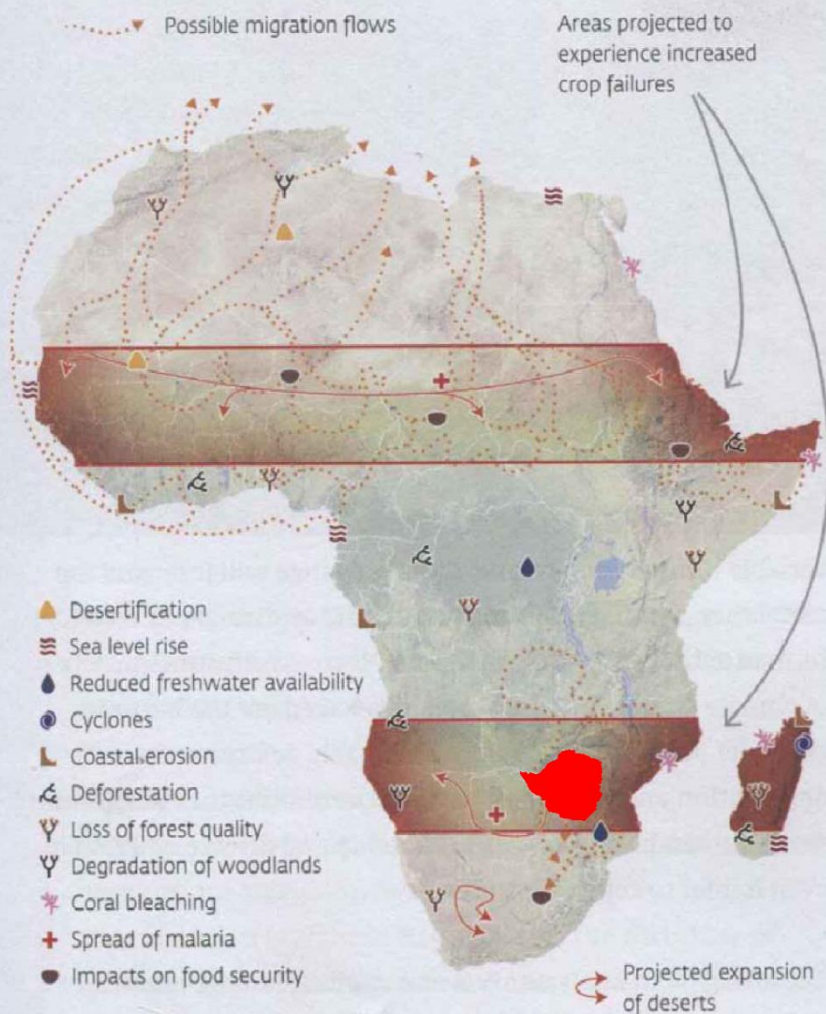
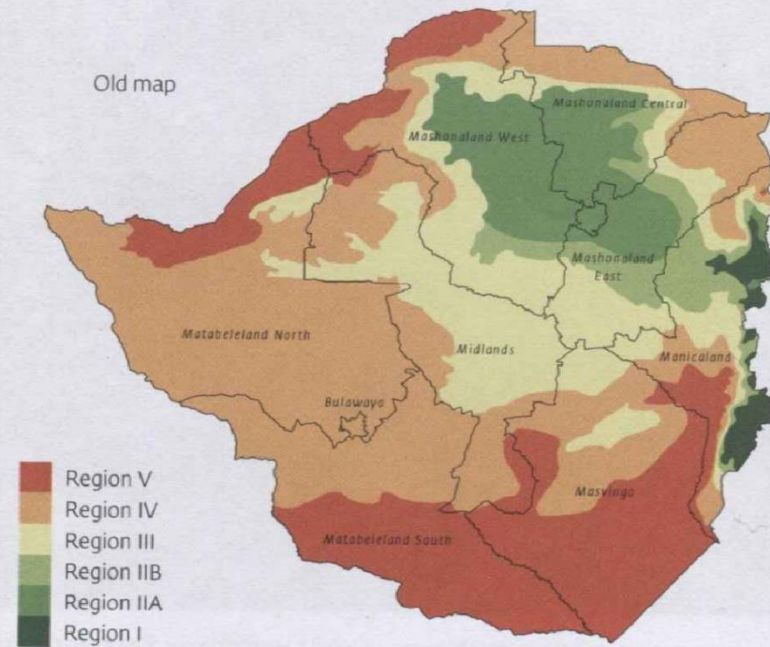




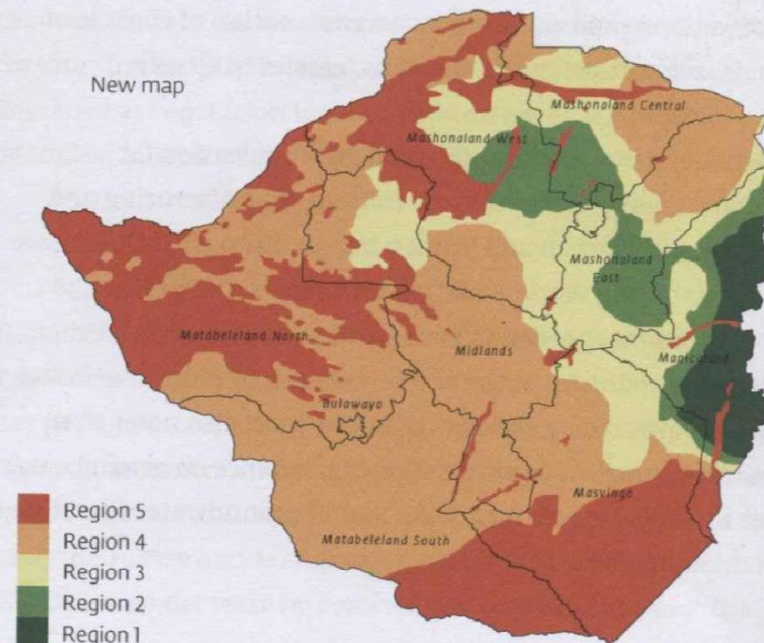
IMG\_2220.mp4



Old map



New map



Zimbabwe is a southern African country between the Zambezi and Limpopo rivers. It has a mid altitude subtropical climate with 8 months of cool and dry and 4 months of hot and wet.

Figure 20: The expected impacts of climate change on Africa

Adapted from Canali 2013





The cool and dry season





The hot and wet season











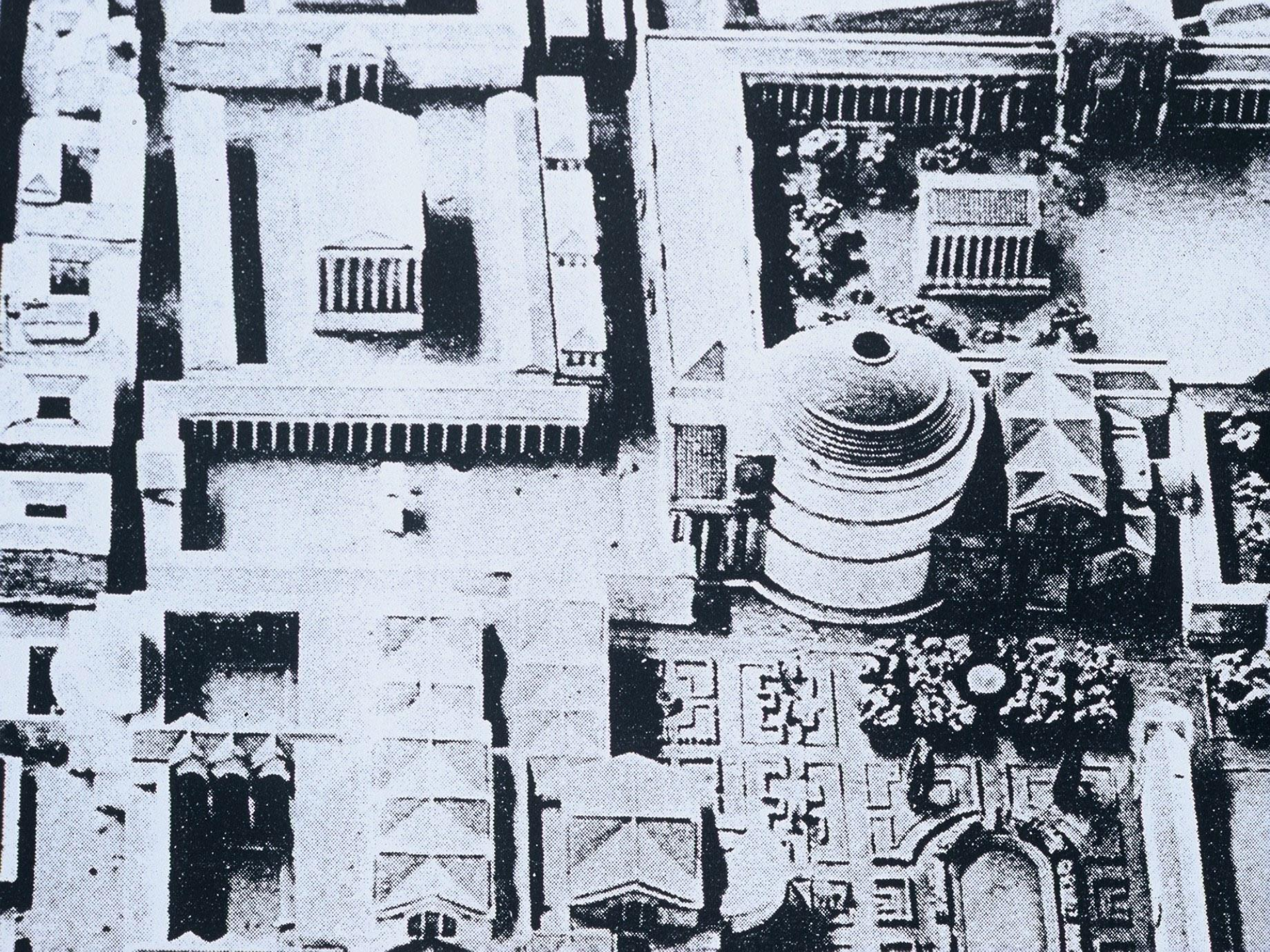


1963

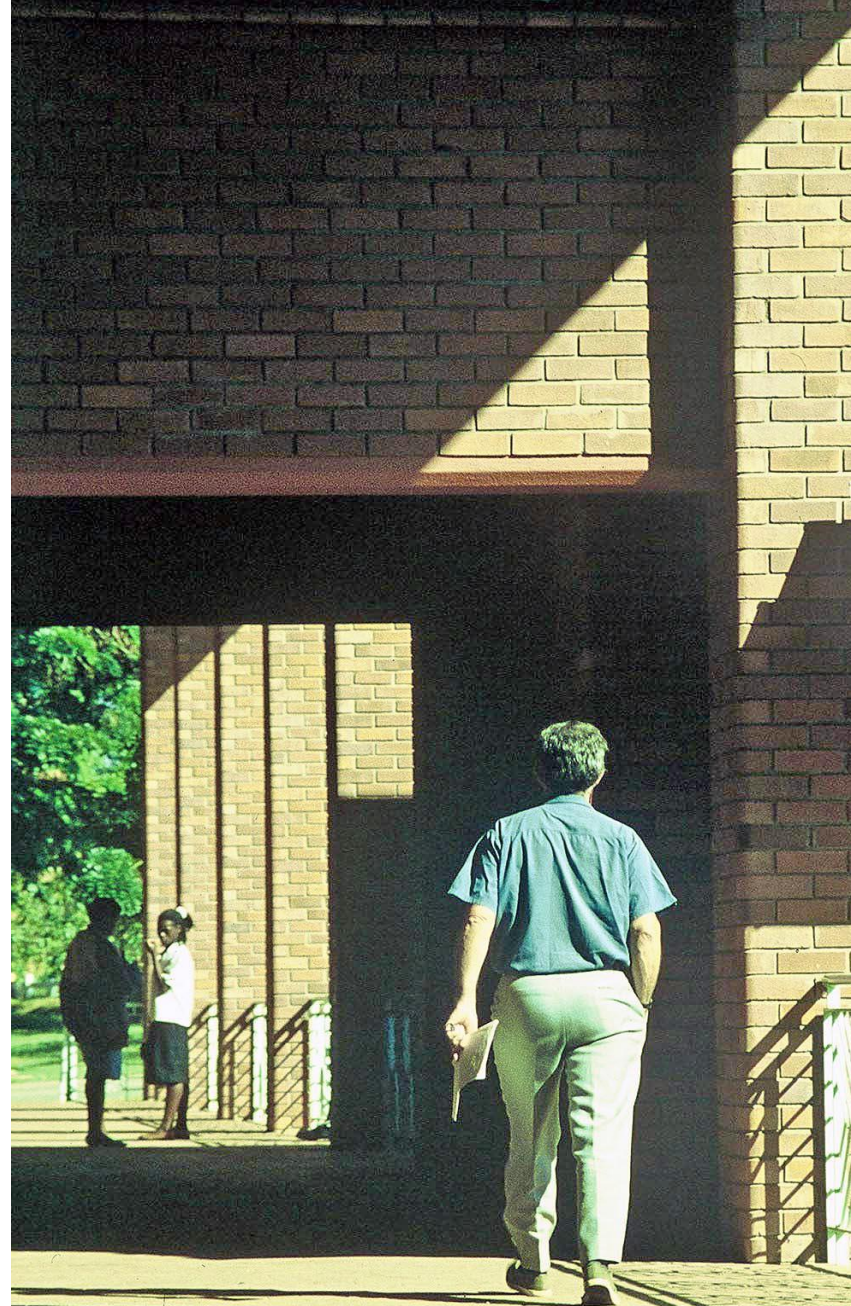












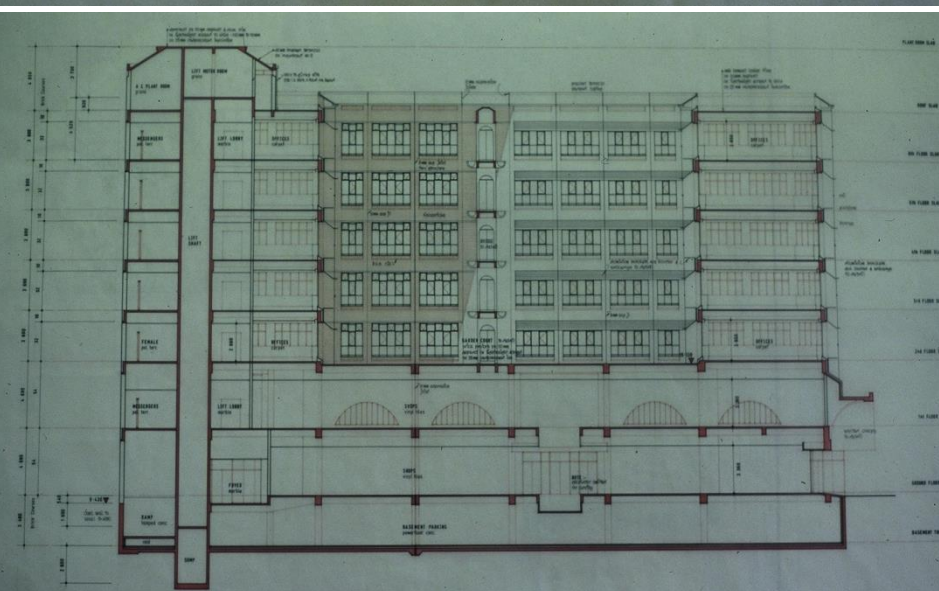












BATANI GARDENS HARARE 1983-1986





















EASTGATE MIXED DEVELOPMENT HARARE 1992 - 1996

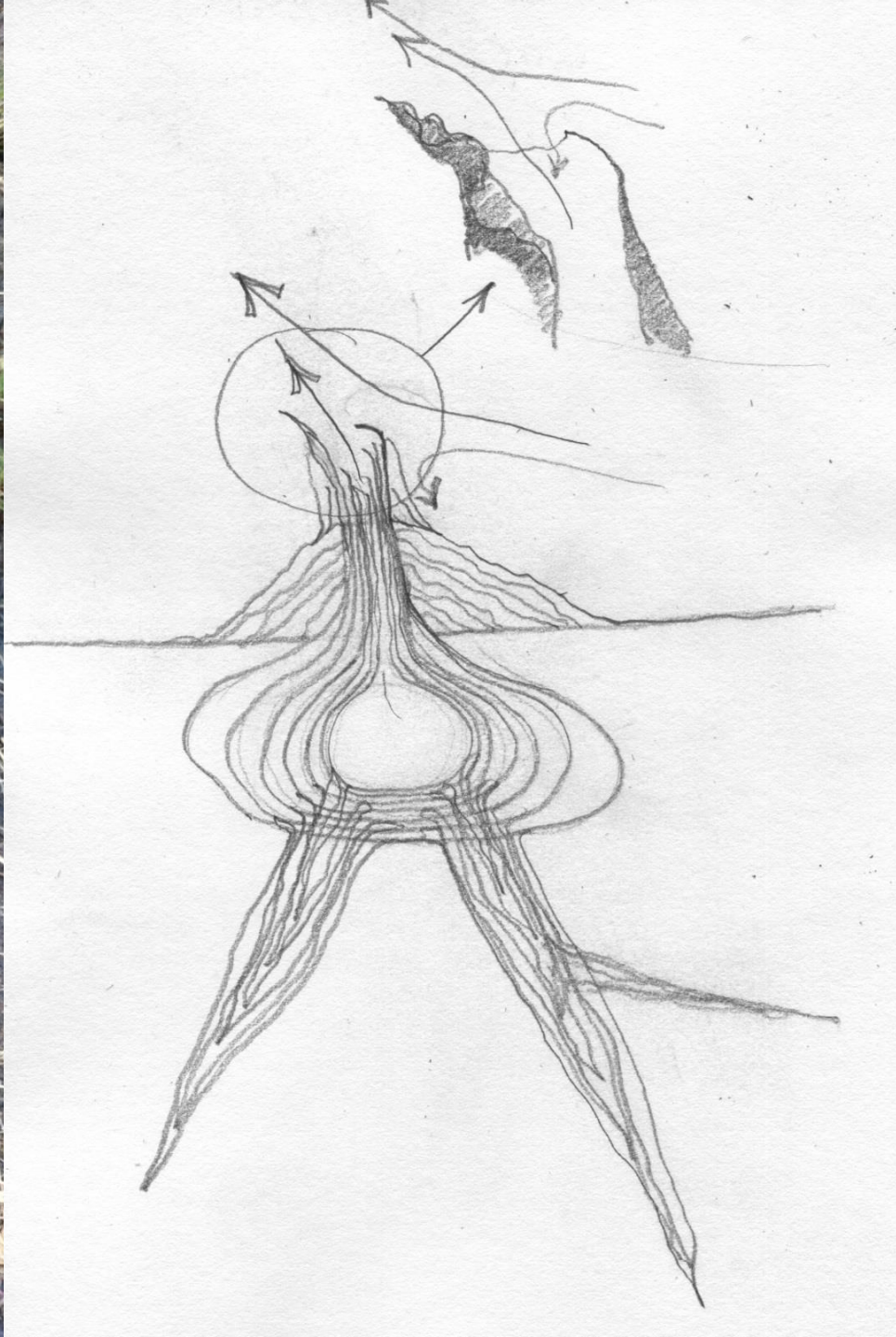












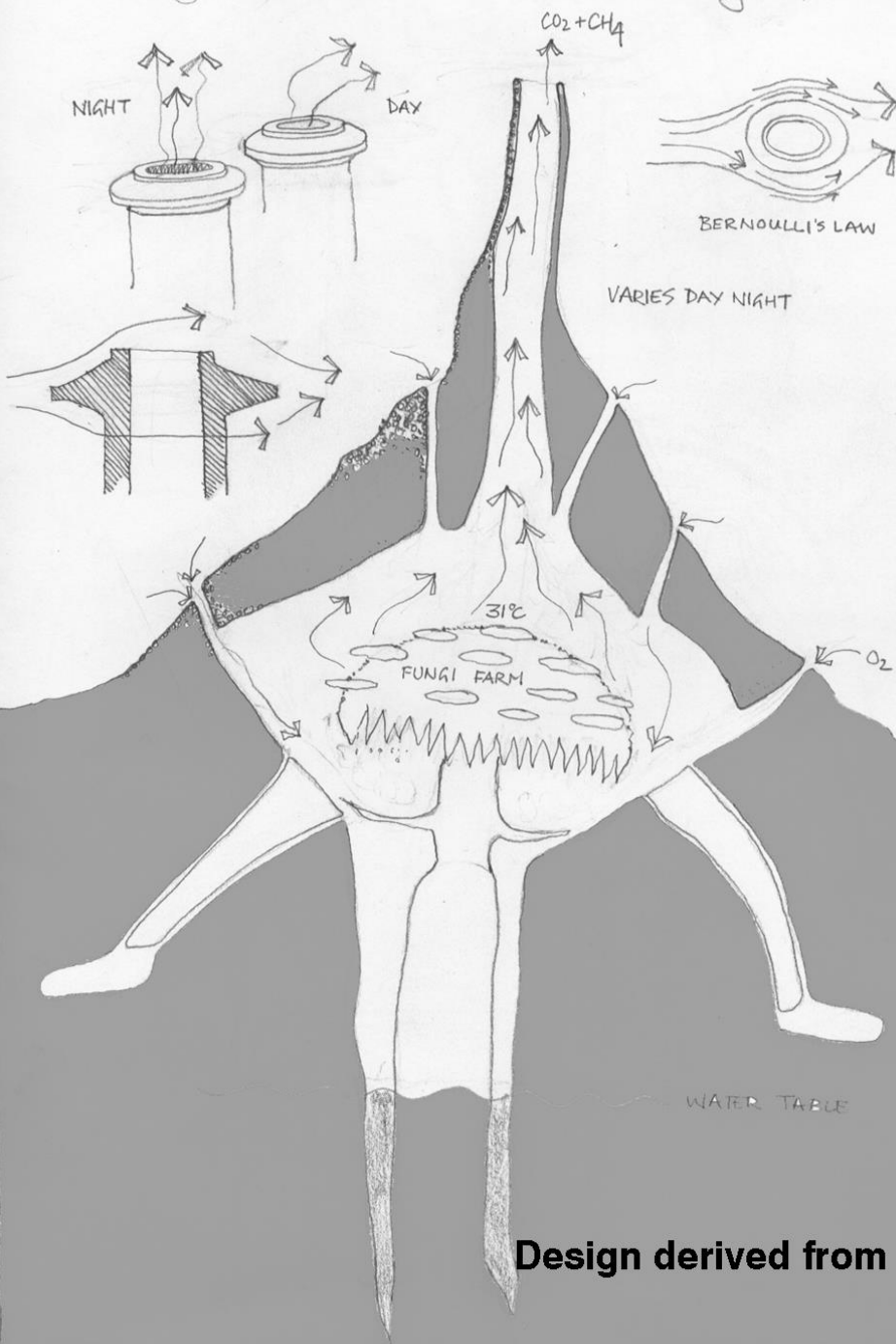


Could the Architect  
be formed by the  
movement of air?

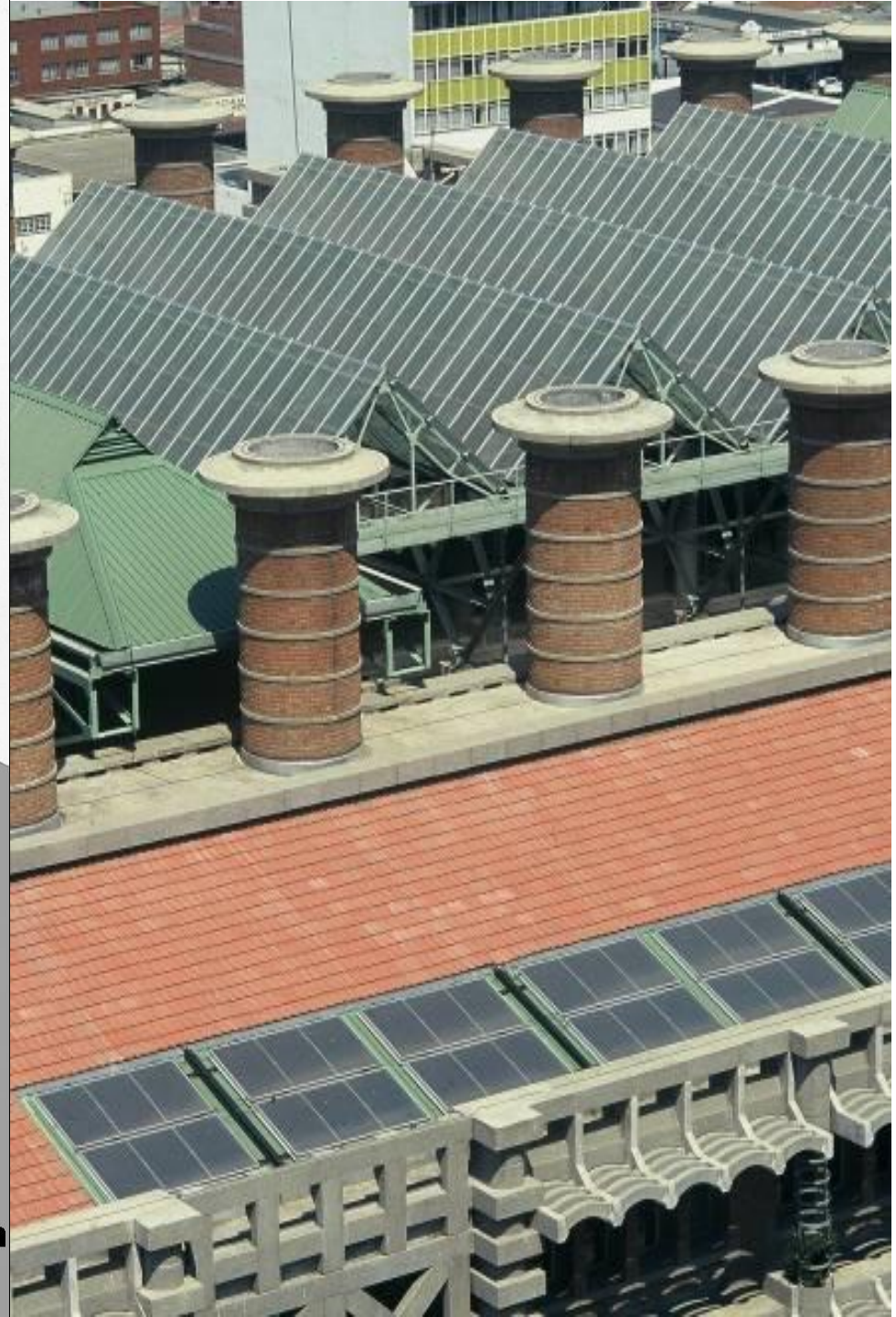




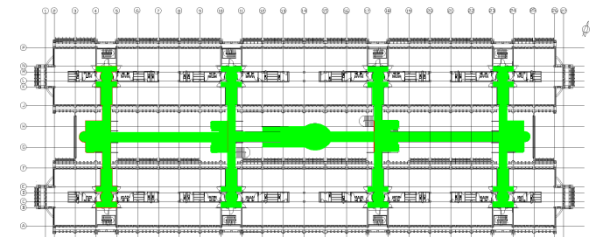
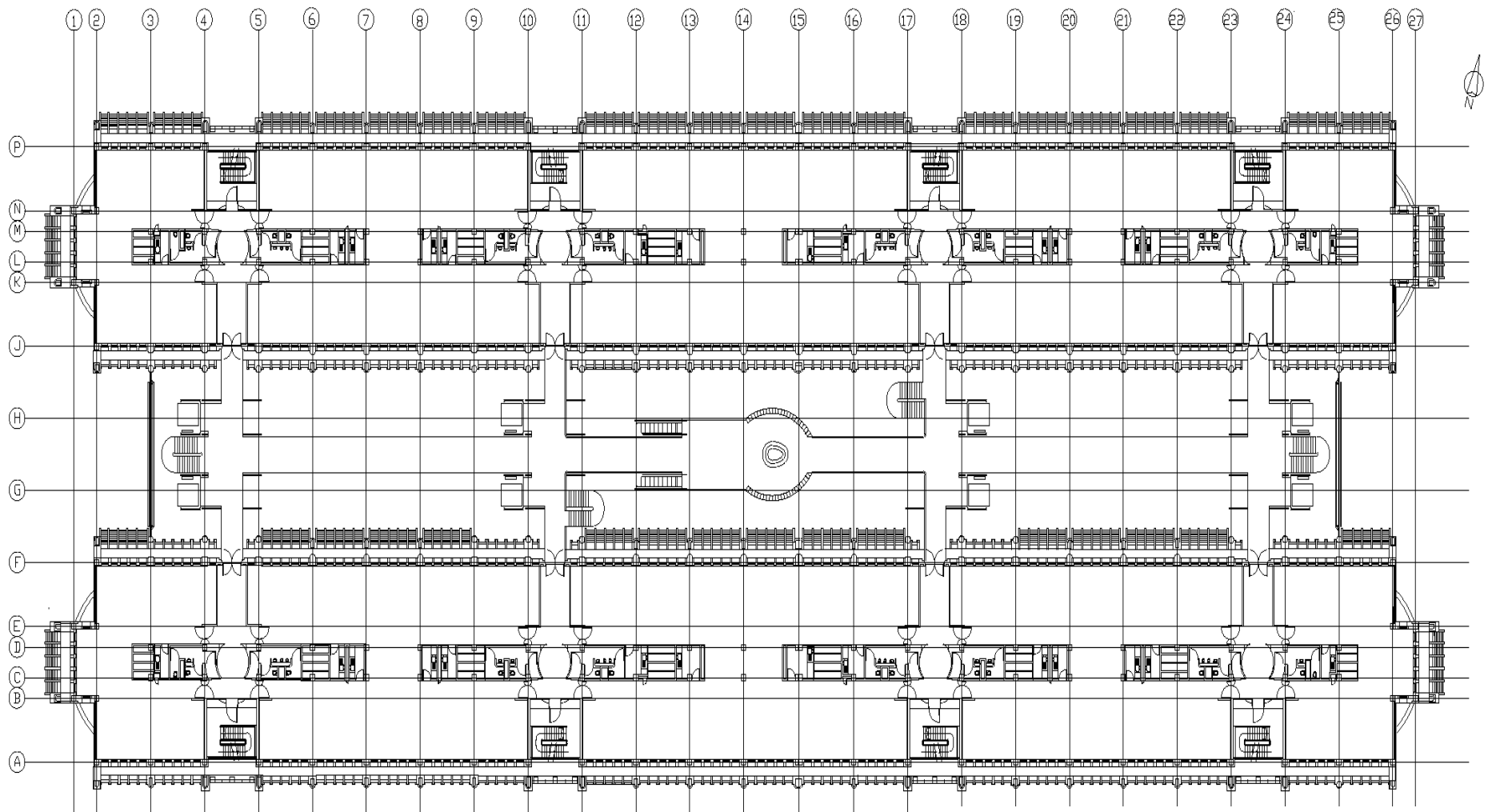
Why Eastgate is like a termite



Design derived from n



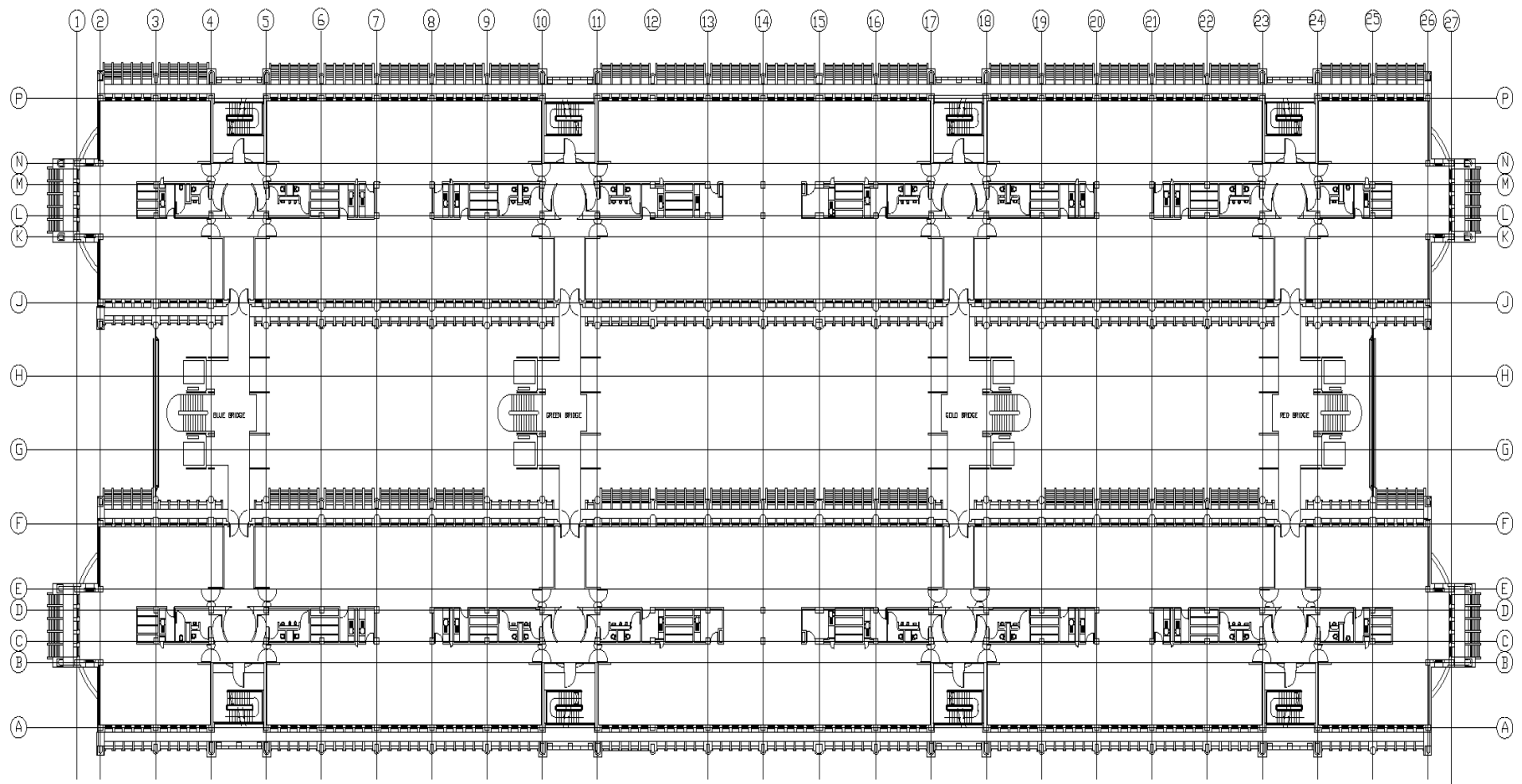




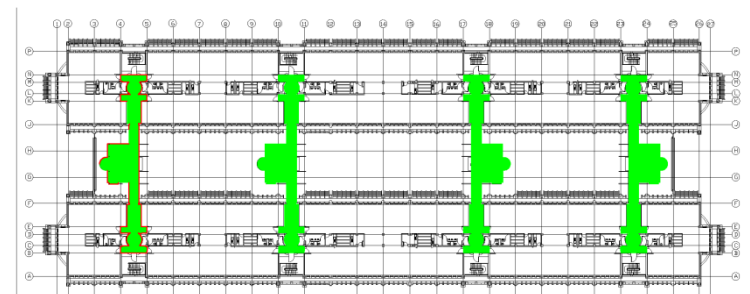
PLAN LEVEL 2

SHOWING ARCHITECTURE OF MOVEMENT LINKING OVER THE STREET





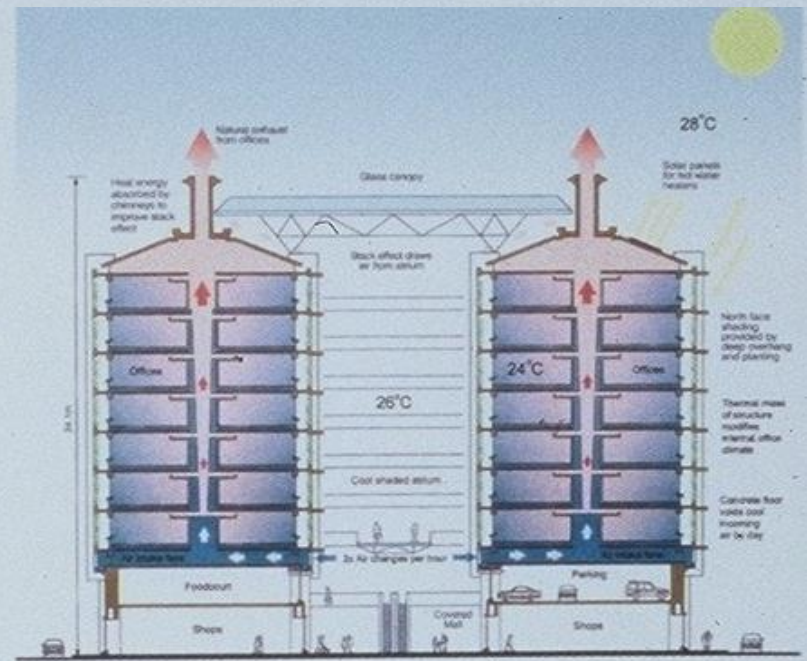
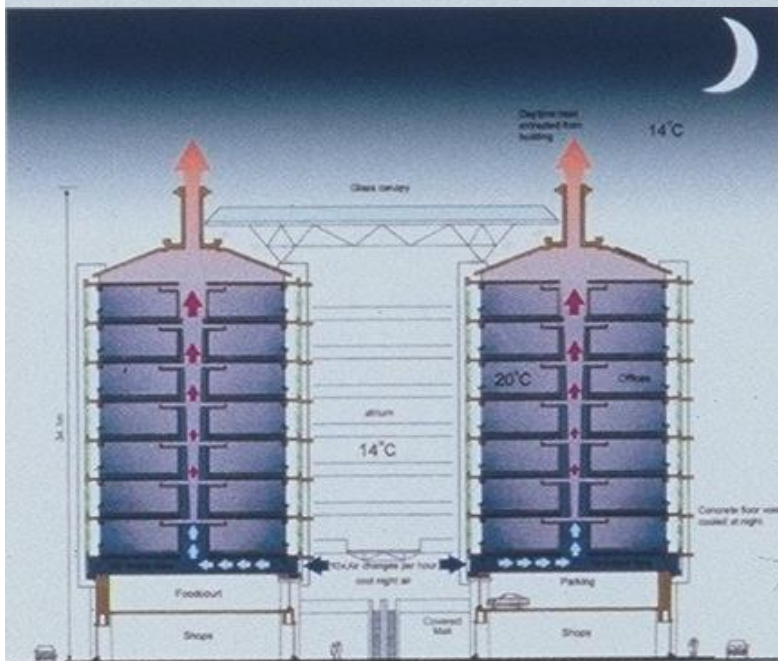
PLAN OF LEVEL 3 TO 8  
 with the four suspended bridges at each level  
 connecting entrance lobbies to tenancies of different  
 sizes varying  
 from 50m<sup>2</sup> to 2000m<sup>2</sup>







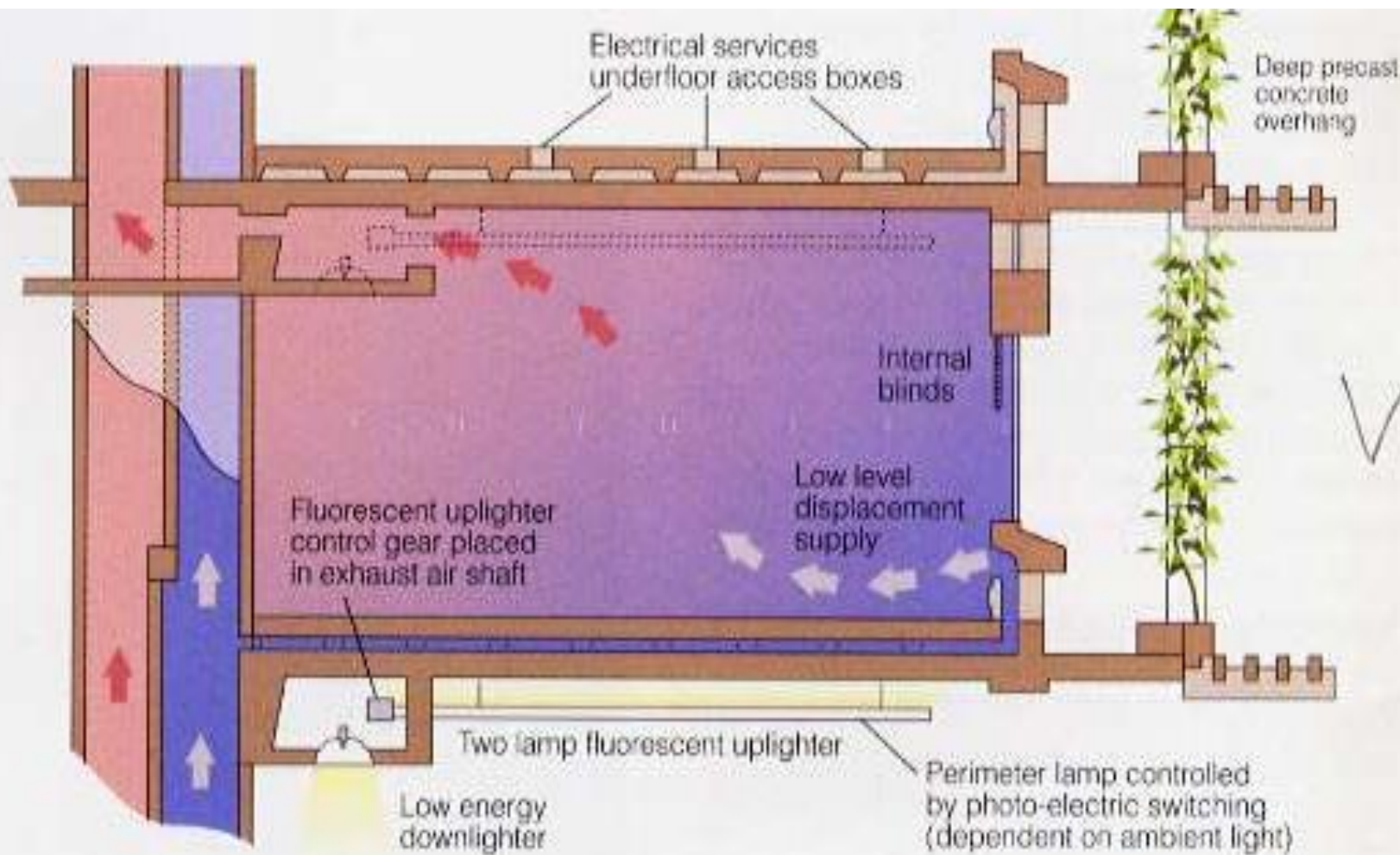
Longitudinal section



Sections showing the passive cooling system



4.  
Cross-section  
through  
typical office.

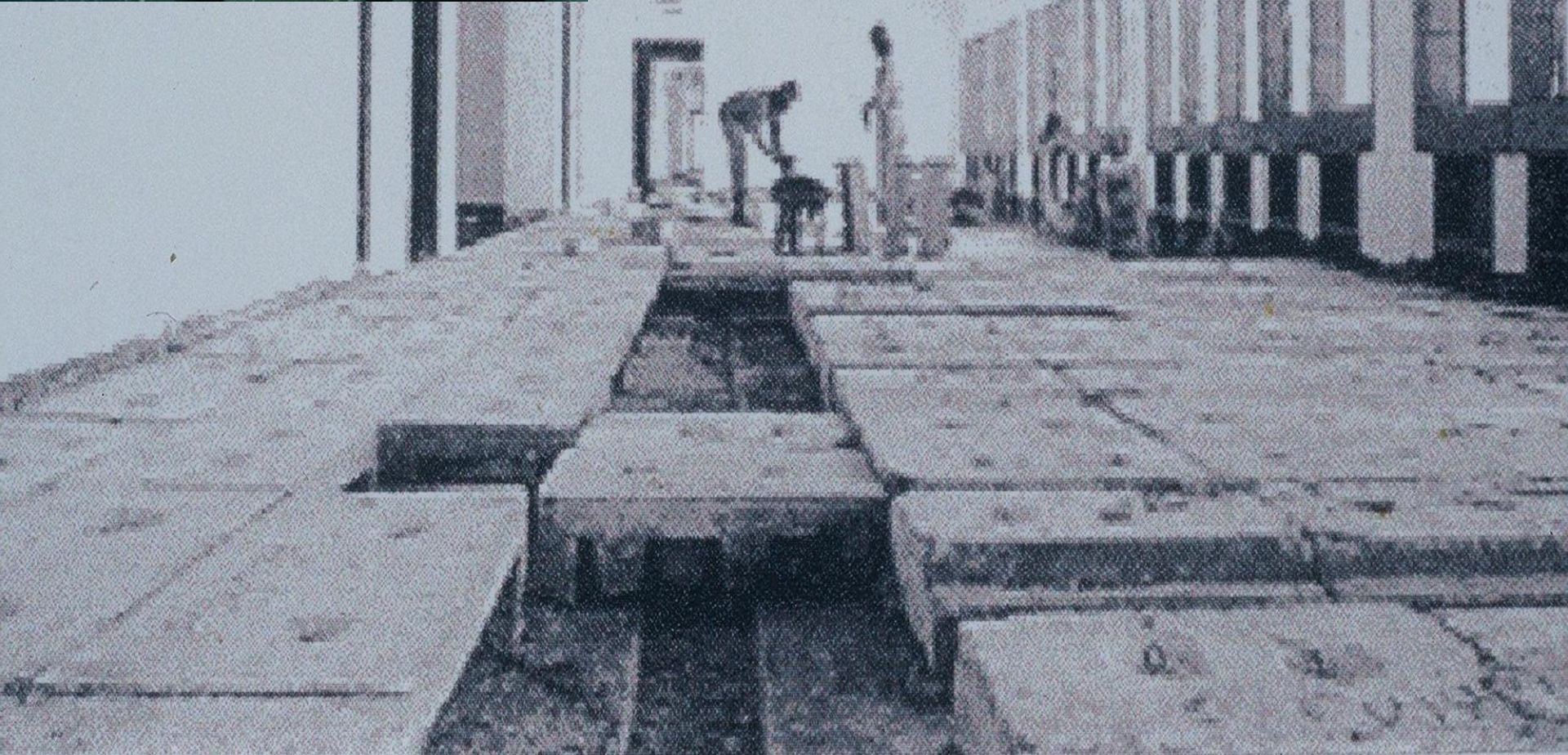


## SECTION THROUGH TYPICAL OFFICE





Precast concrete  
floor units form a  
heat exchanger like  
the termitary







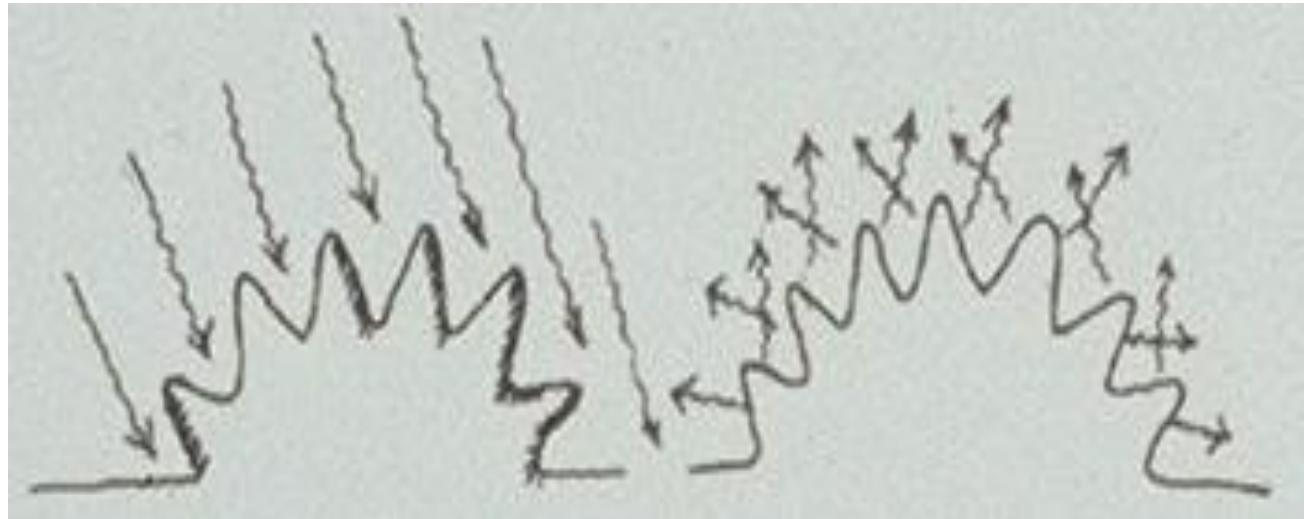
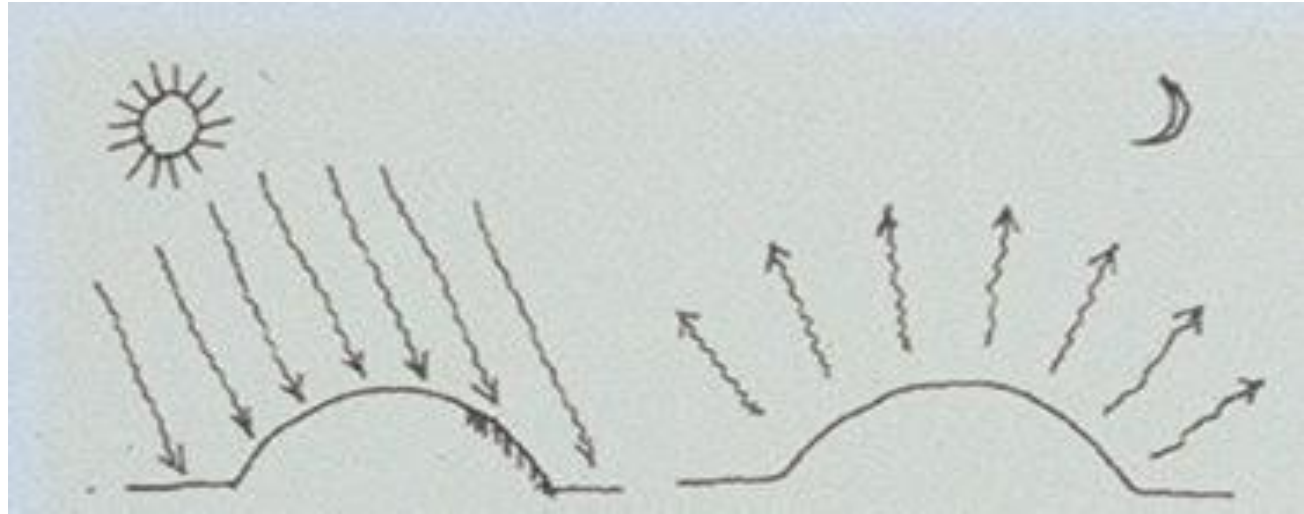




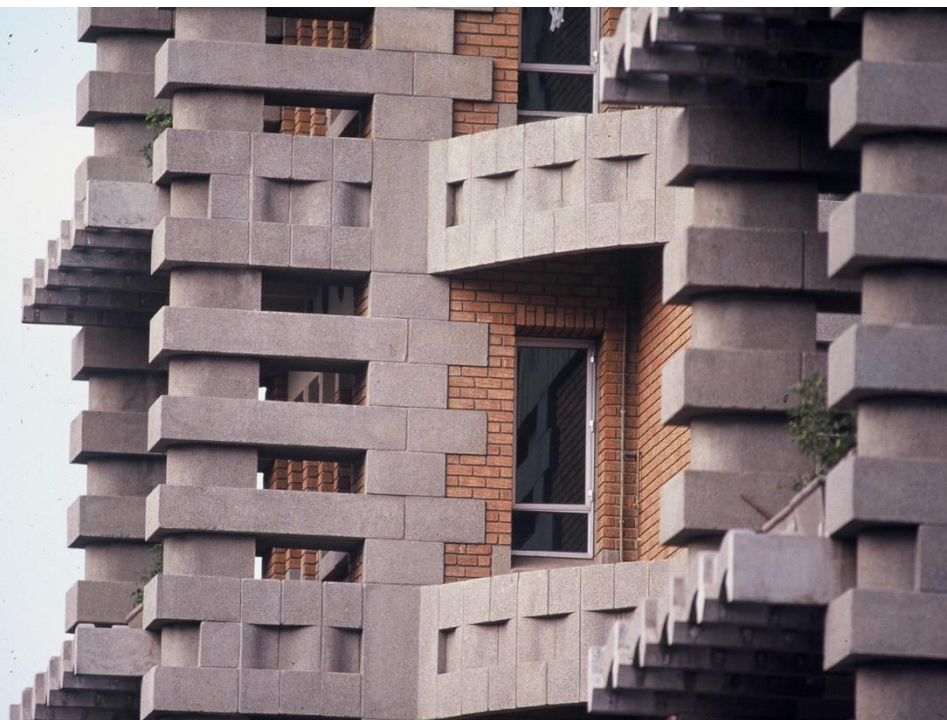


# External façade

- Smooth bodies are better at absorbing heat and poor emitters of heat to space at night
- Prickly bodies are poorer absorbers of heat by day and good emitters of heat at night



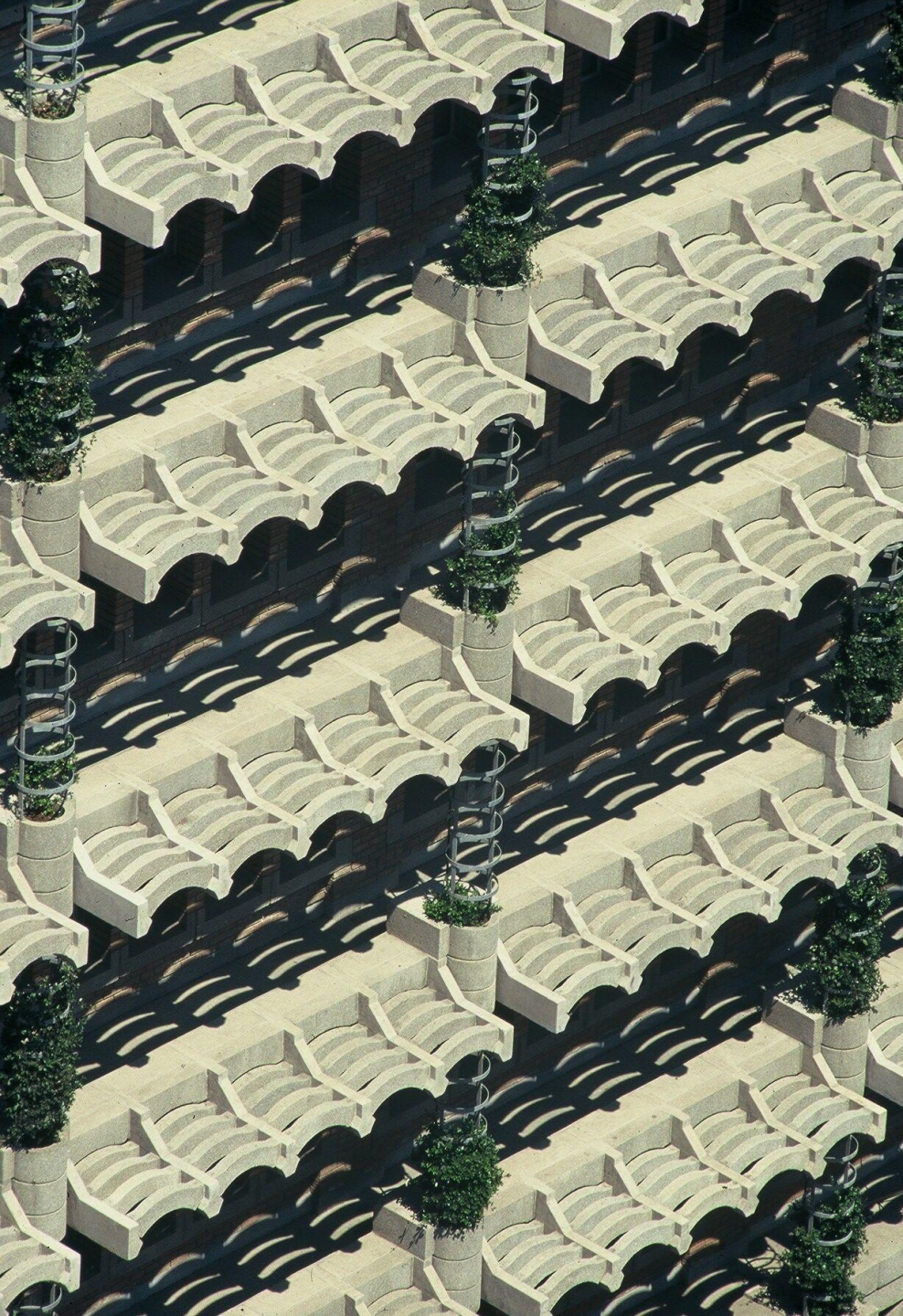




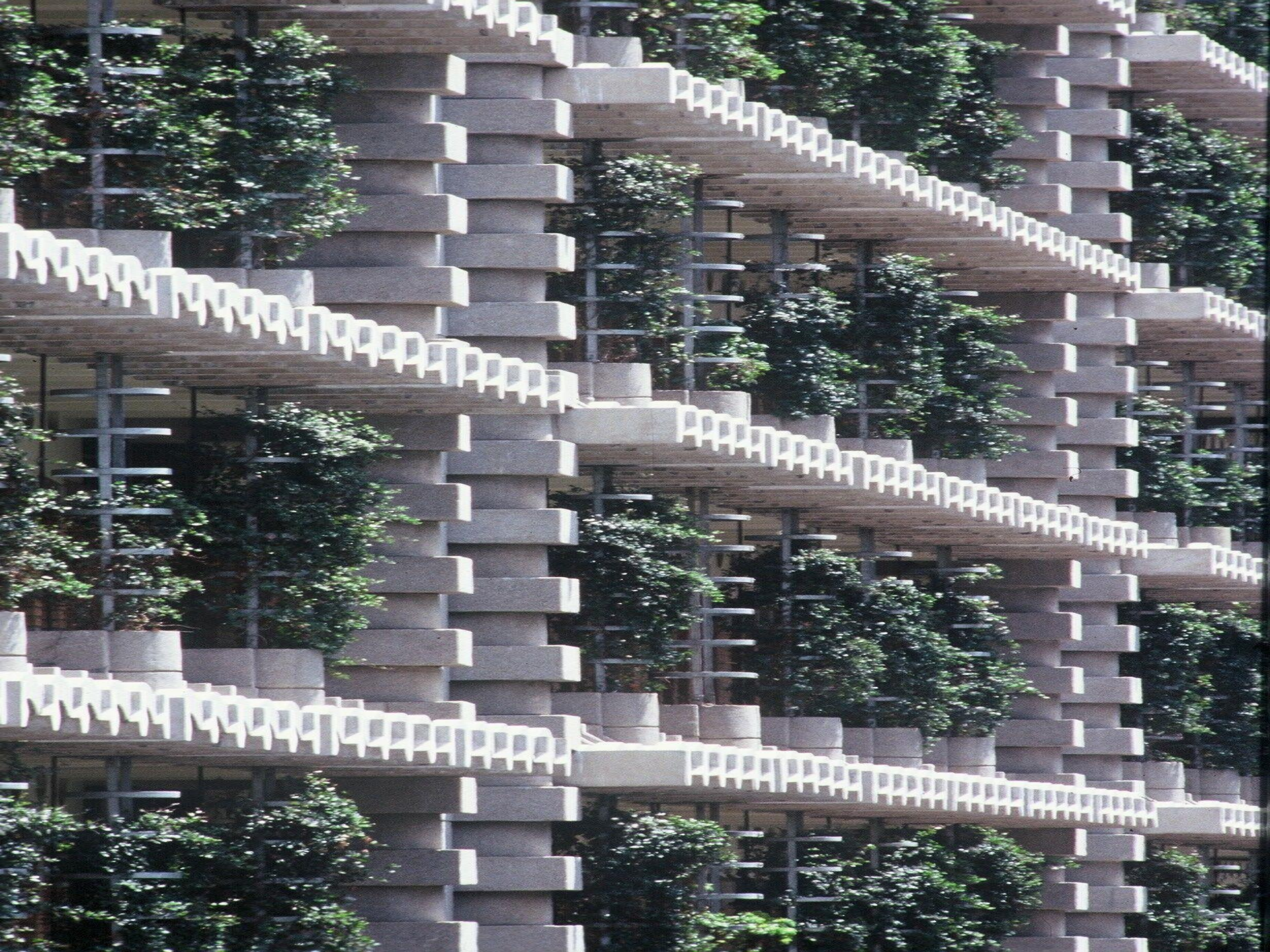
East end







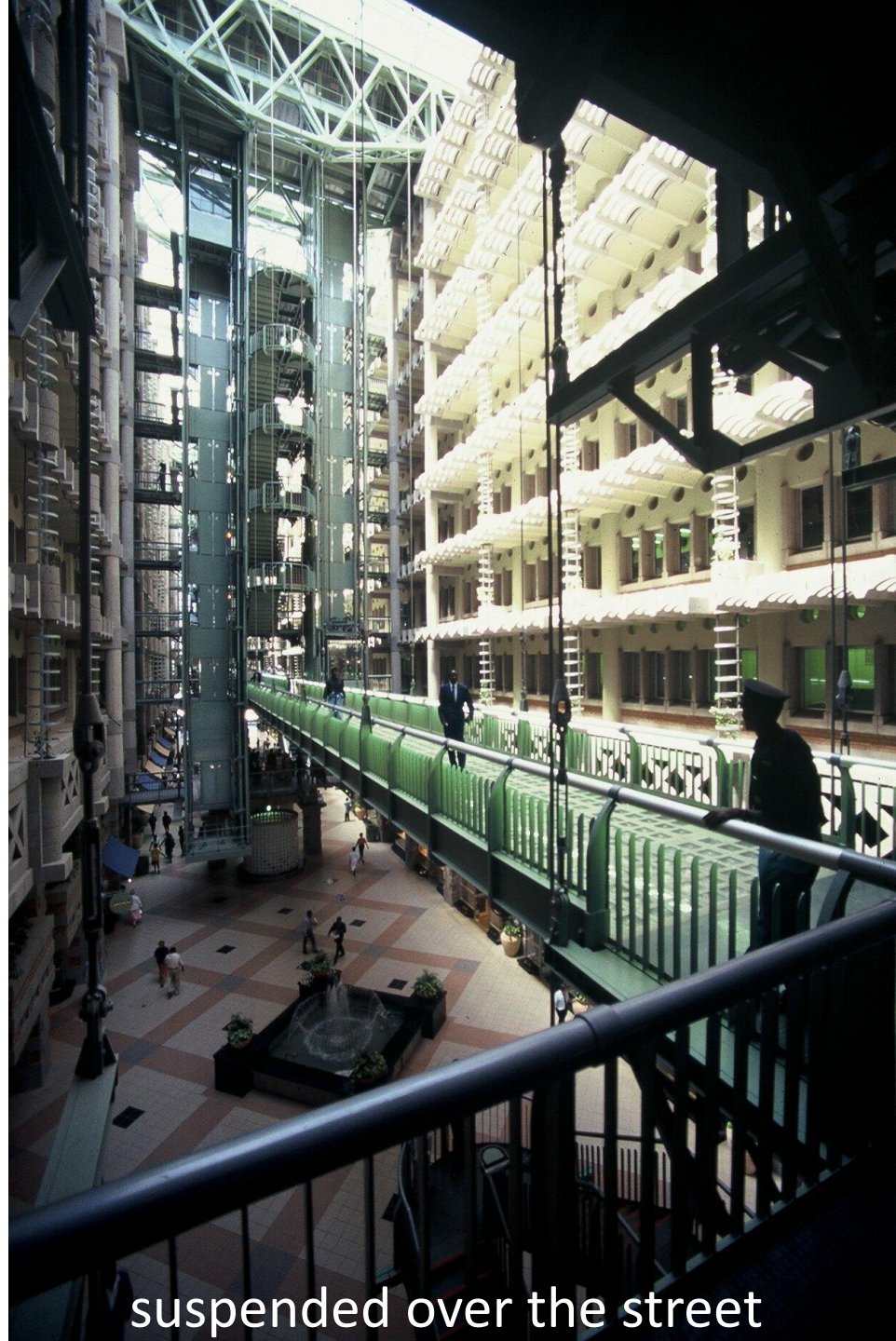






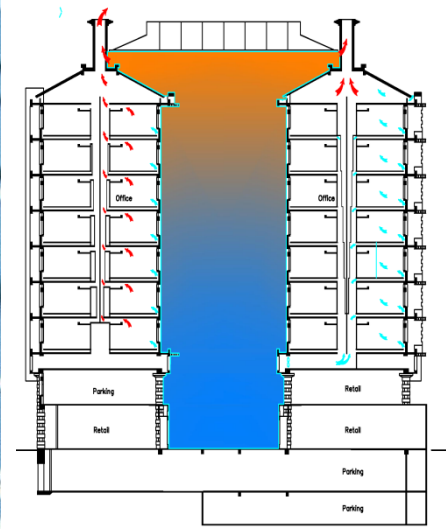


The architecture of movement



suspended over the street





The glass roof over the atrium is open at the ends so that the glass roof draws hot air out of the atrium.





- Steel suspension bridges hanging from cables.







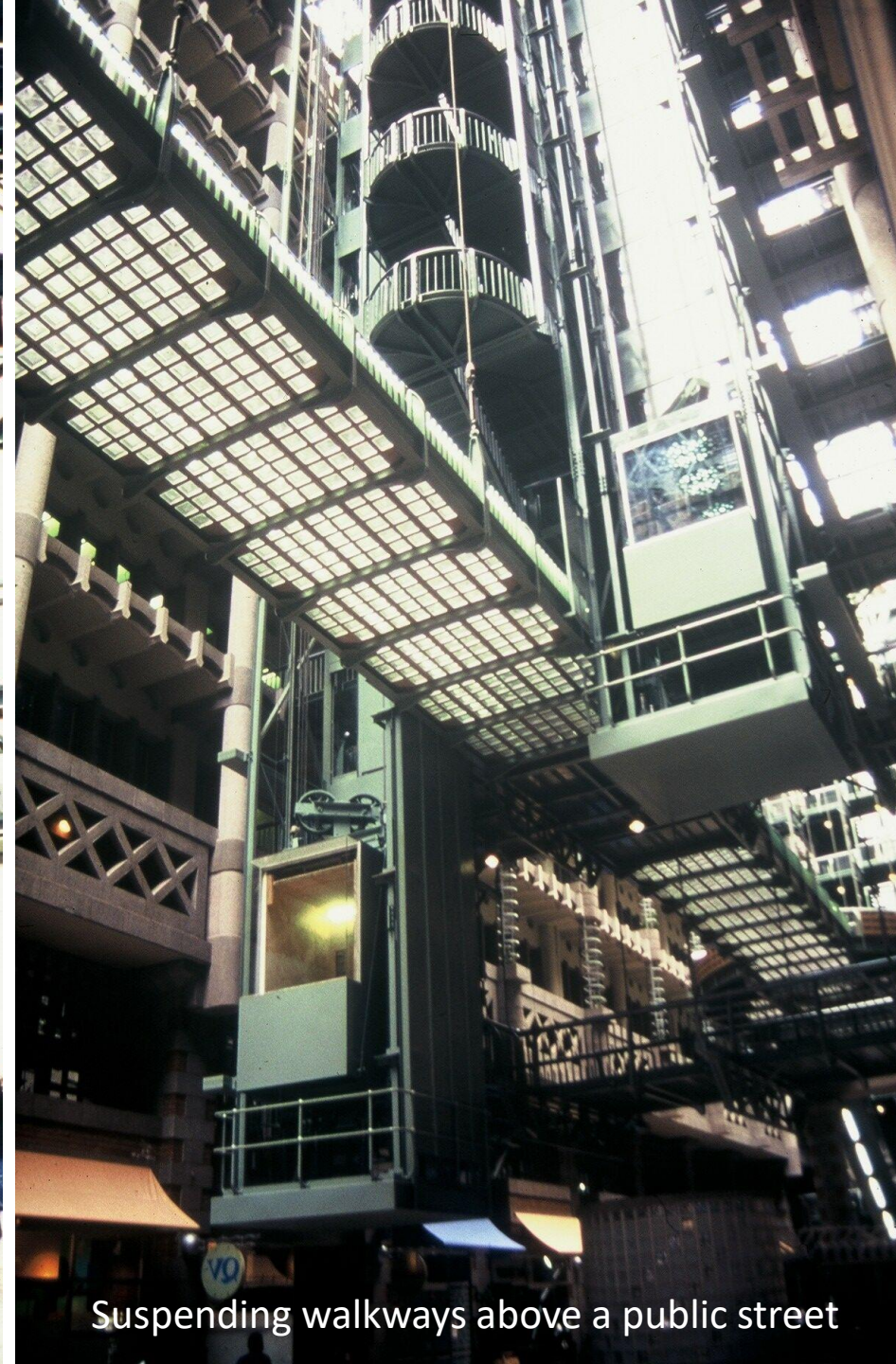


day



night





Suspending walkways above a public street



# Precast concrete elements



- Molds of the chimney tops











Wet brushed  
pre-cast  
concrete units  
finish to look like  
granite stone





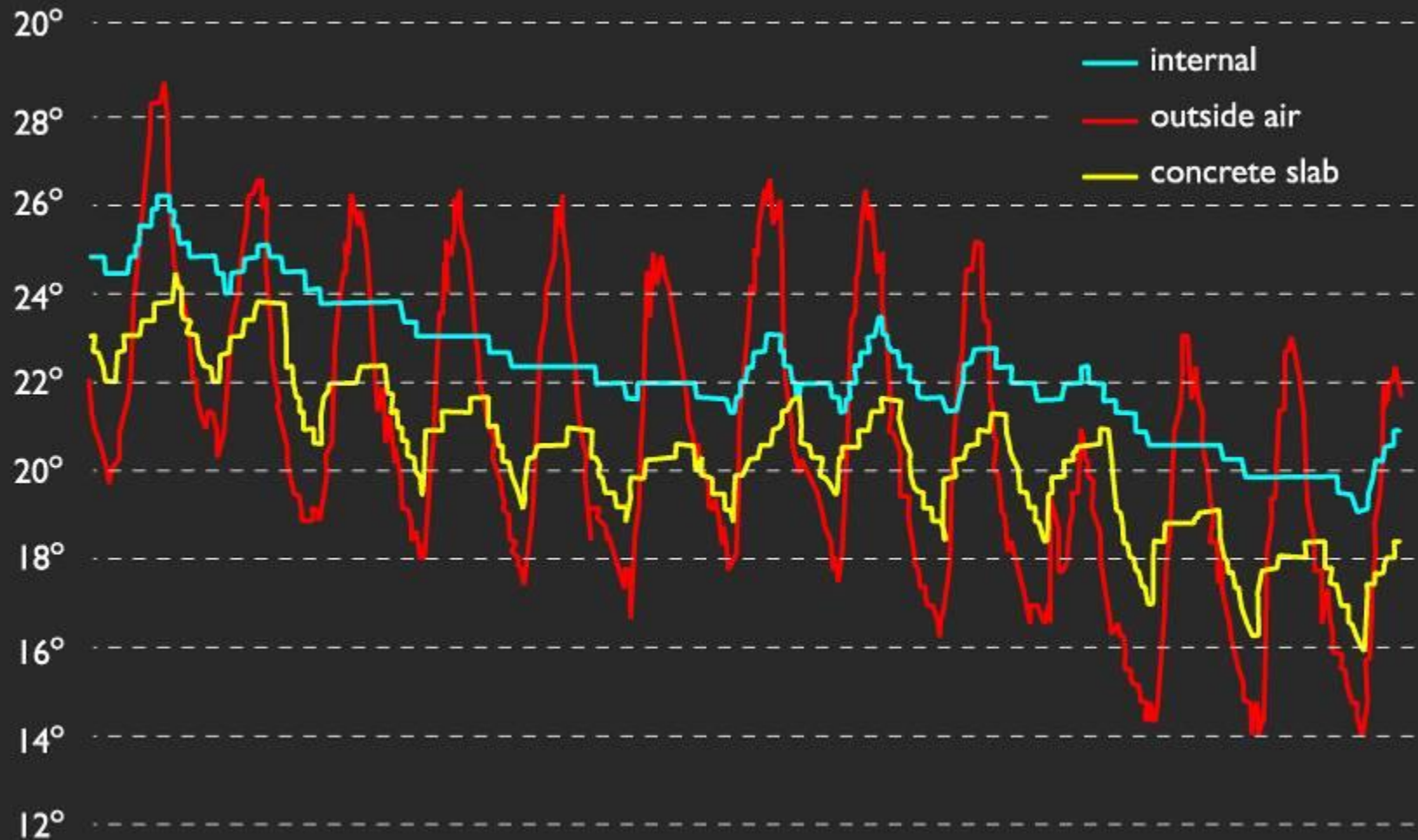








# Degree of internal cooling achieved

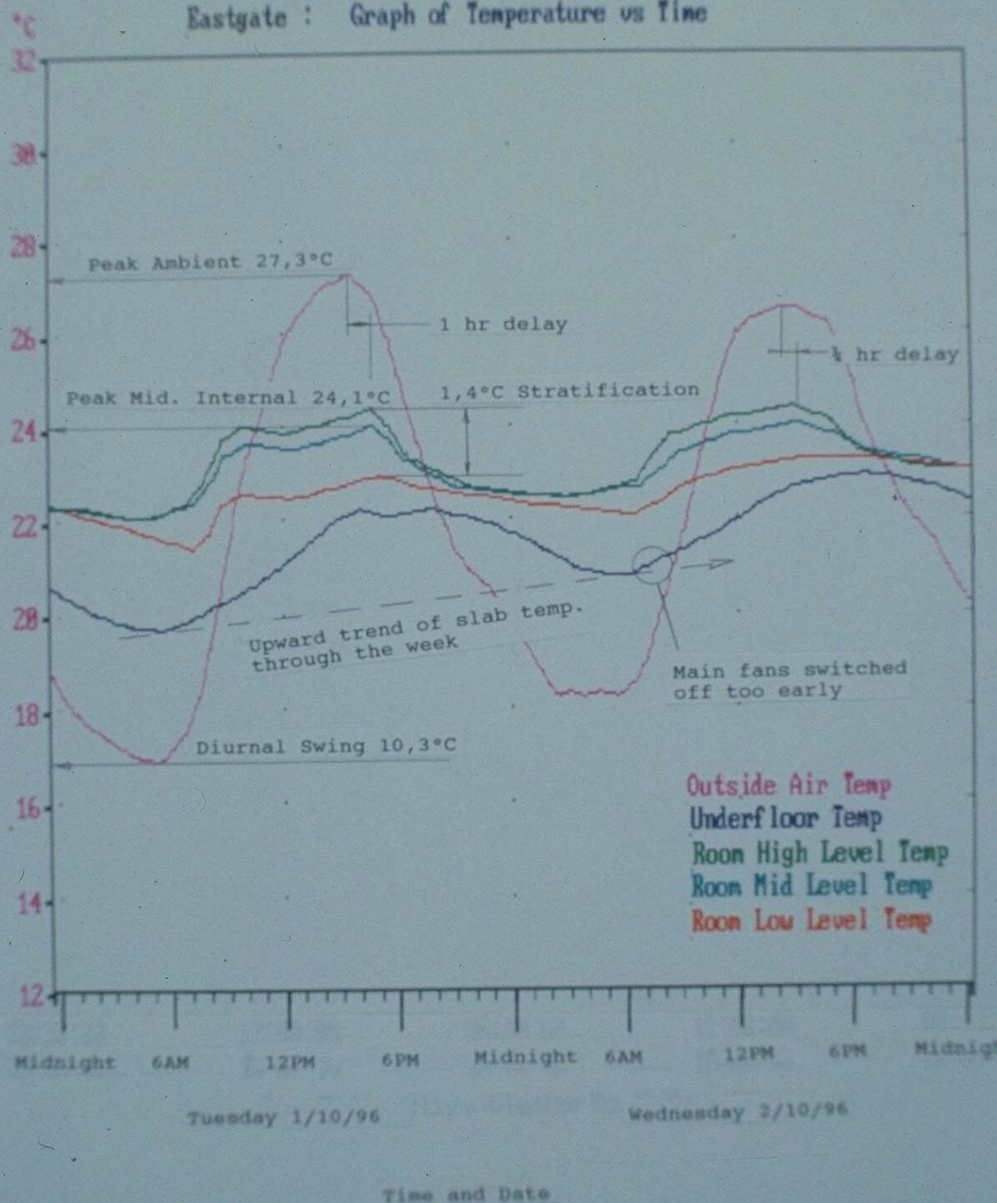


Eastgate, Harare

daily readings for the month of April 1998



Eastgate : Graph of Temperature vs Time



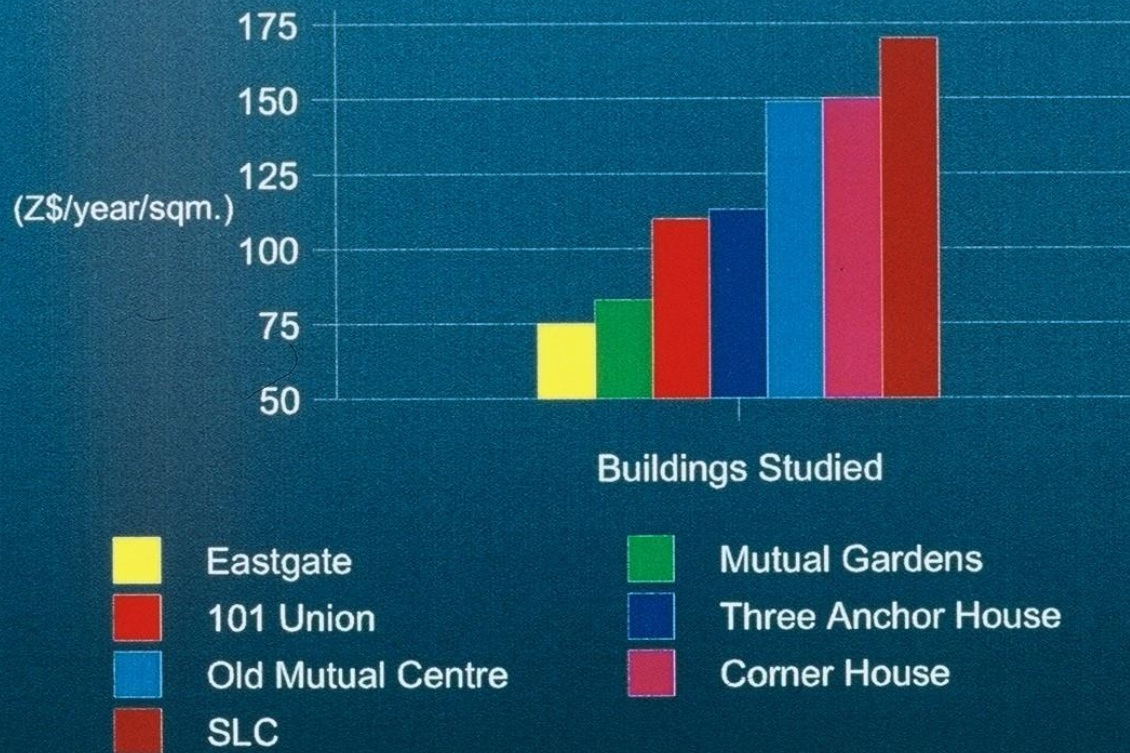
- **ANALYSIS OF DATA LOGGA**
- **1) Thermal lag (difference between outside peak and internal peak = 1 hour only)**
- **2) Temperature inside at peaks is 4<sup>0</sup>C lower with a swing of 12<sup>0</sup>C**
- **3) Stratification is 1.4<sup>0</sup>C in a room 3metres high**
- **4) People and machines contributed 1.5<sup>0</sup>C to heat load.**
- **5) There was an upward trend of temperature of the slab through the week indicating that the night fans were turning off too soon. This was found to be a characteristic of these buildings; they need the week end to cool off.**
- **6) when the night fans were turned off for three days in November it took the building four weeks to cool down. This proved the system**

- **THE BUILDING NEEDED TWO YEARS OF TUNING TO WORK WELL**



# Building Comparison

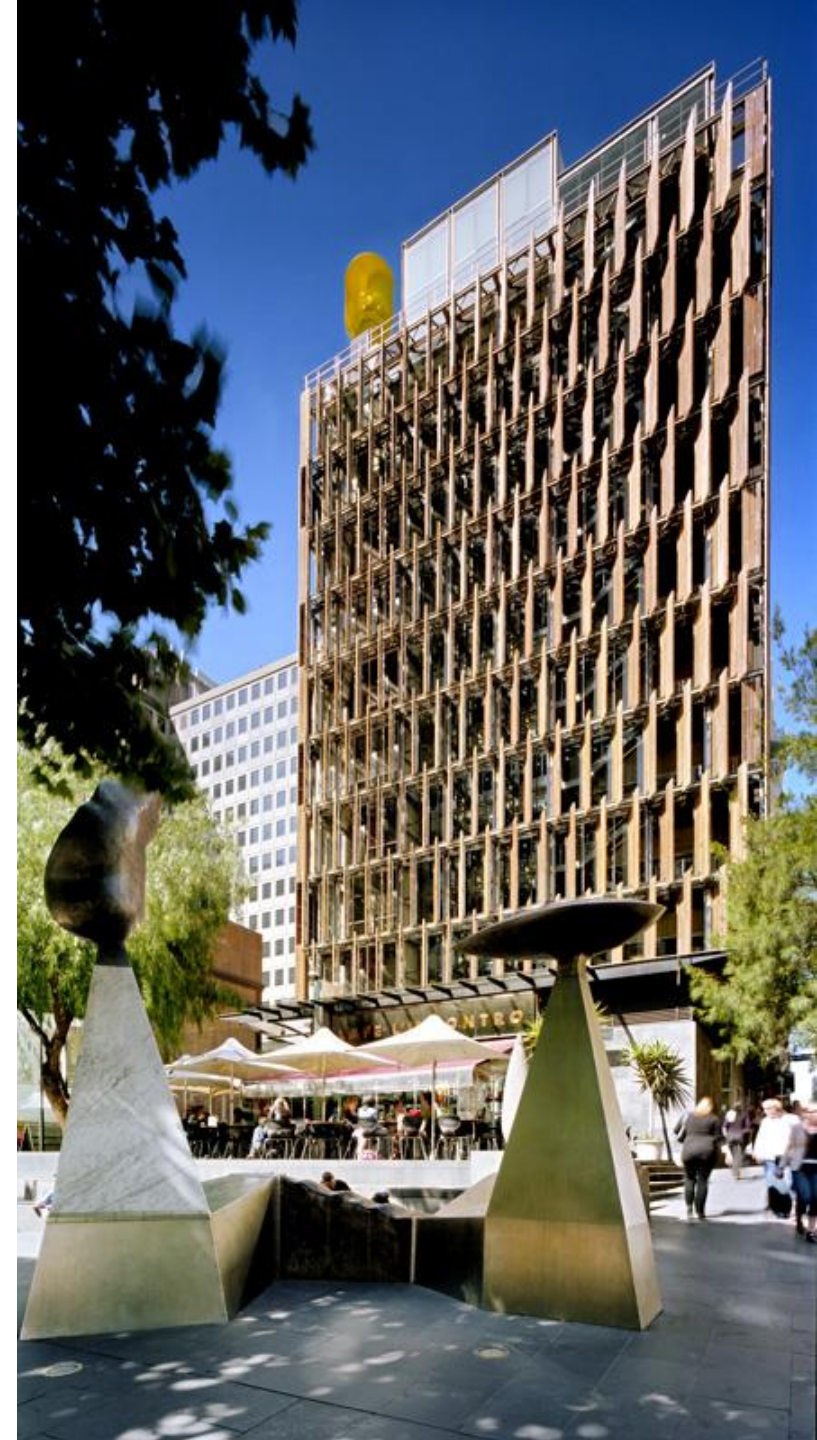
## Total Electricity Cost



Cost of electricity at Eastgate compared with six other recently-built office blocks in Harare. Study done by ARUP.

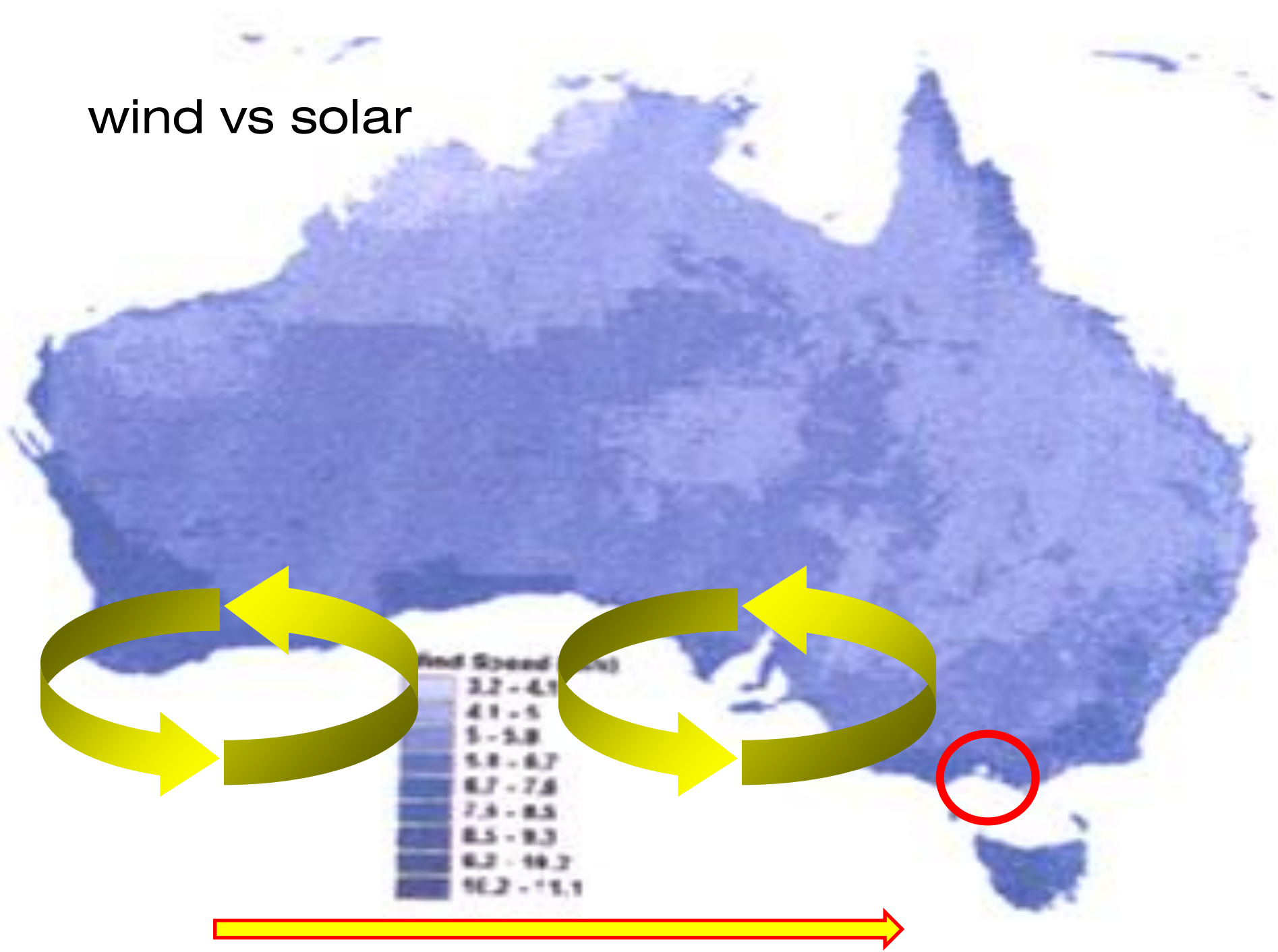


- May 2002 I received a call from my former partners Rob Adams and Rob Moore who were in Melbourne to come and help design CH2.
- Different climate, culture and economy



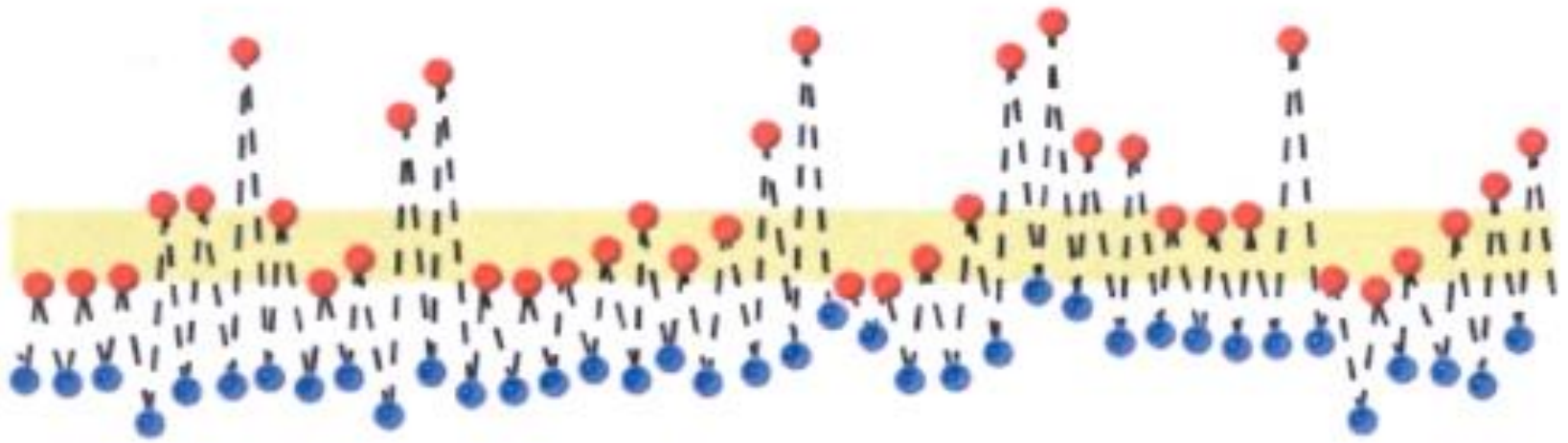


wind vs solar





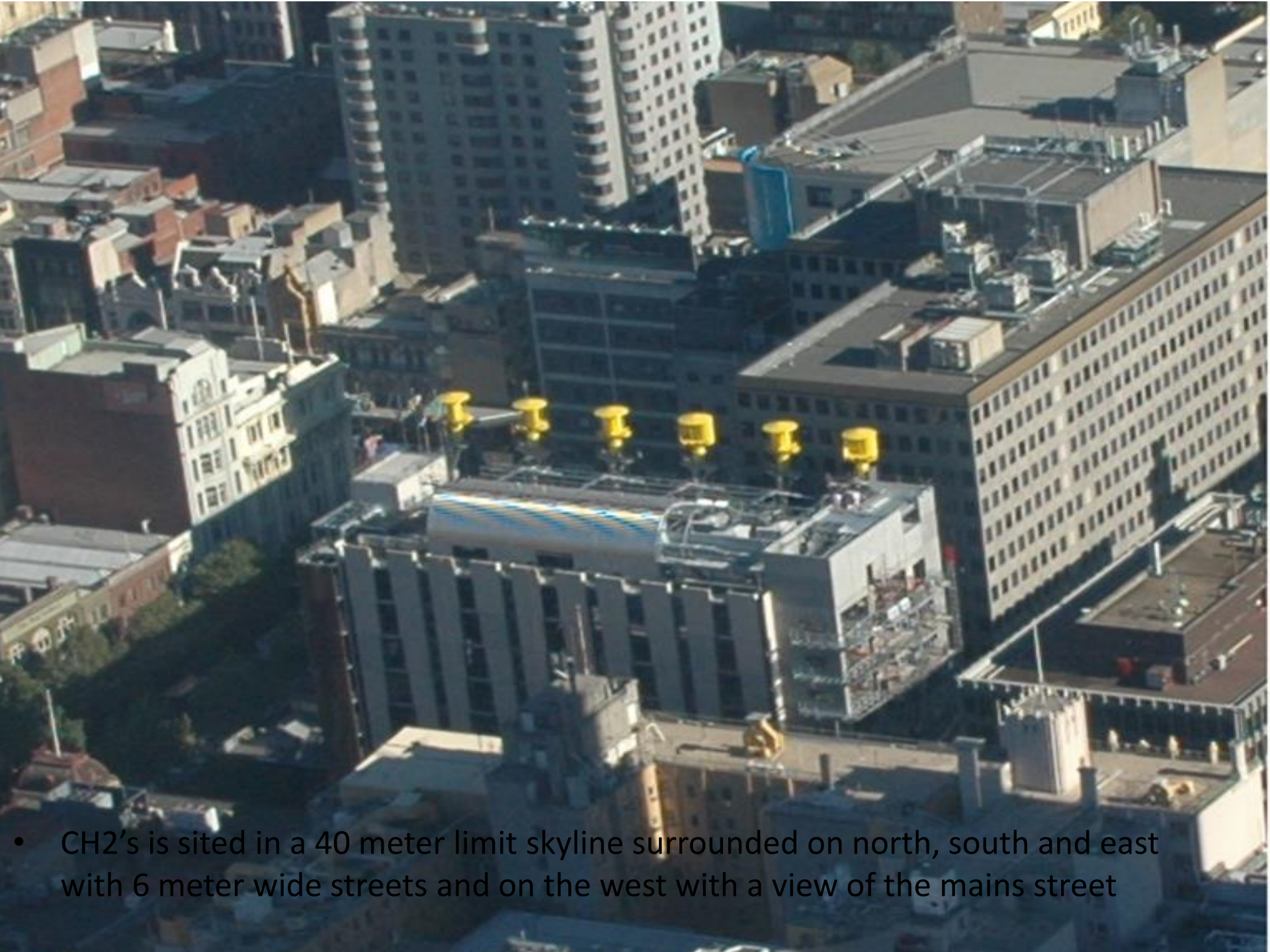
# daily maximum / minimum temperature of Melbourne's weather



Melbourne 1 Jan – 8 Feb 2002

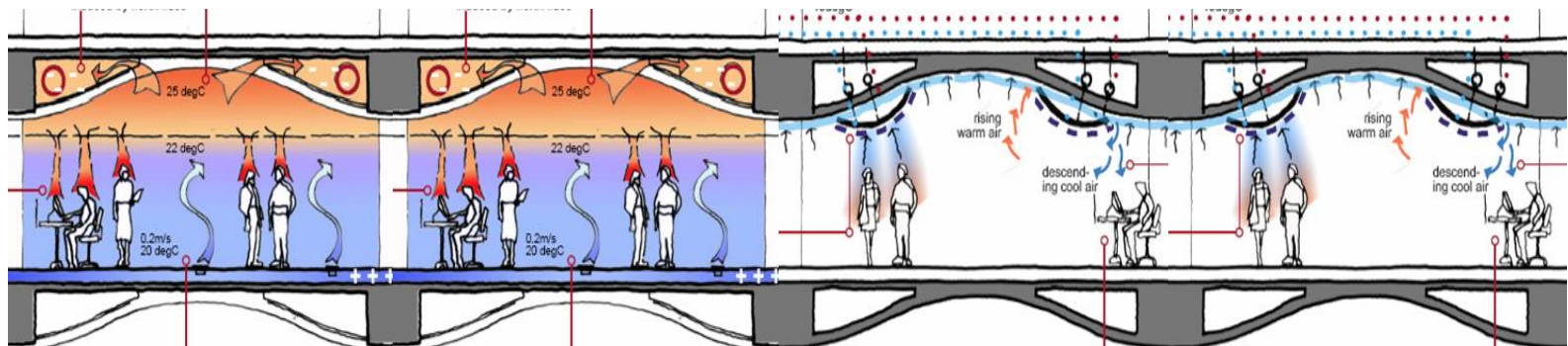
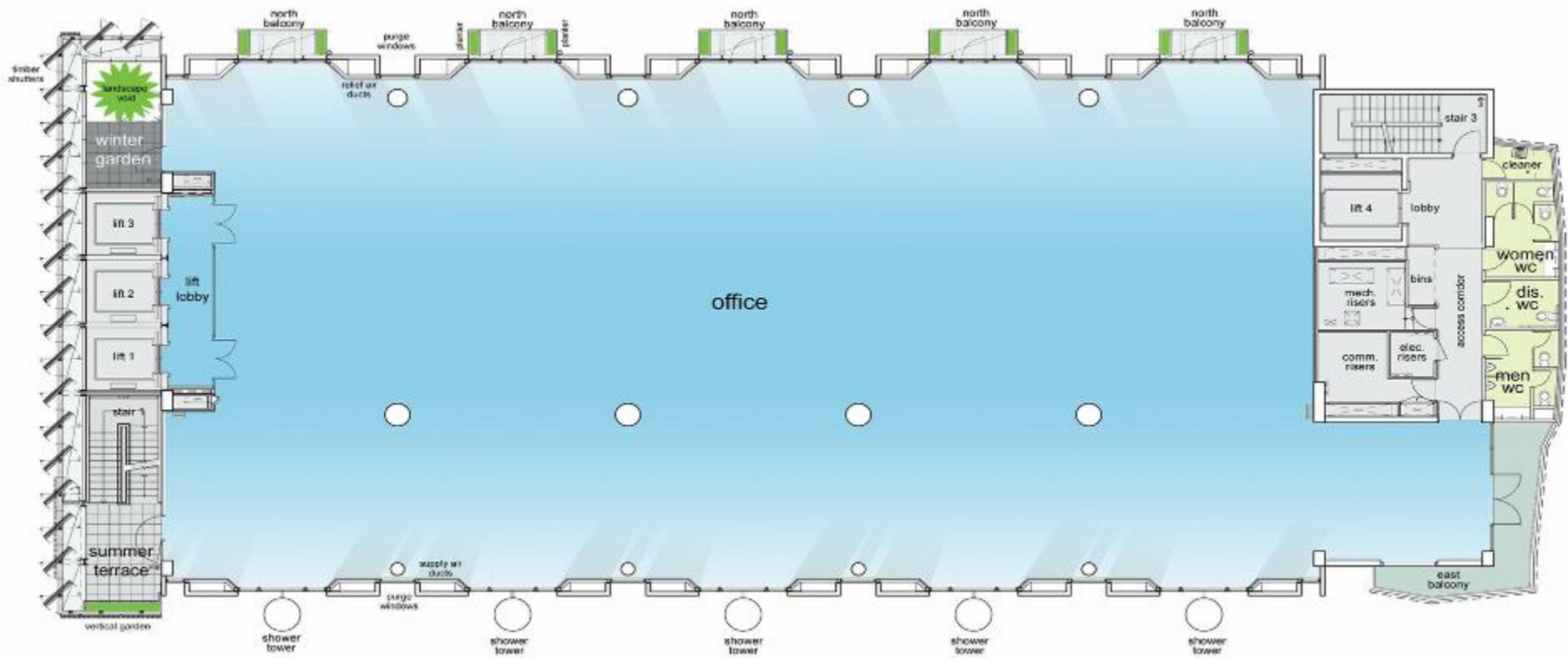
- The zigzag diurnal shows a 3 day cycle shifting above and below the comfort level yellow band
- The challenge here is to utilize this diurnal cycle with appropriate building design of passive and active systems working together to save energy and provide at least grand A comfort level standards for the work place





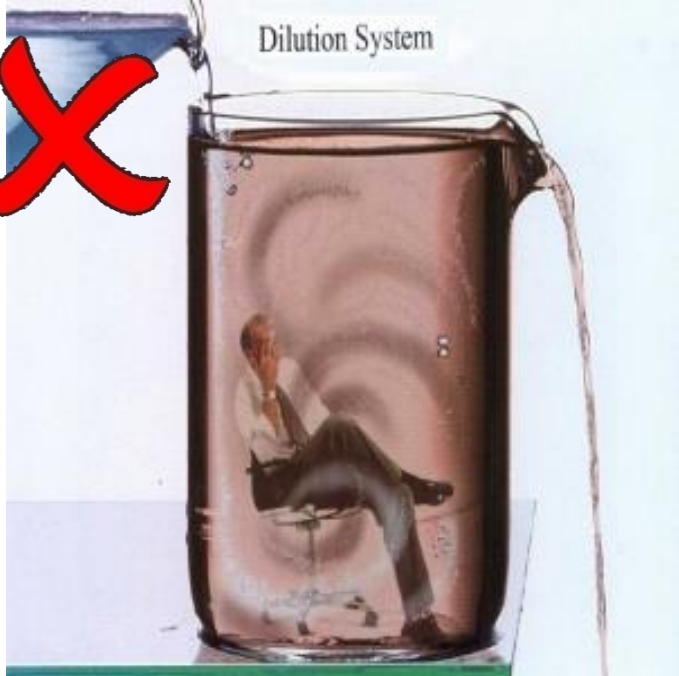
- CH2's is sited in a 40 meter limit skyline surrounded on north, south and east with 6 meter wide streets and on the west with a view of the mains street







Dilution System



Separation System



displacement air

Boundary layer created by displacement air supply.

Occupant and equipment heat plumes

healthy air

100% outside air supply to sealed access floor plenum

exhaust

High level exhaust exit ensures complete emptying of warm air in ceiling spaces.

Exhaust plenum at slightly negative pressure, induced by north flues'

Undulating concrete ceiling line.

25 degC

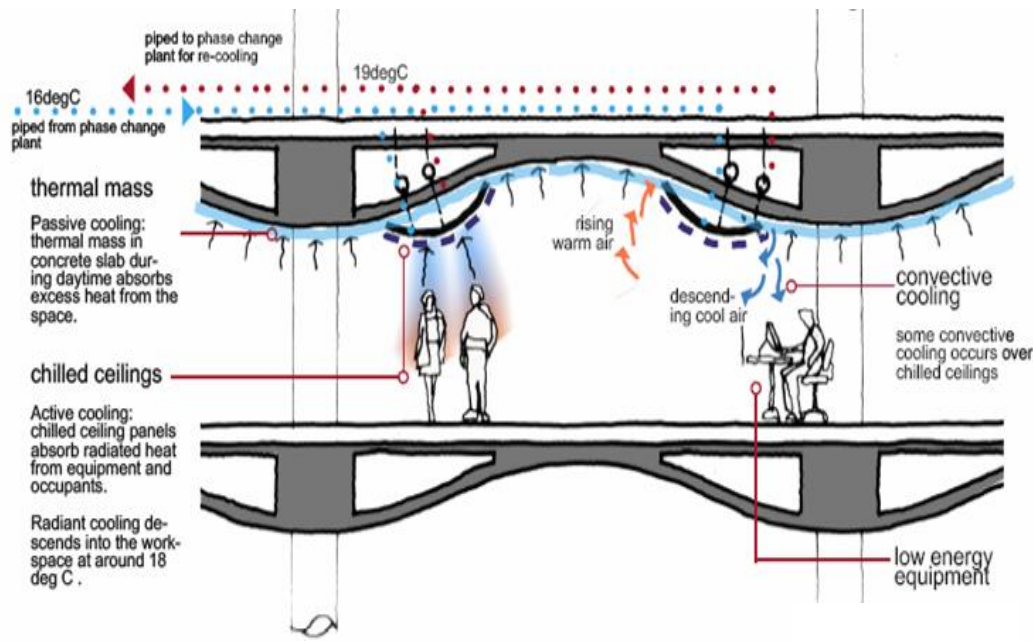
22 degC

0.2m/s  
20 degC

temperature gradient

floor diffusers

Floor mounted, user controlled air diffusers with 'twist' outlets, encourages air to mix, improving circulation.



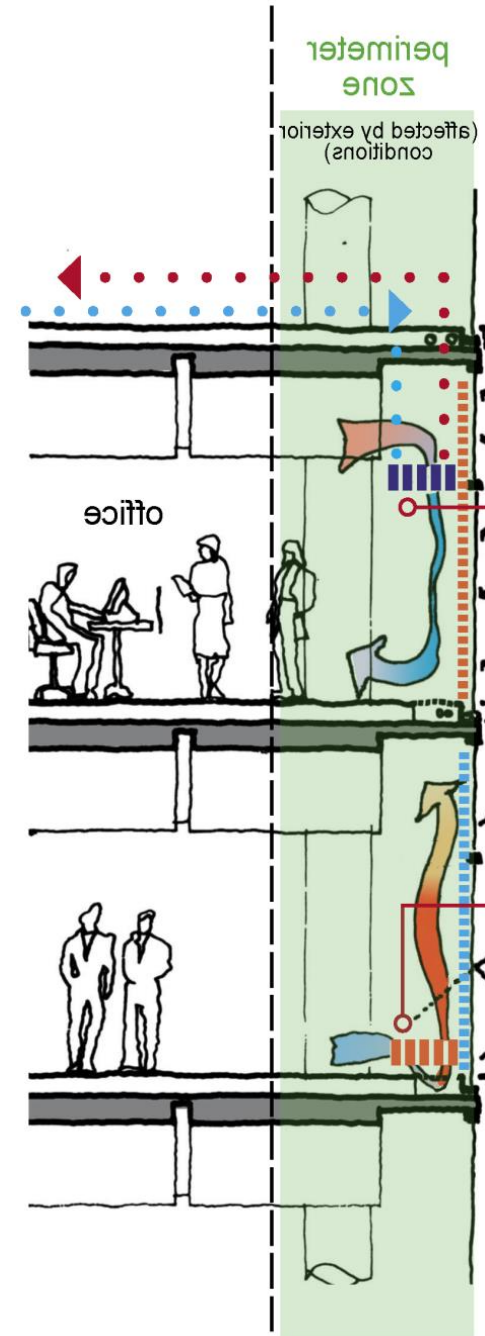


















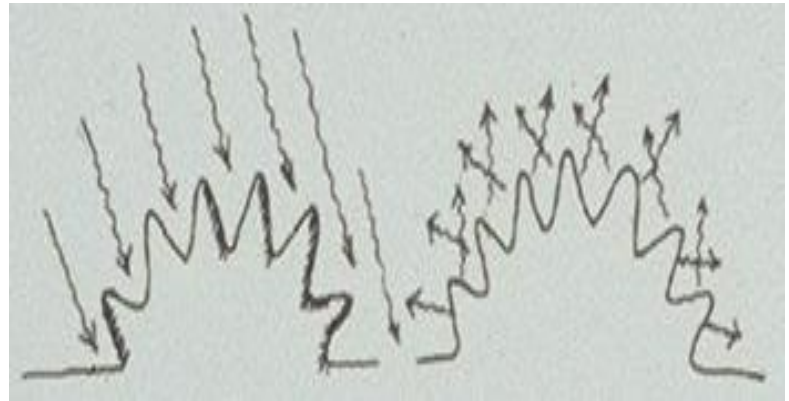


10 ton CH<sub>2</sub> CEILING UNITS

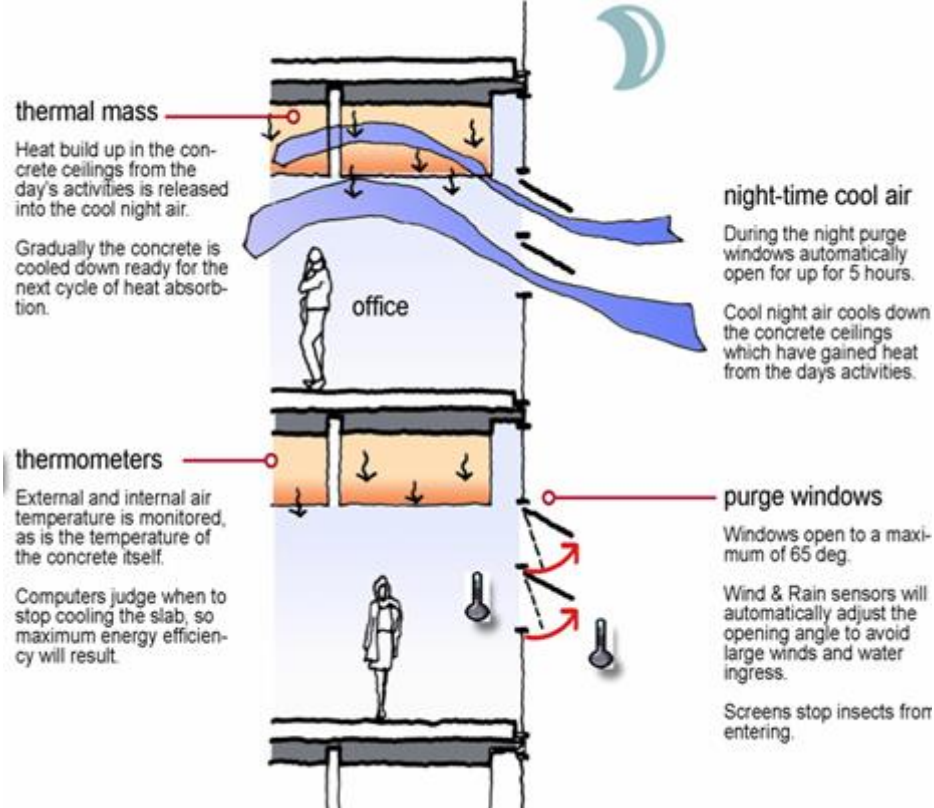










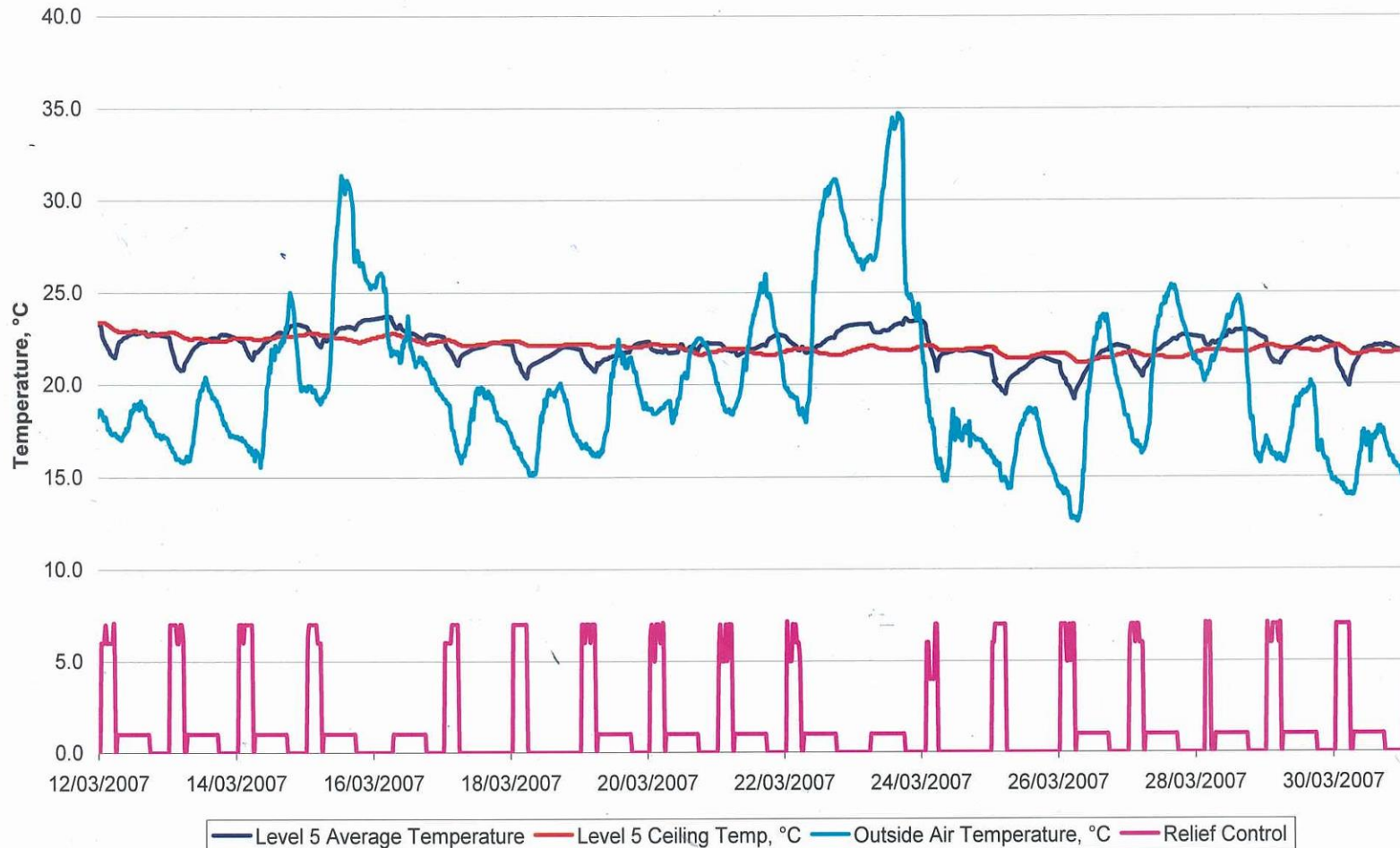


Cooling by night purge is essential in Mediterranean type climates



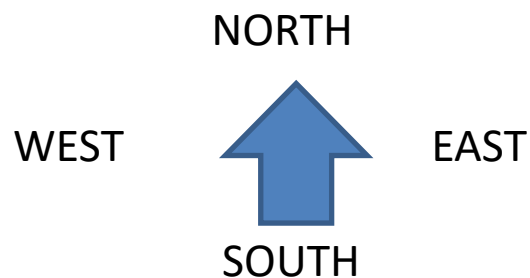
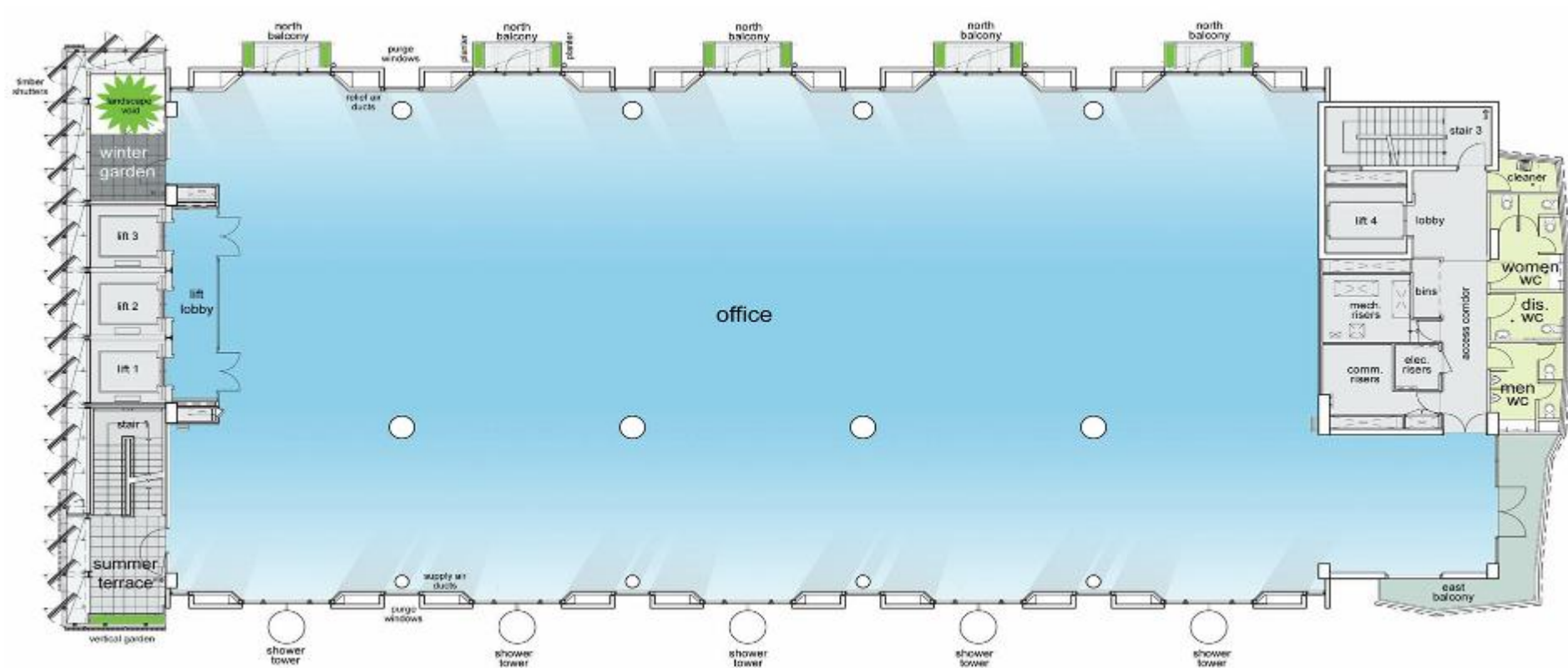


### Night Flushing and Temperature Performance (Level 5) - March 2007



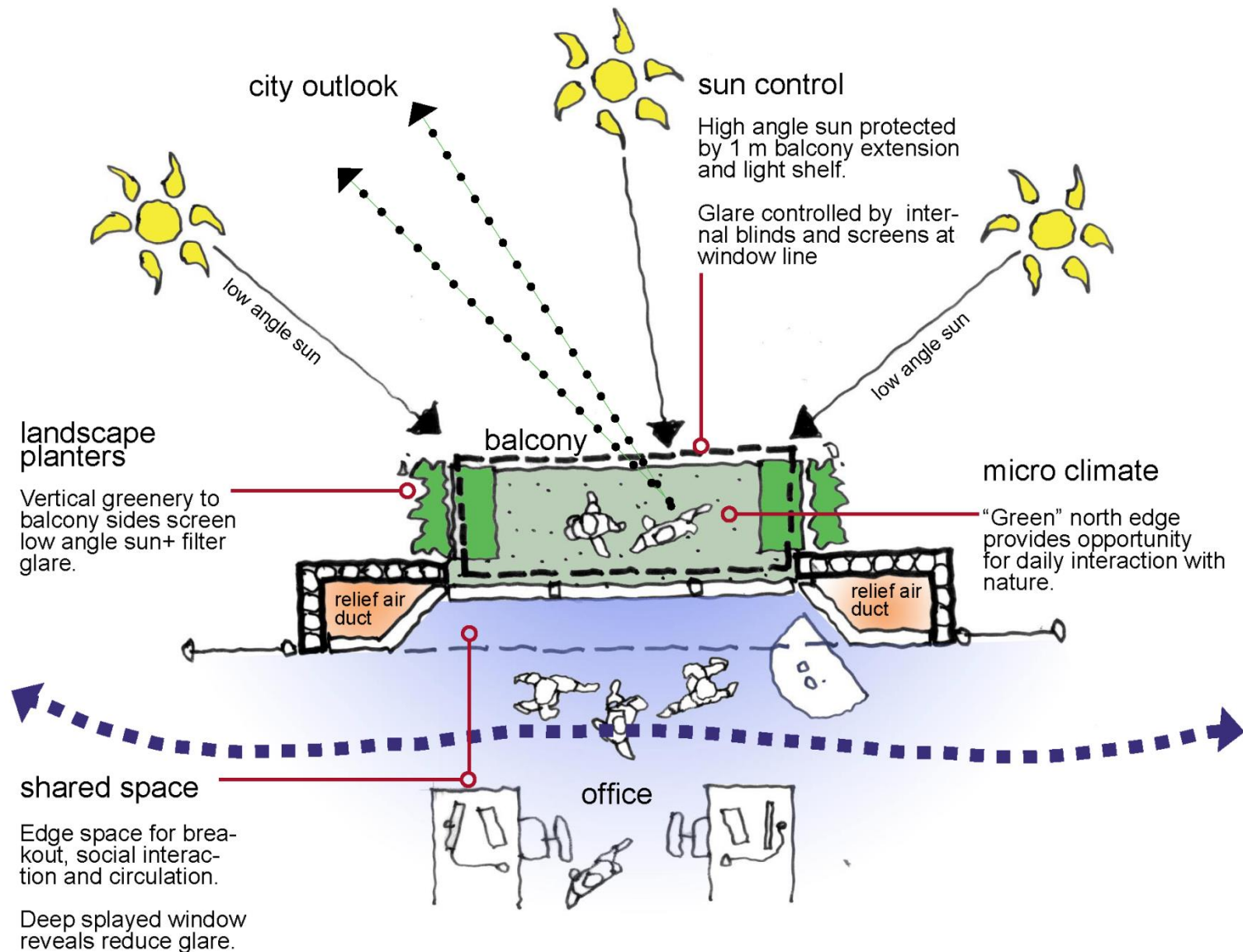
- Here's proof that it works
- light blue is the diurnal shift; Melbourne's 3 day cycle
- Red line is concrete ceiling temperature
- Dark blue is internal air temperature
- Purple line indicates the opening and closing of the flushing windows (which cost the same as an electric powered chiller). This takes care of 15-20% of our cooling load.





EACH ELEVATION WAS DESIGNED TO RESPOND TO ITS ORIENTATION AND FUNCTION





## EDGE SPACE - NORTH BALCONIES



## vertical green shading

Vertical greenery to balcony sides screen low angle sun+ filter glare.

## light shelf

Ambient and direct daylight bounces off external and internal light shelf.

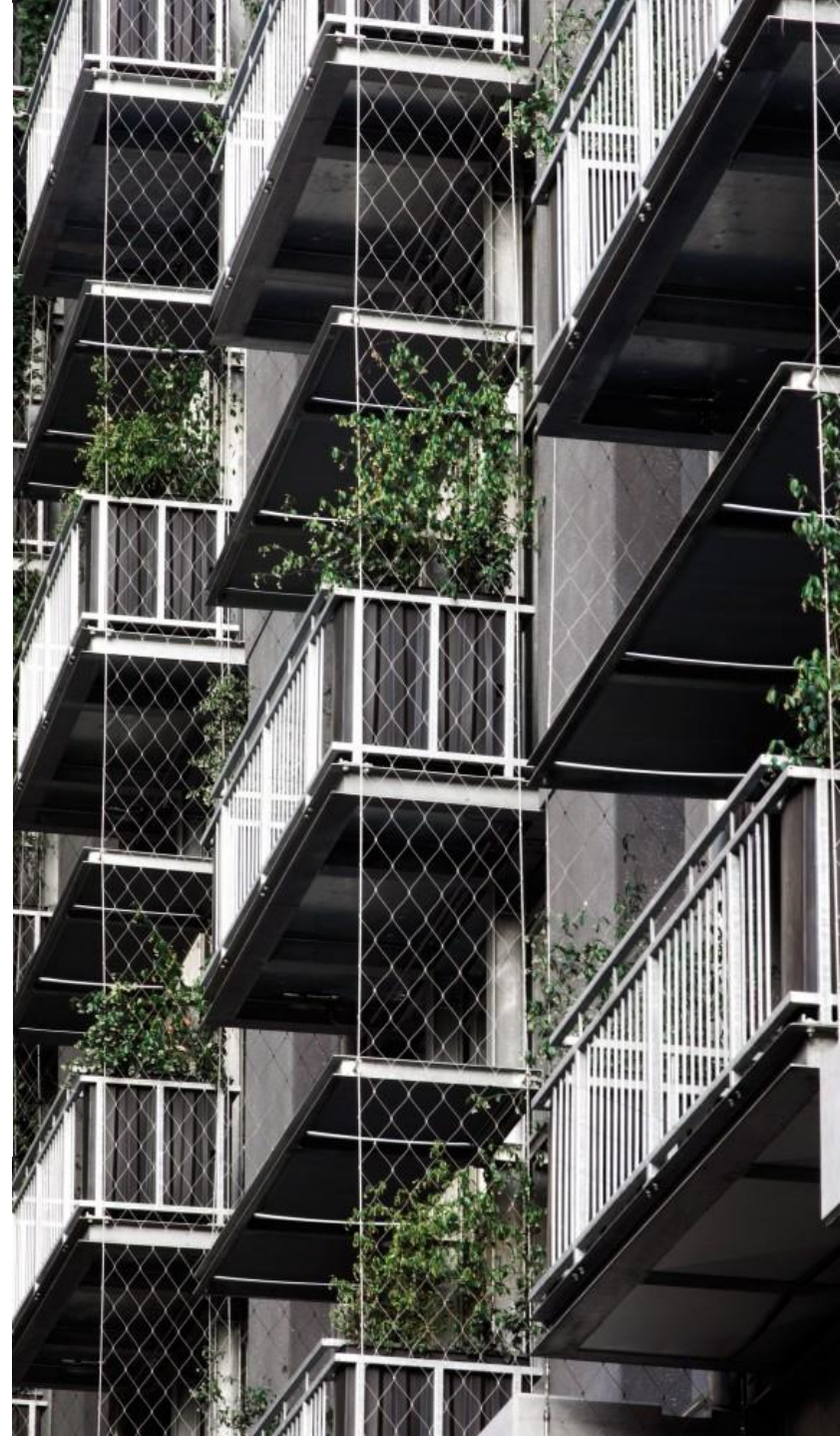
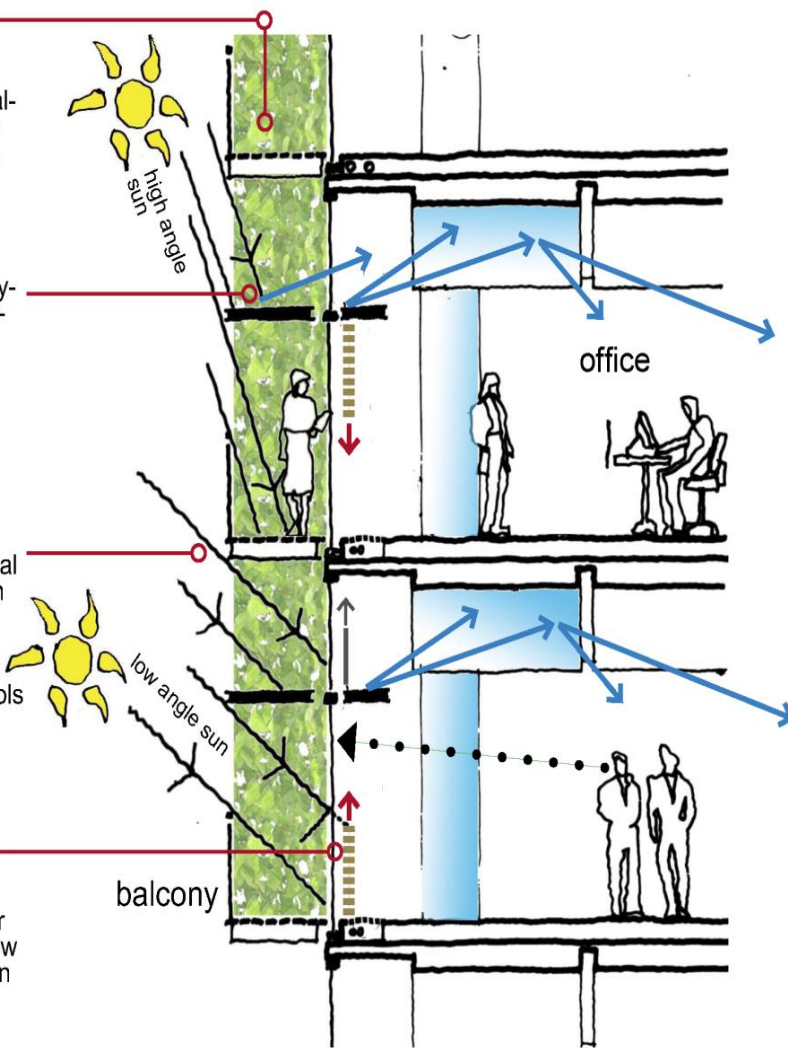
## shading

Light shelf + balcony floors provide horizontal shading from northern sun.

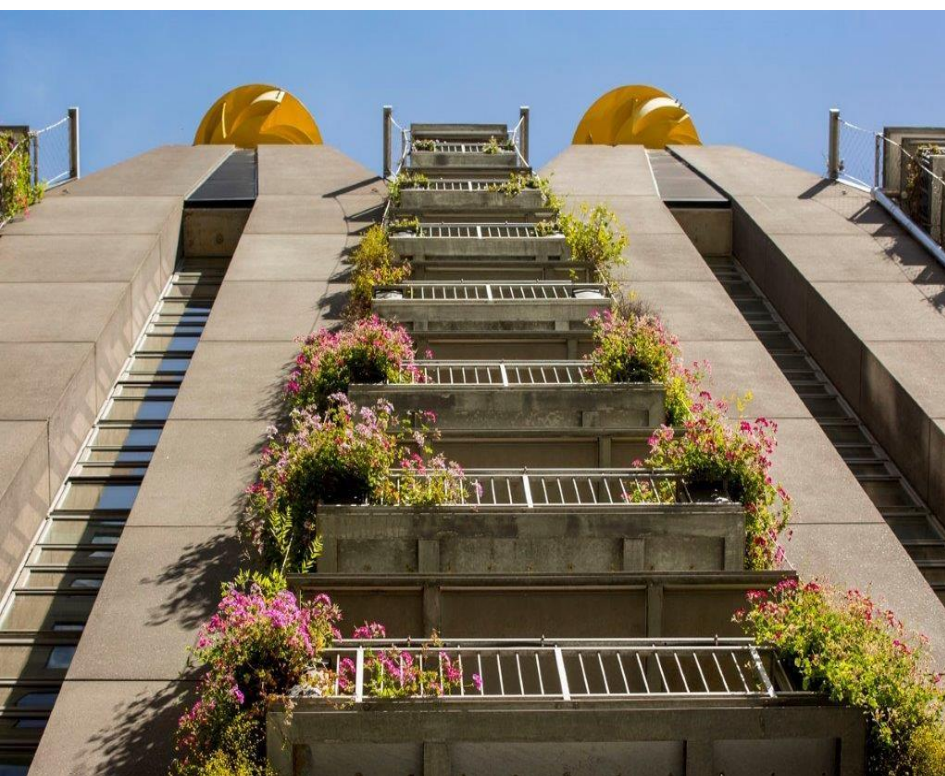
Internal upward rolling retractable blind controls high level glare.

## timber screens

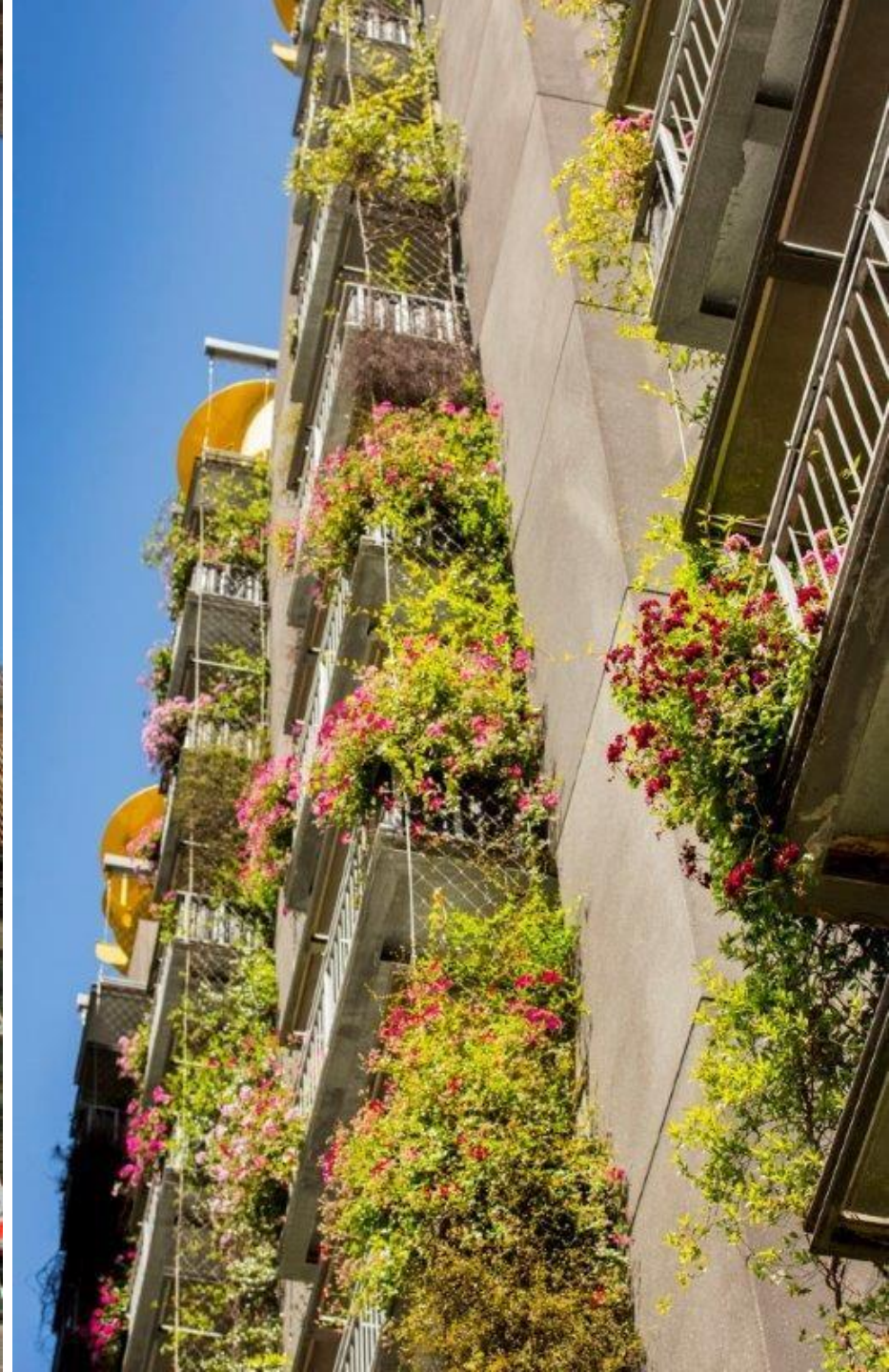
Manually adjustable vertically sliding timber screens block direct low angle sun and maintain views.













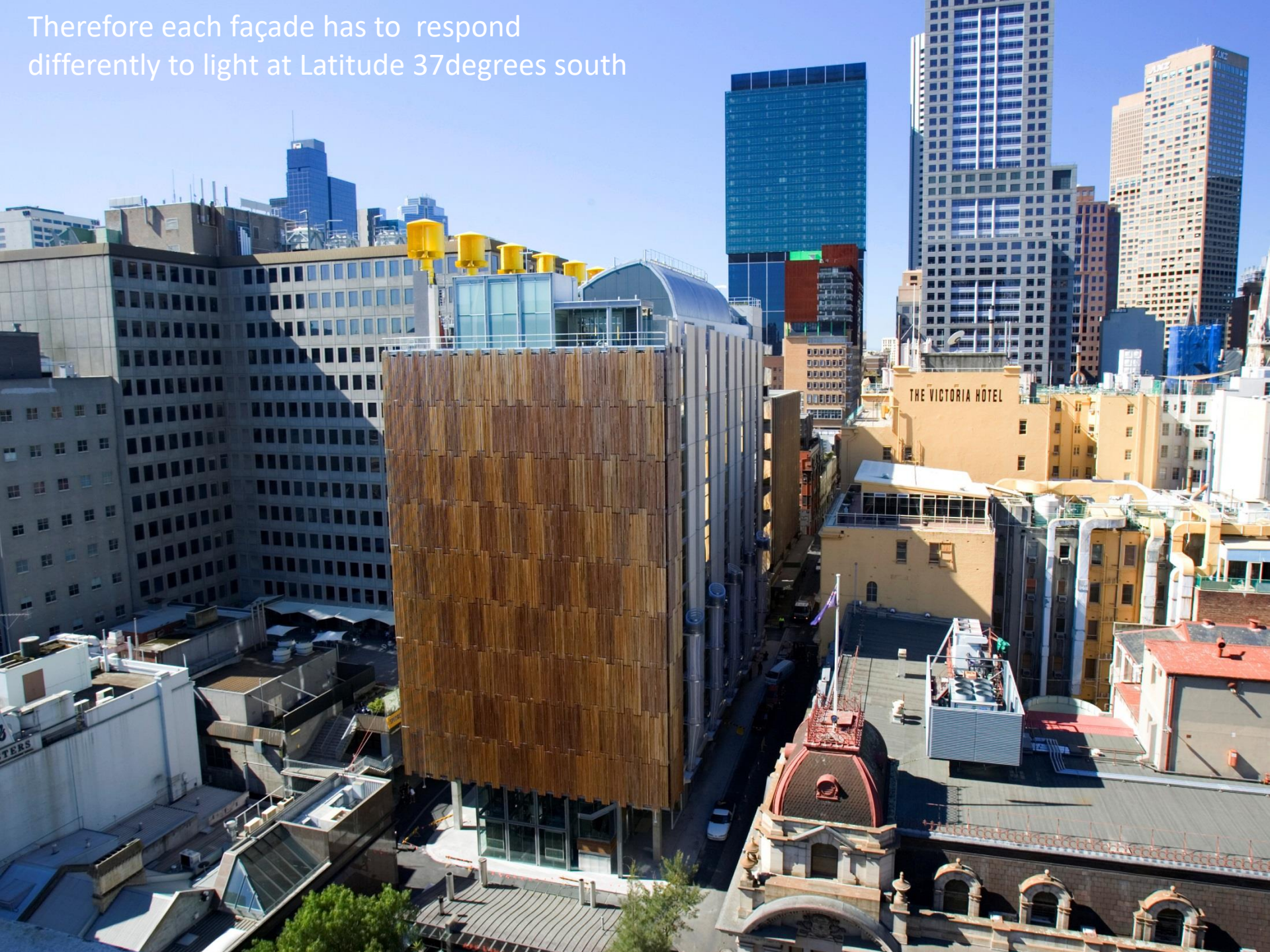








Therefore each façade has to respond differently to light at Latitude 37degrees south





- LEVEL 8

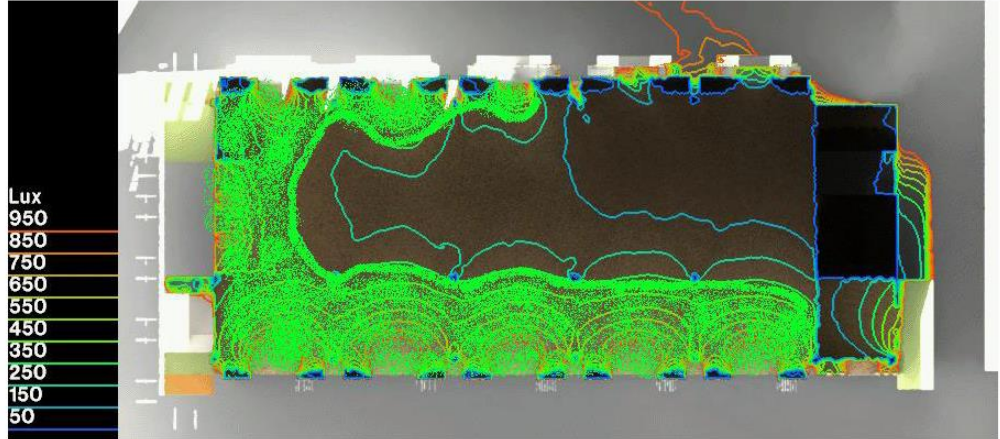


Figure 10: Light levels for a typical sunny March day on level 8

- LEVEL 5

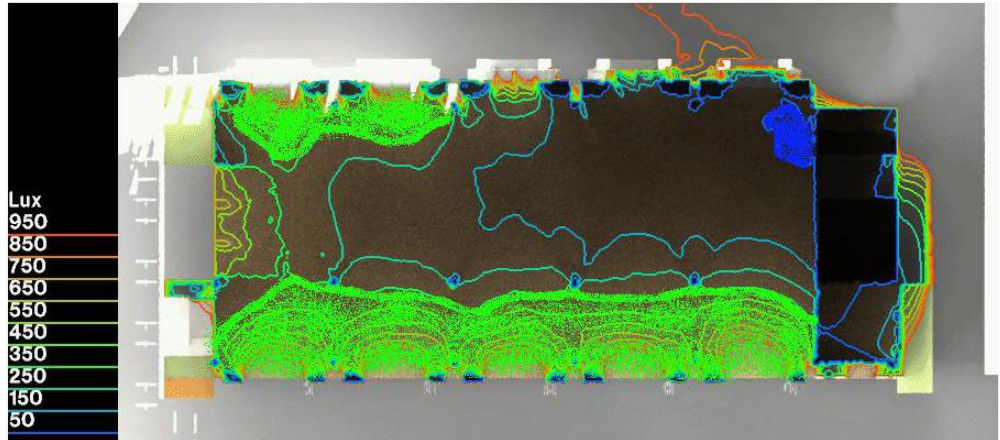


Figure 11: Light levels for a typical sunny March day on level 5

- LEVEL 2

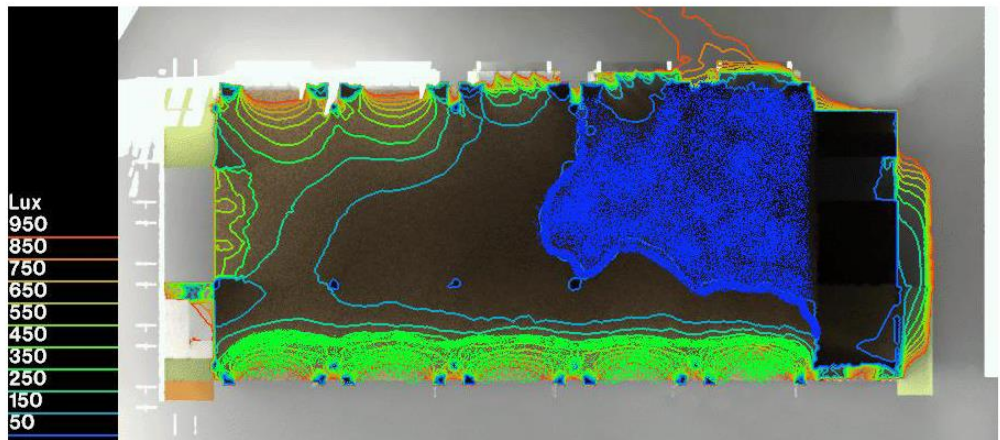
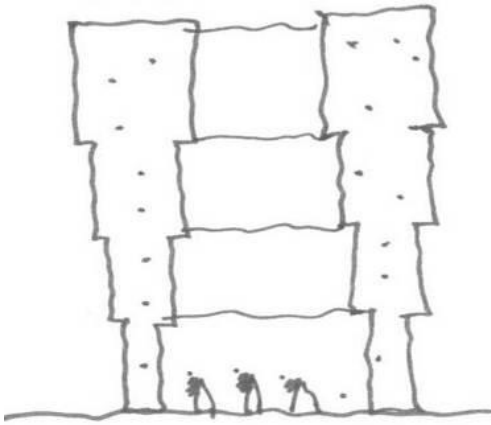


Figure 12: Light levels for a typical sunny March day on level 2

This analysis was done to simulate the light levels under blue sky and cloudy sky to enable us to design the facades for light glare and heat gain/loss. Two very clear results emerged Most light penetration came from the south The fall off of light levels with height which certainly justified tapering windows.







Like the forest designed for light







North elevation



South elevation

Albedo is the diffuse reflectivity power of a surface expressed as a % from zero for black to 1 for white.

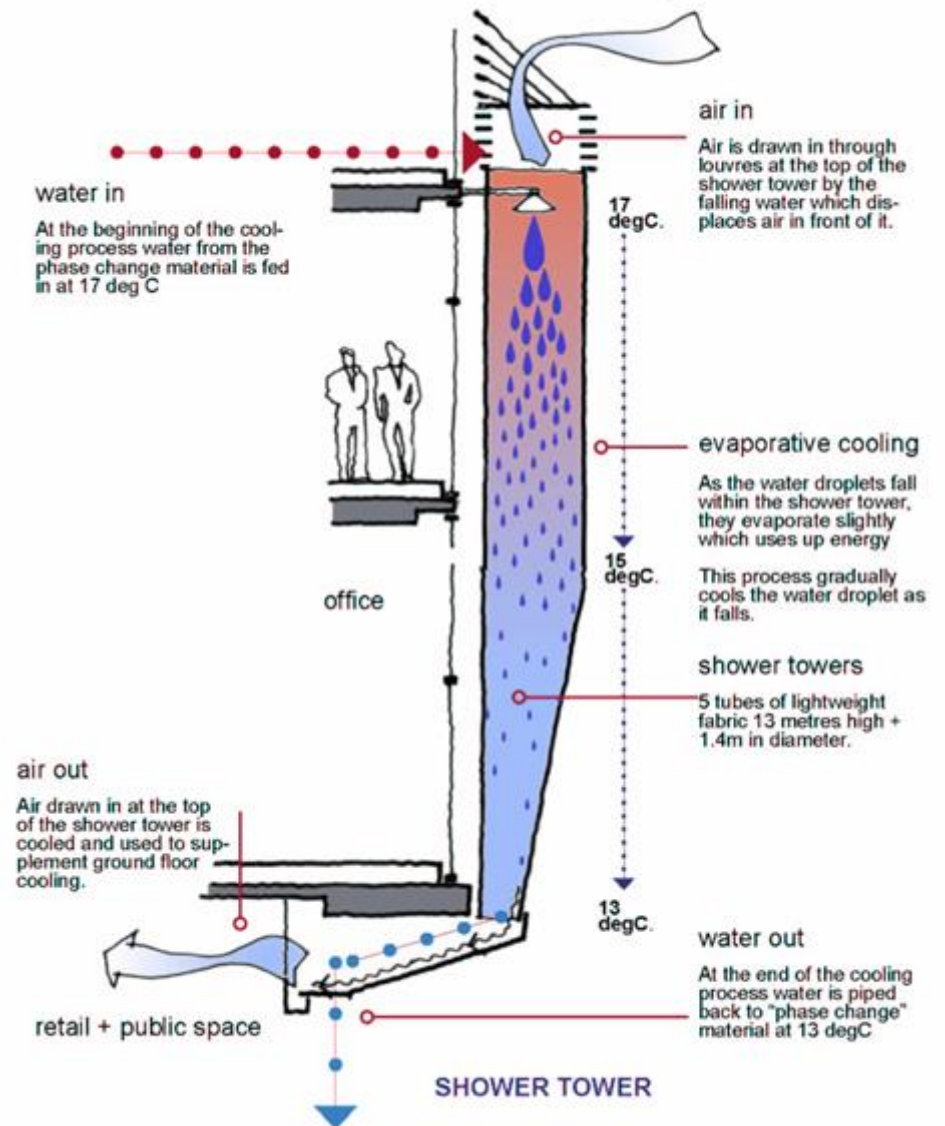




**CH2 SOUTH ELEVATION**



# Cooling - Shower Towers





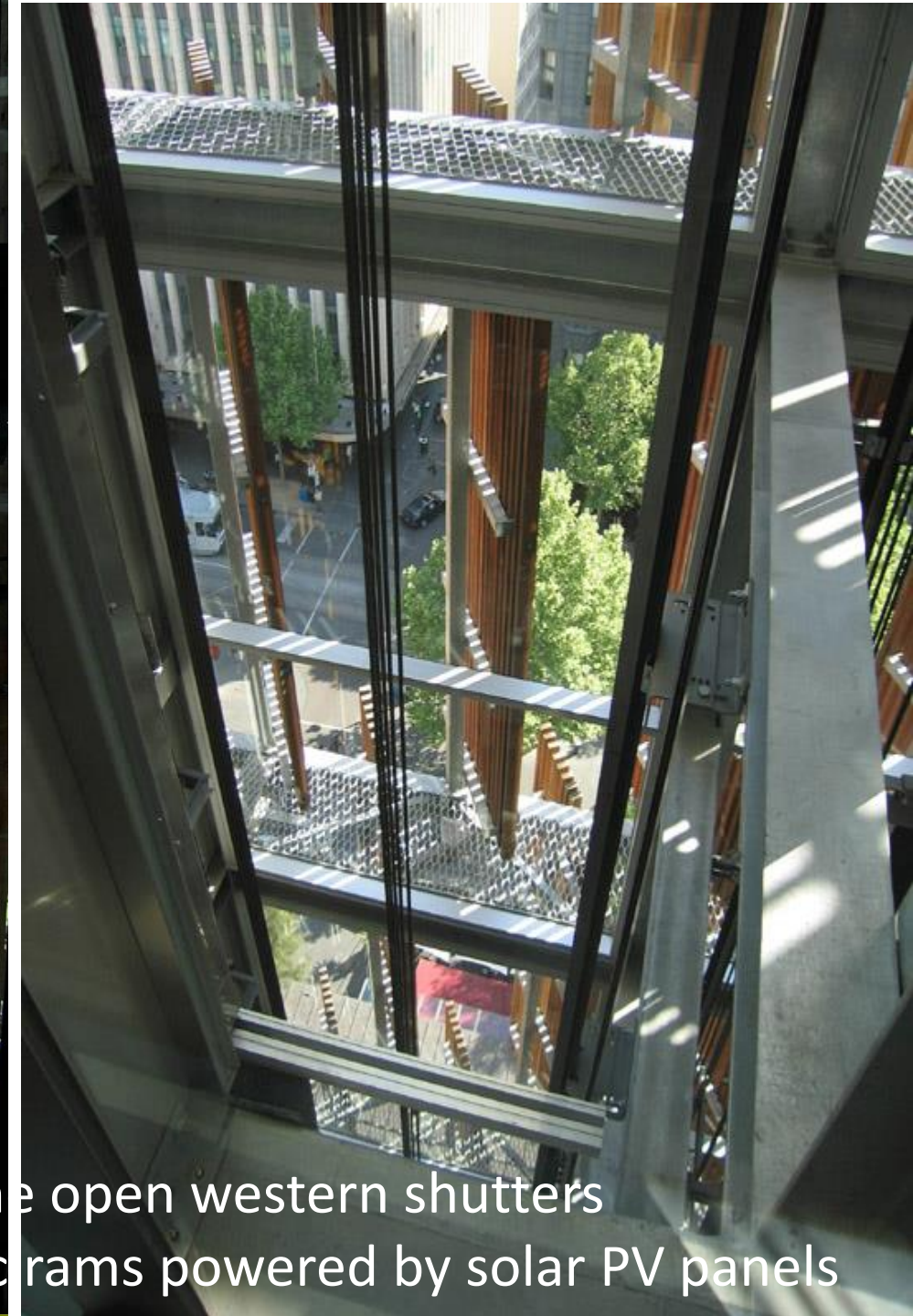


West façade open in mornings and closed in the afternoons for sun









- Looking from inside through the open western shutters
- Which are opened by hydraulic rams powered by solar PV panels



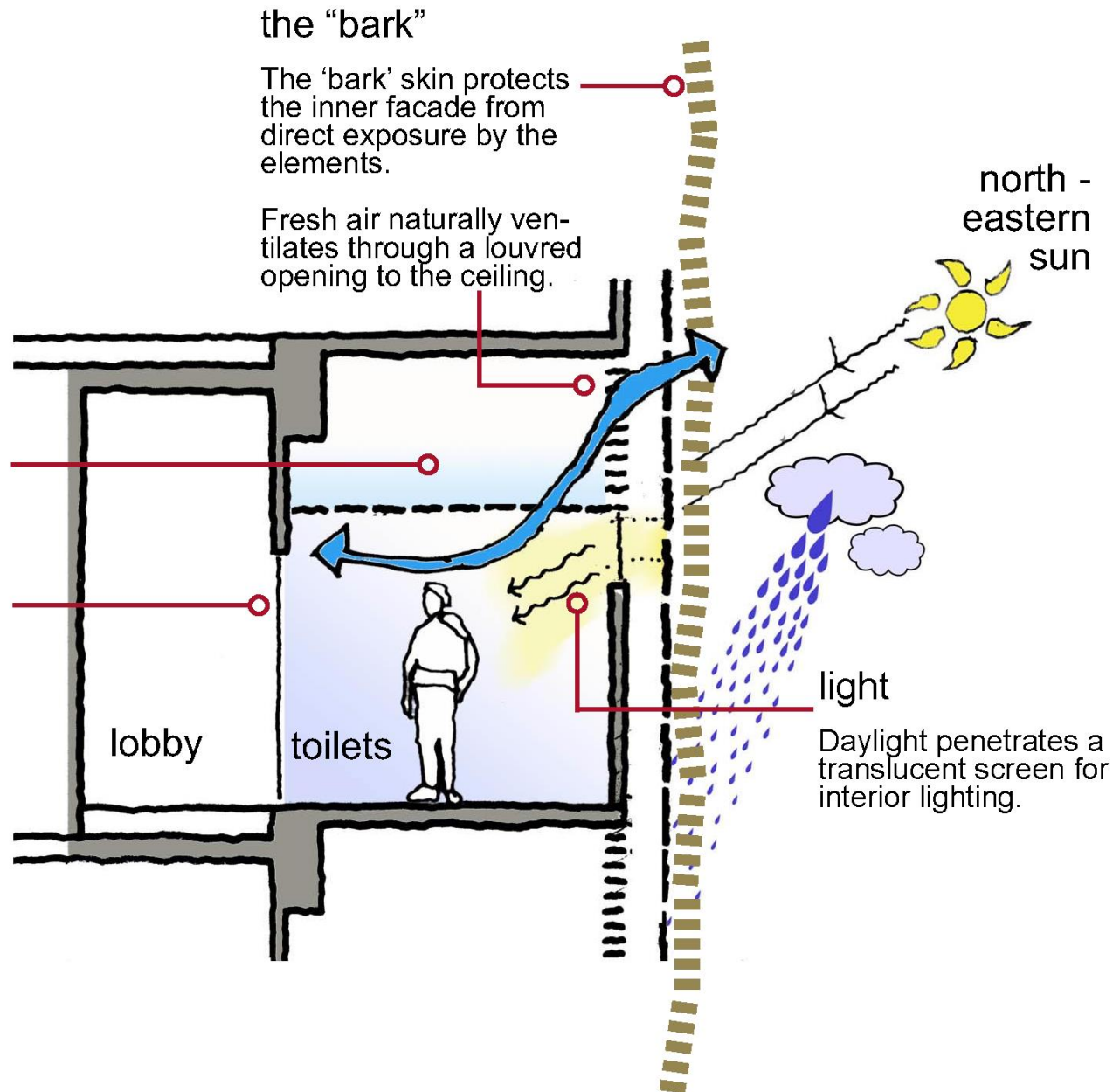




## plenum

A perforated ceiling allows fresh air to circulate at high level - naturally ventilating the interior.

Air seals at entry doors allow conditioned air to stay within conditioned space, so as to minimise air leakage.



## AIRFLOW - NATURAL VENTILATION





• CH2 ROOF TOP GARDEN

APRIL 2016







### wind turbines

The exhaust plenum is at slightly negative pressure, induced by north flues' 'stack-effect' and wind-powered turbines.

### vertical planting

Green north facade and roof top assists shading, glare + air quality.

Access to nature enhances productivity by relieving stress.

### shading + light

Light shelf + balcony floors provide horizontal shading from northern sun.

Ambient and direct day light bounces off external and internal light shelf.

### exhaust

High level ceiling exhaust ensures complete emptying of warm air in ceiling spaces.

### chilled ceilings

Chilled ceiling panels absorb radiated heat from equipment and occupants.

Occupants experience 'coolth' by radiating heat to chilled ceilings overhead.

### roof top energy

Includes photovoltaic cells, solar hot water panels and a gas-fired co-generation plant.

### healthy air

100% outside air supply via vertical ducts deliver air floor by floor to sealed access floor plenum.

### thermal mass

Thermal mass in concrete slab absorbs excess heat from the space.

### displacement air

Fresh air fed at low speed through controllable floor vents.

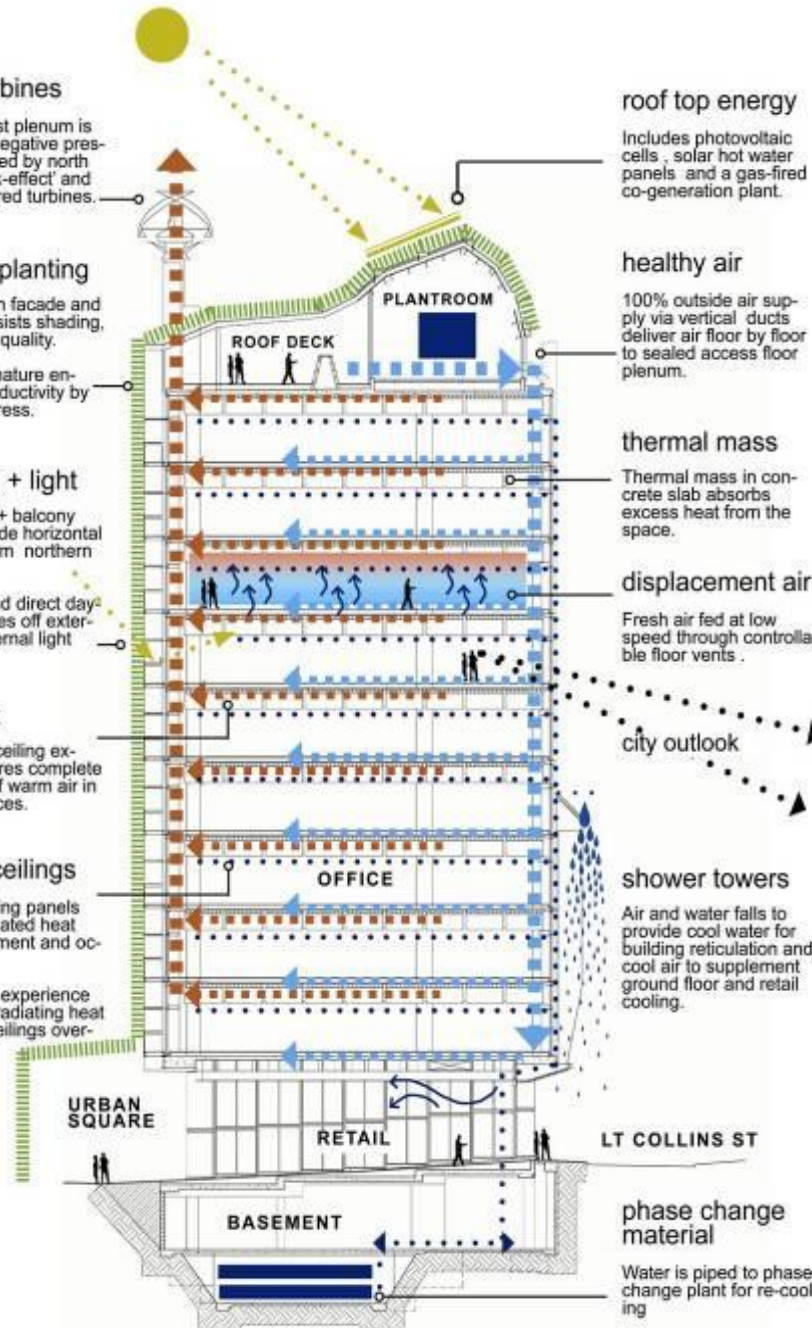
### city outlook

### shower towers

Air and water falls to provide cool water for building reticulation and cool air to supplement ground floor and retail cooling.

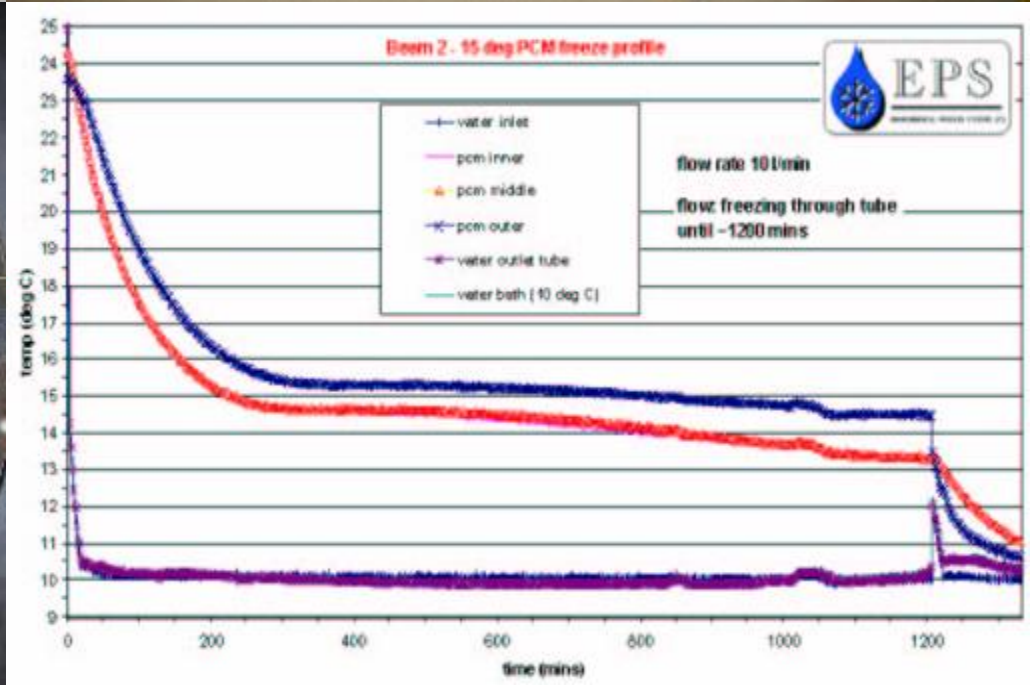
### phase change material

Water is piped to phase change plant for re-cooling.



**RIO CLIMATIC SECTION**













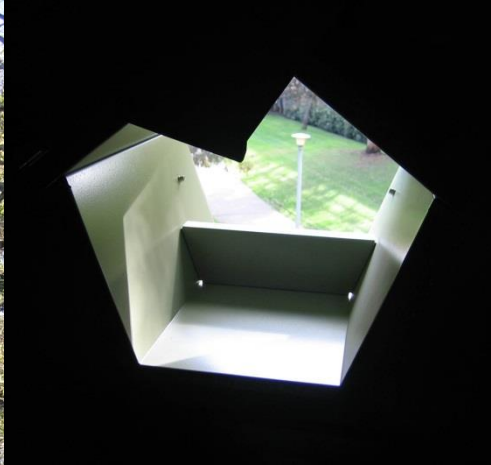
- MWR PLANT has five processes;
- 1) Holding tank of
- 2) 200 micron filtering.
- 3) Ceramic filtering
- 4) Reverse Osmosis
- 5) chemical dosing.



# ANNEXTURE ONE







Pigeons have a place in the city like all life forms but with excessive access to street café food in Melbourne they breed 10 times a year instead of twice. This device I designed to manage the breeding process.













Vanke China Ltd invited me to help develop their research base in Dongguan.



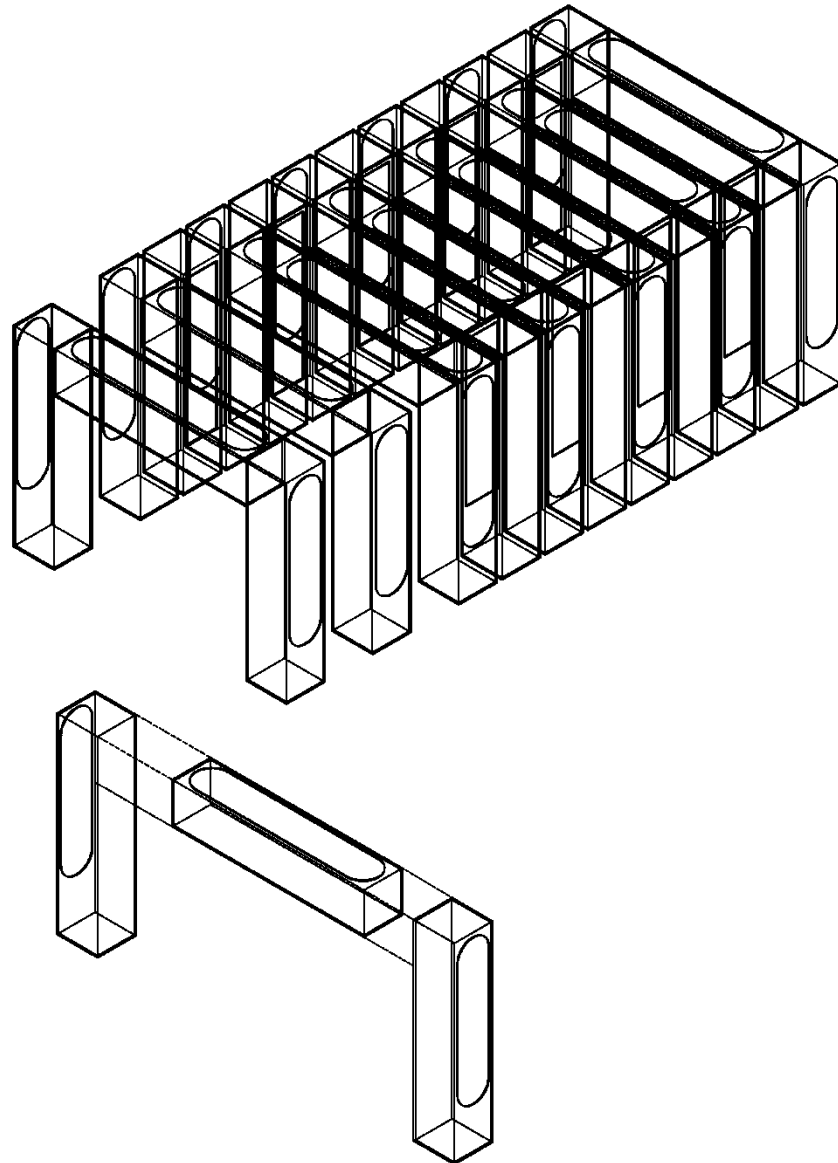


Vanke China Ltd's research base in Dongguan

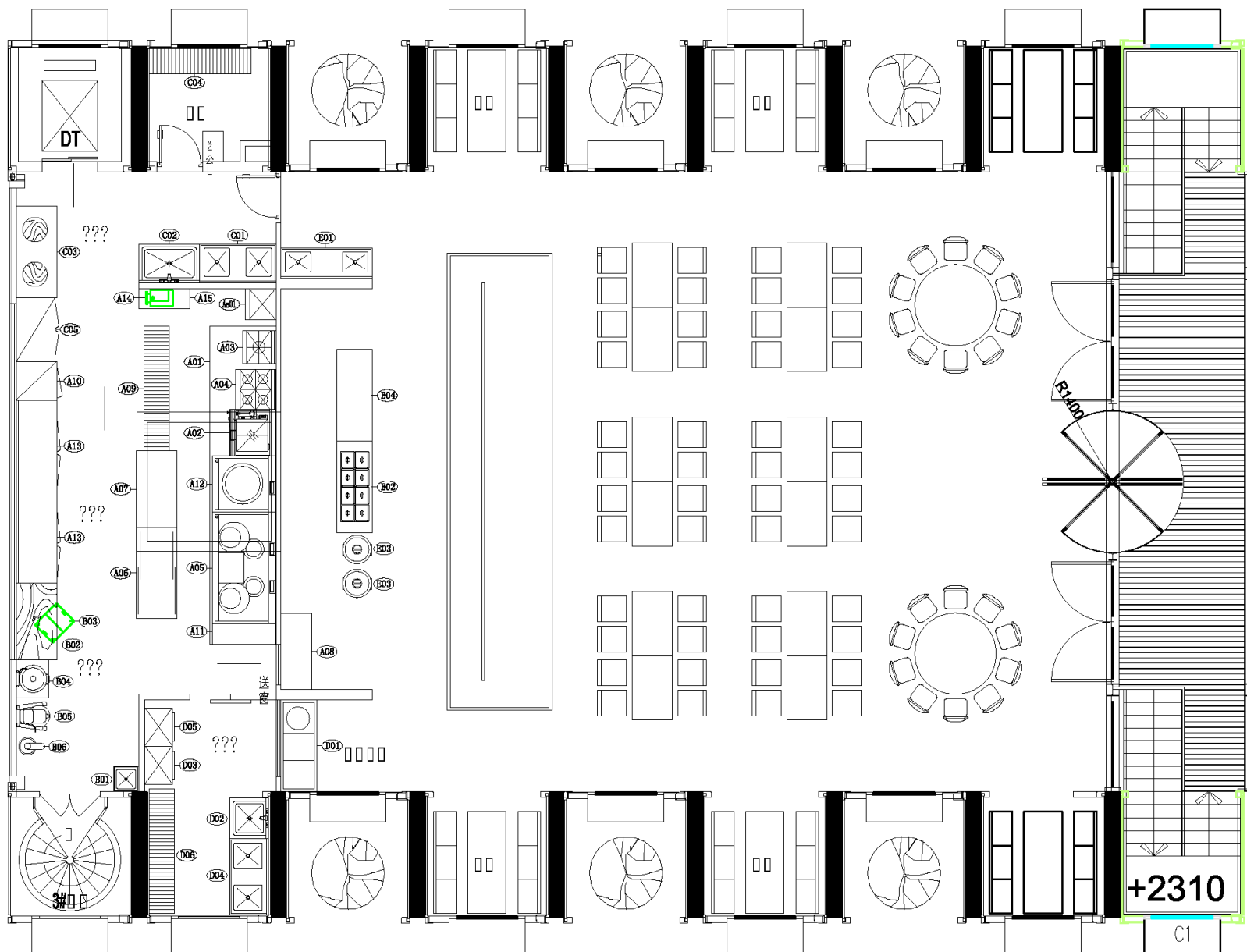




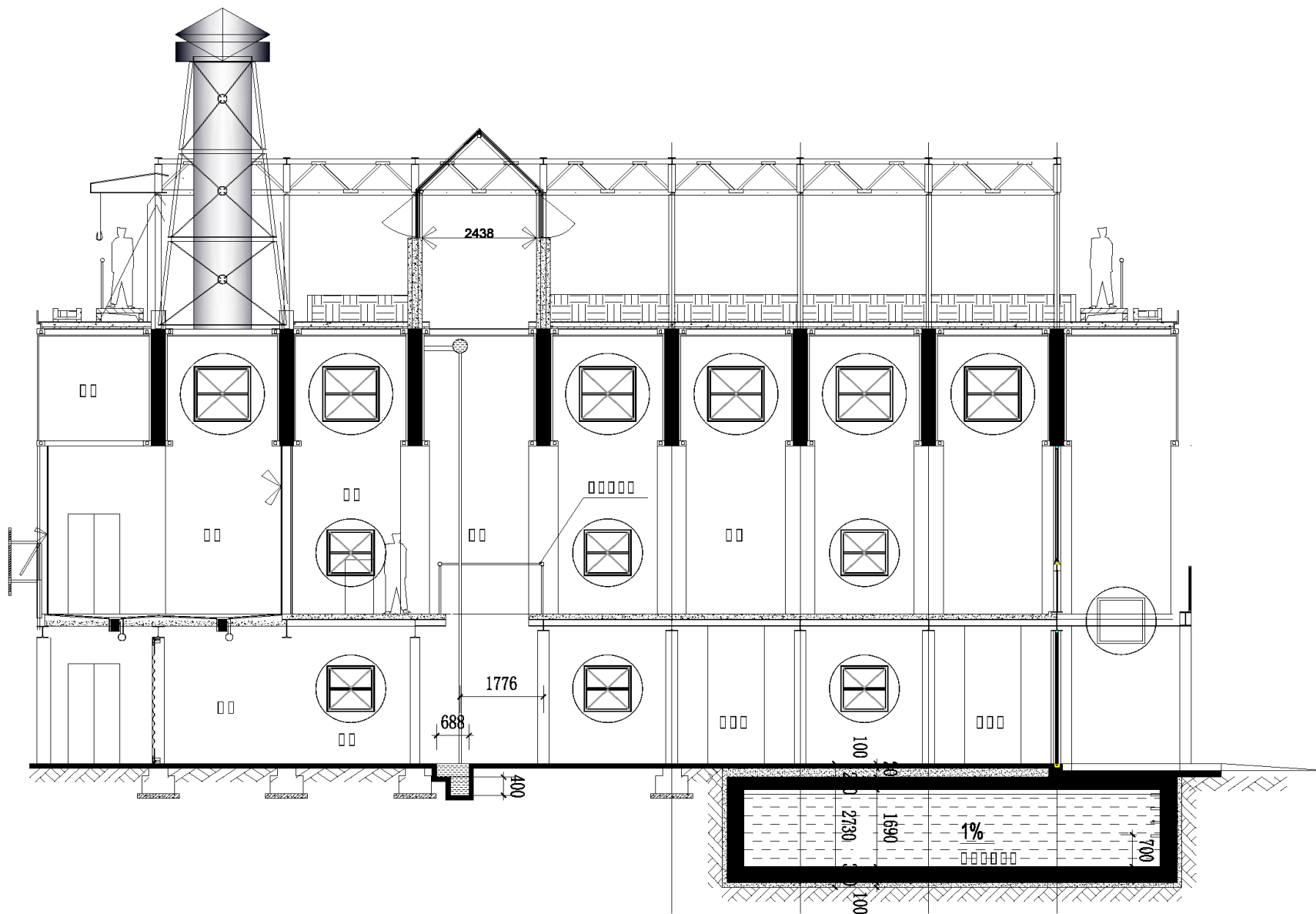




























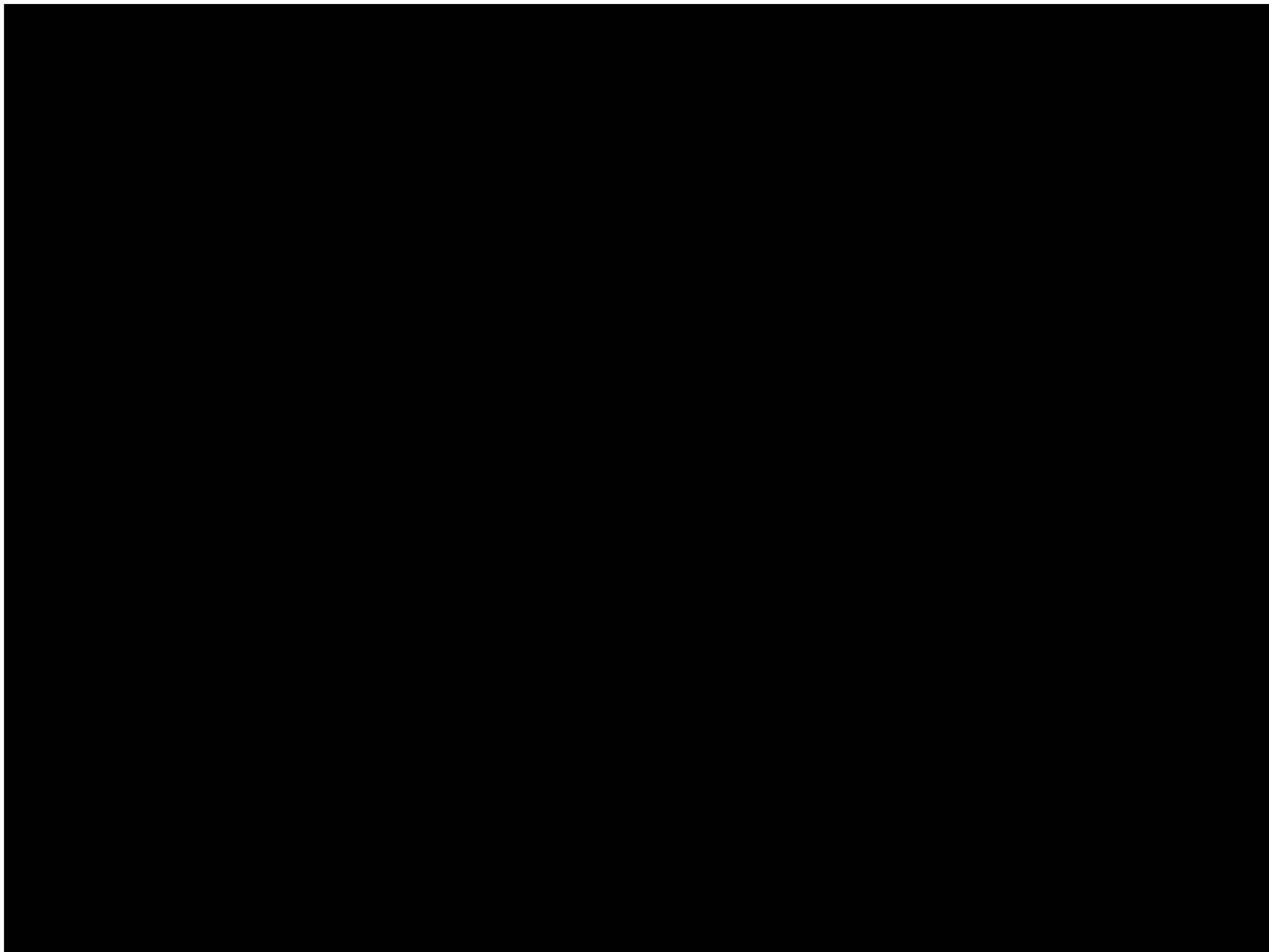




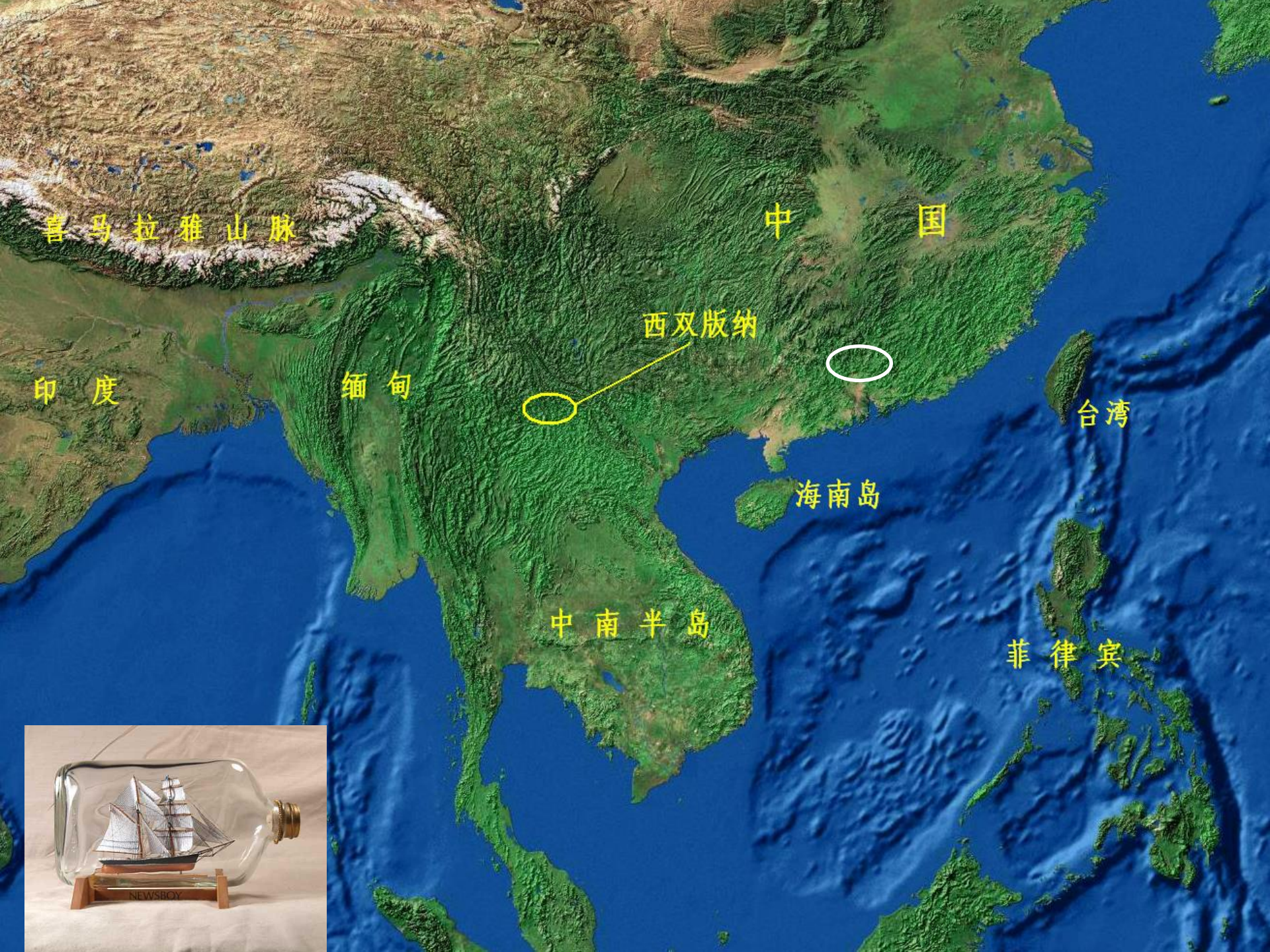


















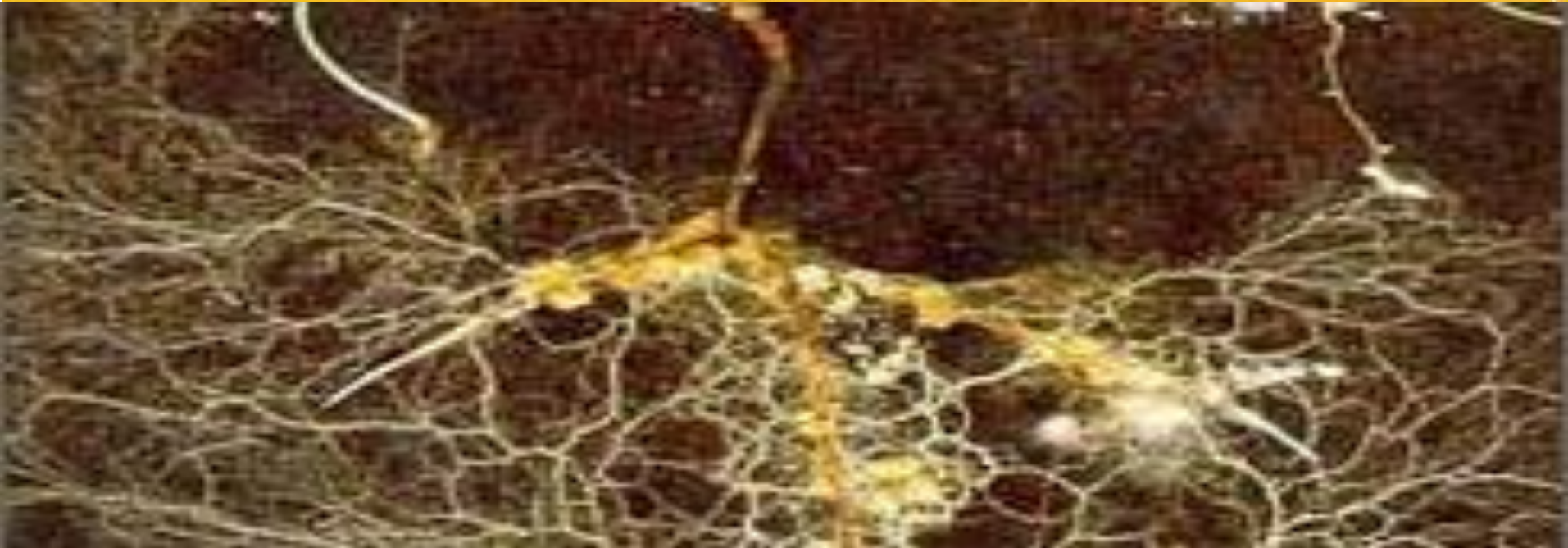


- The forest is layered in 5 layers all competing for a sun window with great diversity of species  
物种丰富的五层植被形成了自然的天窗
- emergent trees 突出层
- Main canopy 大乔木
- Small trees 小乔木
- Shrub layer 灌木层
- Forest floor 地被层



birds.

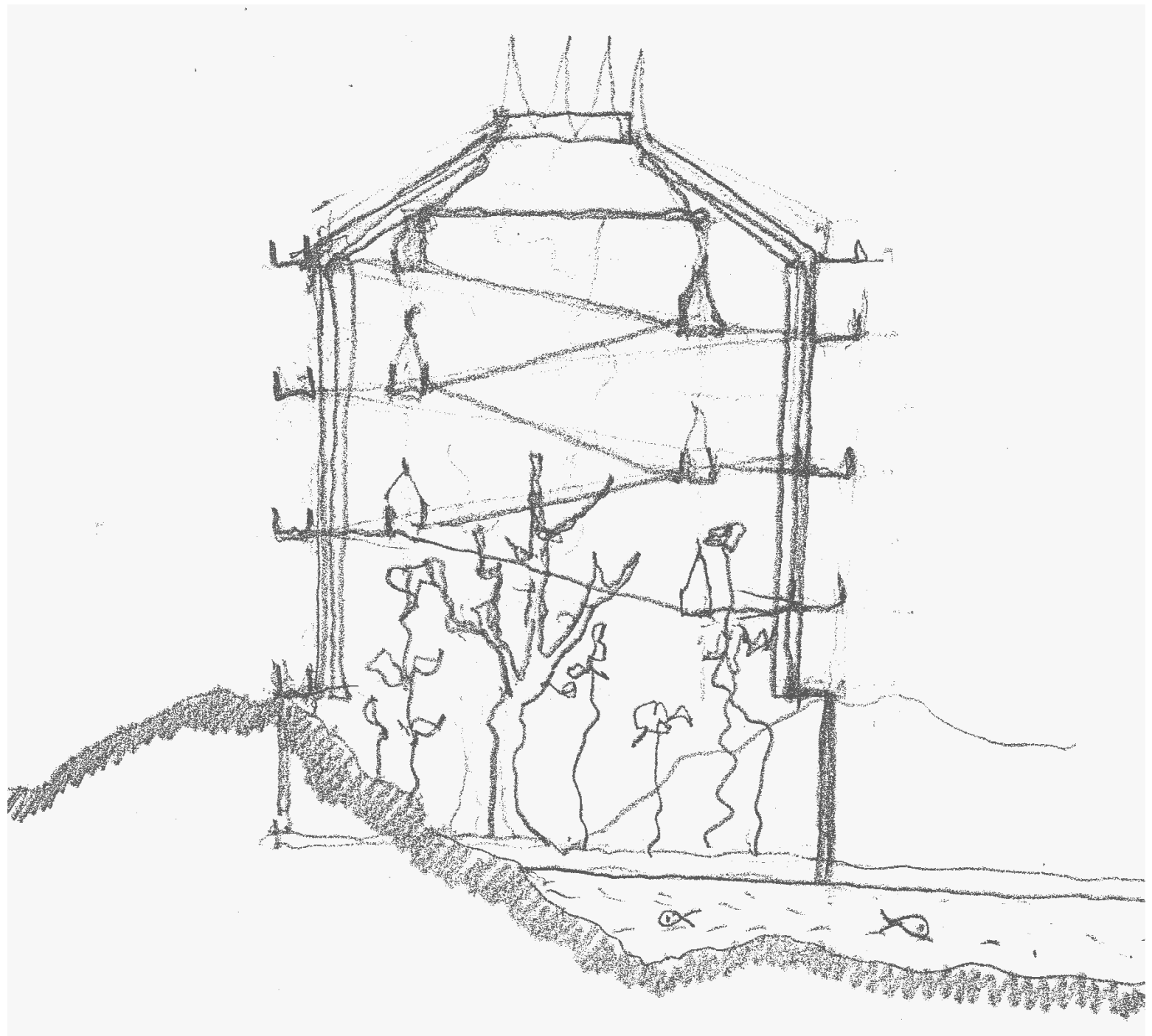
細聽鳥語。



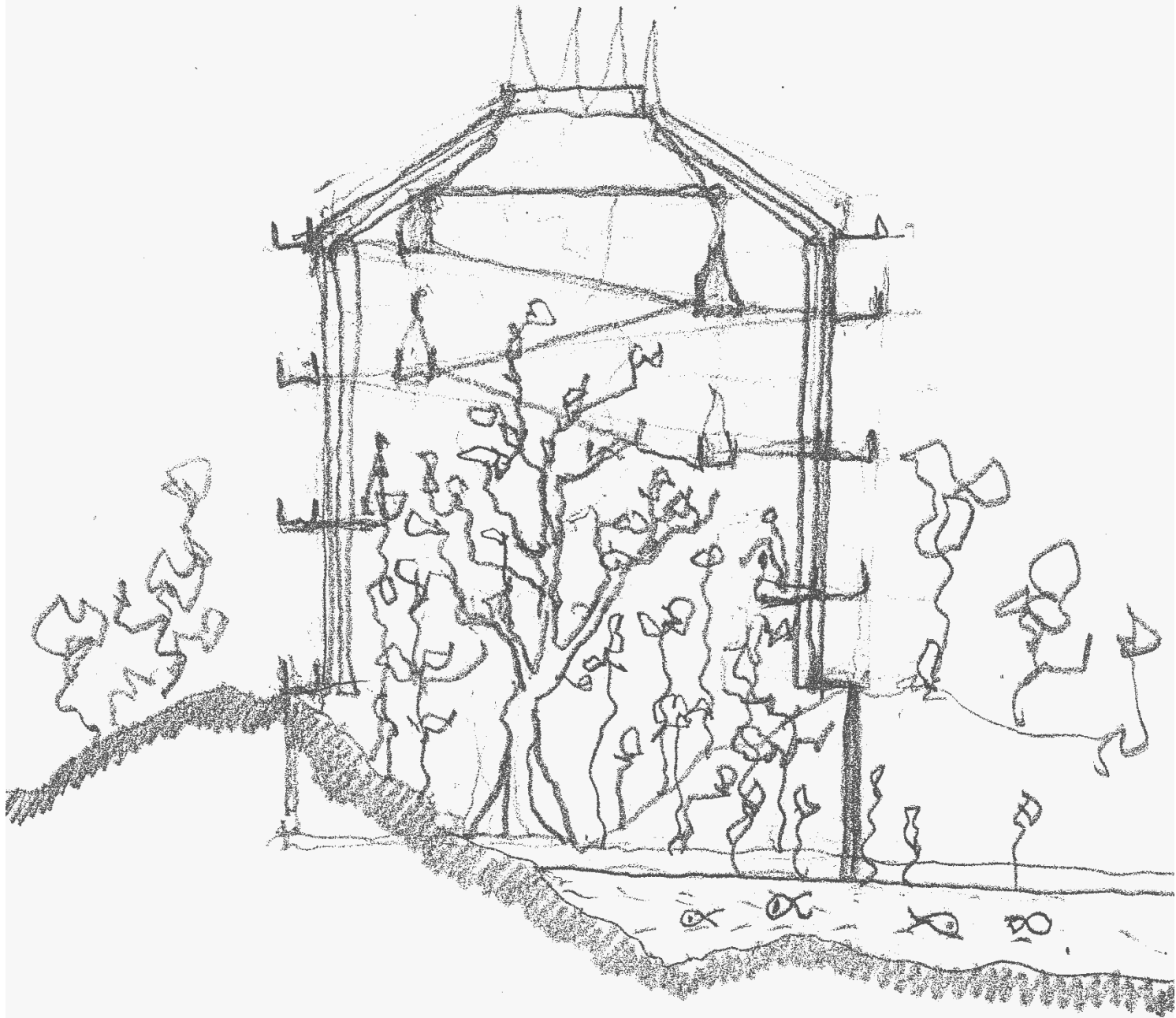
**Public access.**

As much going on below ground as above. How do we see it?

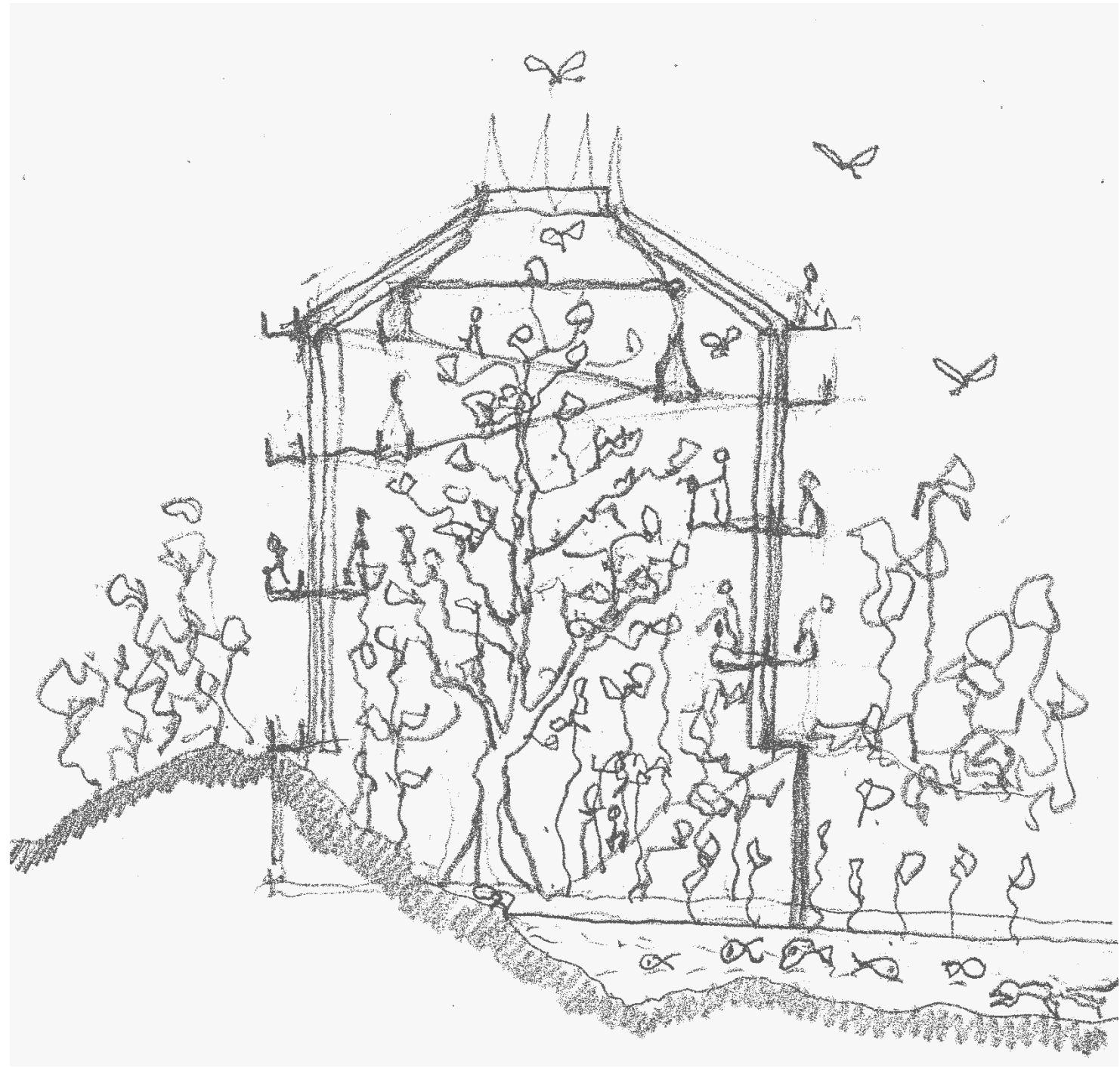




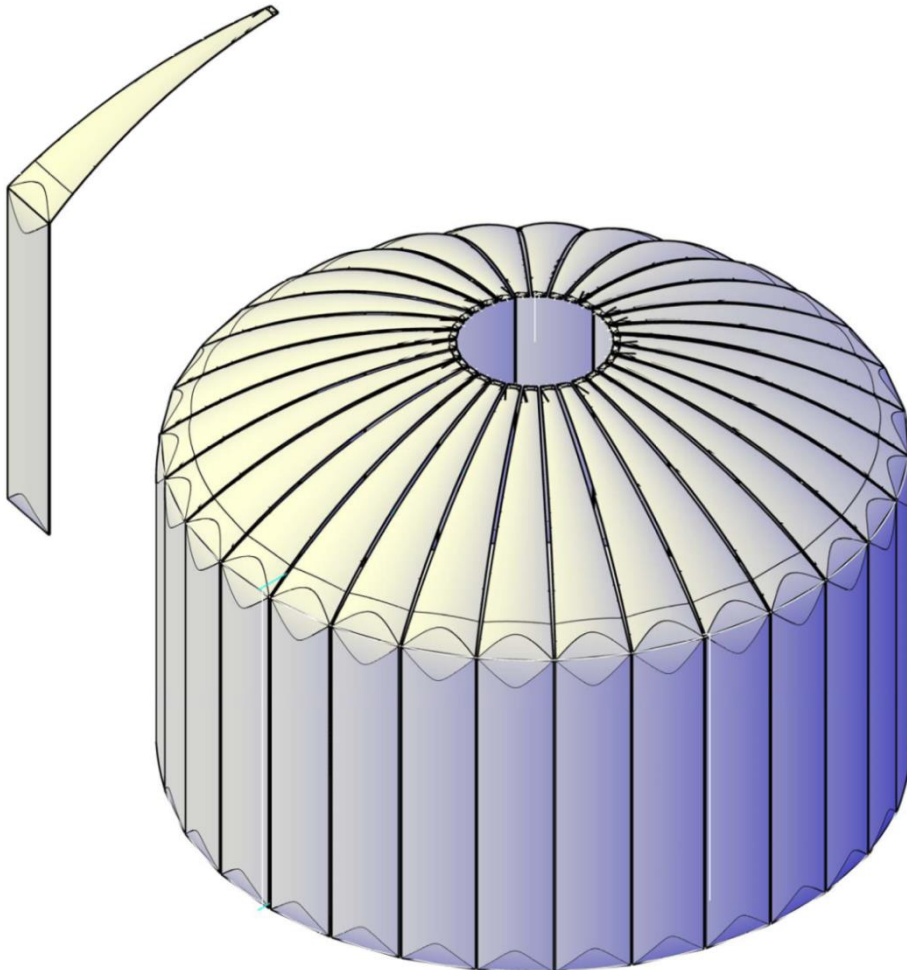




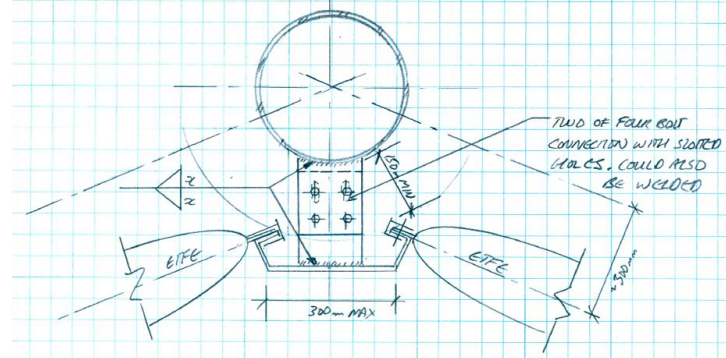






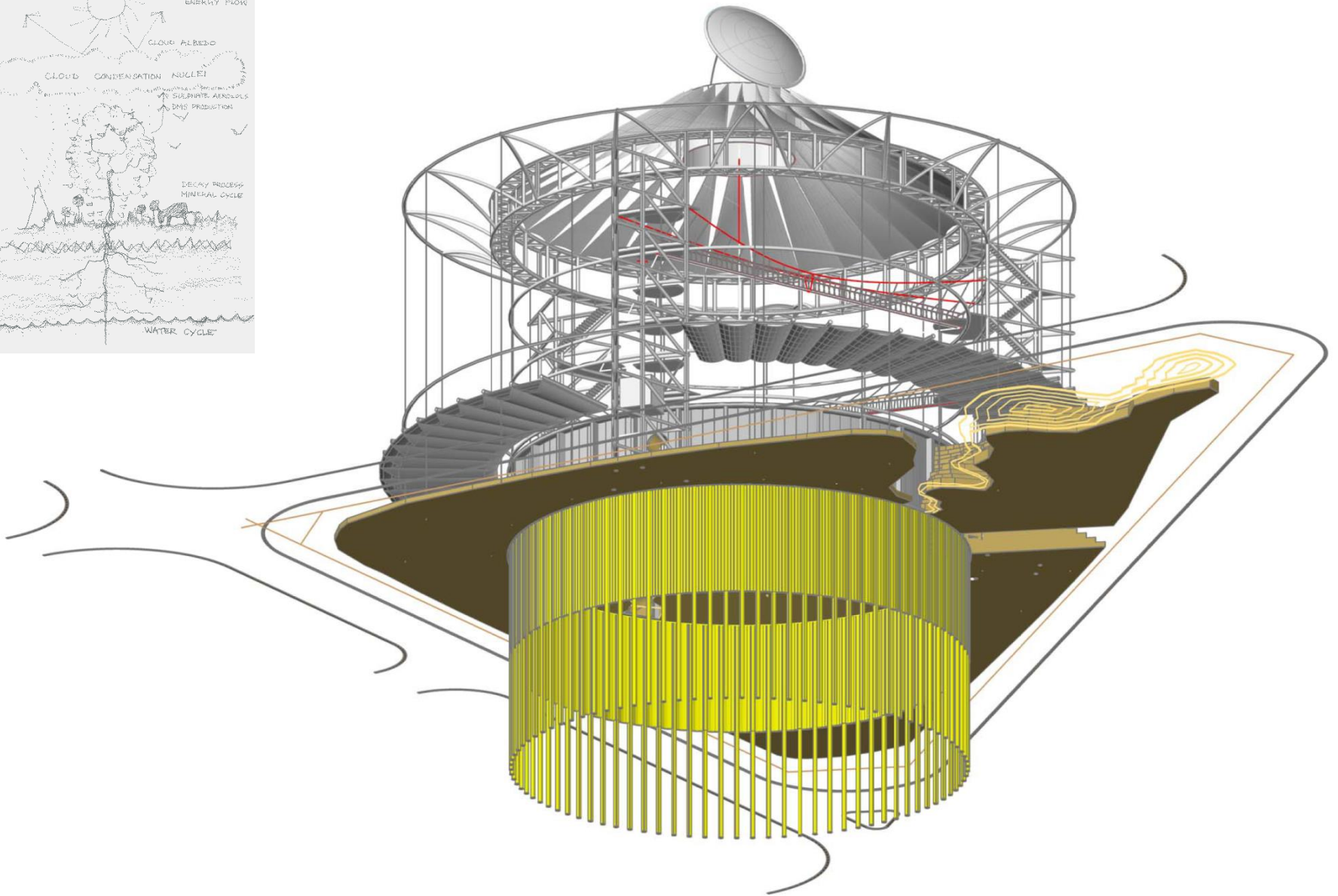
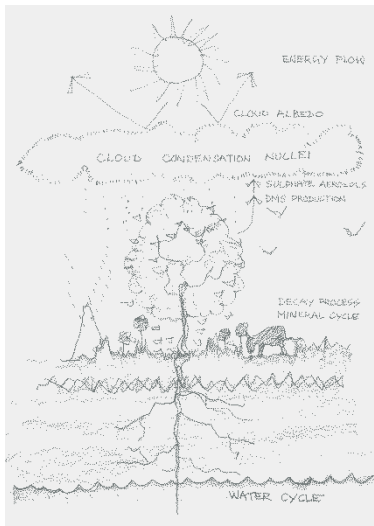


TYPICAL POST-ETFE CONNECTION - BOLTED



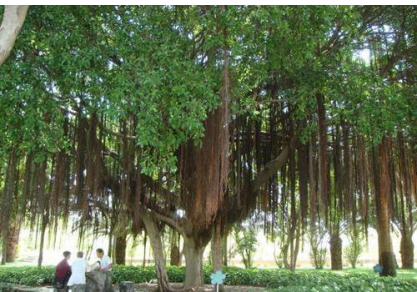
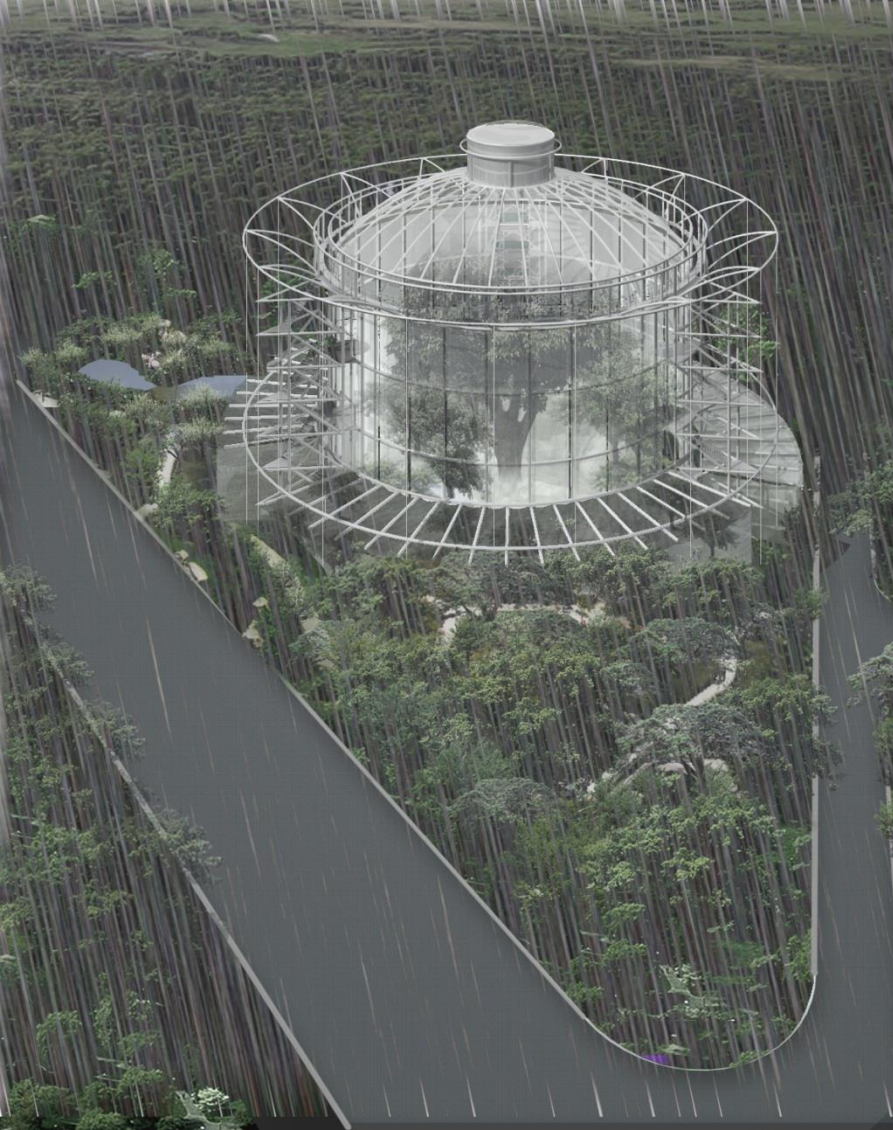
- This interface detail was advised by Vector Foiltec whom supplied the ETFE for both Eden and the Water cube.
- ETFE bubbles are 4000 mm max wide and as long as possible to save pumps.
- This cylindrical is by far the cheapest and most energy efficient form for these proportions and scale





The building is a tree

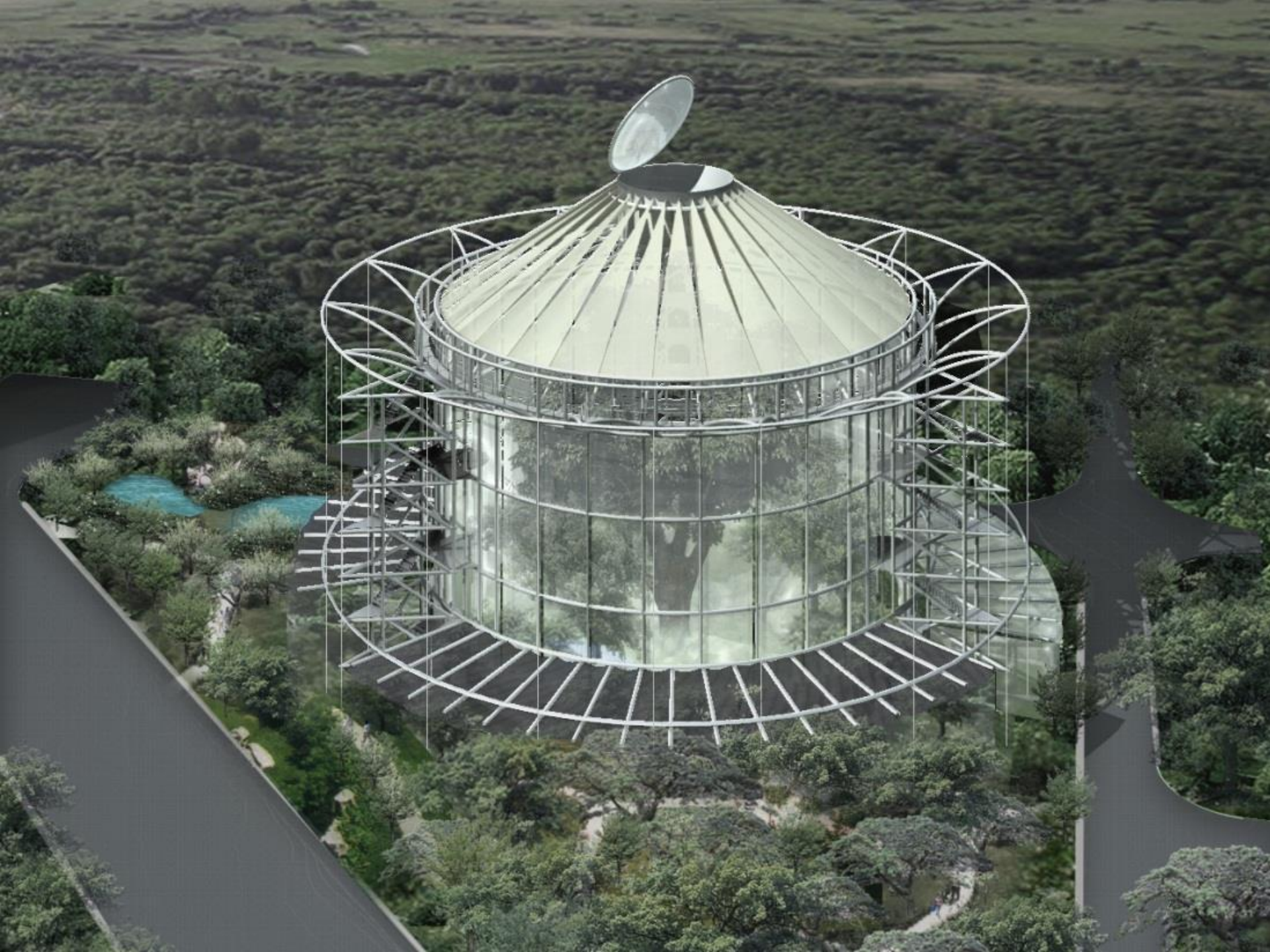




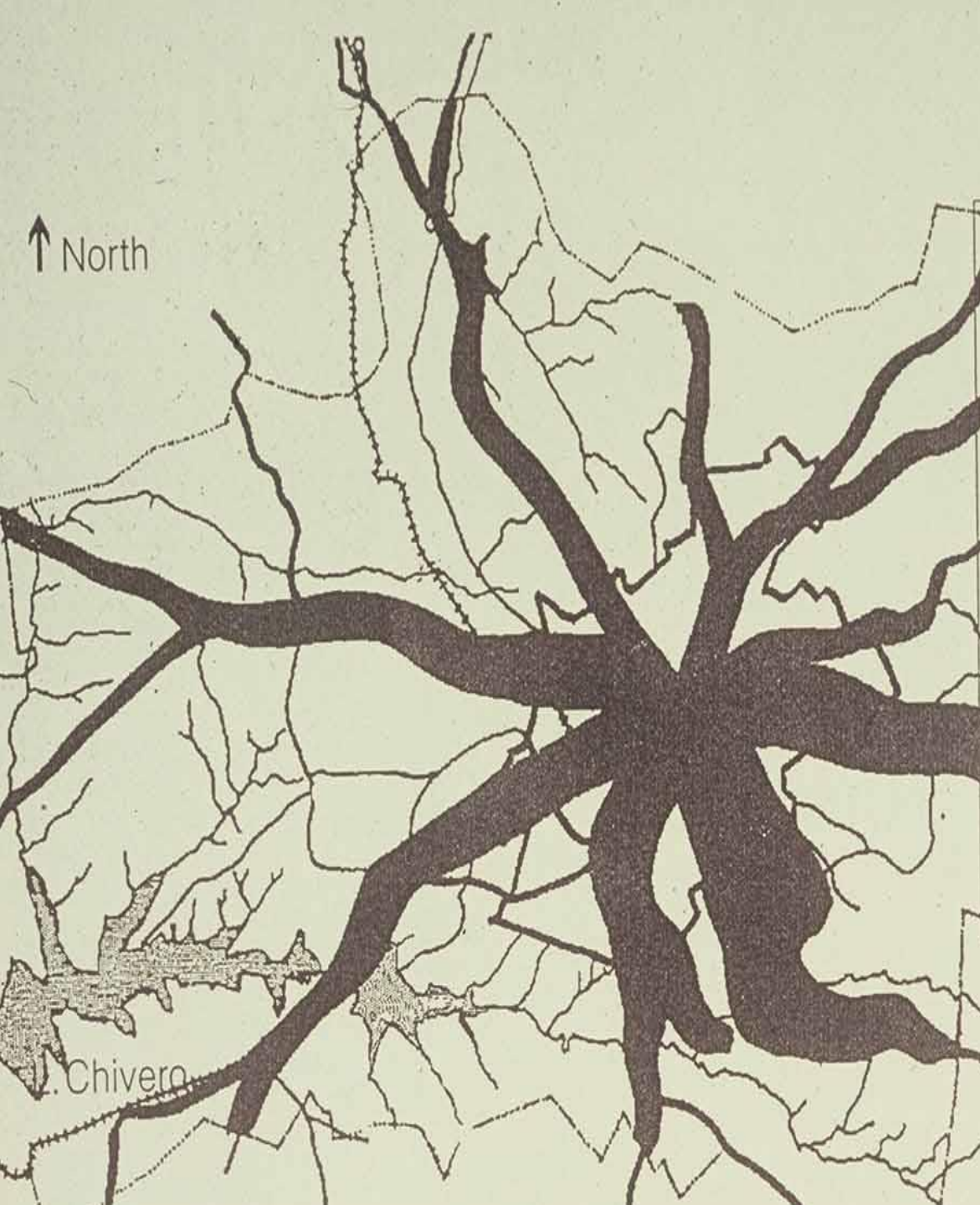
- Is this the web-like adaptive structure?











## Comparative Figures

	Curitiba	Harbin
City area	435 km <sup>2</sup>	500 km <sup>2</sup>
Metropolitan area	3700 km <sup>2</sup>	5000 km <sup>2</sup>
Population	2.6 million	1.5 million
Average distance to work	5.5 km	20 km

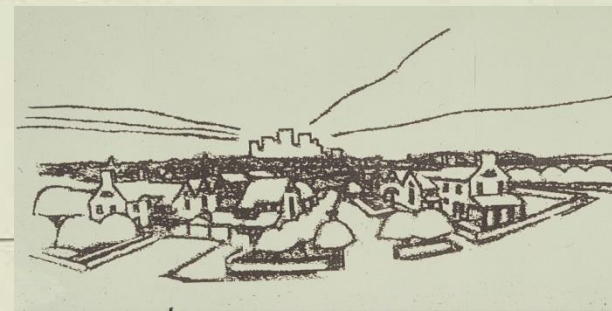










Image © 2010 DigitalGlobe

©2008 Google



THE  
PAVEMENTS  
WERE  
OCCUPIED BY  
STREET  
VENDORS



11.03.2012 17:17





View from above Wynne Street looking south east





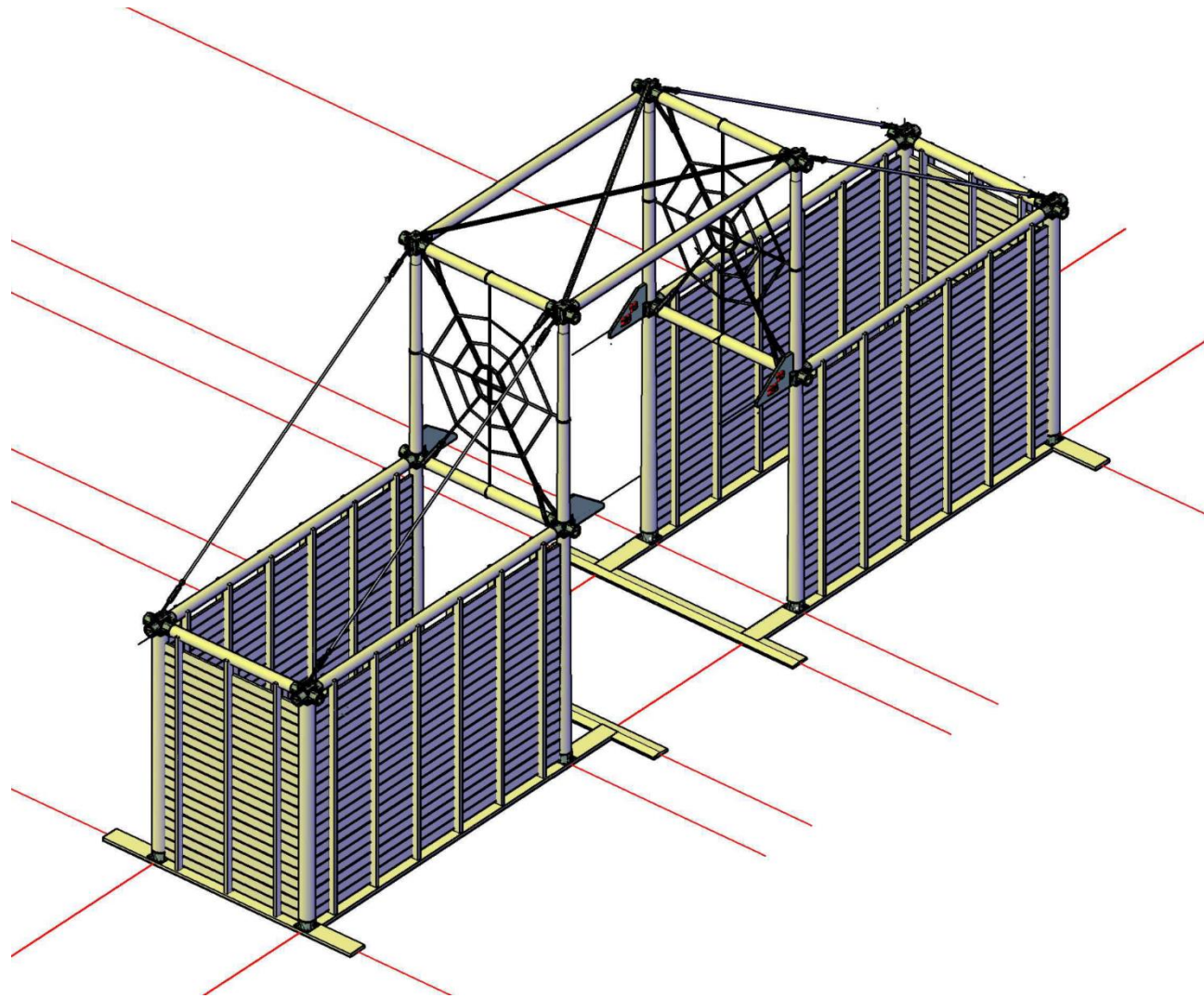
# EASTGATE MARKET

BRIDGE WILL CONNECT TO EASTGATE









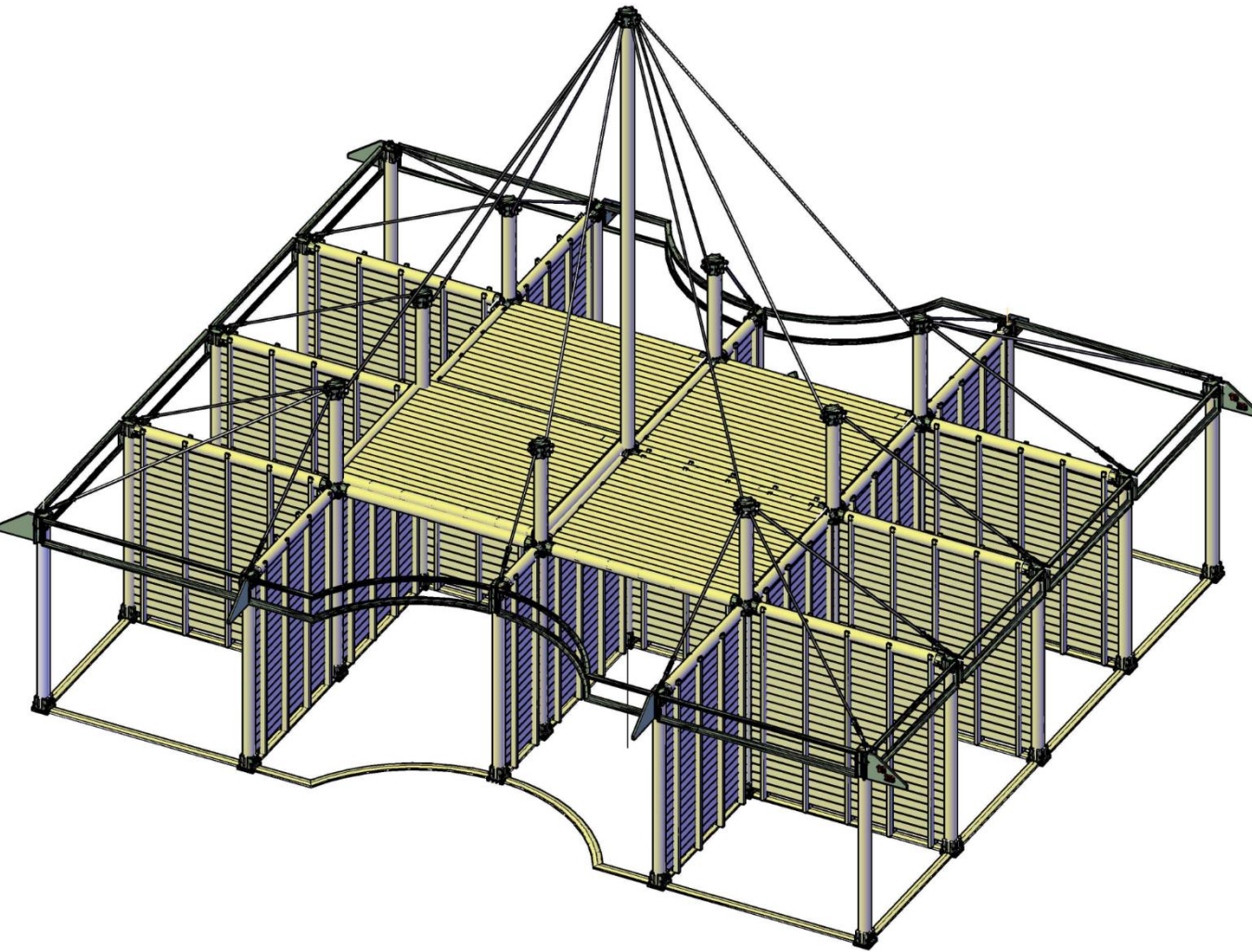
- NORTH STREET STALL

- TYPE N

- This is one typical bay from a north street.
- This unit sits in the a double height space. There are blocks of these standing on two sides of a street, 14 units. These require bracing. This bracing can be done above the partitioning so that partitions can be removed or changed at any time in the future.

There are 138 of these units in all with minor variations.





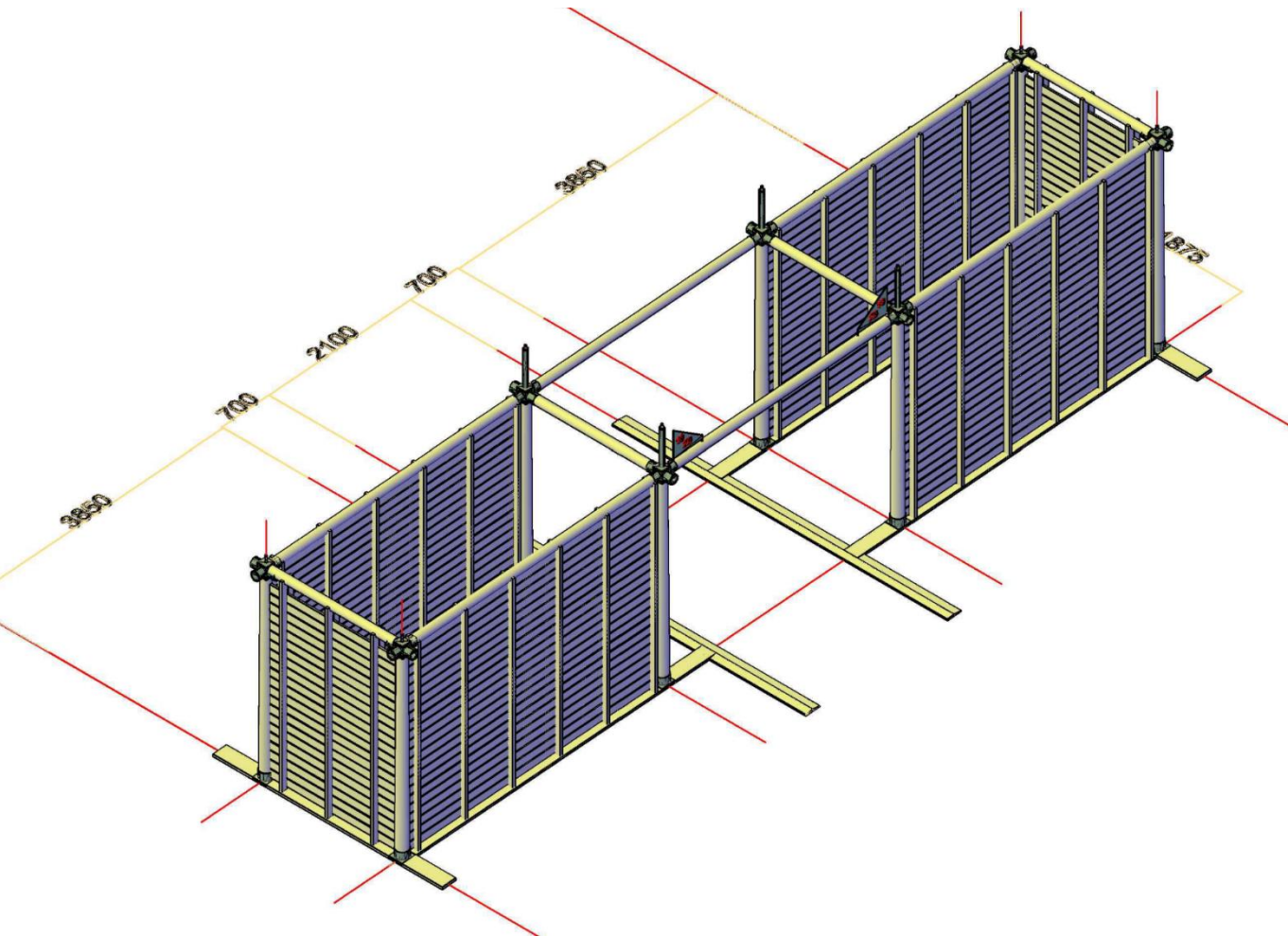
## MALL STALL UNIT

### TYPE M

This unit sits in the middle of a double height space. There are 10 of these free standing units and therefore require bracing. This bracing can be done above the partitioning so that partitions can be removed or changed at any time in the future.

There are 10  
type M units  
in all with  
minor  
variations





## SOUTH STREET STALL

### TYPE S

- This has a concrete ceiling and therefore the columns can be stabilized by a jacking system for stability.
- There are 126 units like this with minor variations

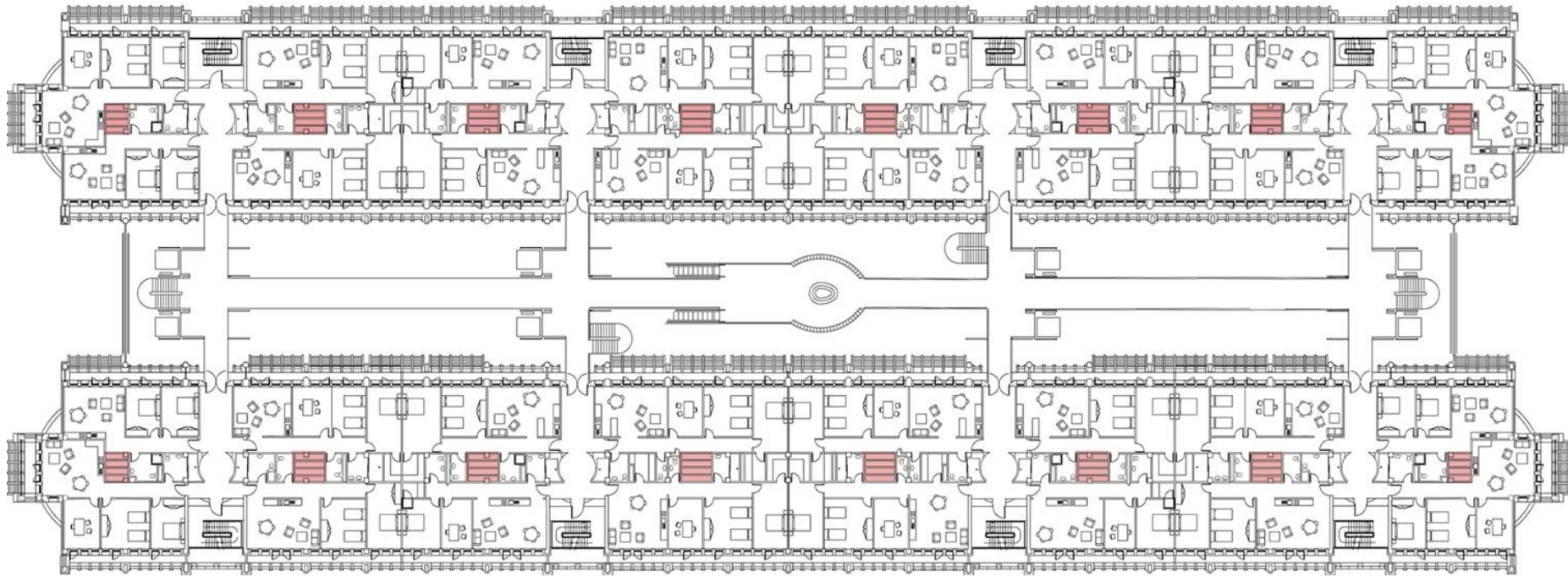




PROPOSAL TO CONVERT PARTS OF EASTGATE INTO APPARTMENTS



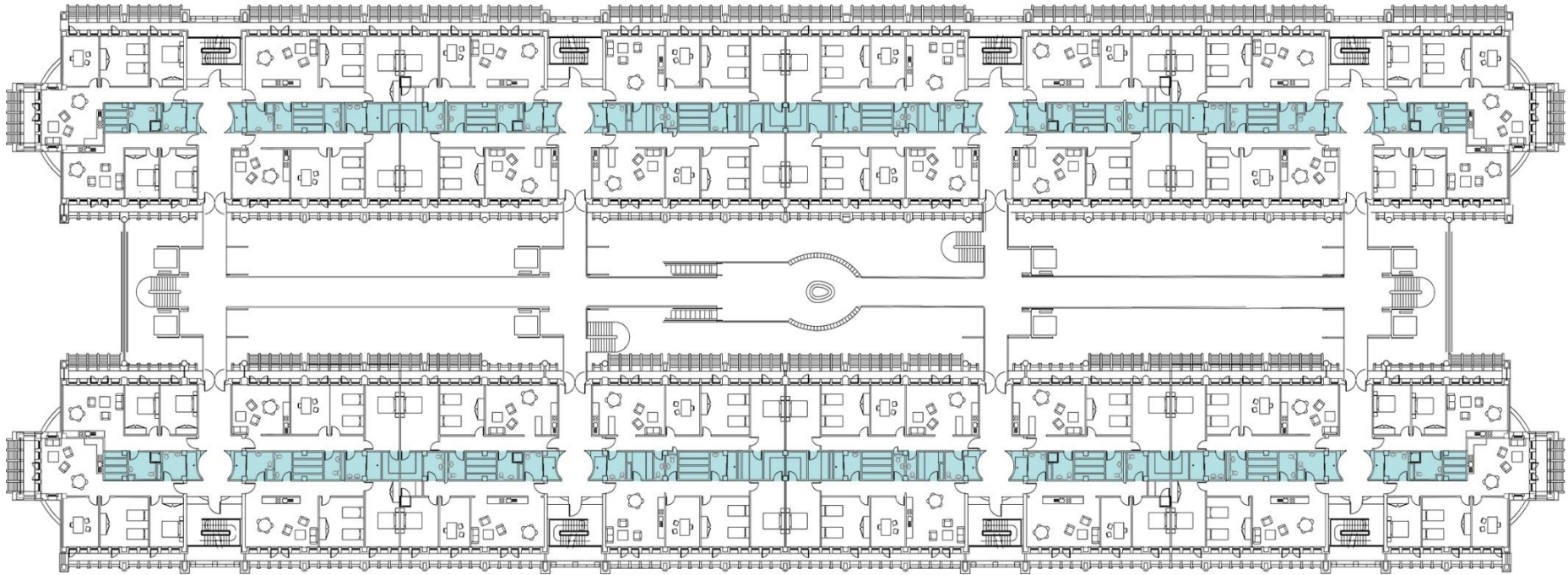
# PROPOSAL > AIR



The air ducts are remained and shared between apartments

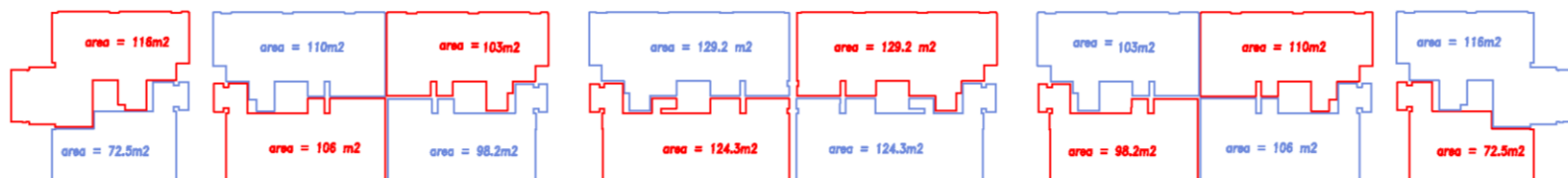
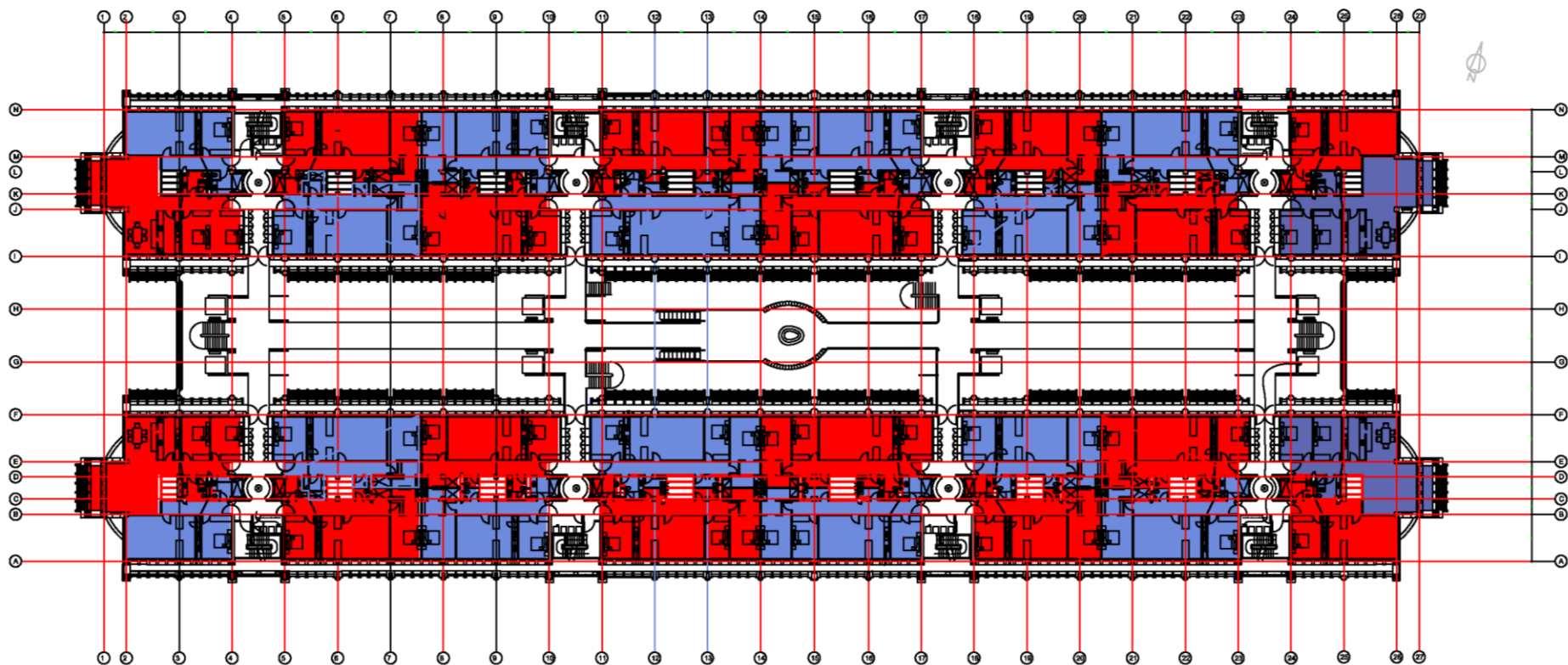
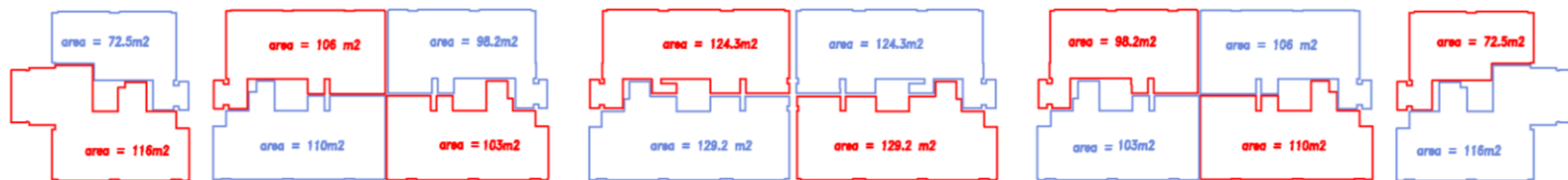


# PROPOSAL > water



Water points remained in the middle of the building





- Plan of level 7 showing 32 one, two and three flat types with lettable areas of each





Zimbabweans have the will and ability to self-build. This is the self build city of Hatcliff before Murumbatzna





**Roofs of houses were made like this from recycled plastic and rubber bands cut from old inner tyre tubes**

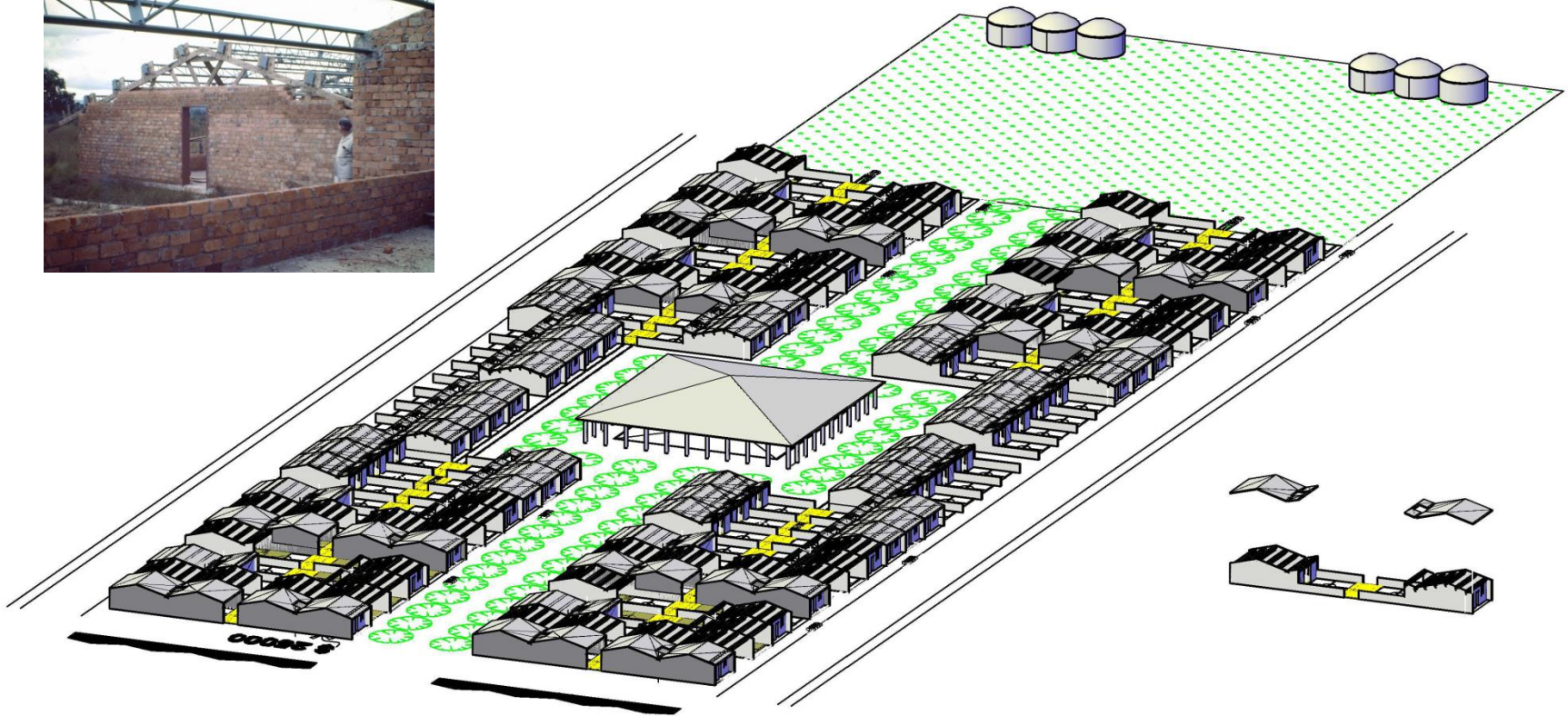




Murumbatzna destroyed the community and the potential to self build . The solution



# AFFORDABLE HOUSING IN BULAWAYO





# A new model village for Zimbabwe

