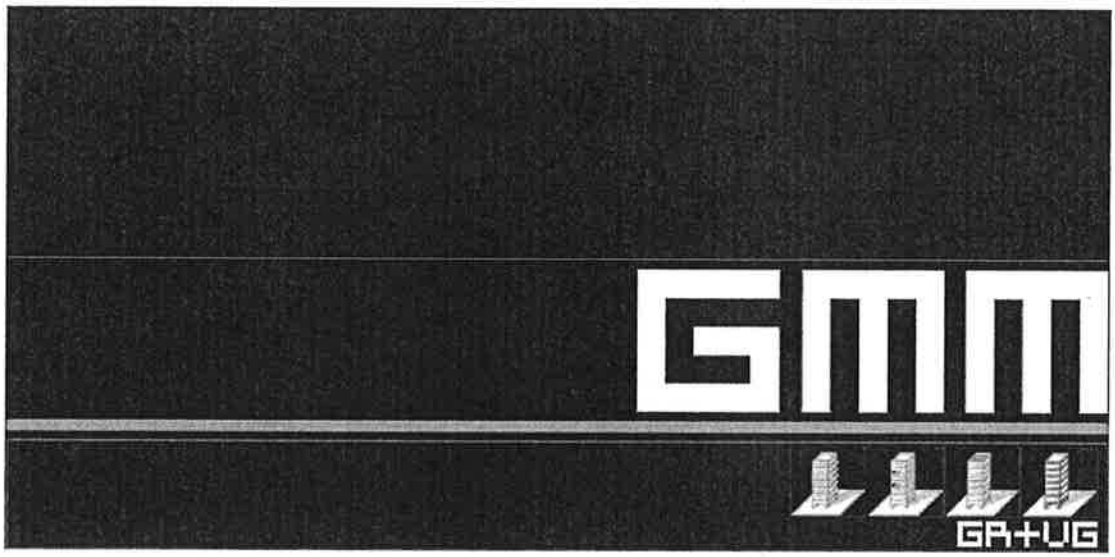


CUGE Centre for Urban Greenery and Ecology

GMM COURSE

Greenery can alleviate Urban Heat Islands directly by shading heat absorbing surfaces, and indirectly through evapo-transpirational cooling

(McPherson, 1994)

First investigated and described by Luke Howard in the 1810s

UHI effects is the phenomenon of an urban area being significantly warmer than its surrounding rural areas.

WHY A GREENER CITY?

The temperature difference between the rural & urban area in Singapore is about 3^{0}C

(Tso, 1996)

Heat retaining material in Urban Development (Primary Contributor)
Waste heat from energy usage (Secondary Contributor)

Introduction of Green surfaces to combat UHI

Introduction of Green surfaces to combat UHI
Oxygen production

Reflect heat — 27% of solar radiation is reflected.
60% is absorbed by the plants (convert into chemical energy)
13% is transmitted into the soil.

Absorb less heat (Plant & soil are poorer thermal conductor)

Streets w/o trees has at least 3X more dirt particles per litre of air (10k -20k dirt particles/litre of air) **than streets with trees** (3k dirt particles/litre of air)

(Minke & Witter, 1982)

Air particles

UHI also decreases the air quality by increasing the production of air pollutants such as ozone.

ozone

UHI also decreases water quality as warmer water flows into streams, stressing the ecosystems.

warmer water

The "white noise" similar to the sound of wind rustling through leaves has been used and help heart attack victims to relax.
The fragrance of flowers and plants can trigger responses that are more cognitive and tend to be remembered more vividly than the visual stimuli.

(Porteous, 1985)

J. Douglas Porteous an English professor, specialising in research in urban geography

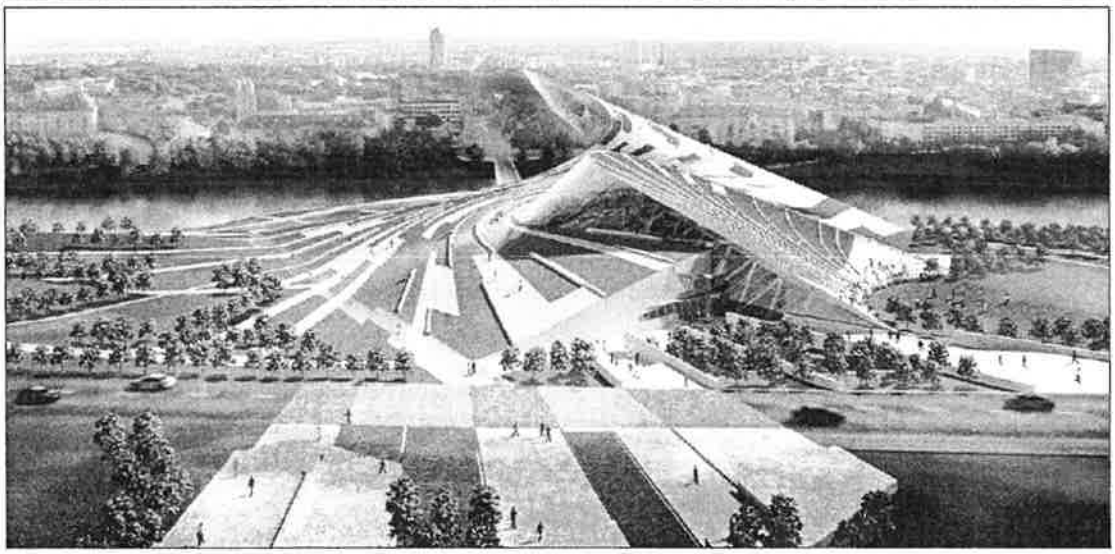
"Biophilia"_ there exist a fundamentally, genetically basic human need and

Propensity to affiliate with nature

(Edward O. Wilson, 1984)

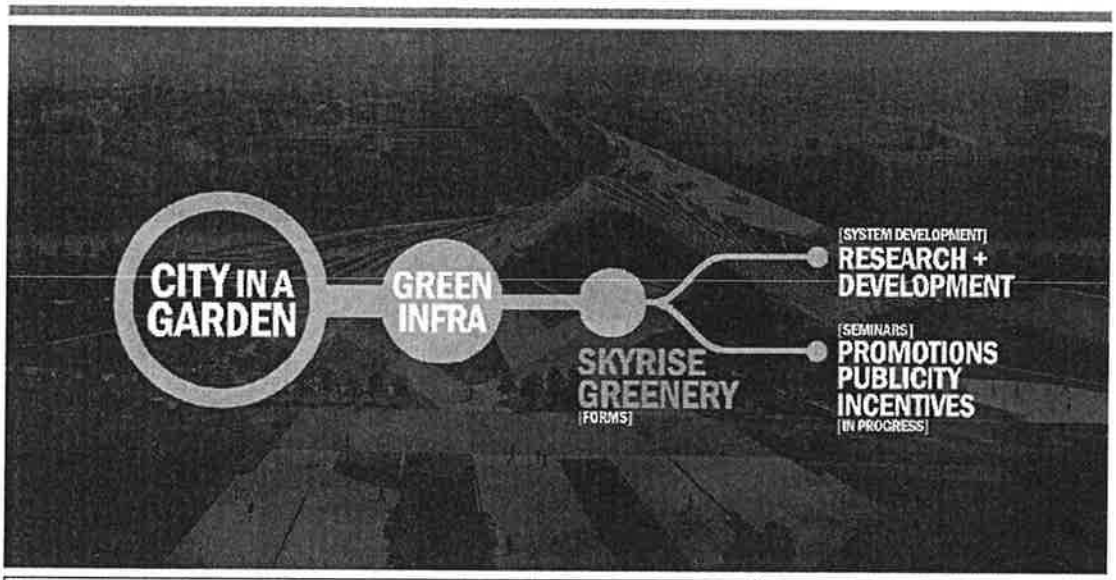
Edward Osborne Wilson (born June 10, 1929) is an American biologist, researcher (sociobiology, biodiversity), theorist (consilience, biophilia), naturalist (conservationist) and author. His biological specialty is myrmecology, a branch of entomology. Wilson is a two-time winner of the Pulitzer Prize for General Non-Fiction.

GMM COURSE



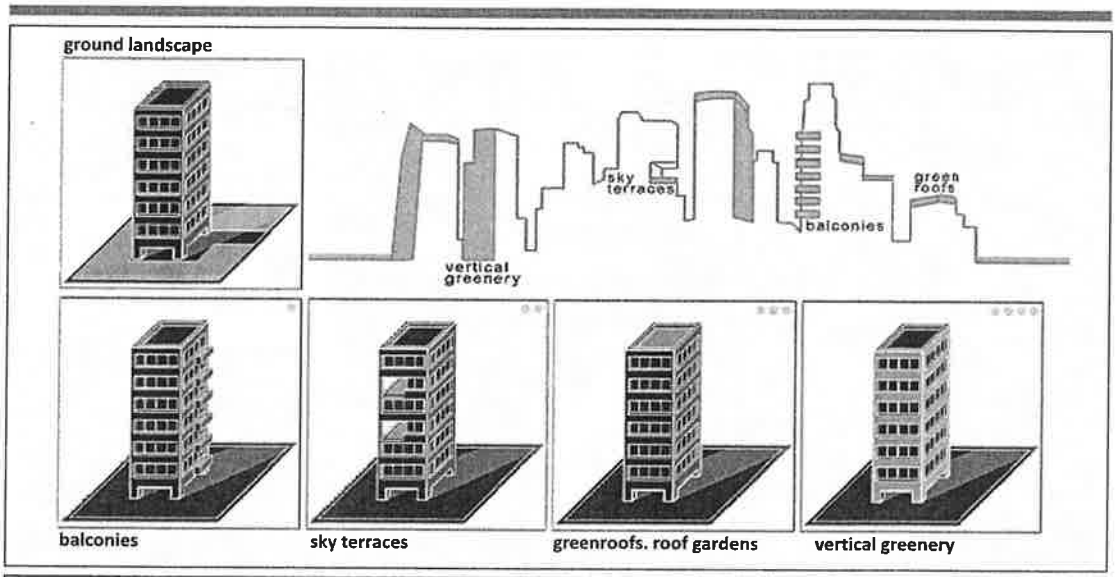
VISION : A CITY IN THE GARDEN

GMM COURSE

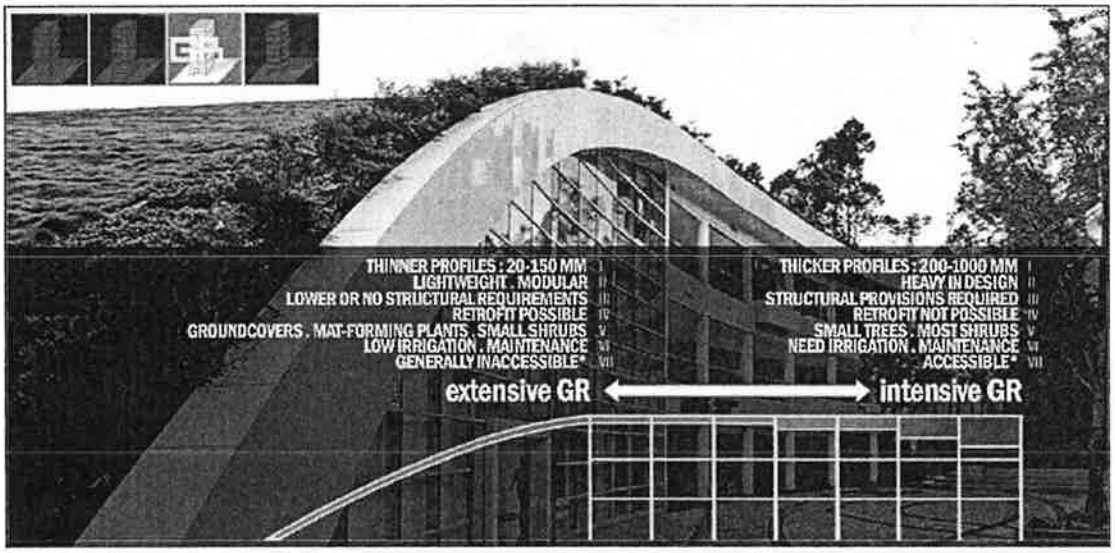


FRAMEWORK

GMM COURSE



SKYRISE GREENERY FORMS



GREENROOFS : TYPES | GR

GMM COURSE



GR

GMM COURSE





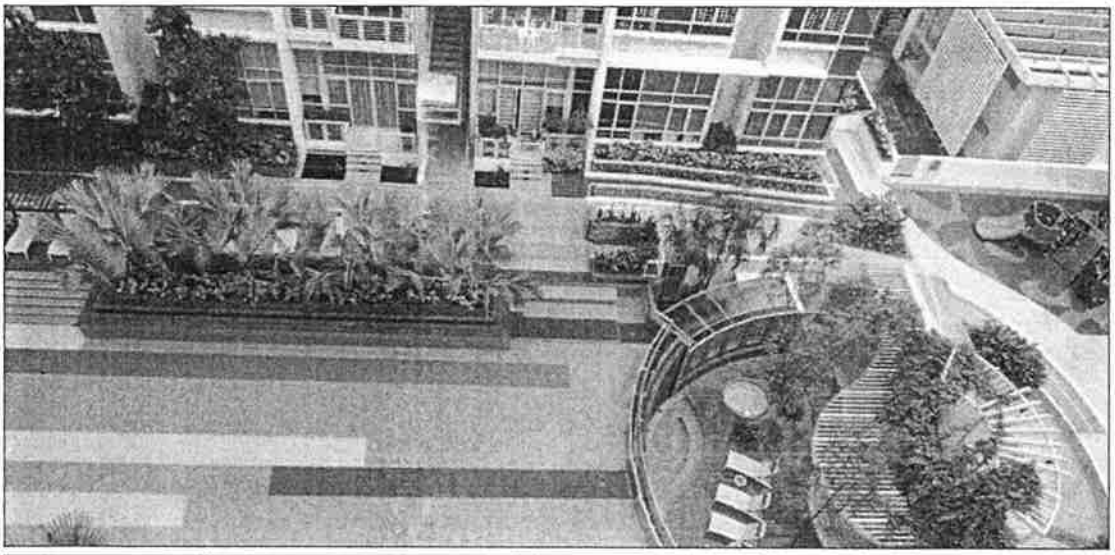
GREENROOFS : INTENSIVE | GR

GMM COURSE



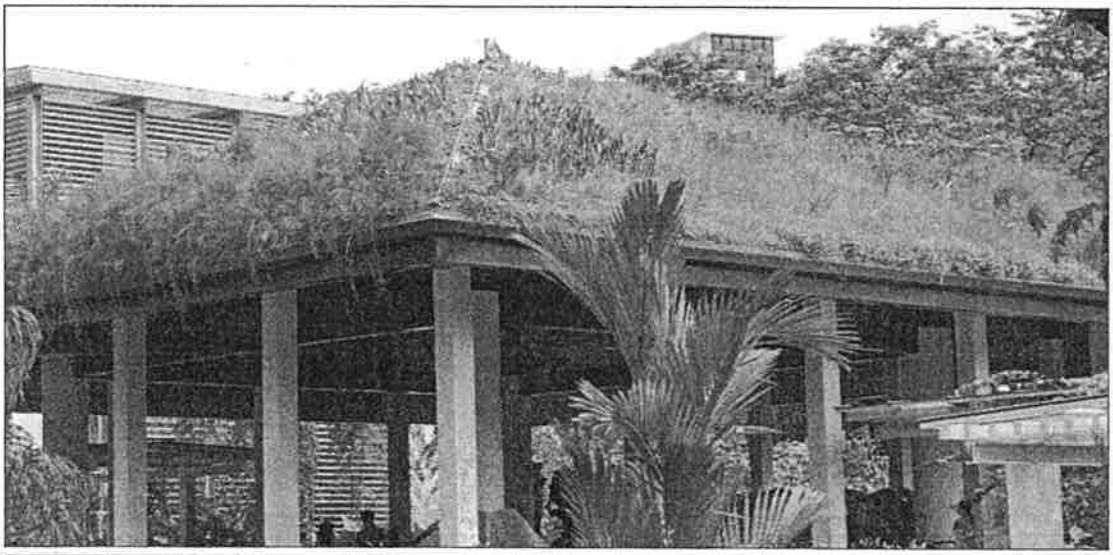
GREENROOFS : INTENSIVE | GR

GMM COURSE



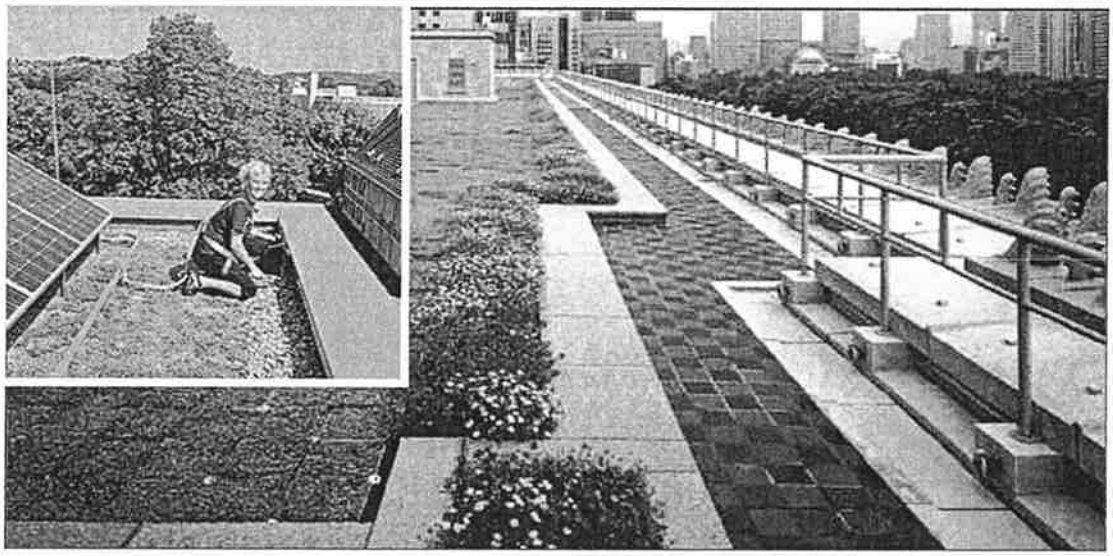
GREENROOFS : INTENSIVE | GR

GMM COURSE



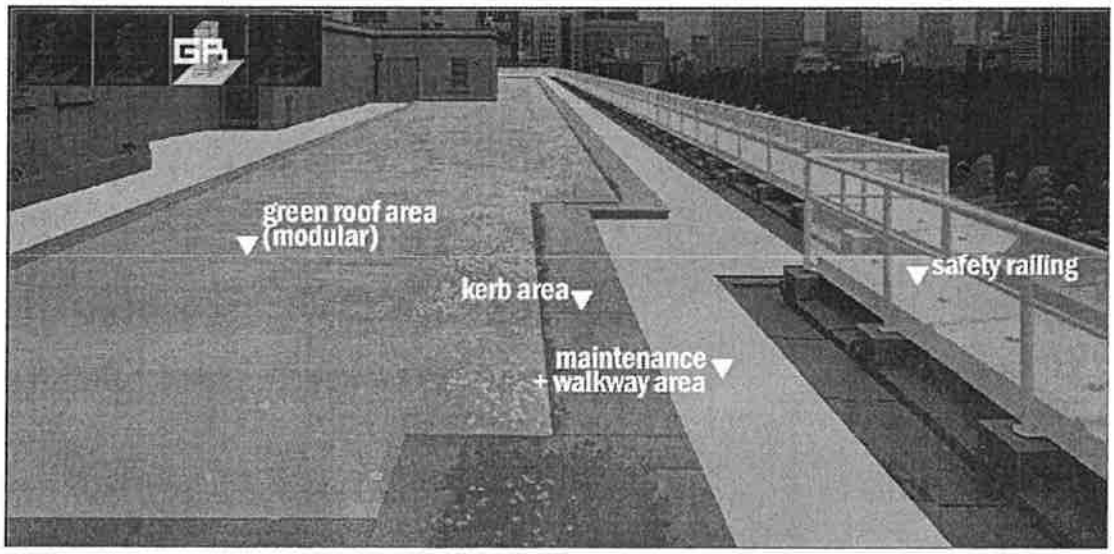
GREENROOFS : EXTENSIVE | GR

GMM COURSE



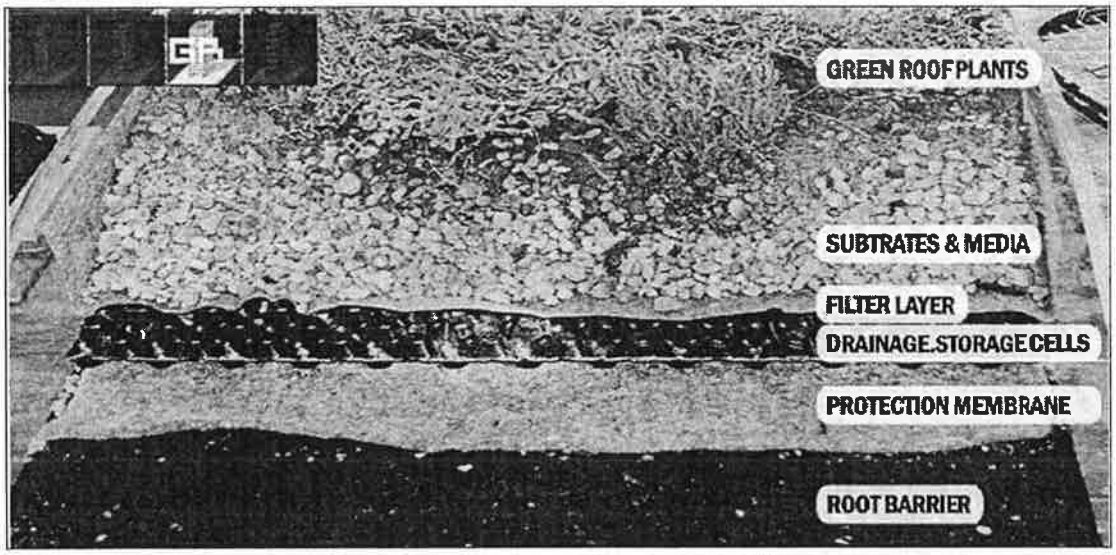
GREENROOFS : EXTENSIVE | GR

GMM COURSE



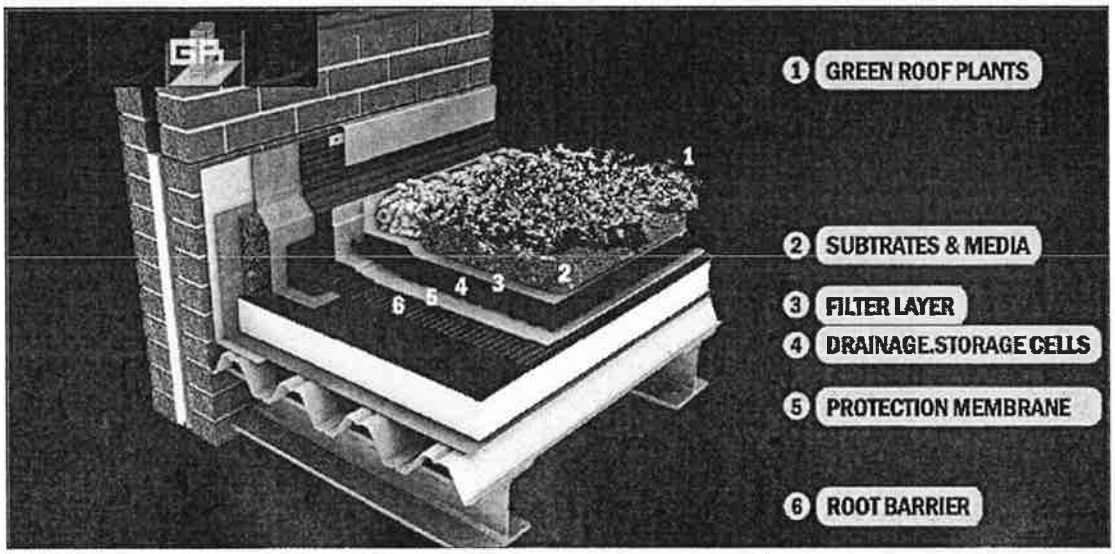
GREENROOFS : EXTENSIVE | GR

GMM COURSE



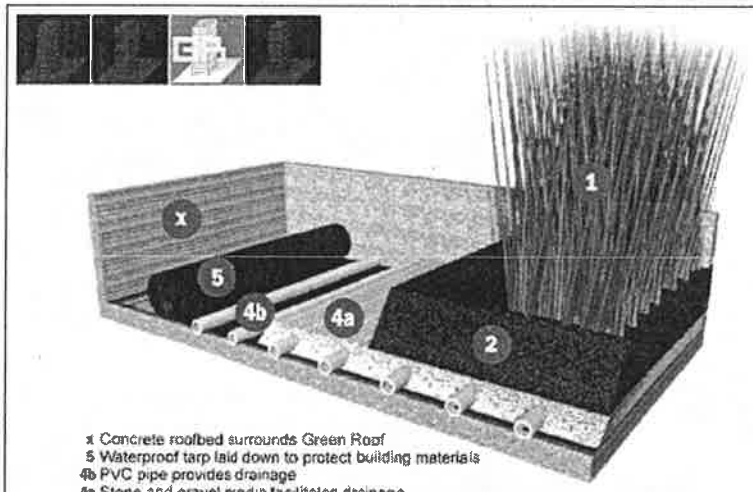
GREENROOFS : PROFILE | GR

GMM COURSE



GREENROOFS : PROFILE | GR

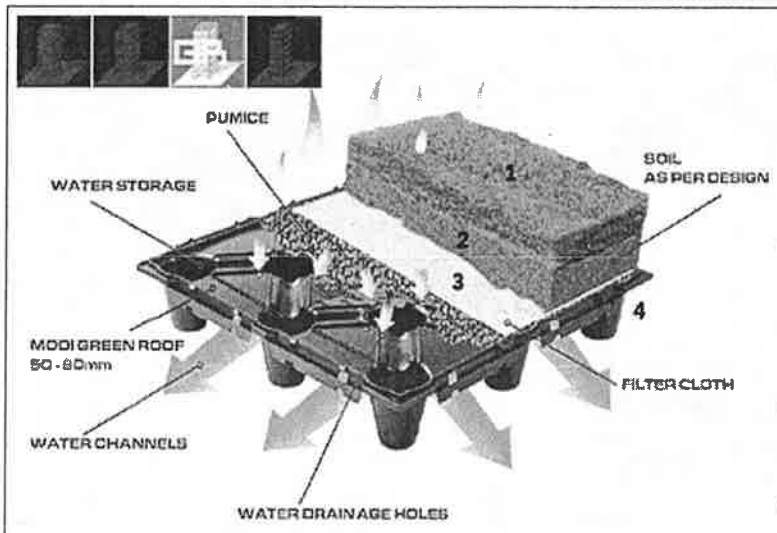
GMM COURSE



x Concrete roofbed surrounds Green Roof
5 Waterproof tarp laid down to protect building materials
4b PVC pipe provides drainage
4a Stone and gravel media facilitates drainage
2 Fertilized soil planted to enrich plantlife
1 Plantlife is introduced and thrives

1. GREEN ROOF PLANTS
2. SUBTRATES & MEDIA
3. FILTER LAYER
4. DRAINAGE STORAGE CELLS
5. PROTECTION MEMBRANE
6. ROOT BARRIER

GMM COURSE



1. GREEN ROOF PLANTS
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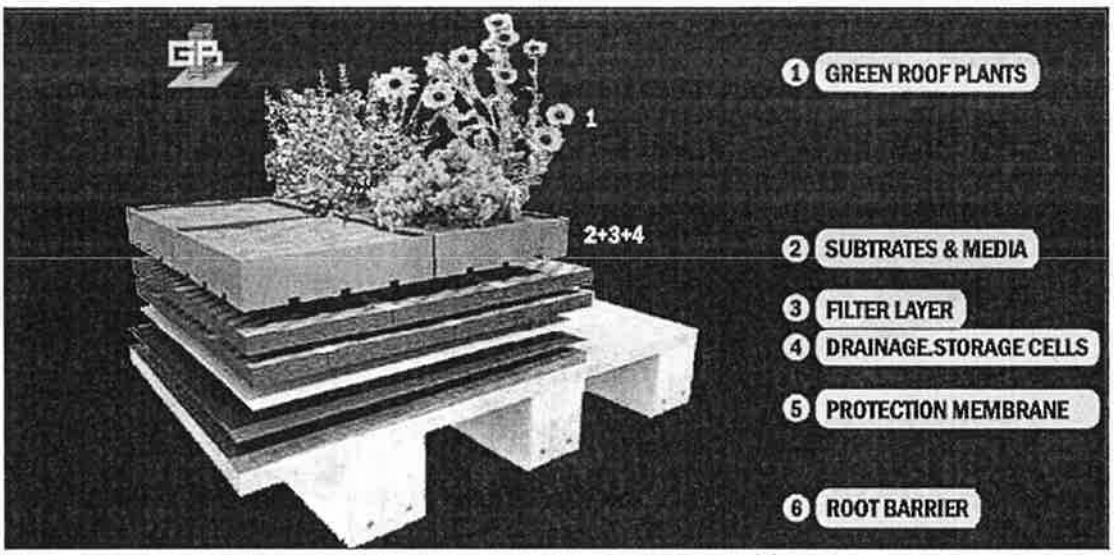
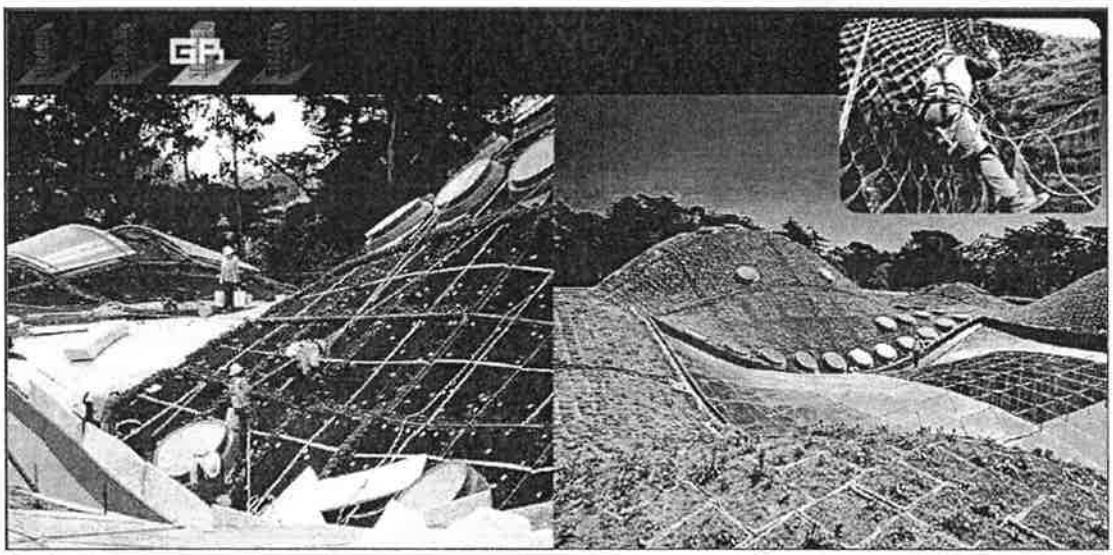
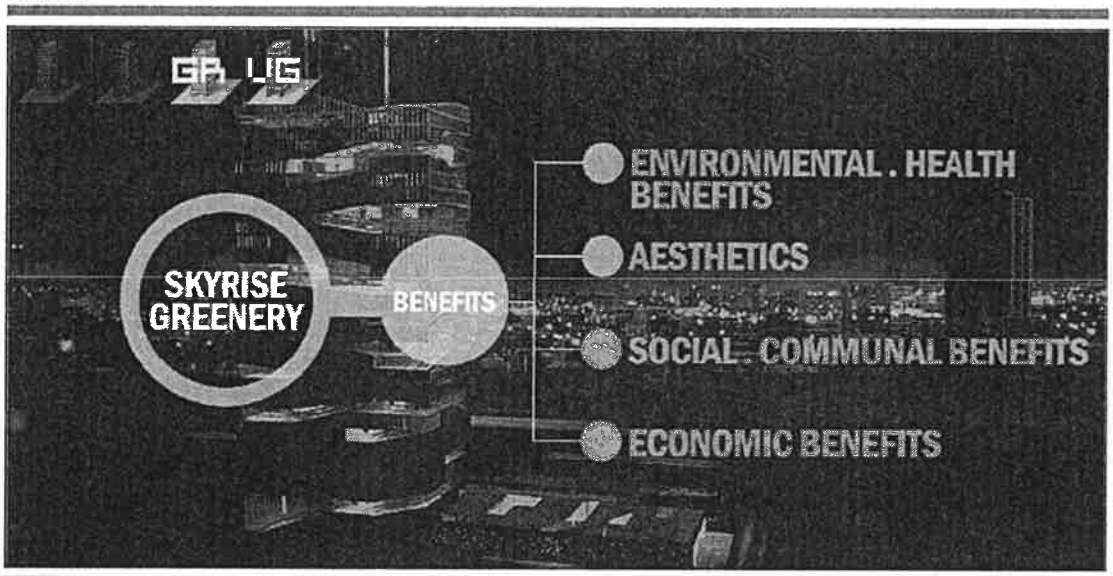


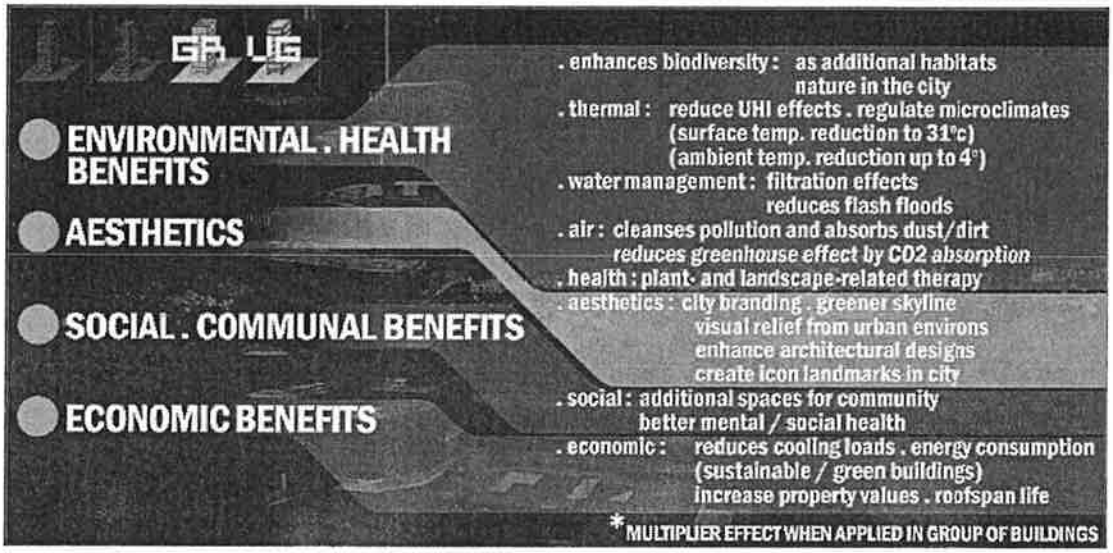
GREENROOFS : PROFILE | GR

GMM COURSE



GREENROOFS : INCLINED PLANES | GR


GR+VG
SKYRISE GREENERY
BENEFITS
ENVIRONMENTAL . HEALTH BENEFITS
AESTHETICS
SOCIAL . COMMUNAL BENEFITS
ECONOMIC BENEFITS


GR+VG
ENVIRONMENTAL . HEALTH BENEFITS
AESTHETICS
SOCIAL . COMMUNAL BENEFITS
ECONOMIC BENEFITS
. enhances biodiversity : as additional habitats
nature in the city
. thermal : reduce UHI effects . regulate microclimates
(surface temp. reduction to 31°c)
(ambient temp. reduction up to 4°)
. water management : filtration effects
reduces flash floods
. air : cleanses pollution and absorbs dust/dirt
reduces greenhouse effect by CO2 absorption
. health : plant- and landscape-related therapy
. aesthetics : city branding . greener skyline
visual relief from urban environs
enhance architectural designs
create icon landmarks in city
. social : additional spaces for community
better mental / social health
. economic : reduces cooling loads . energy consumption
(sustainable / green buildings)
increase property values . roofspan life
* MULTIPLIER EFFECT WHEN APPLIED IN GROUP OF BUILDINGS

GMM COURSE

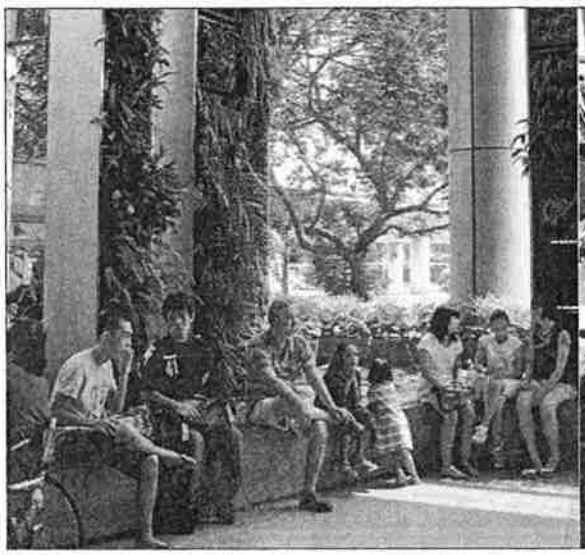


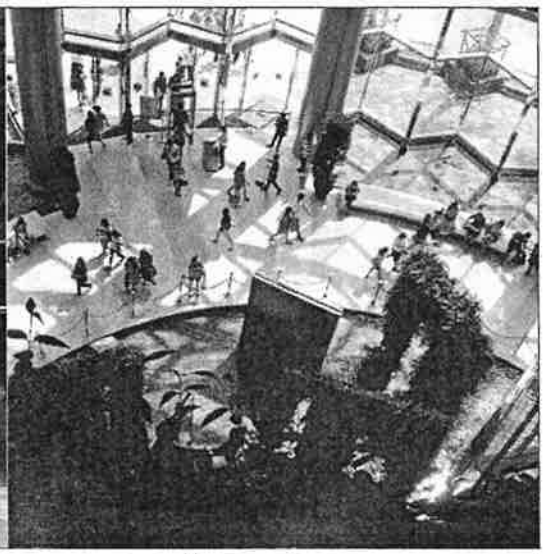




BENEFITS | GR+VG

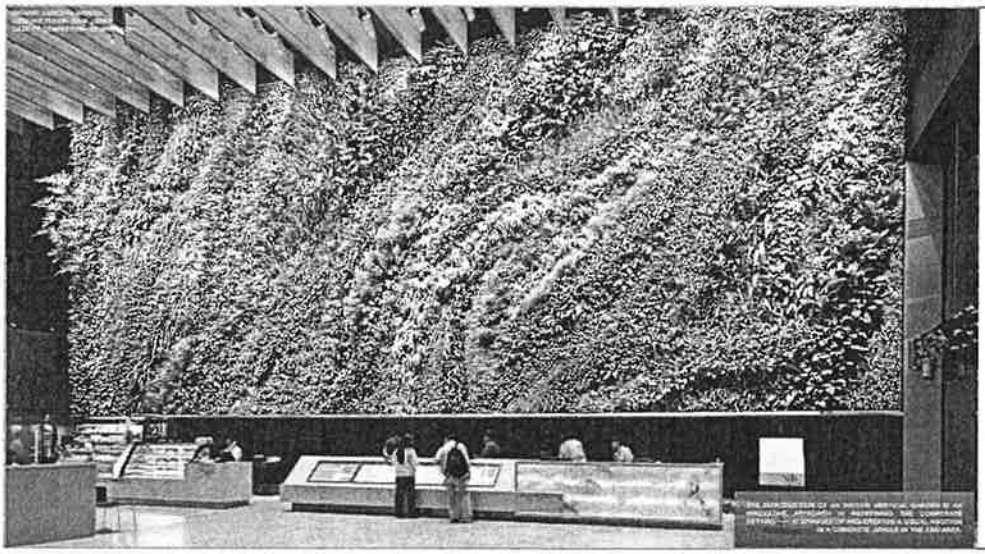
GMM COURSE





BENEFITS | GR+VG

GMM COURSE



BENEFITS | GR+VG

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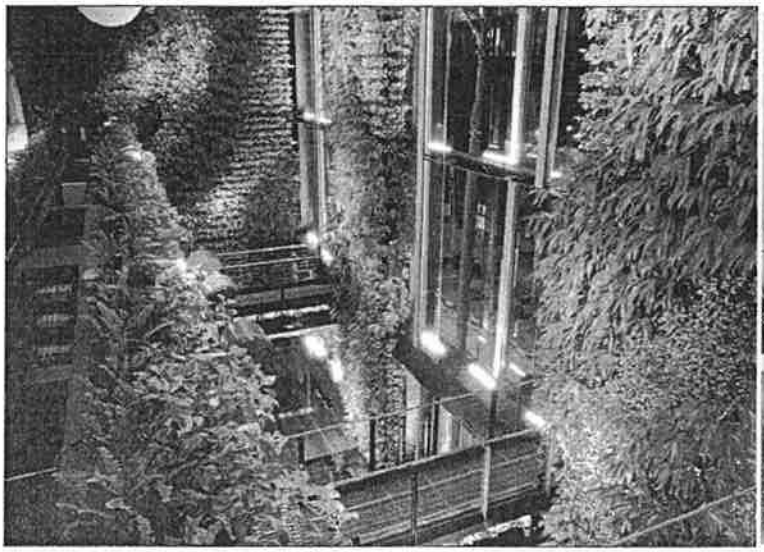
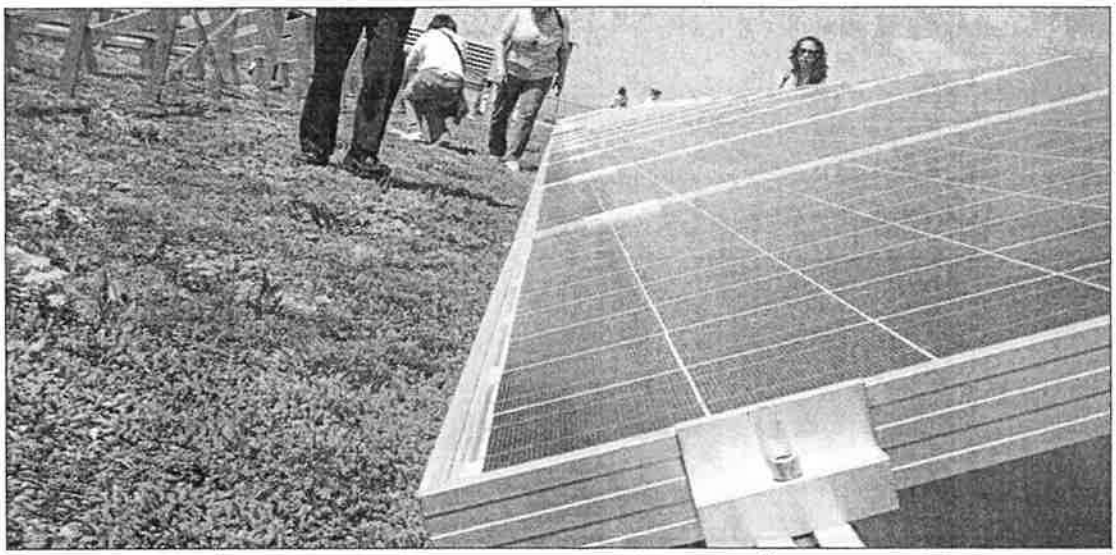




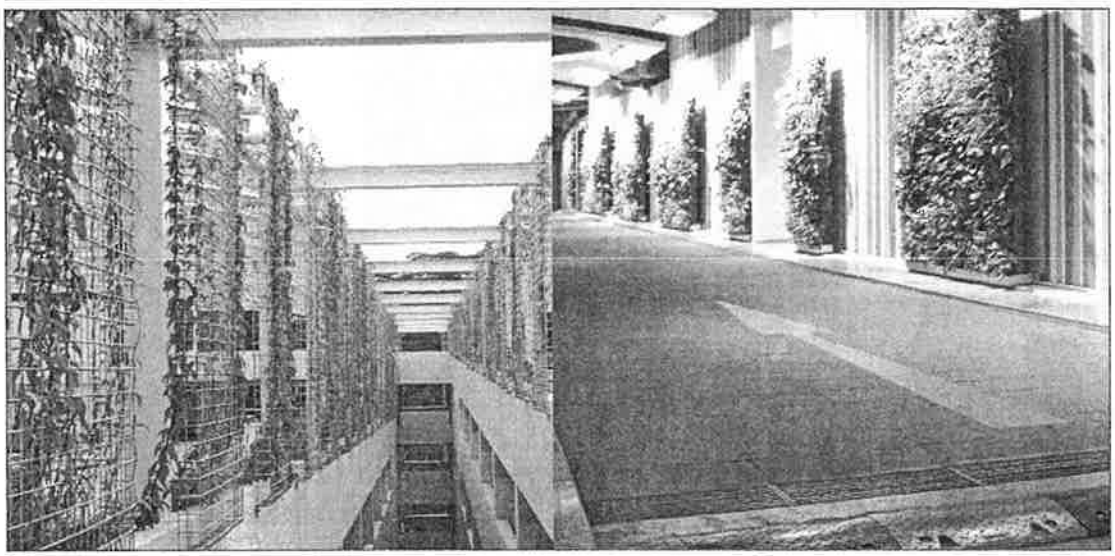
BENEFITS | GR+VG

GMM COURSE



BENEFITS	GR+VG

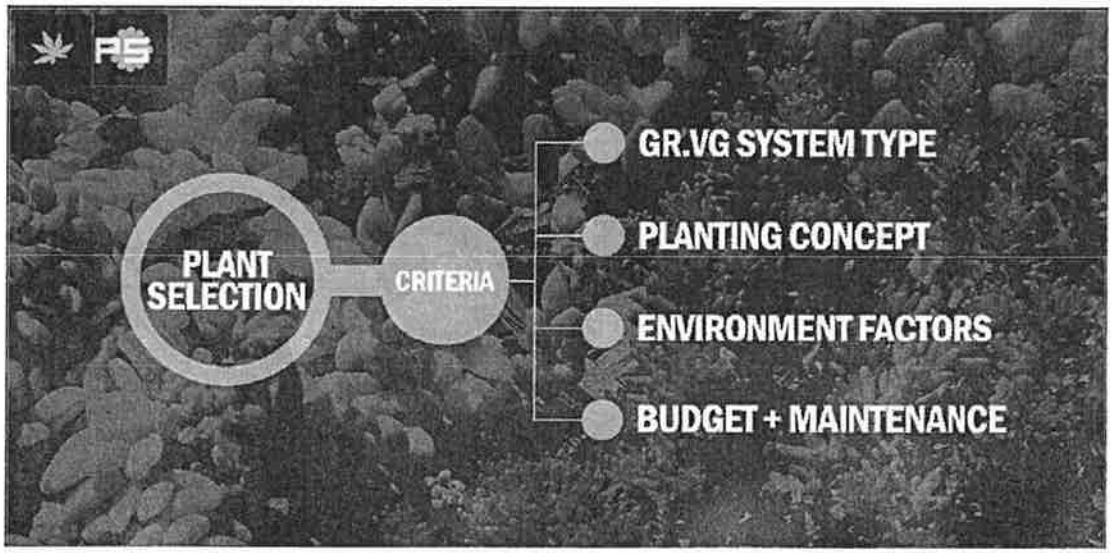
GMM COURSE



BENEFITS	GR+VG

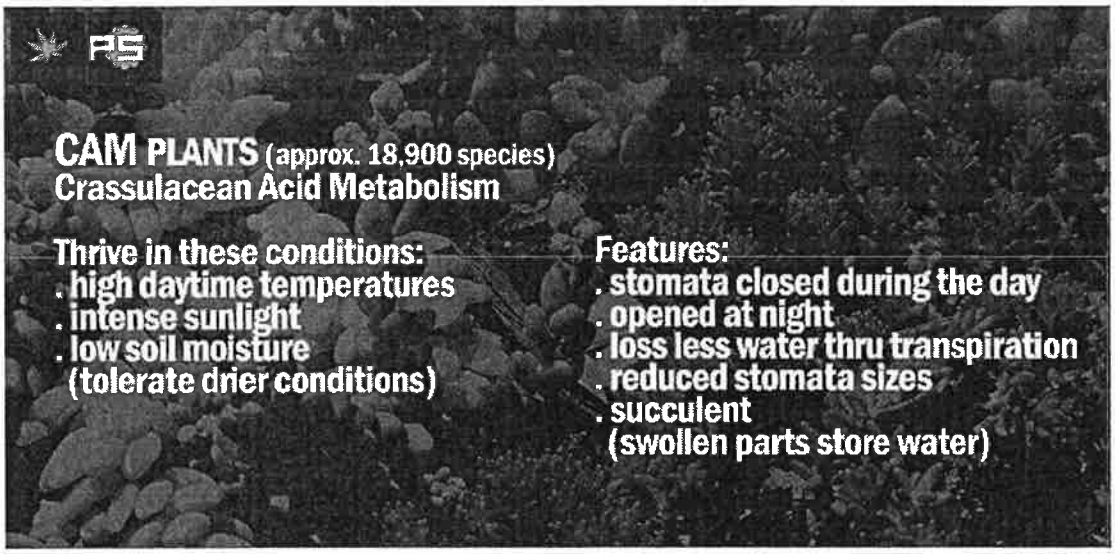


GR+VG



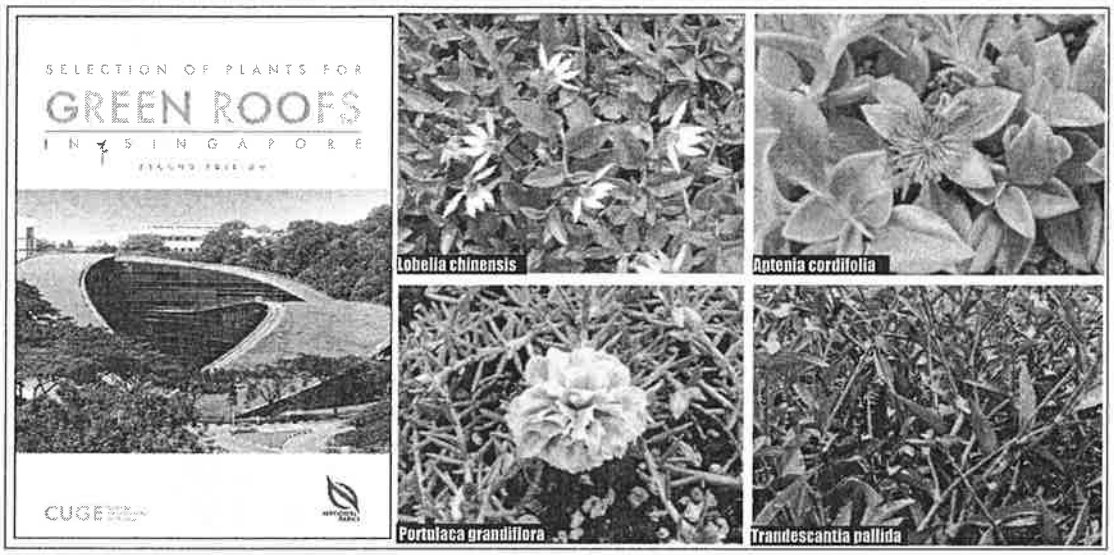
CRITERIA & FACTORS

GR+VG


CAM PLANTS (approx. 18,900 species)
Crassulacean Acid Metabolism
Thrive in these conditions:
. high daytime temperatures
. intense sunlight
. low soil moisture
(tolerate drier conditions)
Features:
. stomata closed during the day
. opened at night
. loss less water thru transpiration
. reduced stomata sizes
. succulent
(swollen parts store water)


CAM PLANTS (approx. 18,900 species)
Crassulacean Acid Metabolism
Crassulaceae: Sedum, Crassula, Bryophyllum, Sempervivum
Aizoaceae: Delosperma, Aptenia
Commelinaceae: Tradescantia, Cyanotis, Commelina
Portulacaceae: Portulaca, Talinum
Dracaenaceae: Sanseveria, Dracaena, Nolina
Piperaceae: Peperomia
Bromeliaceae: Various bromeliads (Neoregalia, etc.)
Asclepiadaceae: Ceropegia, Dischidia, Asclepias
*more information obtained from NParks' website

GMM COURSE



GR+VG

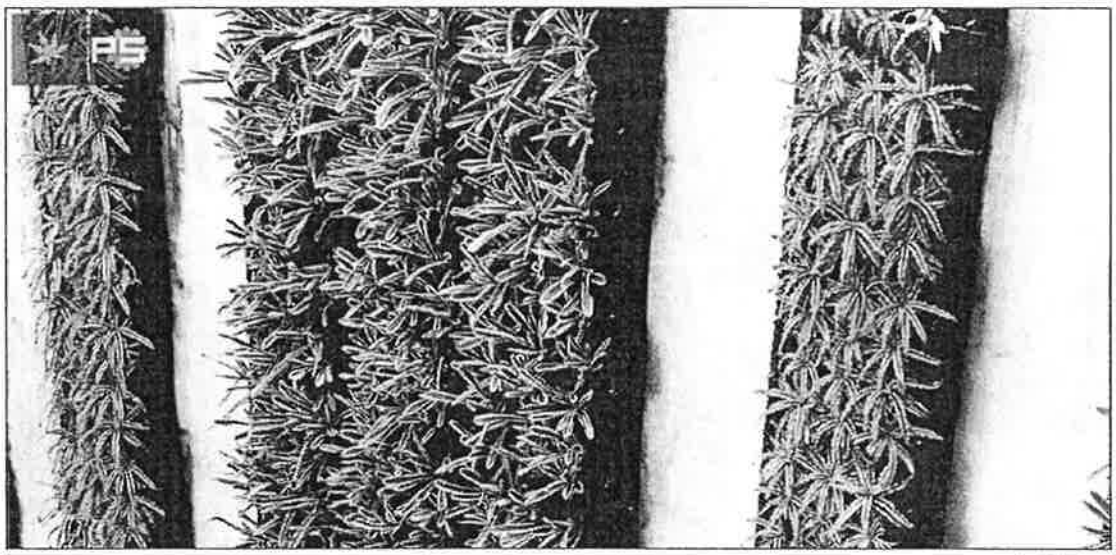
GMM COURSE



SEDUM MEXICANUM

GR+VG

GMM COURSE

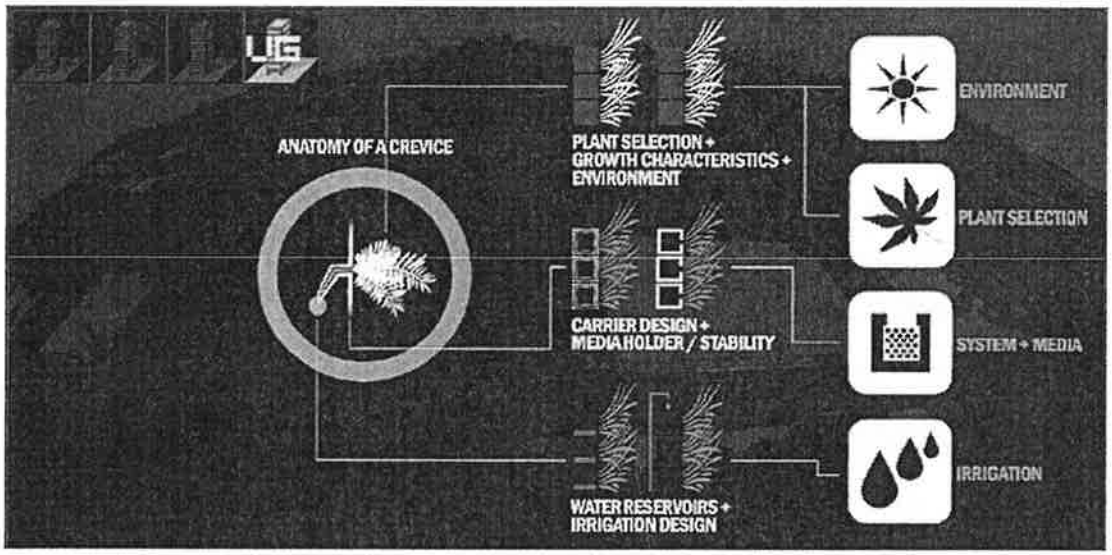


CYRPTHANTHUS SPP . NEOREGALIA SPP	GR+VG

GMM COURSE

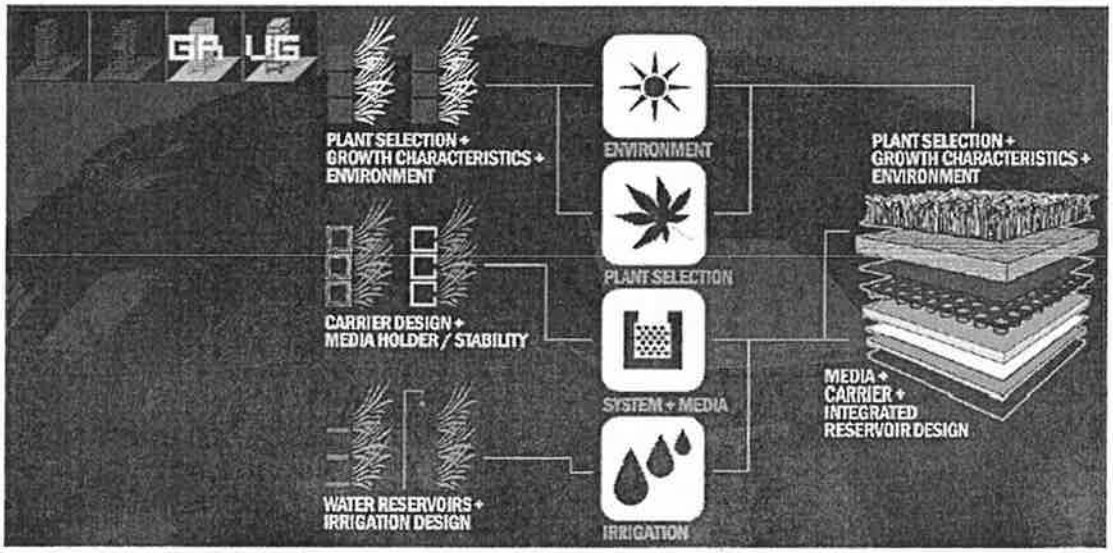


	VG



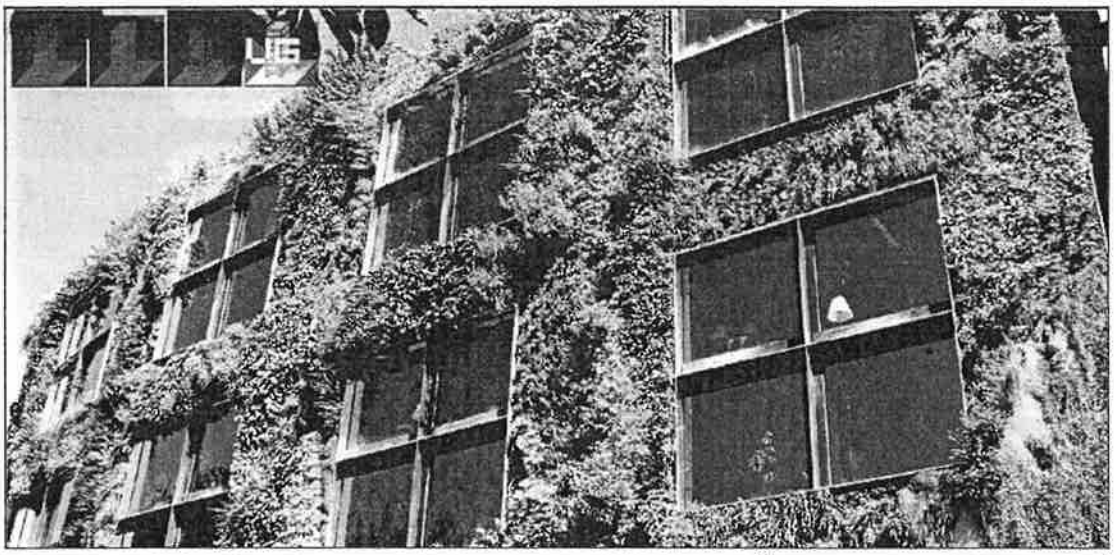
VERTICAL GREENERY : BASIC PRINCIPLES | VG

GMM COURSE



APPLICATION OF COMMON PRINCIPLES | GR+VG

GMM COURSE

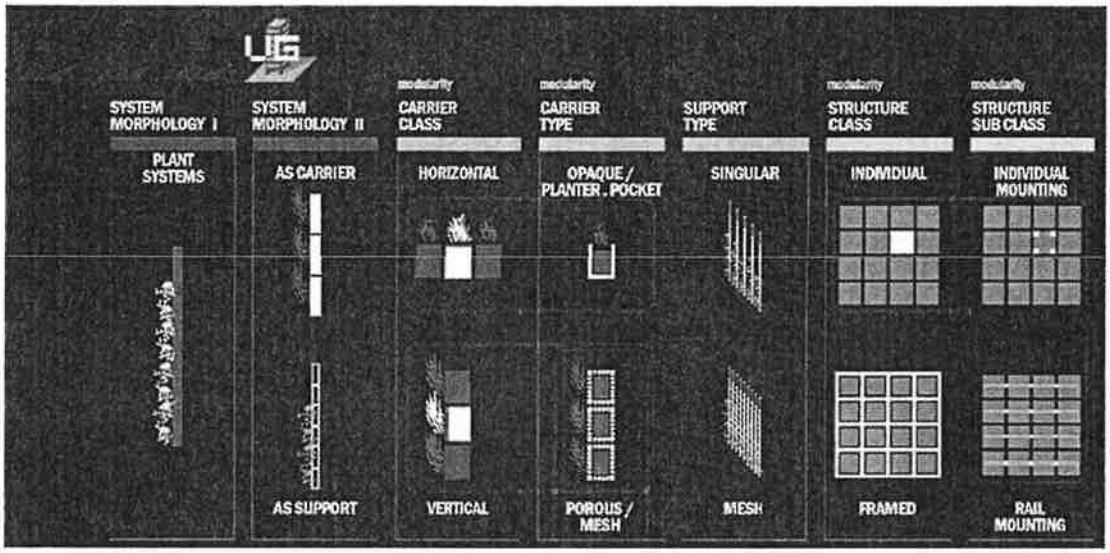


MUSEE DU QUAI BRANLY . PATRICK BLANC	VG

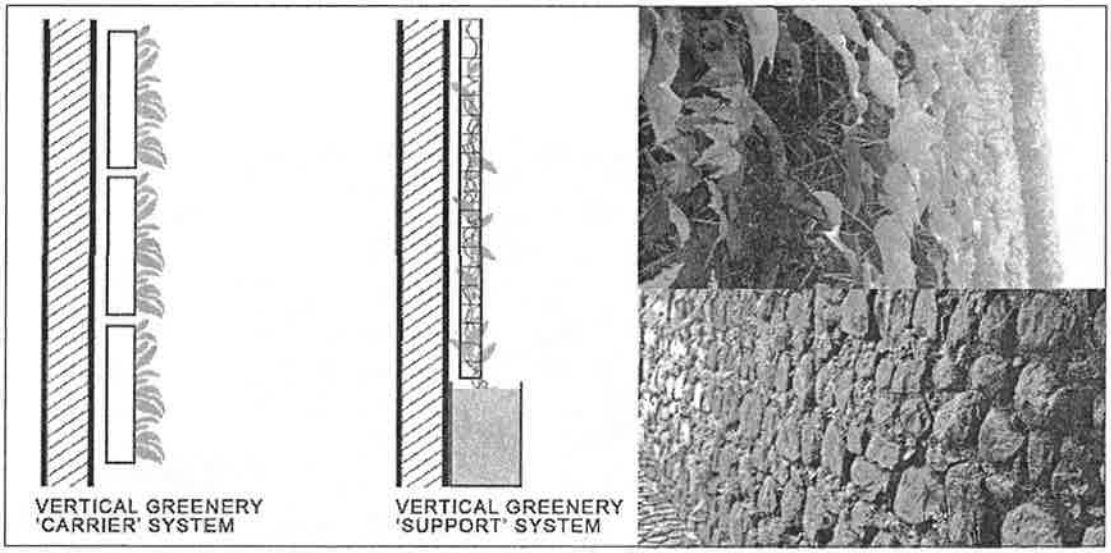
GMM COURSE



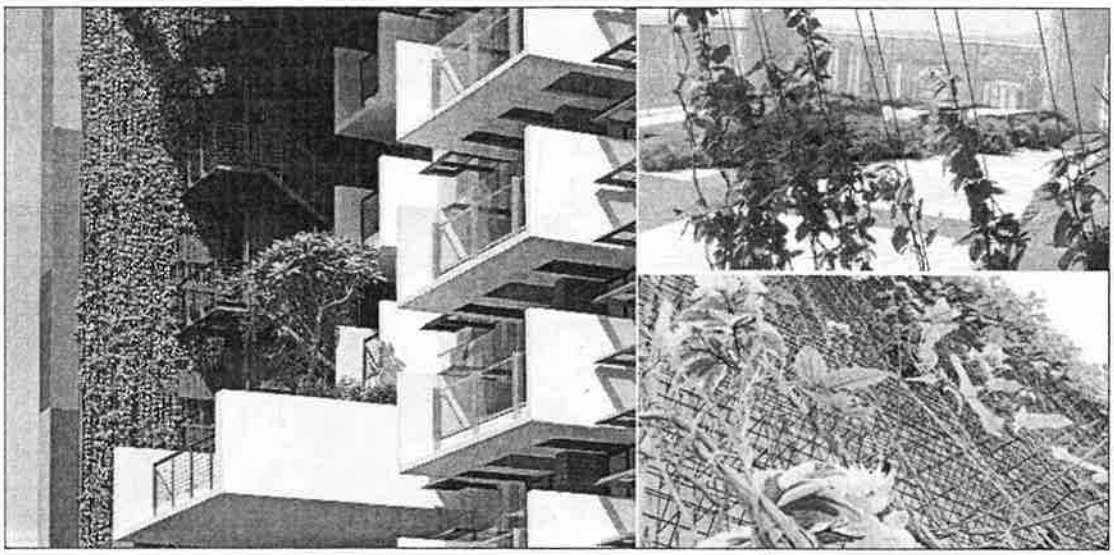
MUSEE DU QUAI BRANLY . PATRICK BLANC	VG



GMM COURSE

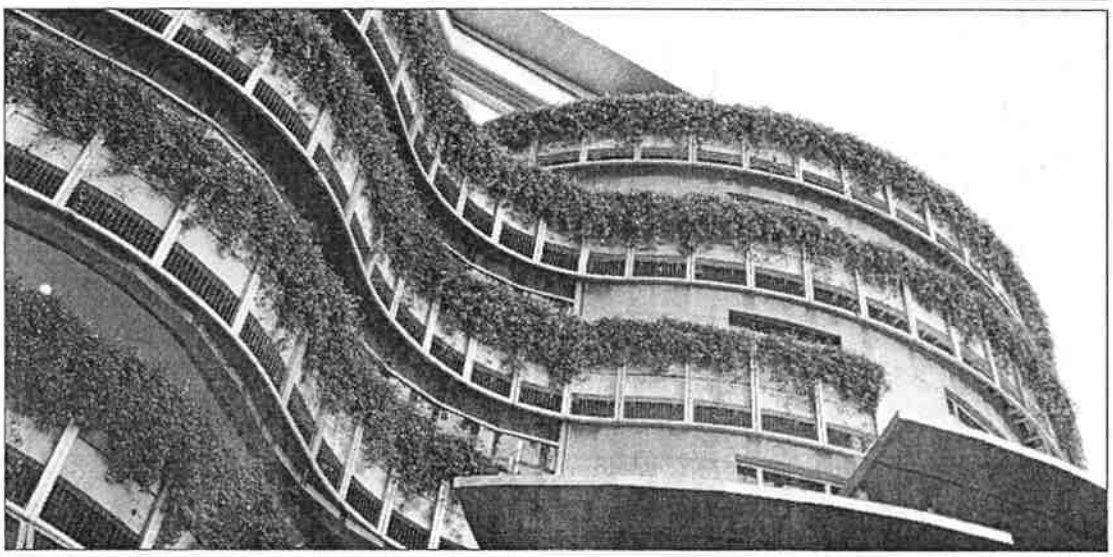


VERTICAL GREENERY : TYPOLOGY VG



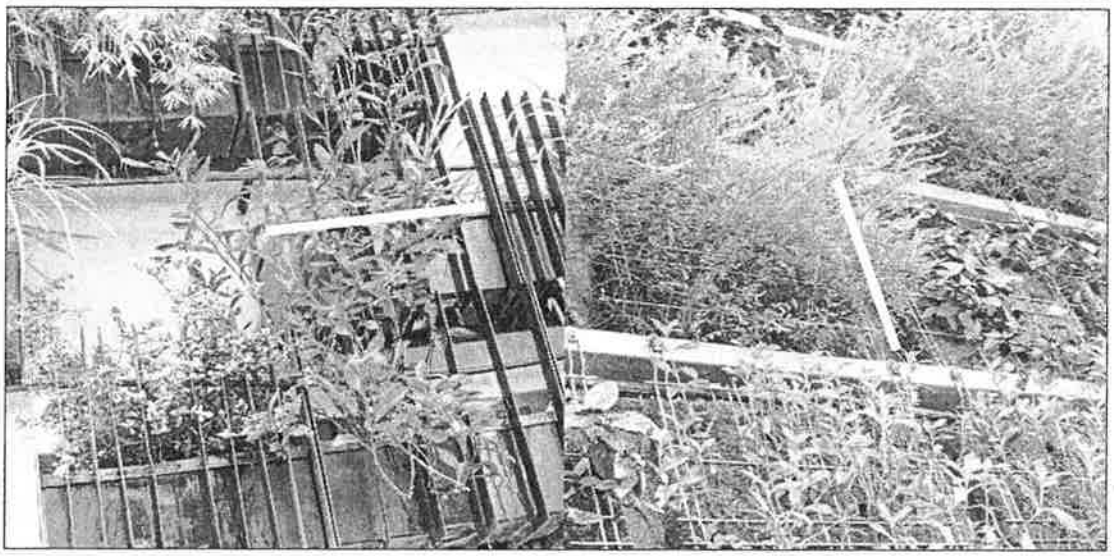
VERTICAL GREENERY : 'SUPPORT' SYSTEM | VG

GMM COURSE



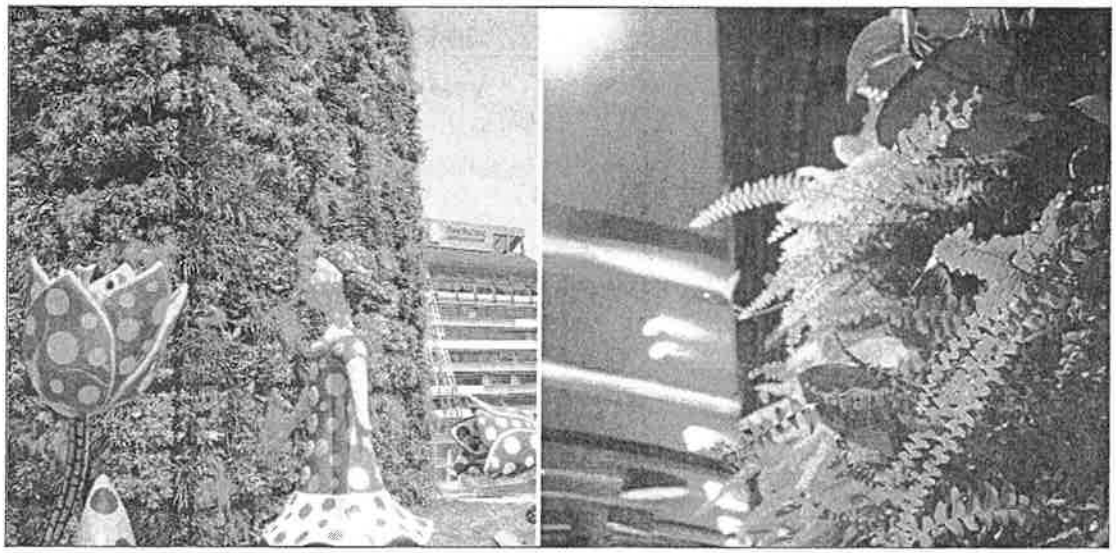
VERTICAL GREENERY : 'SUPPORT' SYSTEM | VG

GMM COURSE



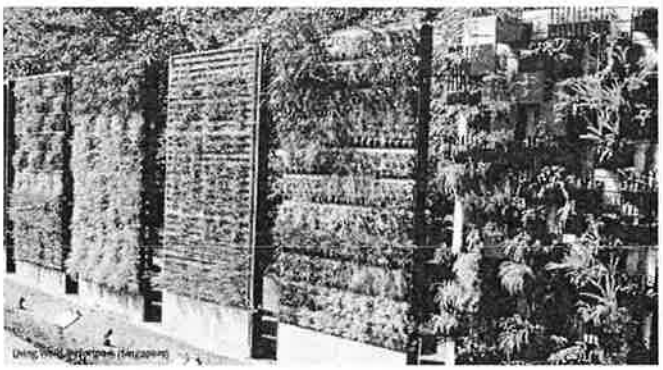
VERTICAL GREENERY : 'CARRIER' SYSTEM	VG

GMM COURSE



VERTICAL GREENERY : 'CARRIER' SYSTEM	VG





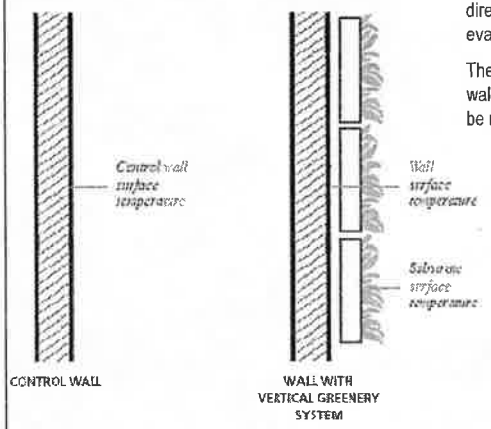
VG

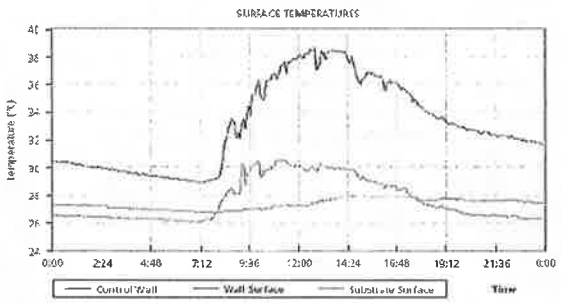
vertical greenery

Reducing temperatures

Greenery can be used as a tool for mitigating the Urban Heat Islands (UHI) effect: directly by shading heat-absorbing surfaces, and indirectly through evapotranspiration cooling.

The results of the field measurements done on eight different vertical greenery walls show that, in the presence of vertical greenery, wall surface temperatures can be reduced by as much as 12oC.





BENEFITS

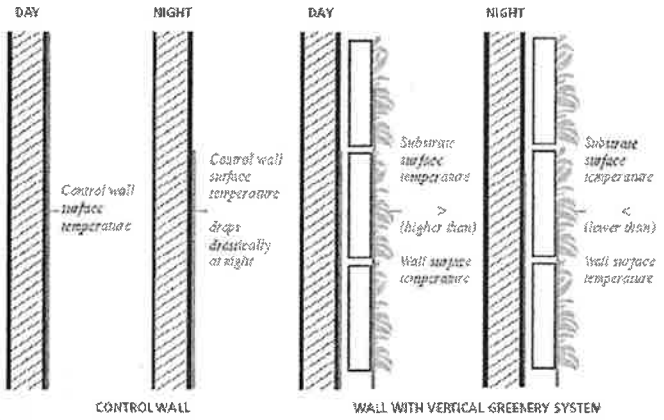
ENVIRONMENT

vertical greenery

Protection to building's facade

The fluctuation in temperature can be reduced to as low as 1° C (from 10 ° C) for a wall installed with vertical greenery.

This prolongs the material lifespan and decreases the need for maintenance, such as repainting, replacement of cladding, etc, and in turn, increase the associated cost savings.



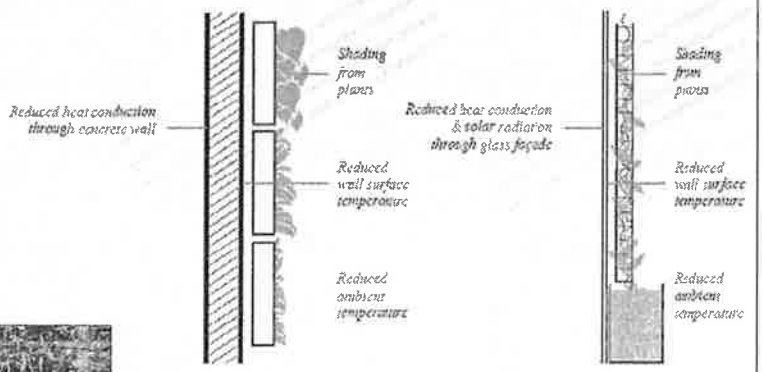
BENEFITS | **ECONOMICAL**

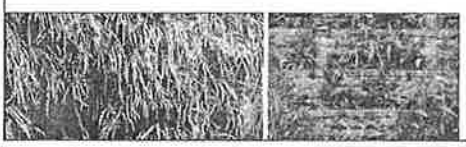
vertical greenery

Reducing buildings' cooling load

Vertical greenery can reduce the mean radiant temperature (MRT) of the room by about 10oC, corresponding to about 74% cost reduction in energy consumption

With the use of plants with good shading capabilities (i.e. plants with denser leaves and wider coverage, the vertical greenery system can reduce the ETTV by more than 40%.

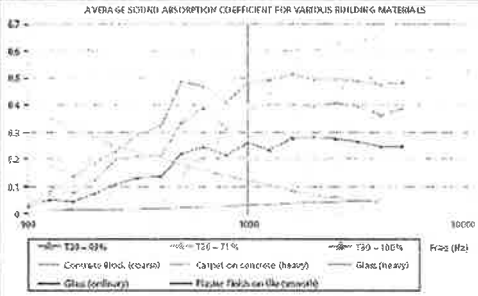




BENEFITS | **ECONOMICAL**

vertical greenery

Improving acoustic insulation



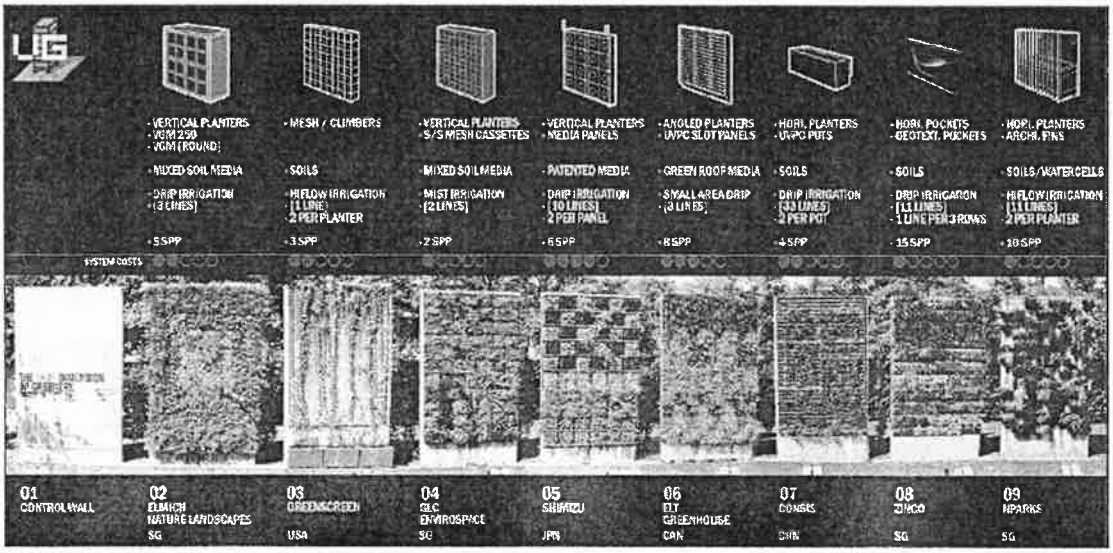
The insertion loss of vertical greenery systems can reach a maximum of 9.9 dB, which is a substantial change in the sound level.

vertical greenery can be used to improve the acoustic quality within interior spaces, due to its high sound absorption coefficient as compared to other surface materials.



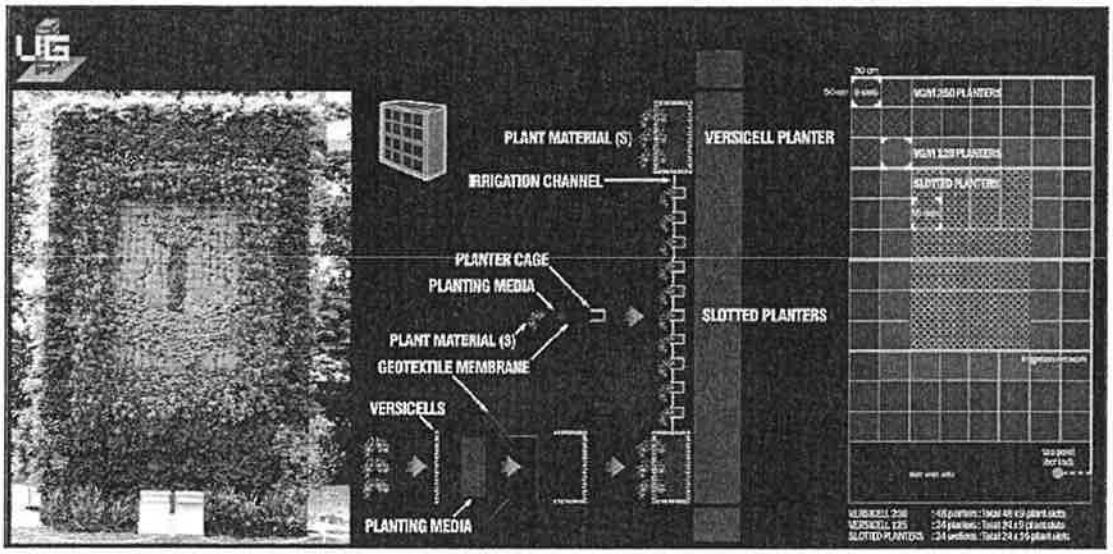
BENEFITS | **ECONOMICAL**

GMM COURSE



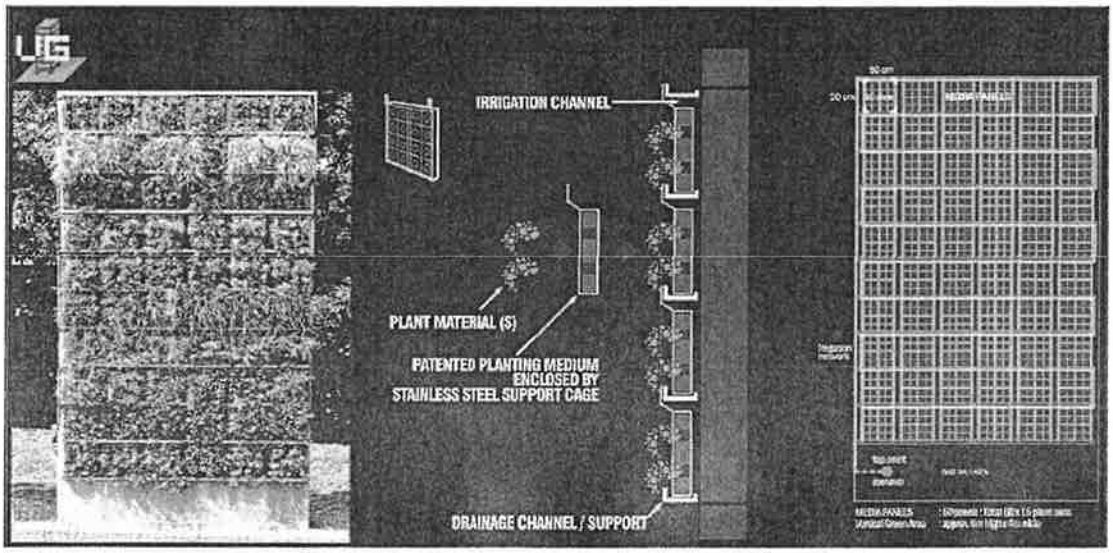
VERTICAL GREENERY : HORT PARK WALLS | **VG**

GMM COURSE



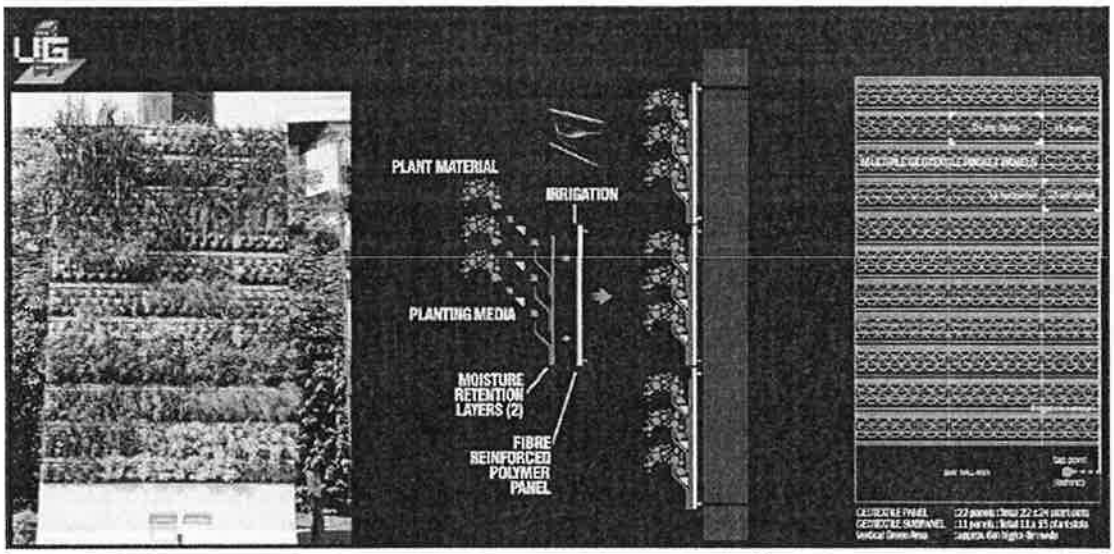
VERTICAL GREENERY : ELMICH . SG | VG

GMM COURSE



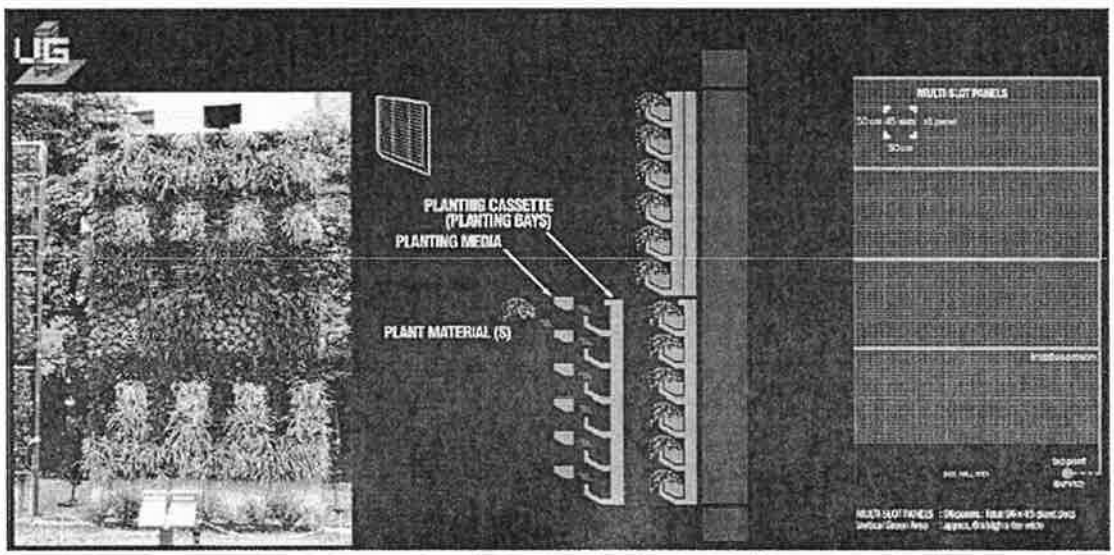
VERTICAL GREENERY : SHIMIZU . JAPAN | VG

GMM COURSE



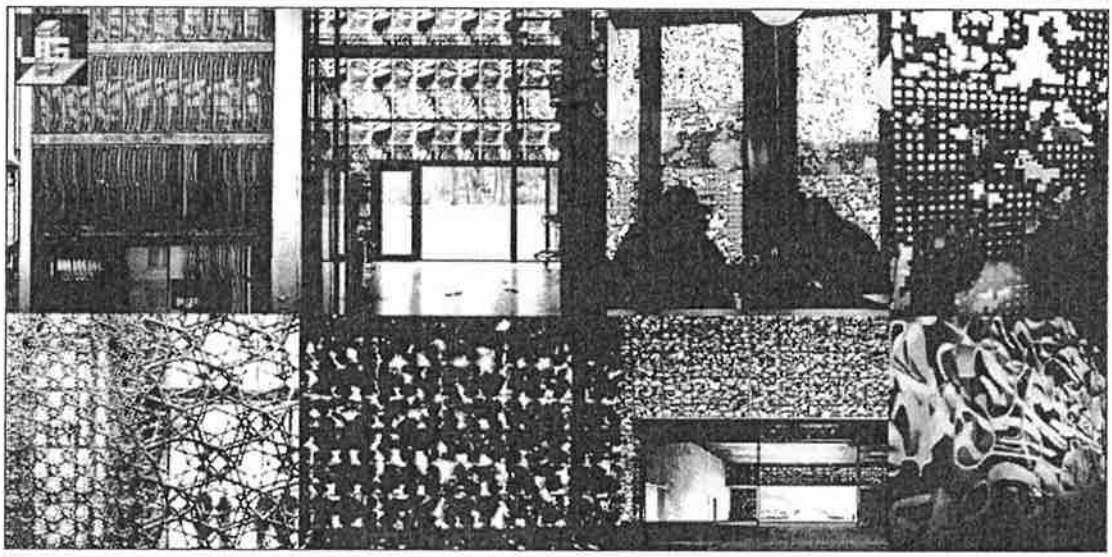
VERTICAL GREENERY : ZINCO . SG | VG

GMM COURSE



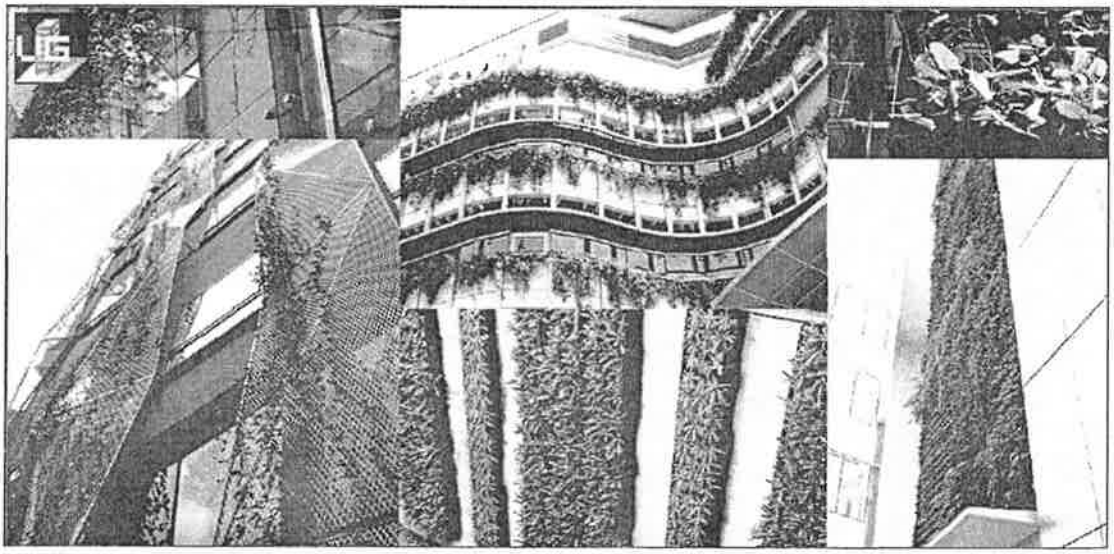
VERTICAL GREENERY : ELT . CANADA | VG

GMM COURSE

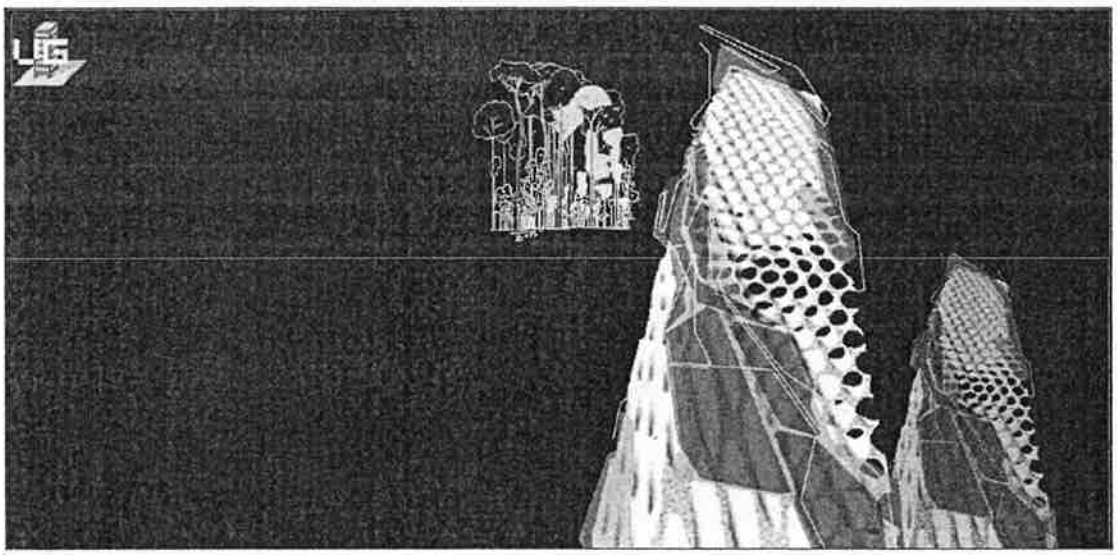


VERTICAL GREENERY : ARCHITECTURAL FACADES | VG

GMM COURSE



VERTICAL GREENERY : GREEN FACADES | VG



VERTICAL GREENERY : ECOSYSTEM AS FACADES | VG

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[THANK YOU]

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Website => http://www.nparks.gov.sg

GMM

GA+UG

CUGE Centre for Urban Greenery and Ecology

Green Plot Ratio Calculation

		A	B	C	A x B x C
Category	**Sub-category**	**LAI**	**Canopy Area (m^2)**	**Quantity**	**Leaf Area (m^2)**
Trees	Open	2.5	60	Quantity (nos.)	Y
	Intermediate Canopy	3.0	60	Quantity (nos.)	Y
	Dense Canopy	4.0	60	Quantity (nos.)	Y
Palms	Solitary	2.5	20	Quantity (nos.)	Y
	Cluster	4.0	17	Quantity (nos.)	Y
Shrubs	Monocot	3.5	NA	Planted Area (m^2)	Y
	Dicot	4.5	NA	Planted Area (m^2)	Y
Turf	-	2.0	NA	Planted Area (m^2)	Y
Vert Greenery	-	2.0	NA	Planted Area (m^2)	Y
				Total Leaf Area	∑Y
				Site Area	Z
				Green Plot Ratio	∑Y ÷ Z