6.13 Visitor pathways are organic. It promotes changing vistas within the garden

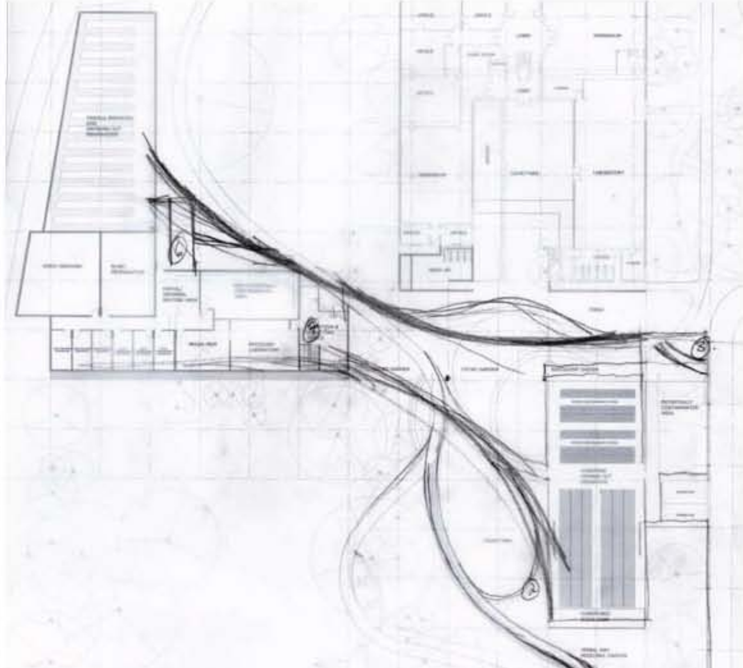


FIG 6.14 One continuing element will combi… the building

6.2.2 Form language exploration:

It is my opinion that a building form language that is developed intuitively can result in a more humanly responsive architecture. Intuitive thought should always be underpinned by a strong research foundation that will support the practicalities of the design. In the case of this design, there is a strong need for the final product to create an architectural experience and expand the *genius loci* of the park as well as act independently and successfully as a high order research facility.

Basic building program and requirements were informed by site-/climatic constraint, the applicable programme required for such a facility and modular fittings for laboratories. This allowed the designer to intuitively respond with a form language that will combine the garden and the facility. This will allow regular users of the garden to move freely around and on top of the facility without intruding in on the higher order functions of the building.

FIG 6.15 Leaves displaces solar energy to from metaphysical spaces

Spatially plants form natural thresholds between humans and different levels of solar energy. Plants consume form their immediate environment what they require and displaces that energy into the fabric that compiles it. Leaves act as giant reservoirs that soak up solar energy. Leaves also form natural gutters and its shade create new ecosystems for other species emerging below it. This can result in an architectural form language that imitate this natural archetype allowing the building envelope to filter solar energy, but also for spaces to ascertain attributes that can be reminiscent of a natural environment. In this regard, the building form language becomes more an extension of the surrounding natural biome instead of dominating it completely. Building envelope becomes the glue between nature and human activity rather than the barrier.

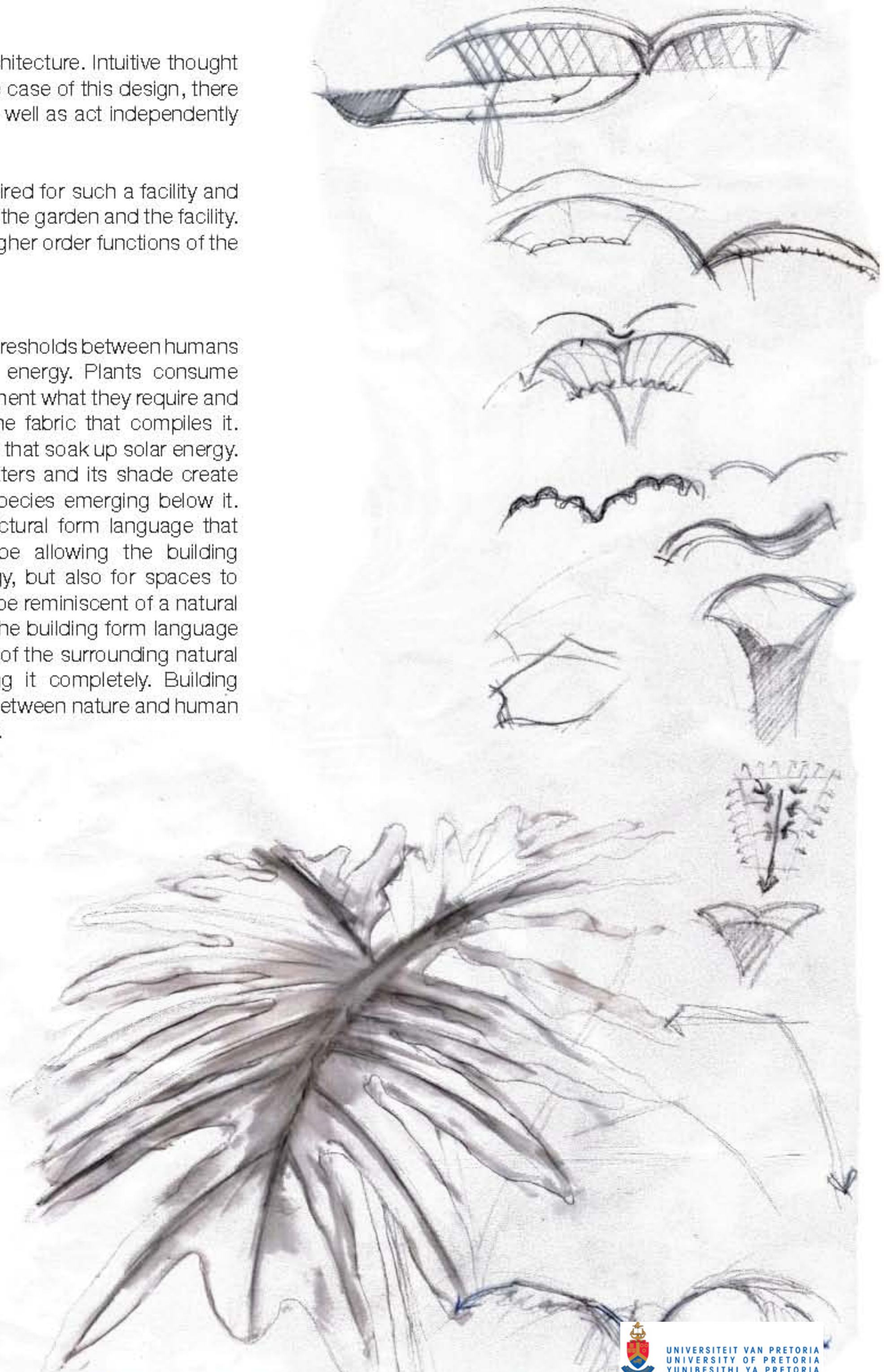


FIG 6.16 Intuitive form exploration from natural archetypes founded on natural intelligence

6.2.3 Alternative form exploration for glasshouses: Fig. 6.14-20

Alternative approaches were undertaken in using a more pragmatic approach. These had the following problems:

- Larger "stacked" greenhouses require more mechanical parts that reflects light
- Reflected light changes frequency and are less successful then for propagating plants
- The building form became too abstract and the desire for the form language to integrate with the garden was lost

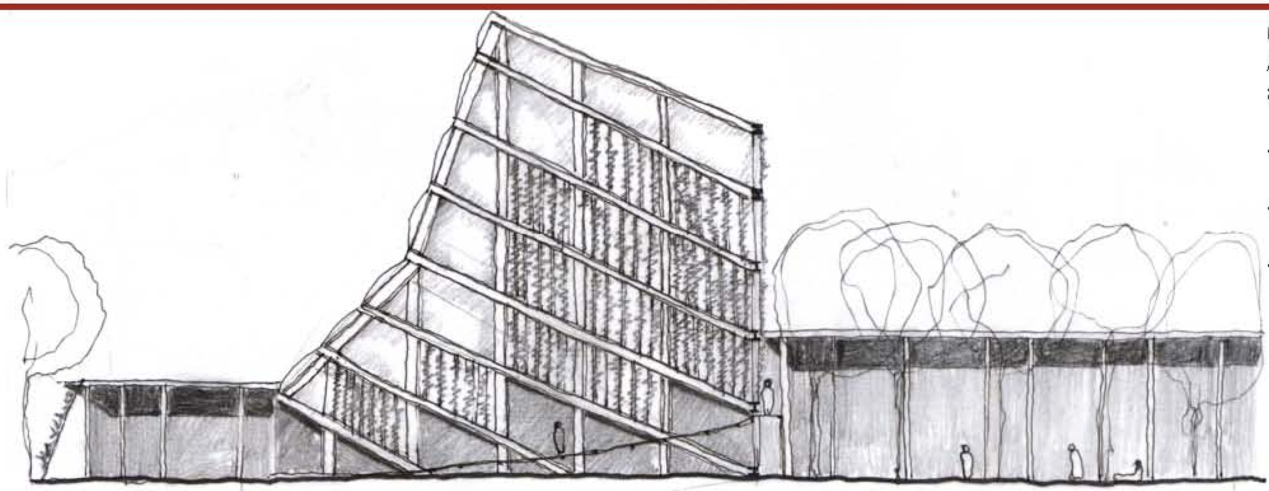


FIG 6.17 Elevation: Stacked greenhouse idea - June 2008

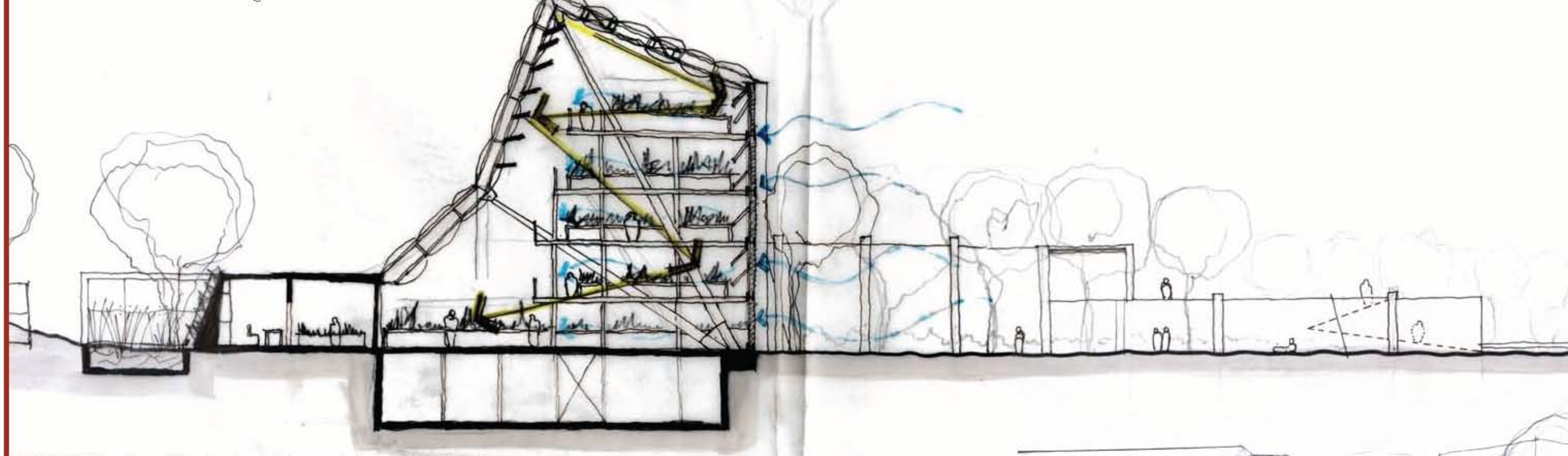


FIG 6.18 Section: Stacked greenhouse idea - June 2008

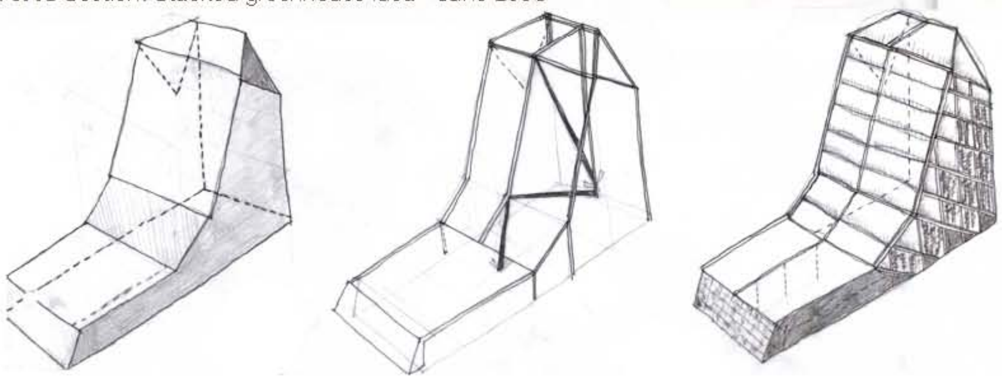


FIG 6.19 Spaceframe structure of stacked greenhouse idea - June 2008

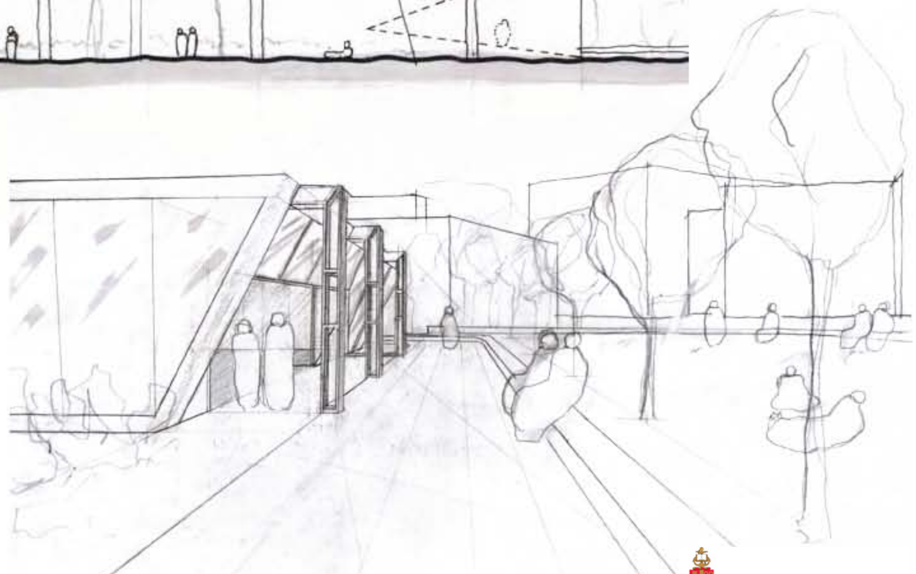


FIG 6.20 View along laboratories: Stacked greenhouse idea - June 2008

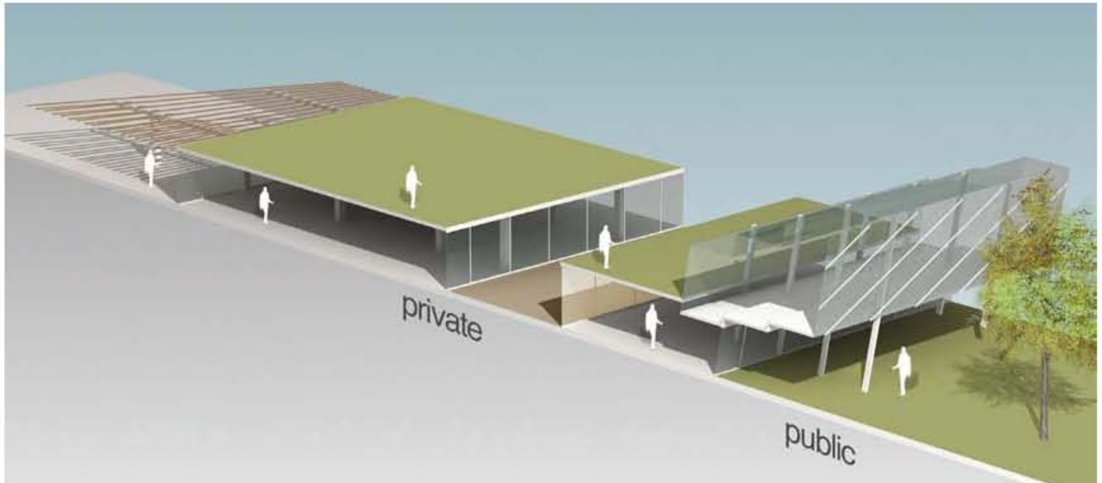


FIG 6.21 Stepping greenhouses with laboratories as thermal mass - July 2008

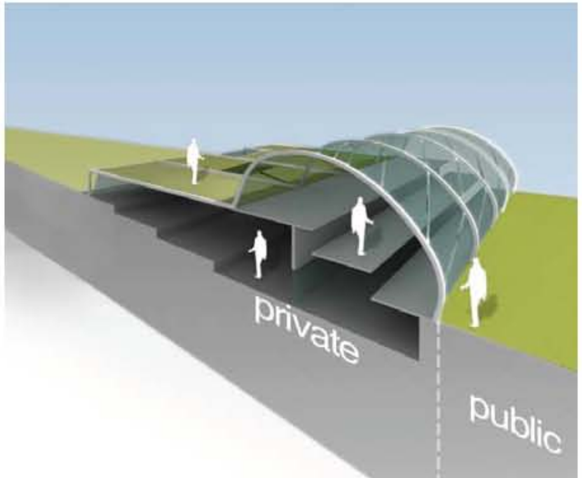


FIG 6.22 Stepping greenhouses with laboratories as thermal mass - July 2008

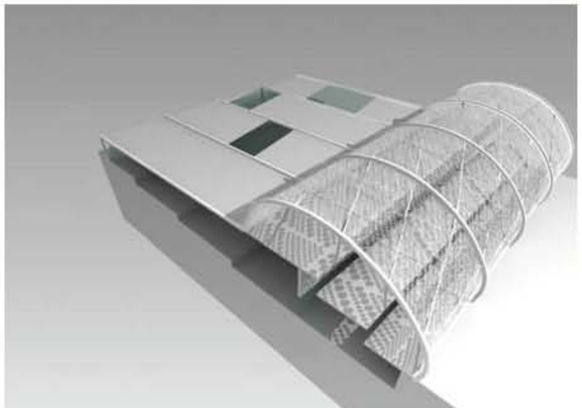


FIG 6.23 Stepping greenhouses with laboratories as thermal mass - July 2008

6.2.4 Roof as a unifying element:

After investigating other more pragmatic solutions for the glasshouses and garden, it was decided to revert back to the idea of using a one organic form language that will act as a unifying element over the entire site, connecting the research buildings with the garden.

The roof was considered to be complimentary to the footpaths and will allow for different controlled growing areas for plants.

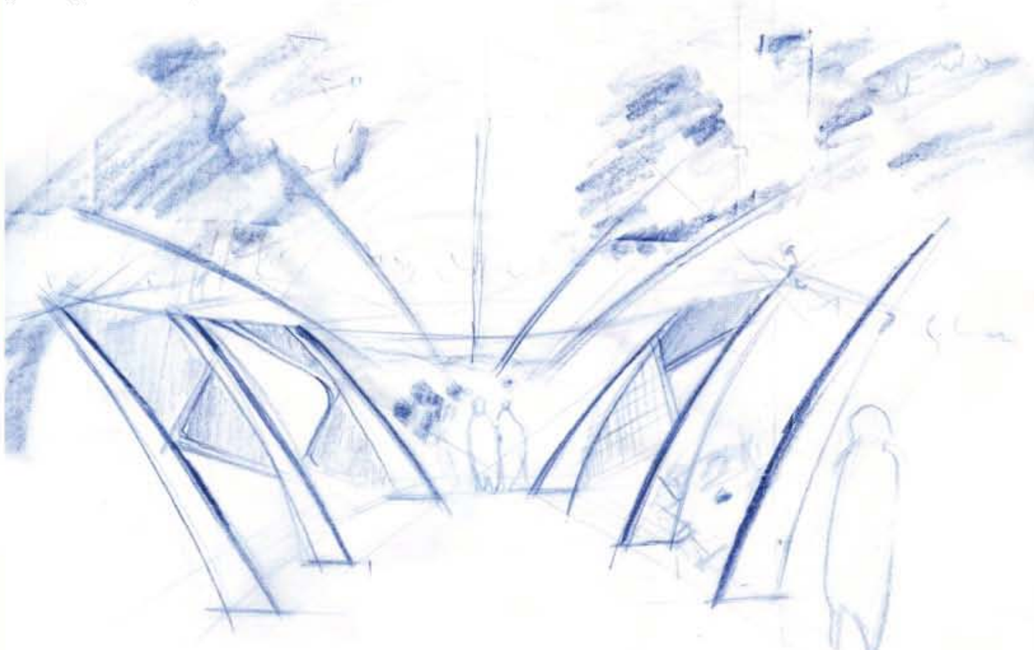


FIG 6.24 Visitors can move through the garden and between the building where the structure of the roof forms a permeable boundary - August 2008

FIG 6.25 Glasshouse facade elevation - August 2008

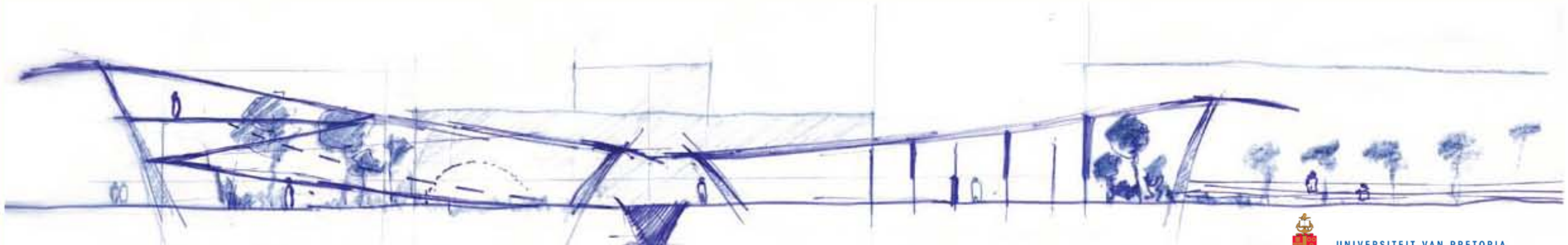


FIG 6.26 Roof structure drapes over sections of the garden and research functions. Users can move up over the building via r

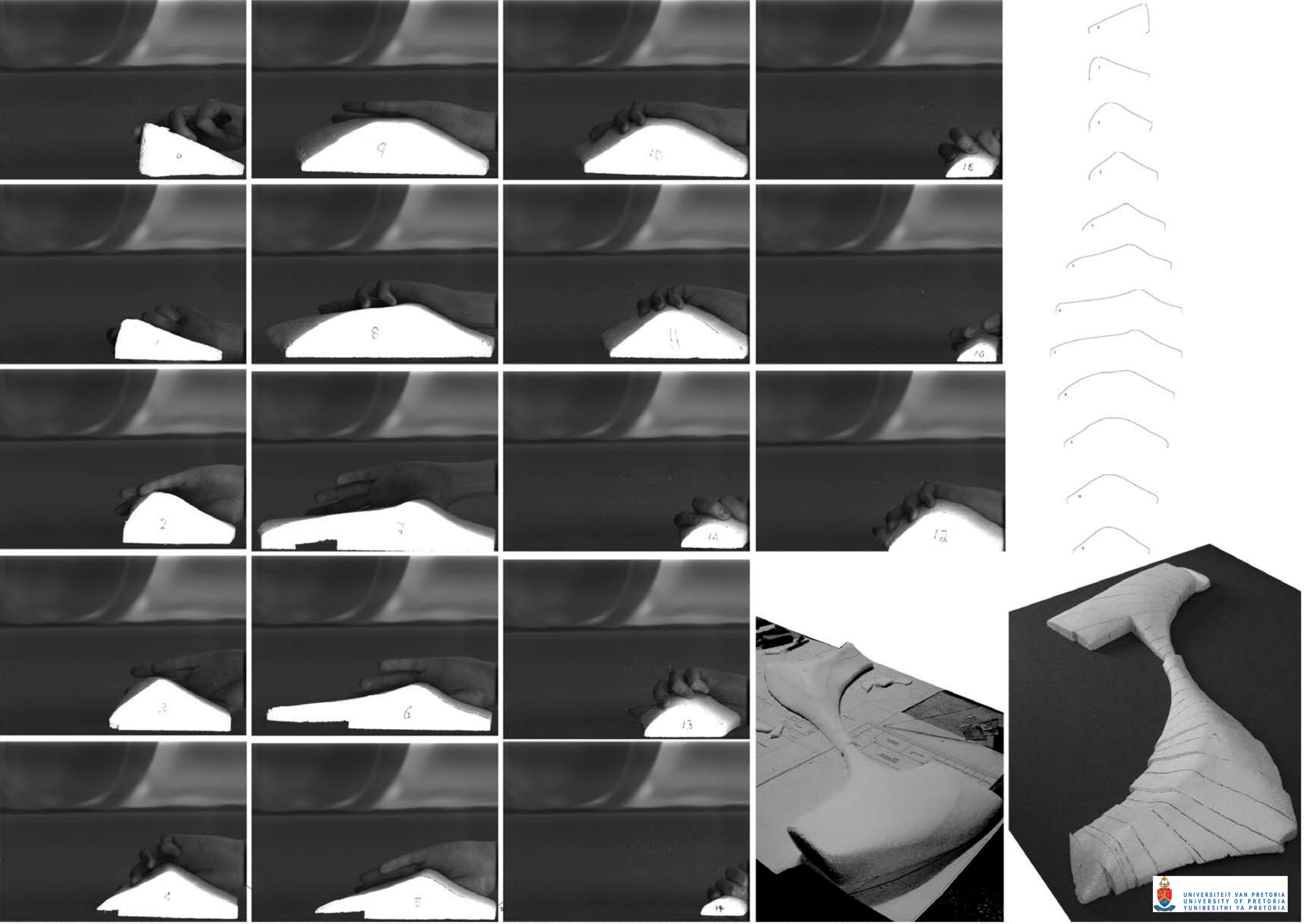


FIG 6.27-30 Roof form exploration with polystyrene models. Sections of the model was then scanned and interpolated onto appropriate 3D software - August 2008

FIG 6.28 Polystyrene model interpolation on computer - August 2008

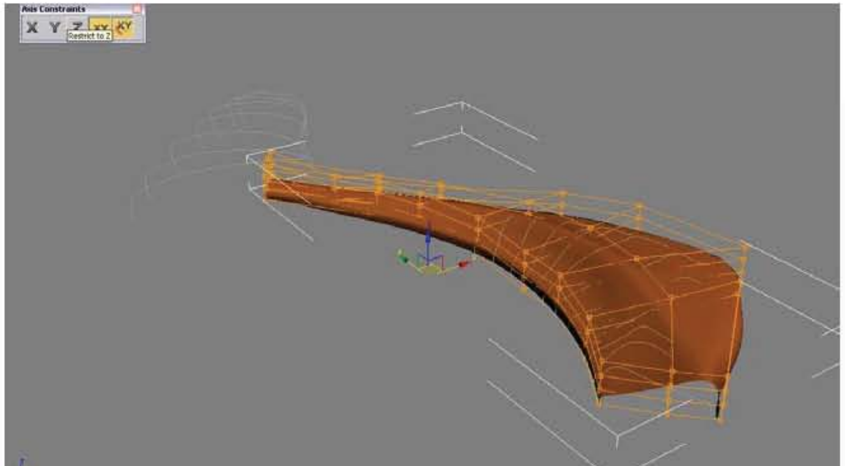


FIG 6.29 Manipulating surfaces - August 2008

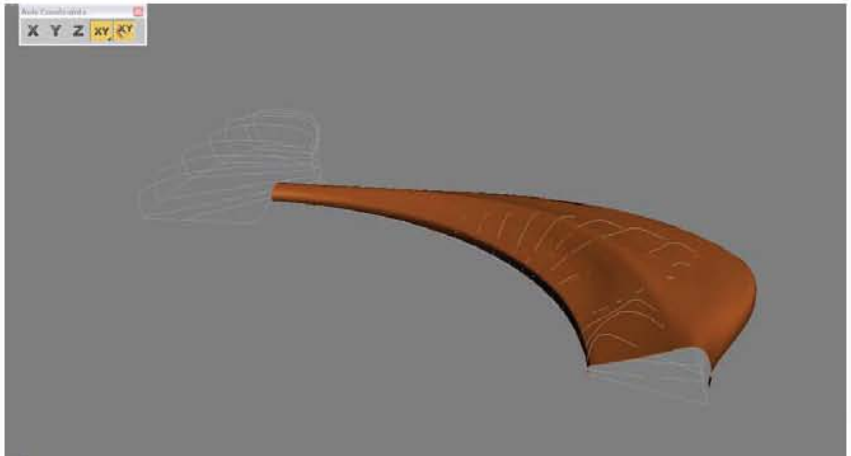


FIG 6.30 New roof form - August 2008

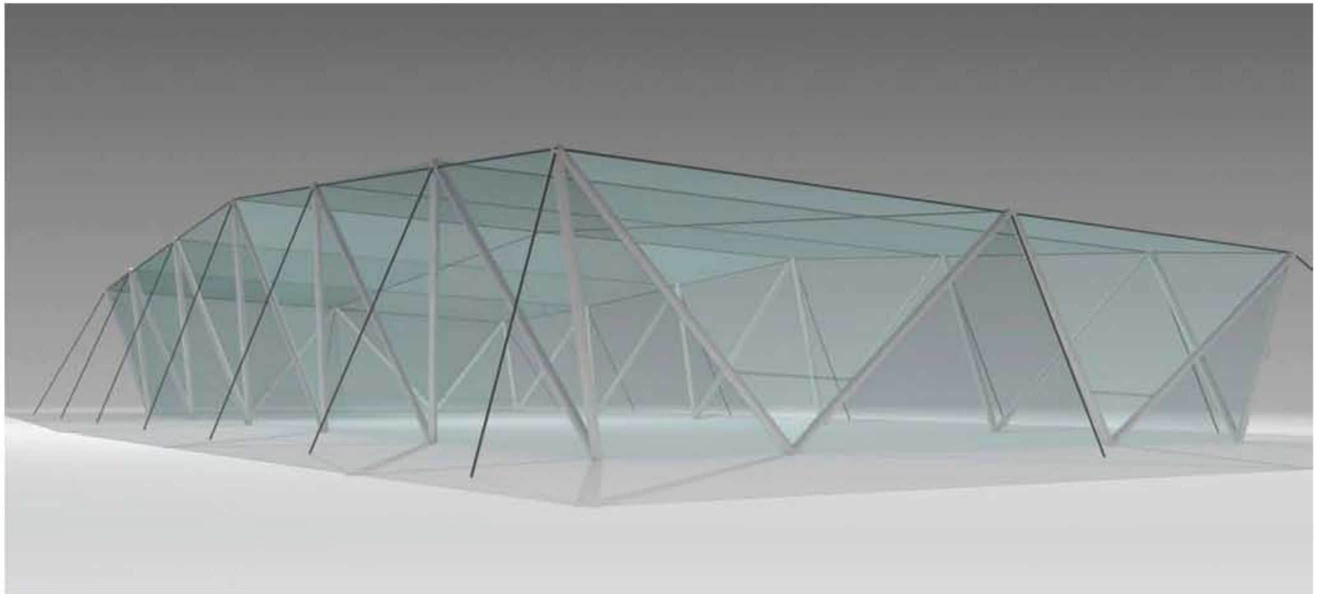


FIG 6.31 Experimenting with tensile cable structure for glasshouse assembly- August 2008

6.2.5 Tensile roof structure as a solution for creating large free areas and organic shapes

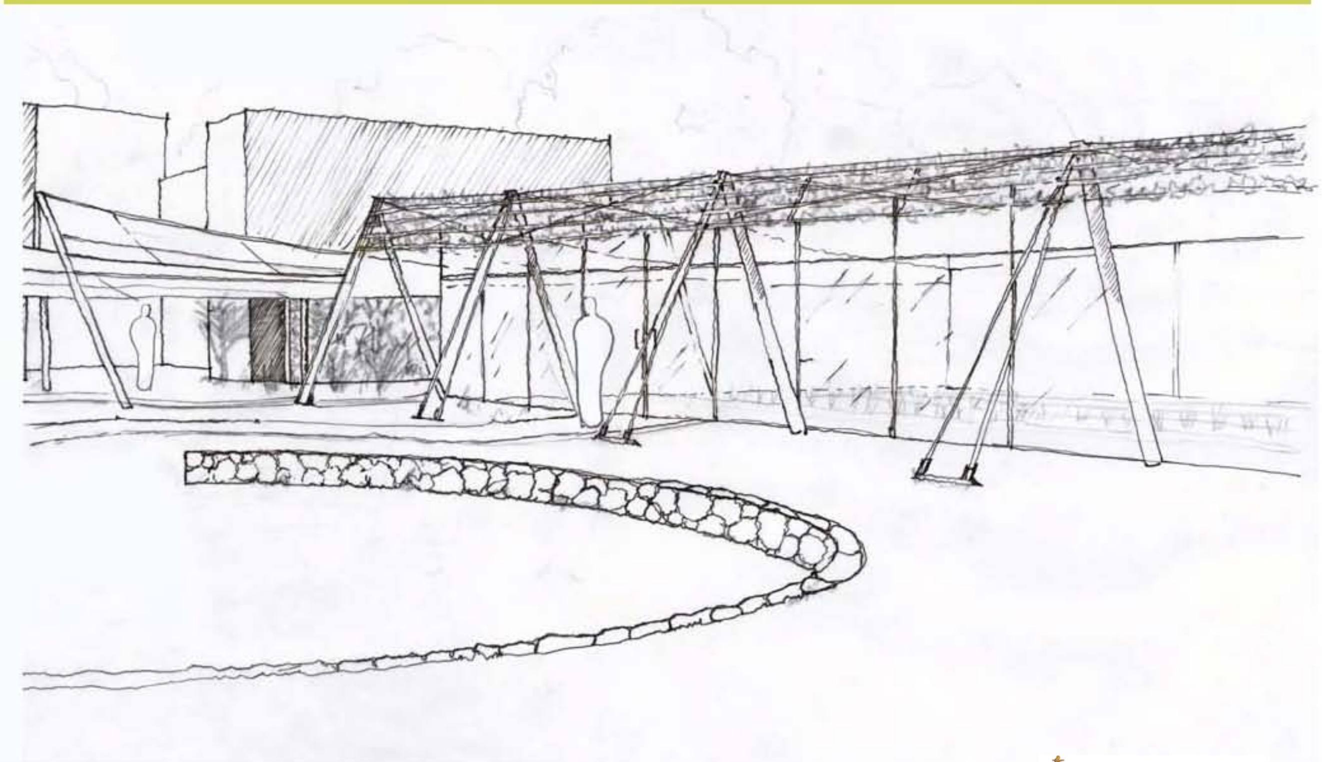


FIG 6.32 View from visitor's footpath towards glasshouse. Vegetation can be grown onto cables us ovide essential facade shading- August 2008

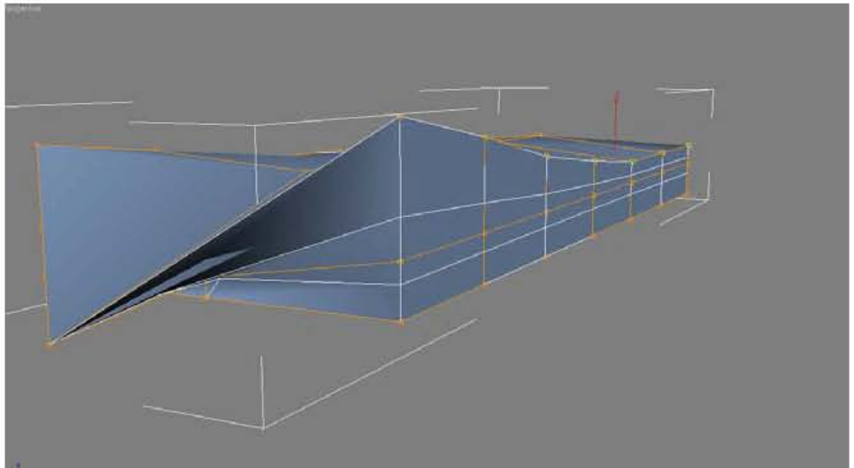


FIG 6.33 Exploring tensile structure possibilities - August 2008

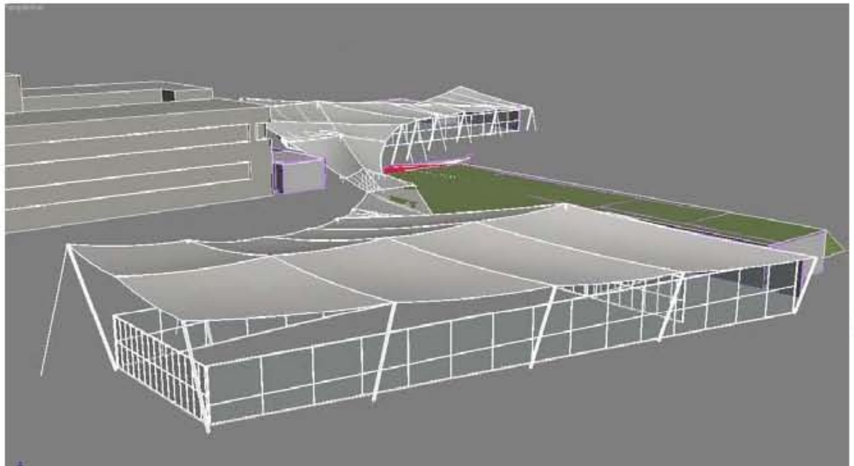


FIG 6.34 Cable roof structure connects the two galsshouses - August 2008

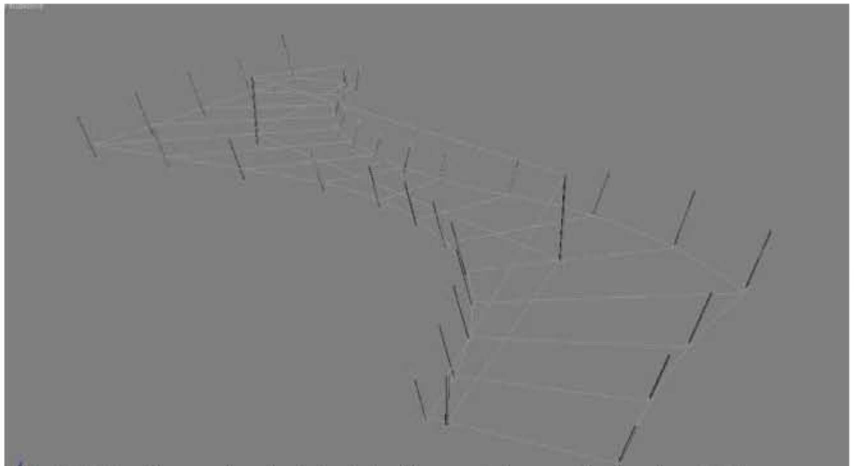


FIG 6.35 Deriving a structural logic for the roof shape - September 2008

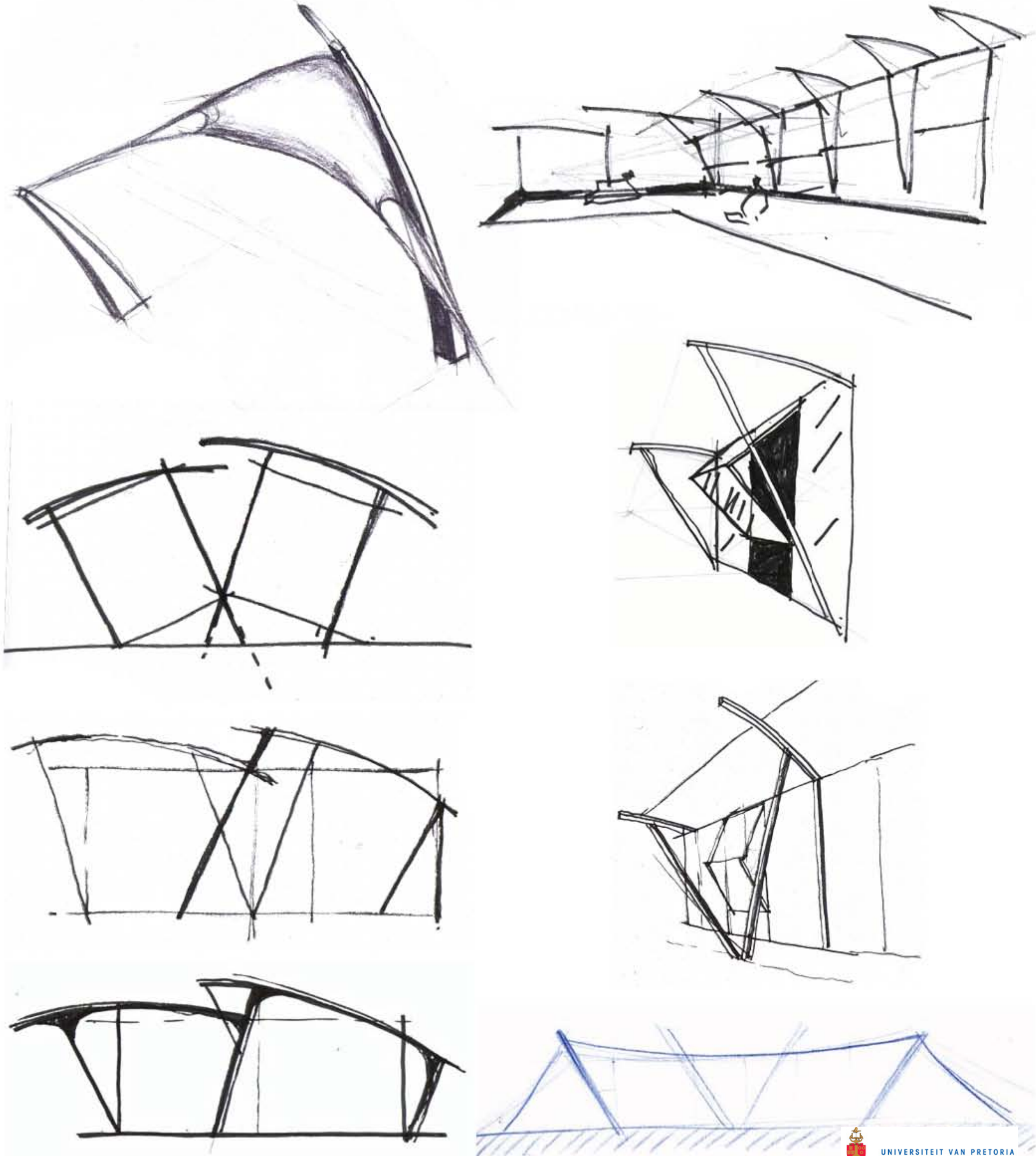


FIG 6.36 Exploring facade and section details of tensile structure. Deriving a language for structural sup vill integrate with mechanical facade elements like ventilation panels etc. September 2008

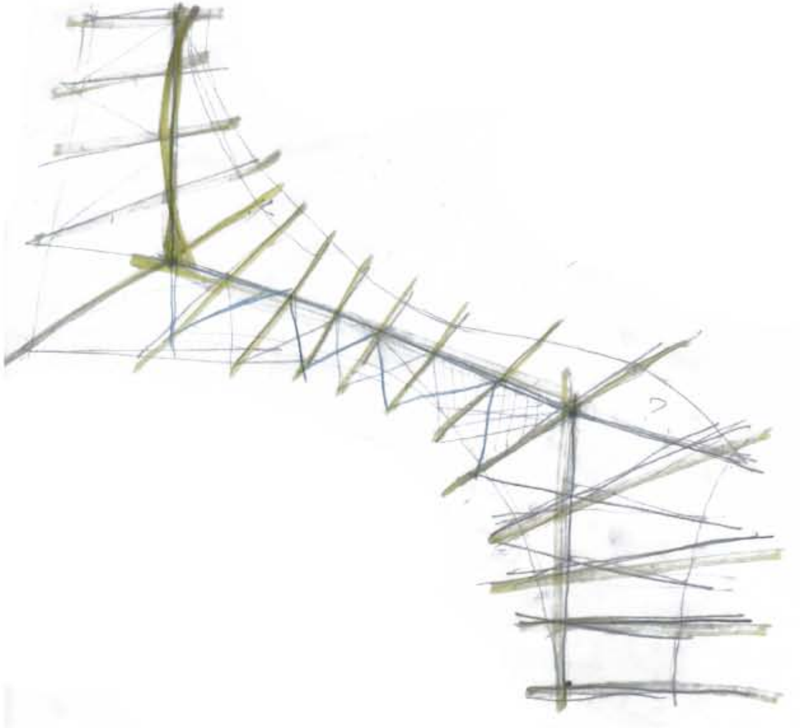
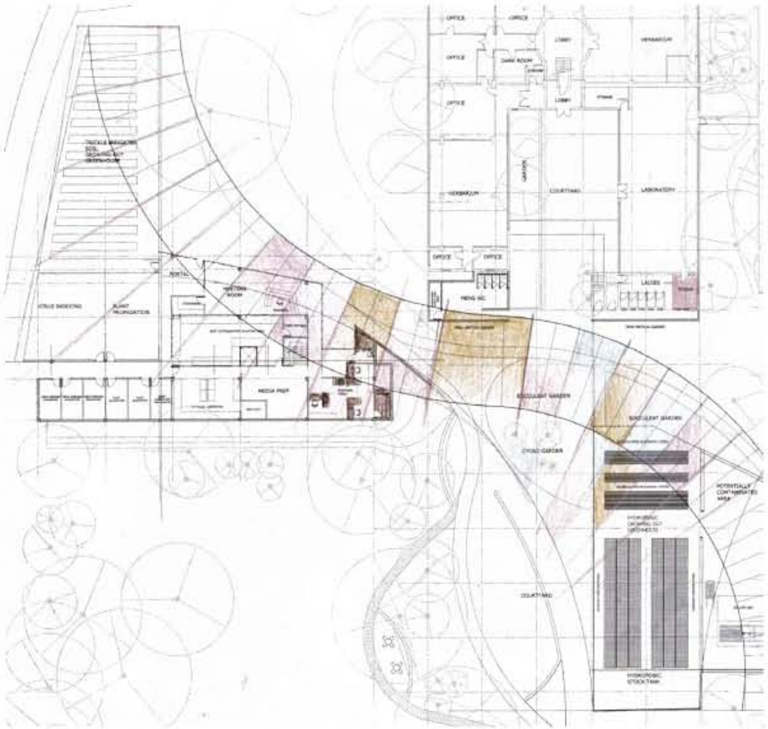


FIG 6.37-38 Deriving a structural logic. Trapezium shapes for main supporting structure proved to be successful at creating the desired shape on plan between the two glasshouse facilities. September 2008



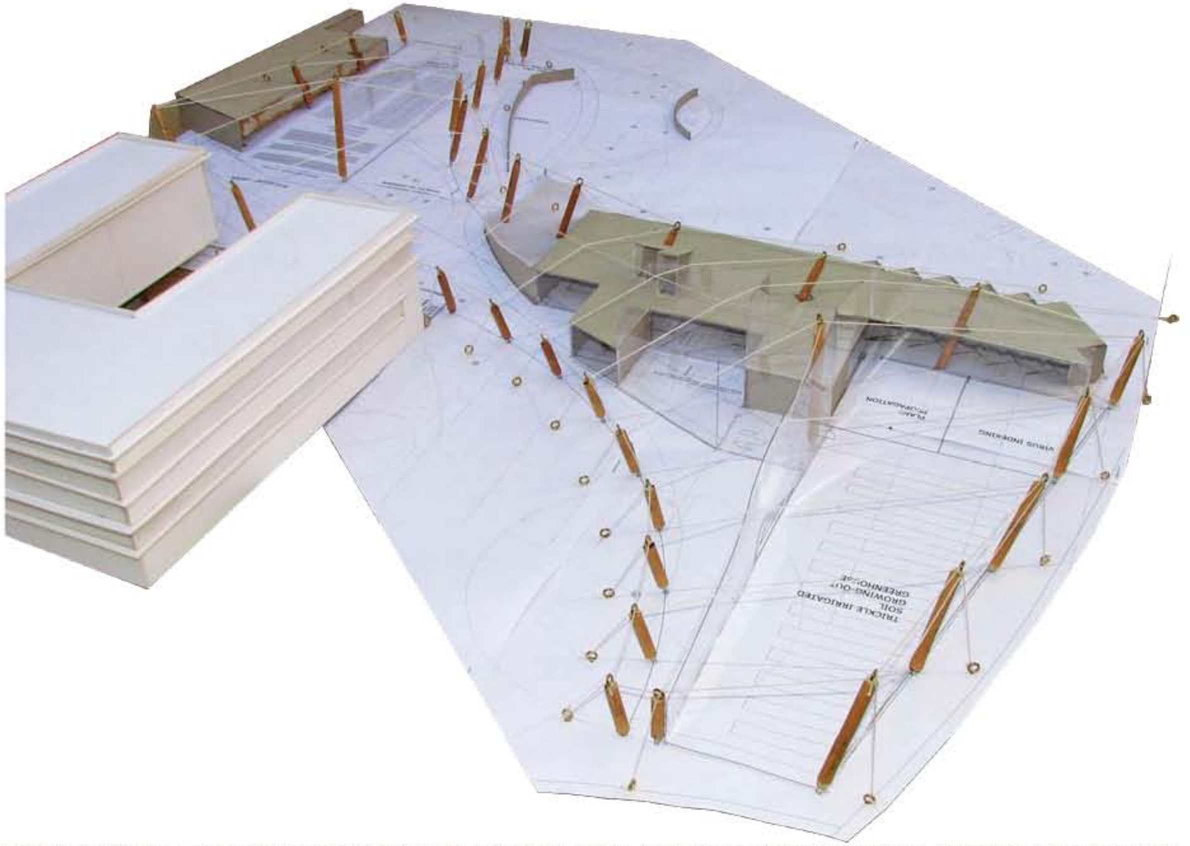


FIG 6.39-40 Final concept model using rope to imitate tensile members. This was used to determine the structural integrity of the assembly and the cohesion of the form language created with the site. September 2008

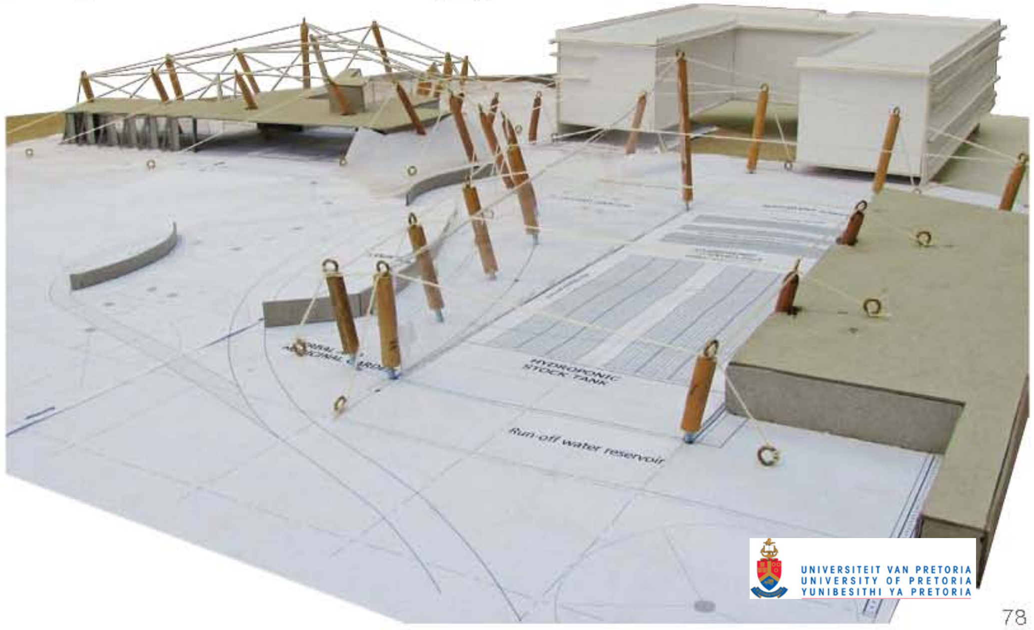
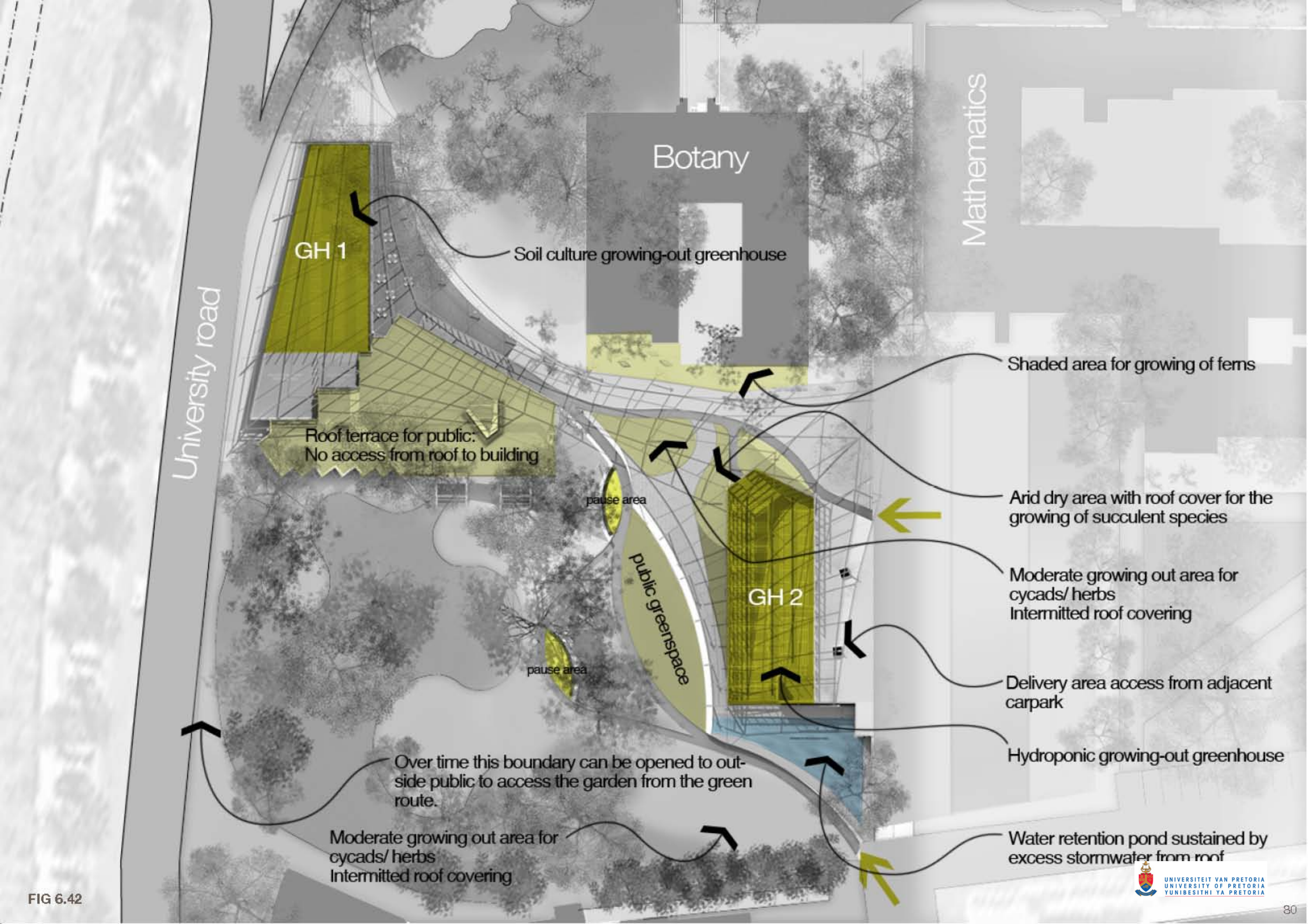


FIG 6.41

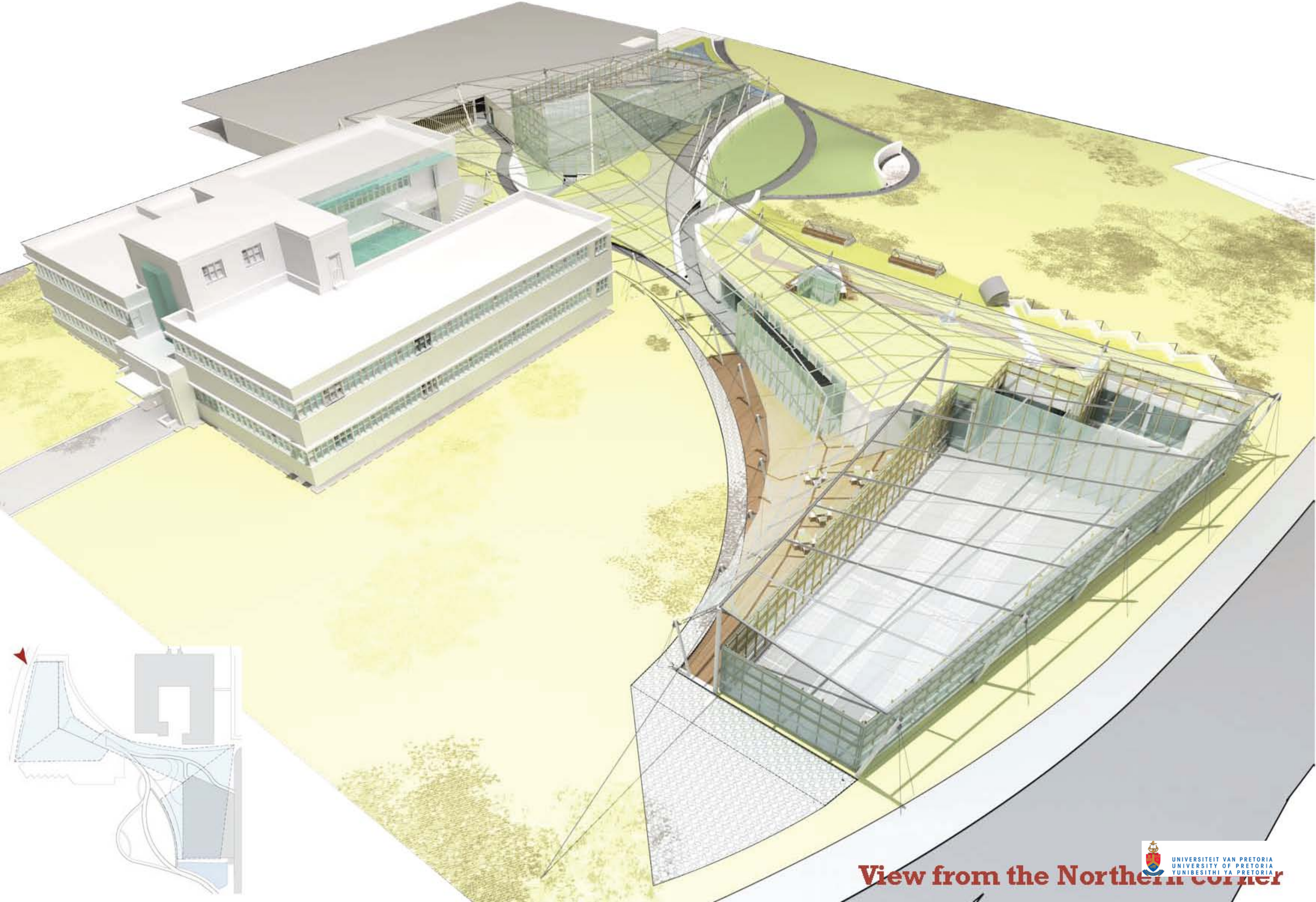
Final intervention proposal



Botany
Mathematics
University road
GH 1
Soil culture growing-out greenhouse
Shaded area for growing of ferns
Roof terrace for public:
No access from roof to building
pause area
Arid dry area with roof cover for the growing of succulent species
public greenspace
Moderate growing out area for cycads/ herbs
Intermitted roof covering
GH 2
pause area
Delivery area access from adjacent carpark
Hydroponic growing-out greenhouse
Over time this boundary can be opened to outside public to access the garden from the green route.
Moderate growing out area for cycads/ herbs
Intermitted roof covering
Water retention pond sustained by excess stormwater from roof

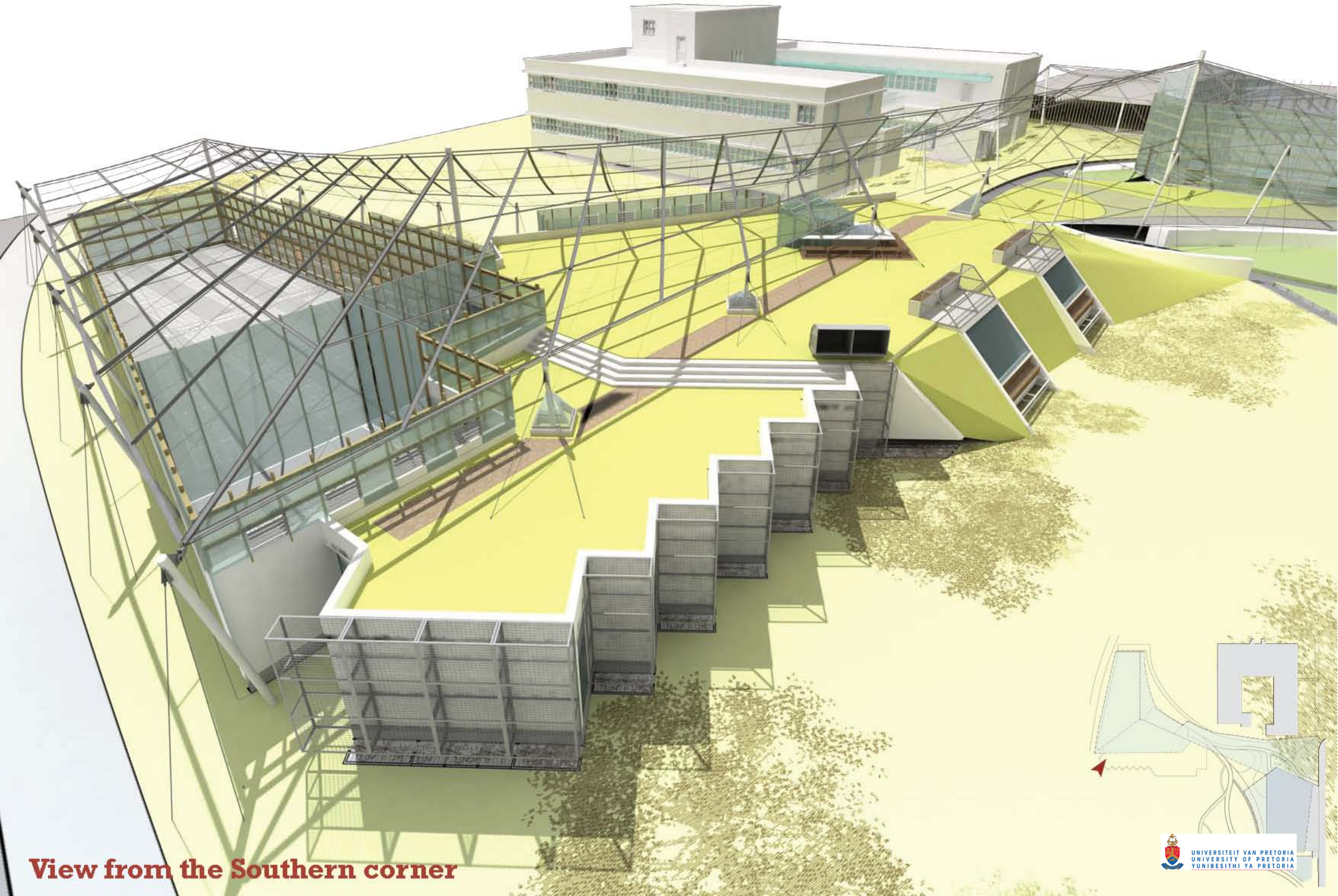
FIG 6.42

FIG 6.43



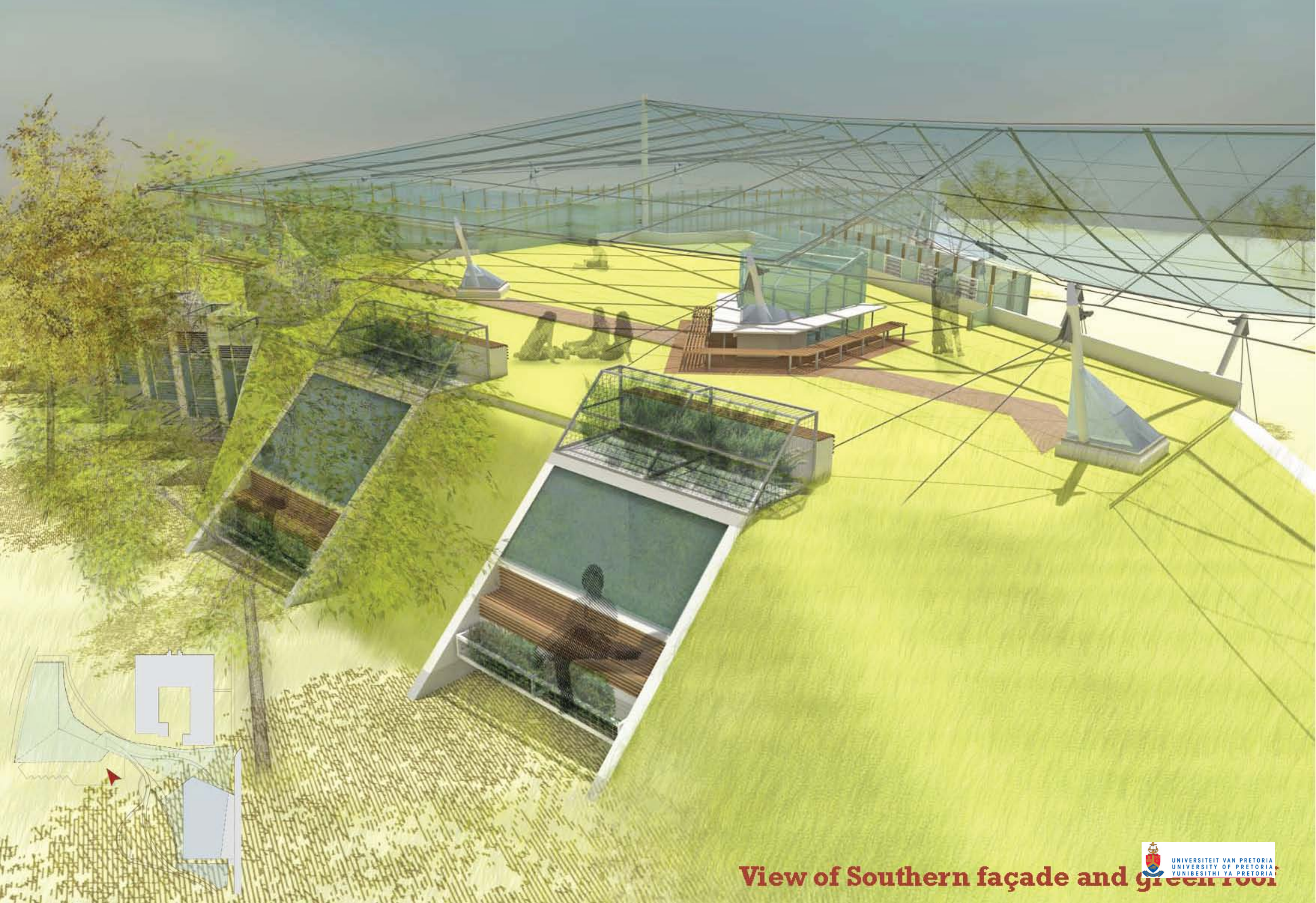
View from the Northern corner

FIG 6.44



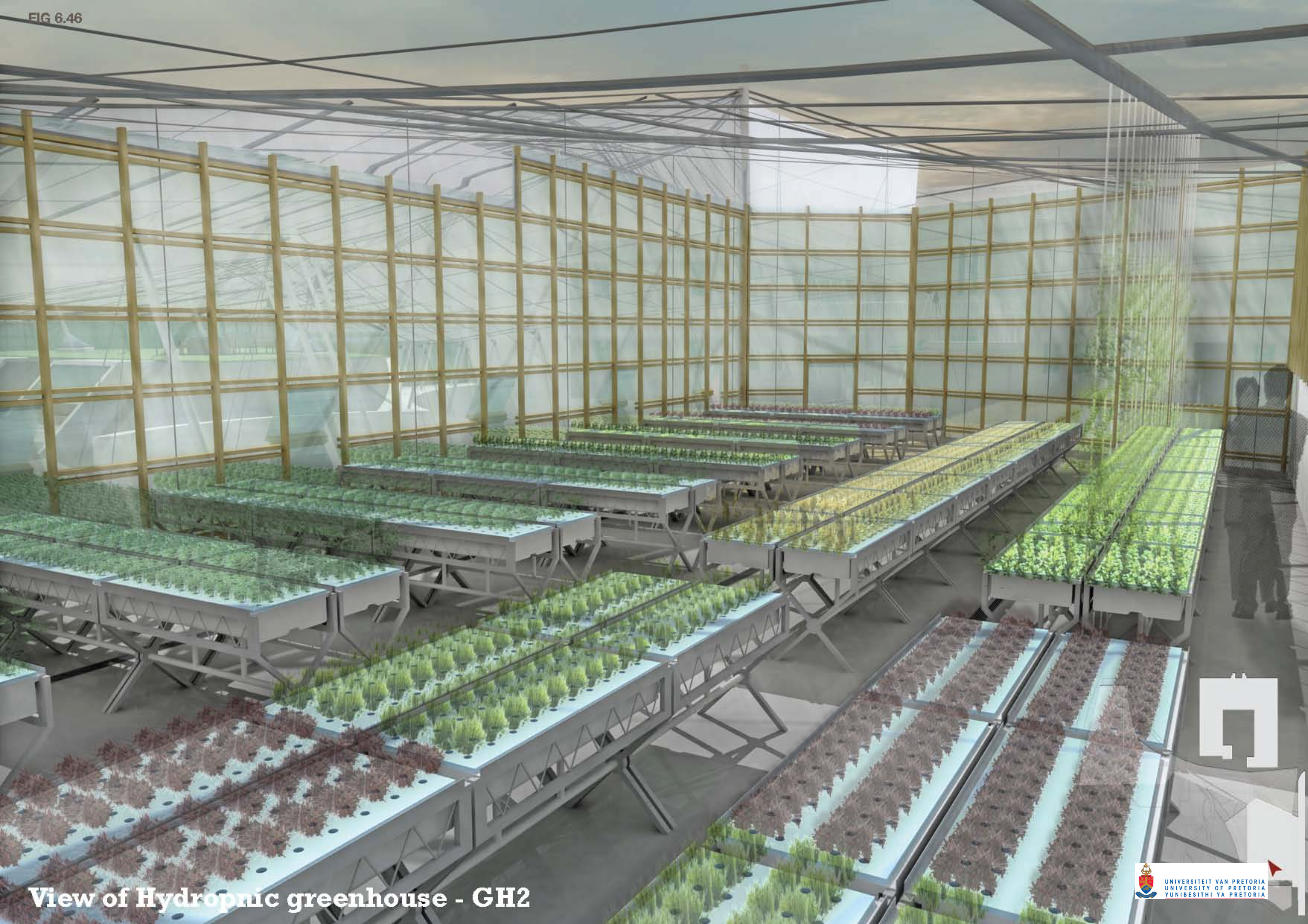
View from the Southern corner

FIG 6.45



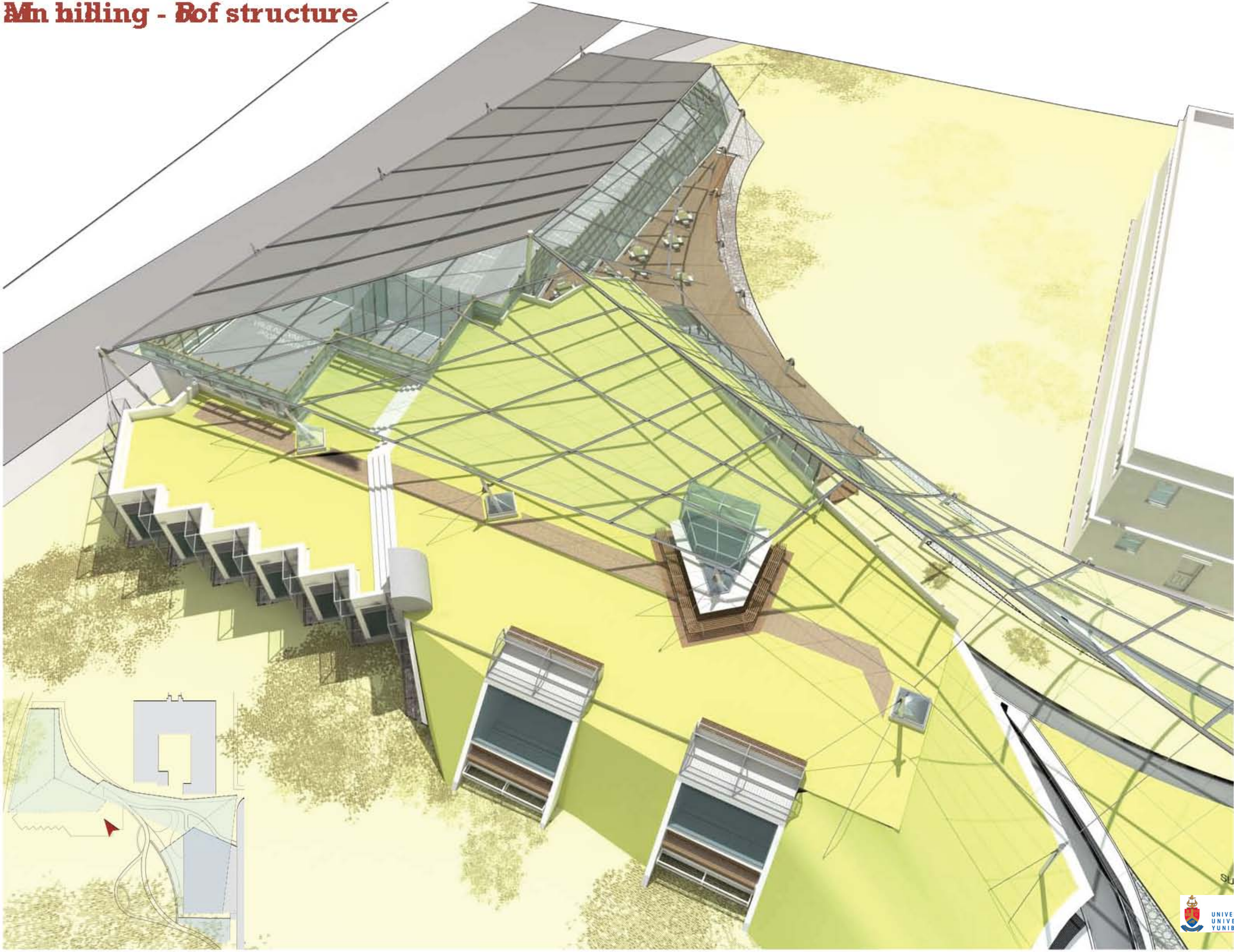
View of Southern façade and green roof

FIG 6.46



View of Hydropnic greenhouse - GH2

Main building - Roof structure



UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

FIG 6.47

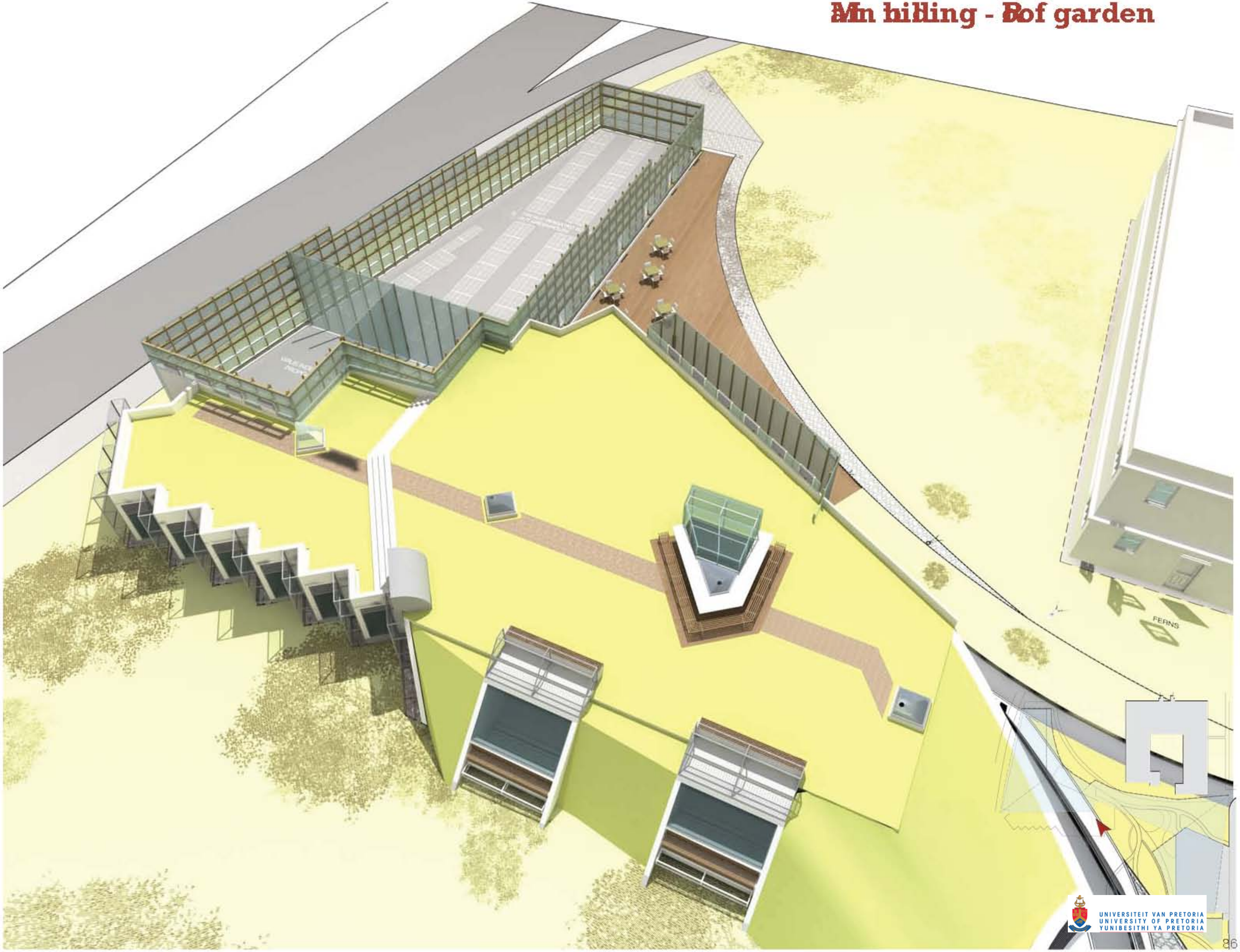
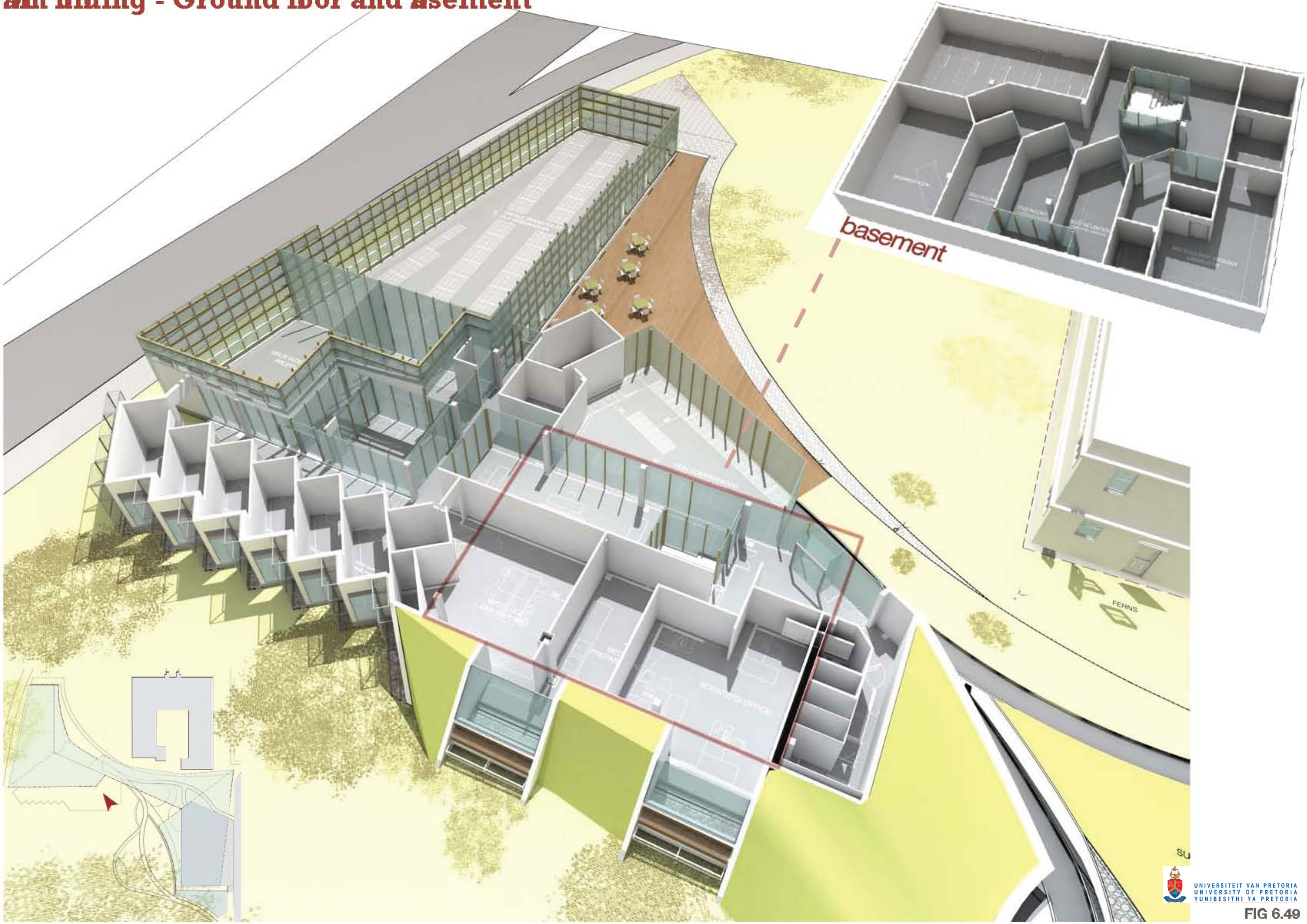


FIG 6.48

Main building - Ground floor and basement



UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

FIG 6.49

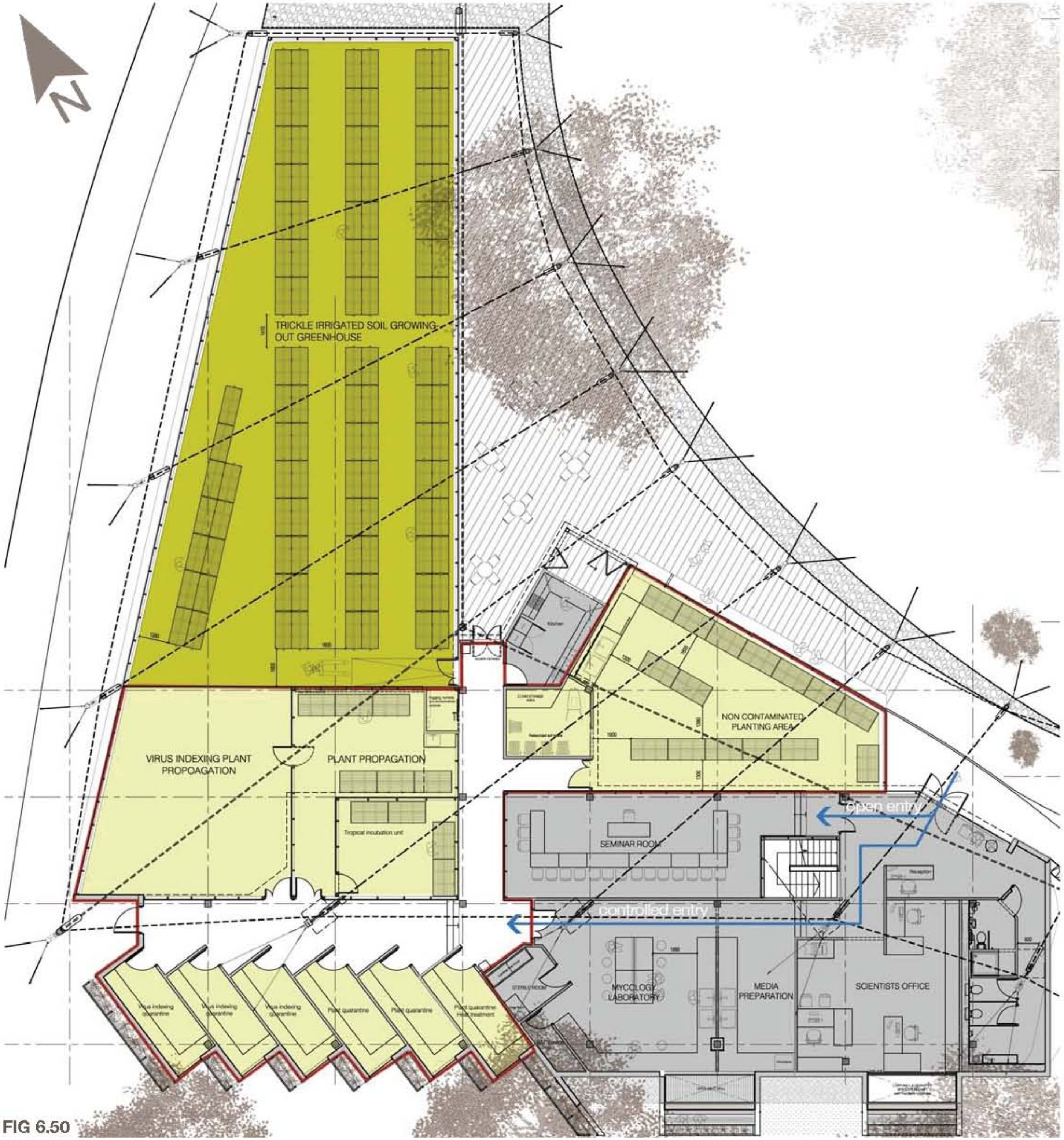


FIG 6.50

PLEASE REFER TO FIG. 6.2 FOR A DETAILED DESCRIPTION ON EACH PHASE

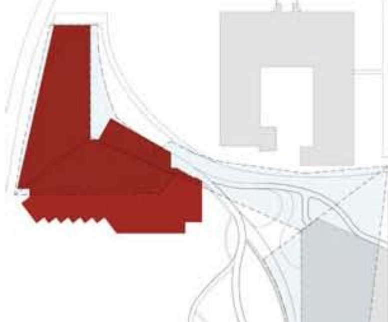
PHASE 1

PHASE 2

PHASE 3

CONTAINMENT FACILITY (PC2 RATED)

ACCESS



Hydroponic greenhouse - GH2

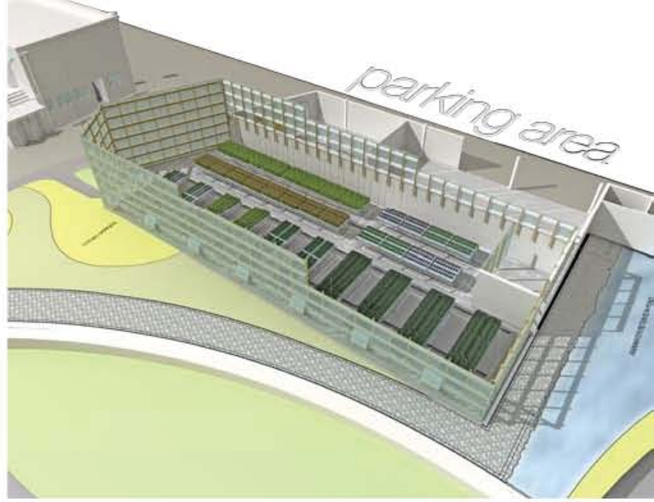


FIG 6.52

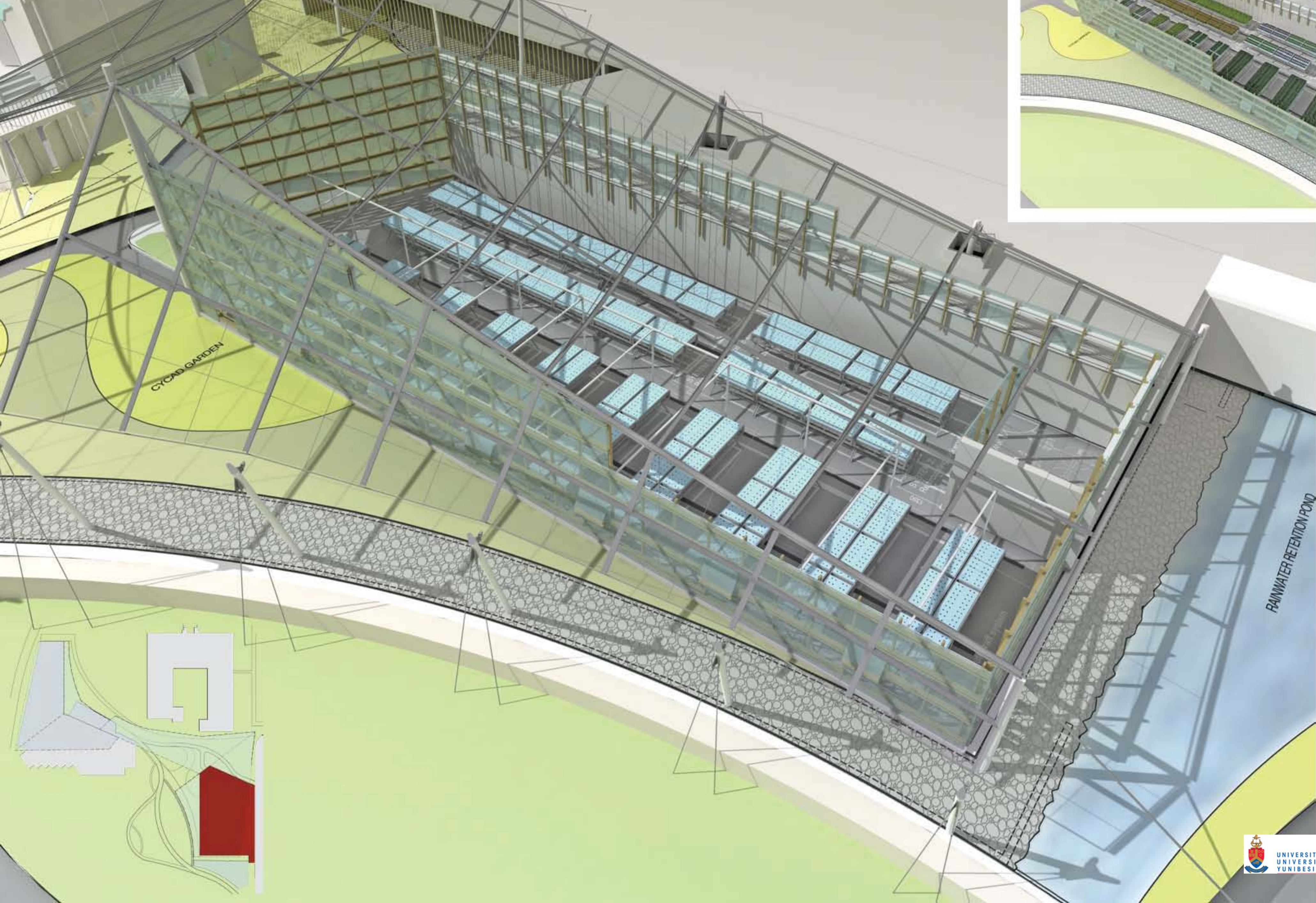


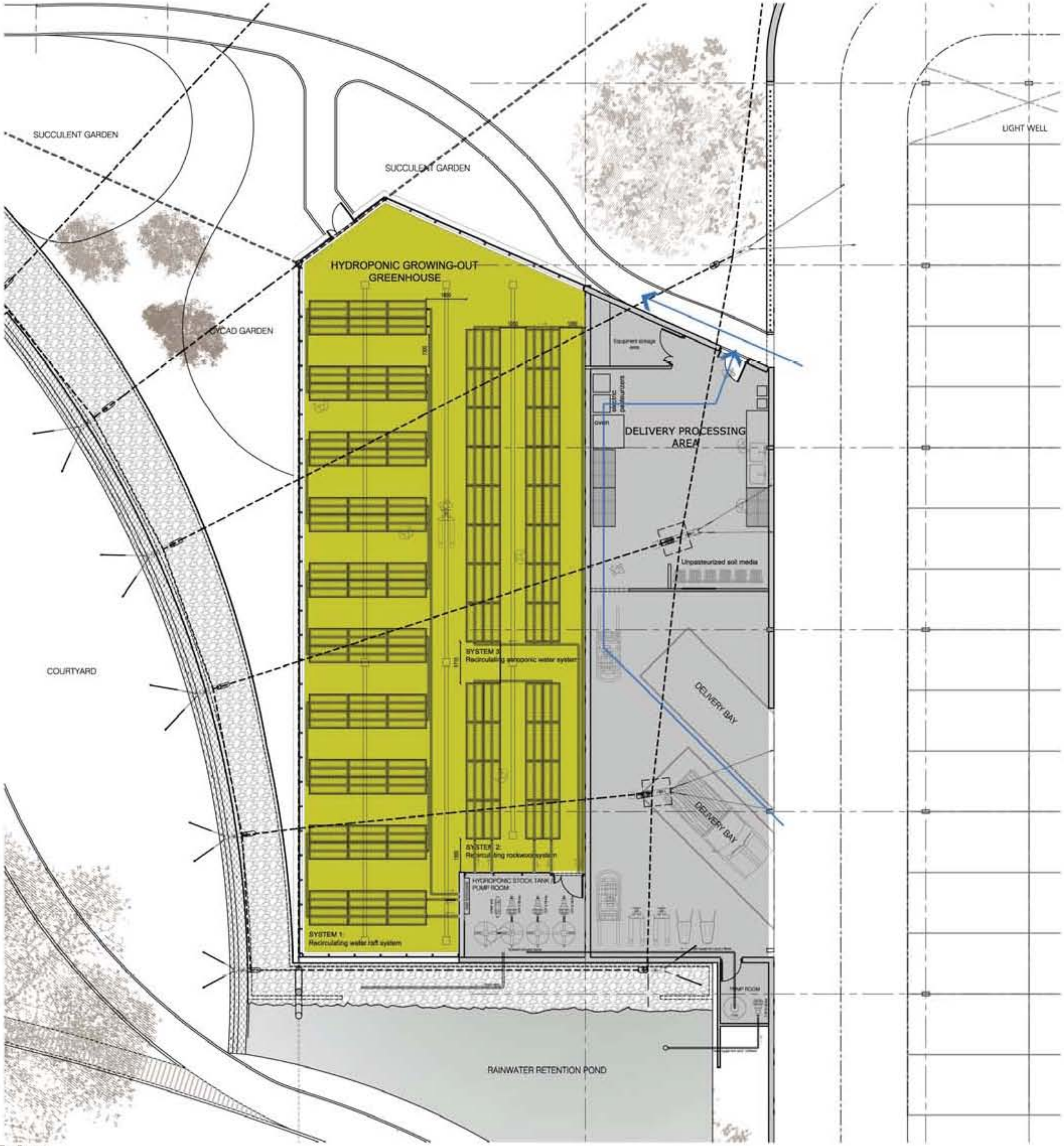
FIG 6.51

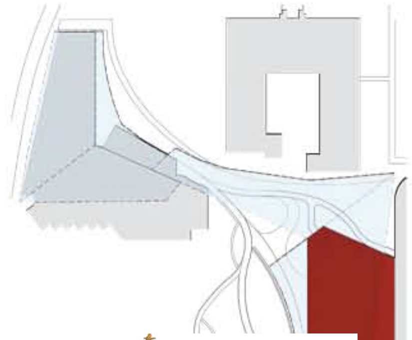
PLEASE REFER TO FIG. 6.2 FOR A DETAILED DESCRIPTION ON EACH PHASE

PHASE 1

PHASE 3

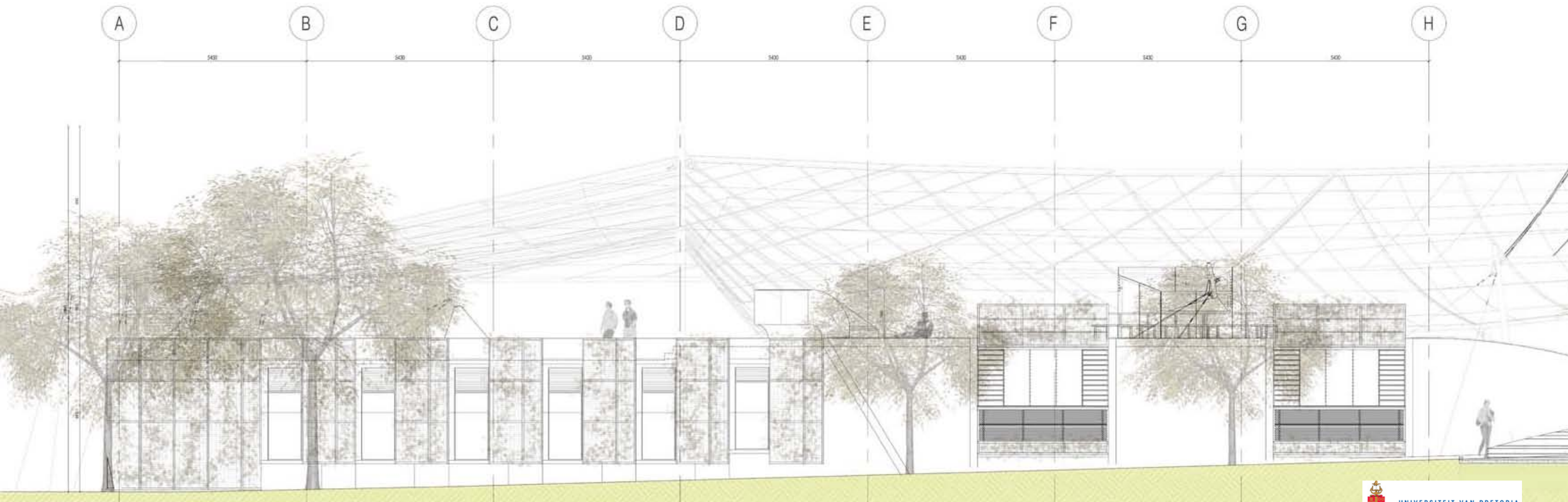
ACCESS





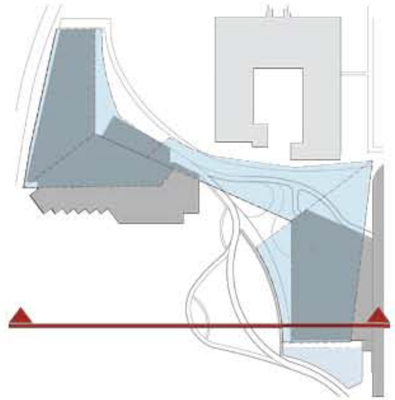
UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

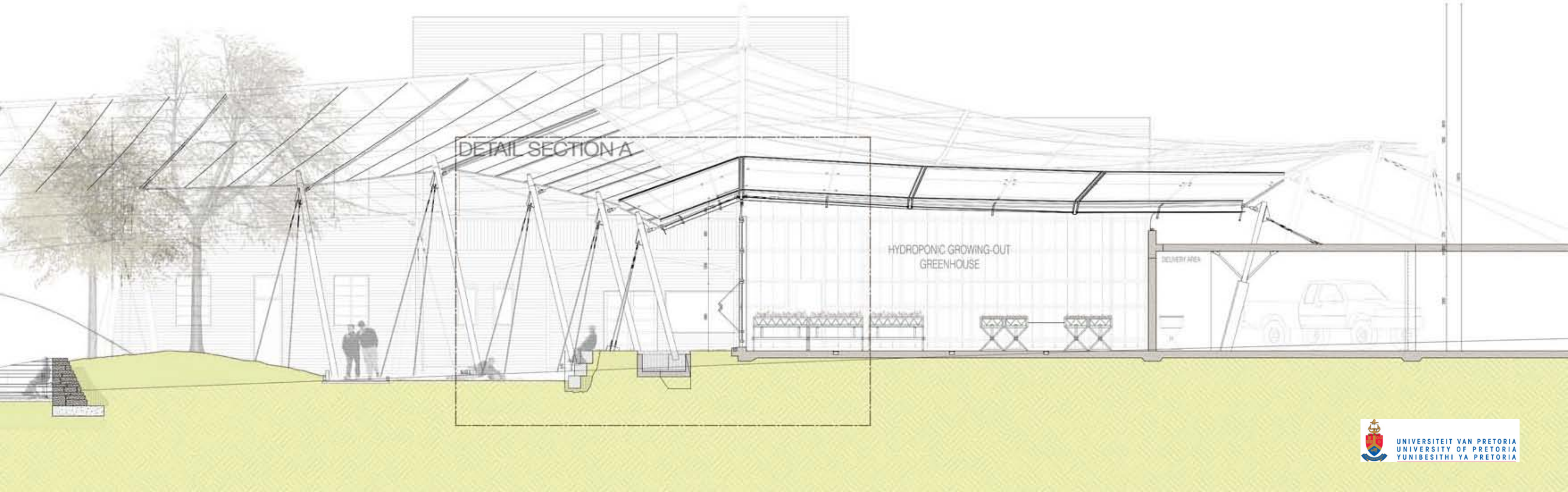
FIG 6.53



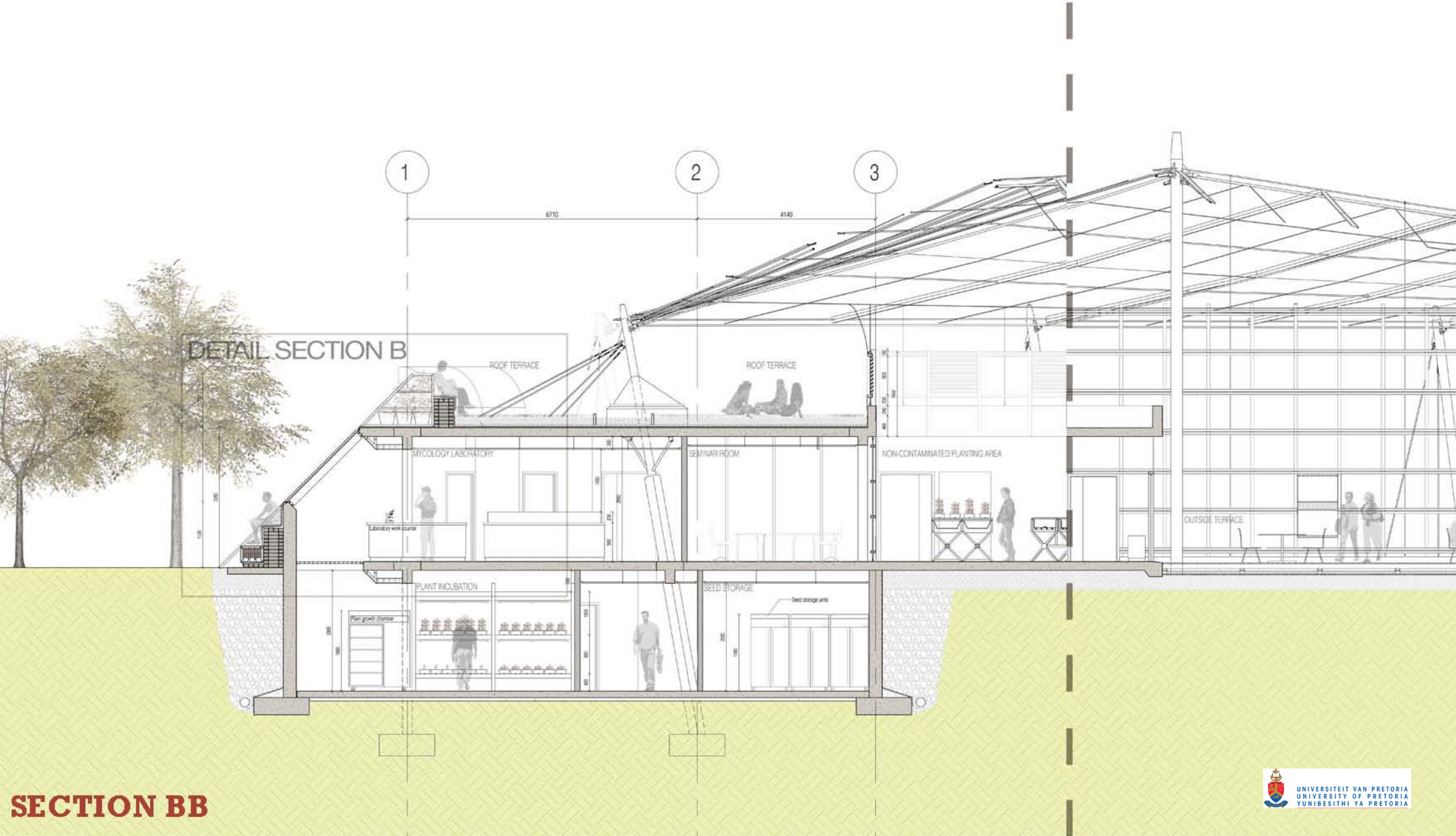
SECTION AA

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA



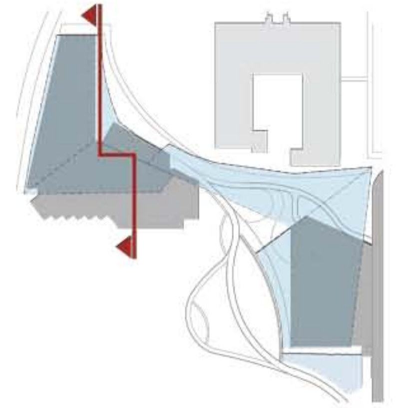


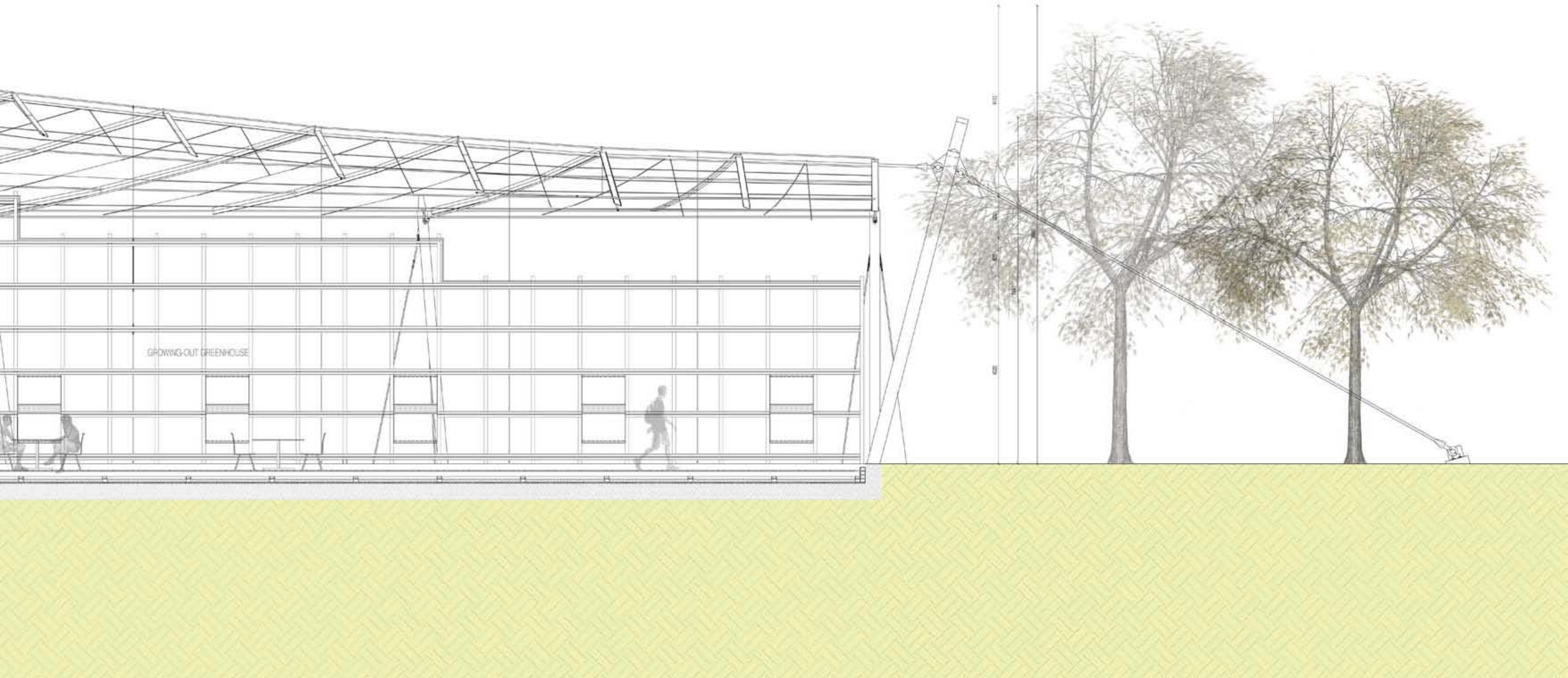
UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA



SECTION BB

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA





UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA