APPENDIX 1

Range of definitions of sustainable development (Du Plessis 1989:21-22)

Table 3.1 - Definitions of Sustainable Development

Sustainable development means improving the quality of human life while living within the carrying capacity of supporting ecosystems (IUCN/UNEP/WWF, 1991b, p.221)	Sustainable development meets the needs of the present without compromising the ability of future generations to meet their own needs. (WCED, 1987, p.8)	Sustainable development means that we should leave future generations a stock of capital no smaller than we have now. (Pearce, D *et al*, 1994)
Sustainability is a vision of the future that provides us with a road map and helps us to focus our attention on a set of values and ethical and moral principles by which to guide our actions" (Viederman, S, 1995, p.37)	Sustainable development should be a process which allows for the satisfaction of human necessities without compromising the basis of that development, which is to say, the environment(Winogard, M,1995, P.203)	Sustainable development is a process of change with the intention of achieving harmony between social, economic and ecological objectives and system requirements in the short and long run. (Hediger, W, 1997, p.101)

"Sustainable development is not a fixed state of harmony, but rather a process of change in which the exploitation of resources, the direction of investments, the concentration of technological development and institutional change are made consistent with future as well as present needs" (WCED, 1987, p.9)	Sustainable development embodies a belief that people should be able to alter and improve their lives in accordance with criteria which take account of the needs of others and which protect the planet and future generations. Thus people's rights and responsibilities form the crux of any discussion of sustainability" (Sharp, R. 1996, p.309)	Sustainability is the general requirement that a vector of development characteristics be non-decreasing over time, where the elements to be included in the vector are open to ethical debate and where the relevant time horizon for practical decision-making is similarly indeterminate outside of agreement on intergenerational objectives (Pearce, *et al*, 1990, p.3)
Sustainable development is a development strategy that manages all assets, natural resources and human resources, as well as financial and physical assets, for increasing long-term wealth and well-being. (Repetto, R, 1986, p.15)	Sustainable development is the complex of activities that can be expected to improve the human condition in such a manner that the improvement can be maintained. (Munro, DA. 1995. p 29)	Sustainable development is development that delivers basic environmental, social and economic services to all residences of a community without threatening the viability of the natural, built and social systems upon which the delivery of those systems depends. (ICLEI, 1996, p.4)
Sustainability is the doctrine that economic growth and development must take place, and be maintained over time, within the limits set by ecology in the broadest sense - by the interrelations of human beings and their works, the biosphere and the physical and chemical laws that govern it. (Ruckelshaus, WD, 1989)	Sustainability refers to the ability of a society, ecosystem, or any such ongoing system to continue functioning into the indefinite future without being forced into decline through the exhaustion of key resources. (Robert Gilman, President of Context Institute, online in CESD)	Sustainability is an economic state where the demands placed upon the environment by people and commerce can be met without reducing the capacity of the environment to provide for future generations. (Hawken, P, 1993, p.139)

APPENDIX 2

Extract from the *Manual for Energy Conscious Design* – "The Highveld climatic zone" (Holm 1996:64-73)

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6 .12 Climatic zone – Highveld

6.12.1 Background

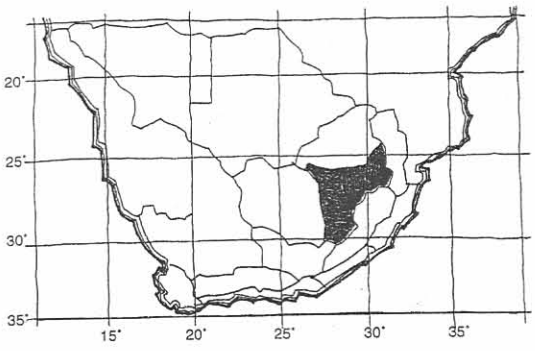

Fig. 6.12.1 – Climatic zone – Highveld.

Location

26,1° to 31,2° East and 24,5° to 30,8° South.

Towns in region

Lydenburg, Ficksburg, Johannesburg International Airport

Description of zone climate

Distinct rainy and dry seasons exist with a large daily temperature variation and strong solar radiation. Humidity levels are moderate.

6.12.2 Climate

Temperature

The maximum diurnal variation occurs in September. The average monthly diurnal variation is 11K.

Humidity

The average monthly relative humidity is 56%.

Wind

Summer winds are predominantly north-easterly, and winter winds are predominantly north-westerly, but there is also a fair amount of south-westerly wind.

6.12.3 Comfort zone

Temperature

The summer temperatures which exceed the comfort zone are insignificant. Winter temperatures are approximately 15K below the comfort zone.

Humidity

Humidity levels are low in the winter.

6.12.4 Planning

Urban

Compact with protection for pedestrians against high ultra violet radiation and summer rains.

Table 6.12.1 – Climatic data for Johannesburg International

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ave
Maximum average monthly temperature (°c)	25,6	25,1	14,7	21,2	18,9	16	16,6	19,3	22,8	23,7	24,1	25,2	21,10
Minimum average monthly temperature (°c)	14,7	14,2	13,2	10,4	7,3	4,2	4,3	6,3	9,5	11,3	12,7	13,9	10,17
Average monthly amplitude (K)	10,9	10,9	1,5	10,8	11,6	11,8	12,3	13,0	13,3	12,4	11,4	11,3	10,93
Average monthly relative humidity (%)	64,0	65,0	64,0	61,5	53,5	51,5	48,5	46,0	46,0	52,5	59,5	60,5	56,04
Average monthly rainfall (mm)	126	90	91	52	13	8	4	6	28	73	118	105	59,50
Rham	78	80	80	78	71	70	67	64	63	67	73	74	72,1
Rhpm	50	50	48	45	36	33	30	28	29	38	46	47	57,60

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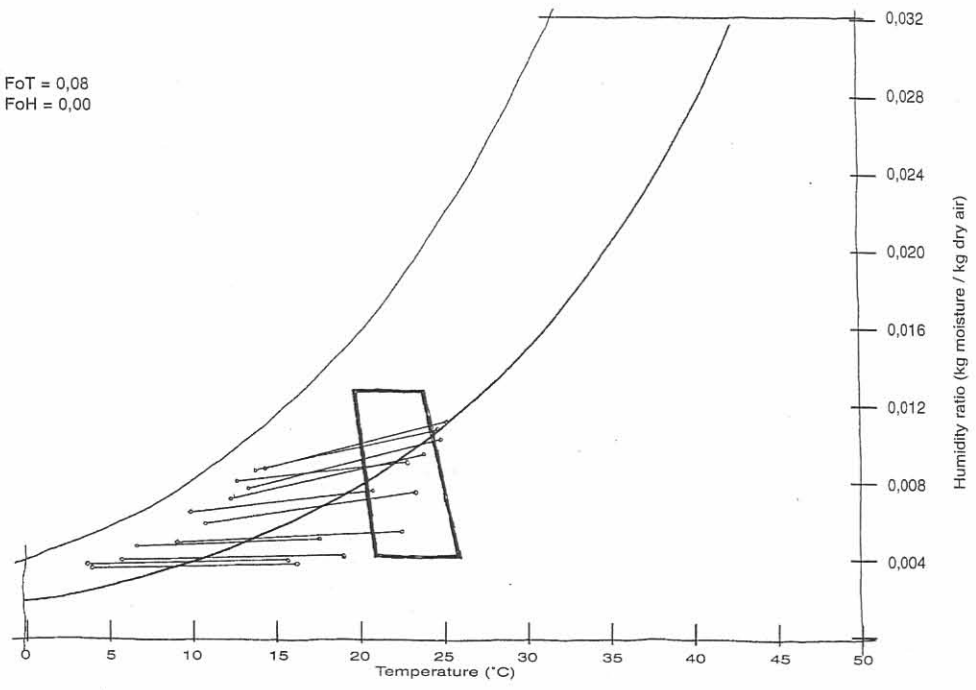

Fig 6.12.2 – Psychrometric chart showing the comfort zone's position relative to the climatic lines.

Plan form

Winter and summer requirements differ. The winter demands include a compact plan form, a well-insulated envelope, and solar gain is desirable.

Position of functions

External spaces should provide shade in summer for outdoor activities.

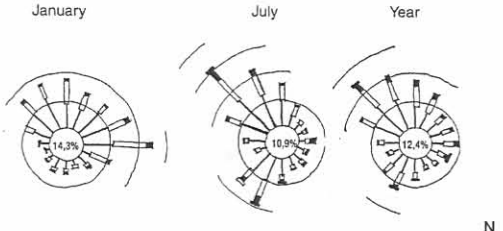

Fig. 6.12.3 – Wind rose for Johannesburg International airport

Rain protection

Building entrances can be shielded from sporadic thunderstorms.

6.12.5 Building envelope

Mass

Thermal mass is also advisable especially in inland areas when the daily temperature swing is larger than 13K. It can be provided by massive floors and internal partitions. It is effective for approximately half of the under heated period and for the entire overheated period.

Insulation

Lightweight insulated roofs are feasible in this region.

Properties of materials

All external surfaces should be light coloured or reflective (but not shiny metal) to minimize solar heat gain in the overheated period.

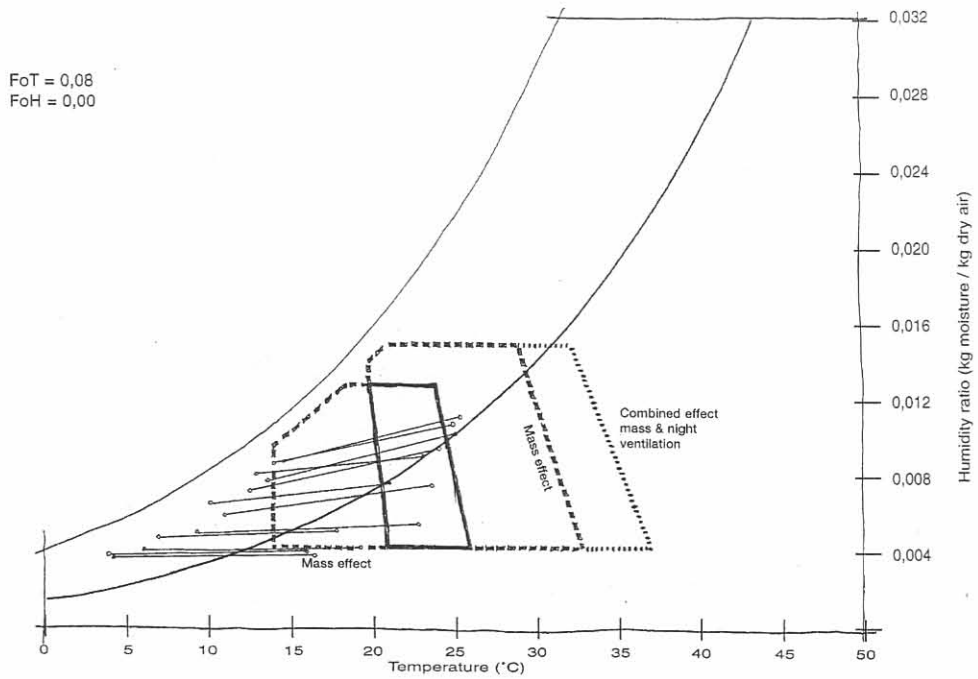

Fig. 6.12.4 – Psychrometric chart showing the enlarged comfort zone obtained by supplying thermal mass to the structure. The combined effect of ventilation and thermal mass on the comfort zone is also shown. 22,2 % of the mass effect is sufficient in summer.

6.12.6 Solar control

Sun angles

It is recommended that summer sun be screened and winter sun be allowed to penetrate.

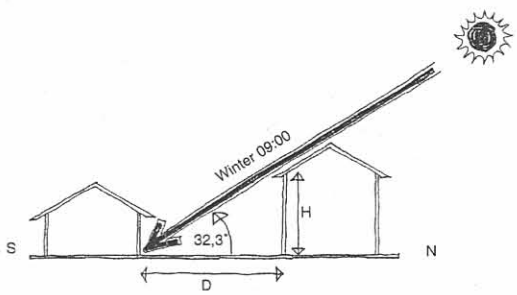

Fig. 6.12.5 – Solar access for building spacing in Johannesburg International. D=1,6 H

Equatorial window

An equatorial window with an area equal to 19,2 % of the floor area is effective for the entire overheated period. Openings for solar gain should be orientated towards the winter sun and screened in summer when solar control is necessary to prevent overheating.

6.12.7 Ventilation

Ventilation is effective for alleviating overheating, but may be unnecessary if thermal mass is exploited. Night ventilation can be implemented to compensate for insufficient mass.

6.12.8 Management

Opening of windows if night ventilation is feasible.

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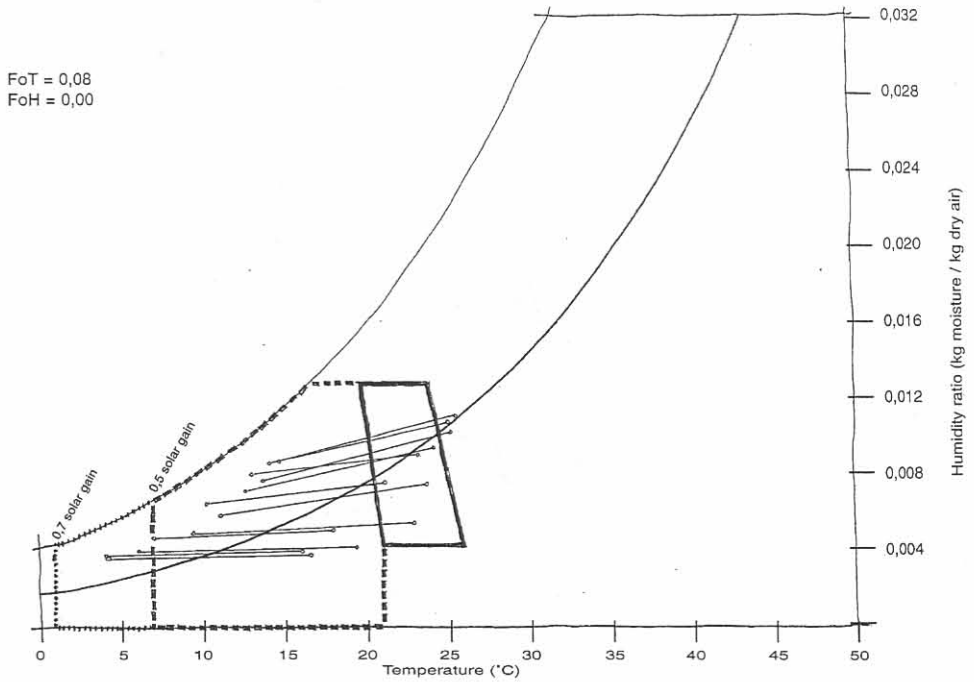

Fig. 6.12.6 – Psychrometric chart with equatorial window with efficiencies of 0,5 and 0,7 sized 24,3% and 16,4% respectively of floor area.

6.12.9 Systems

Evaporative cooling

Direct evaporative cooling is effective for controlling the entire overheated period, but is unnecessary if thermal mass is exploited.

Active

Airconditioning is not necessary unless the building function demands it.

Table 6.12.2 – 12:00 sun angles for Lydenburg, Johannesburg and Ficksburg

Vertical sun angle at 12:00 solar time			
	Latitude (South)	Solstice (21 Mar/23 Sept)	Winter (22 June)
Lydenburg	25,10°	64,9°	41,4°
Jhb International	26,13°	63,87°	40,37°
Ficksburg	28,86°	61,14°	37,64°

Mechanical

Mechanical ventilation is not necessary unless the building function requires higher ventilation rates.

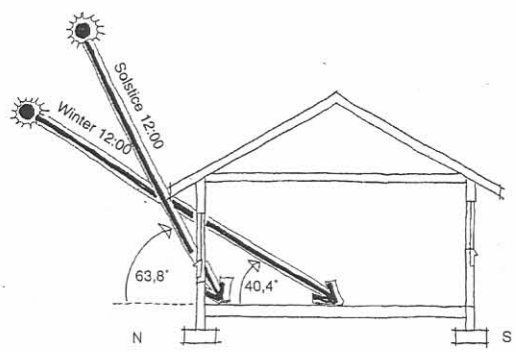

Fig. 6.12.7 – Roof overhang, window height and positioning for Johannesburg International Airport.

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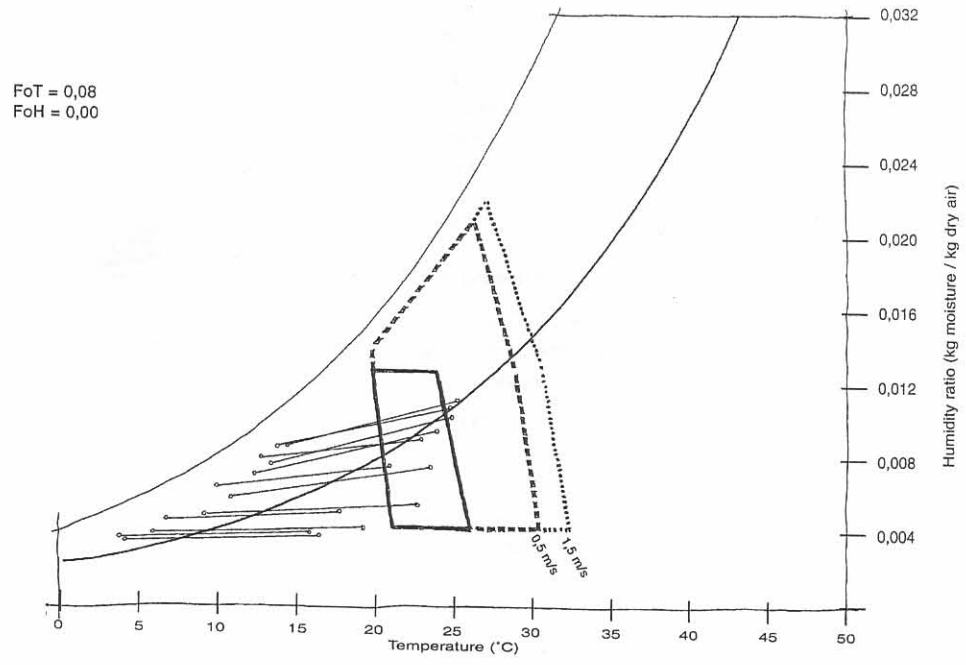

Fig.6.12.8 – Psychrometric chart with ventilation. A minimum requirement is 28,6 % of the effect of 1m/s required to deal with the worst case summer condition.

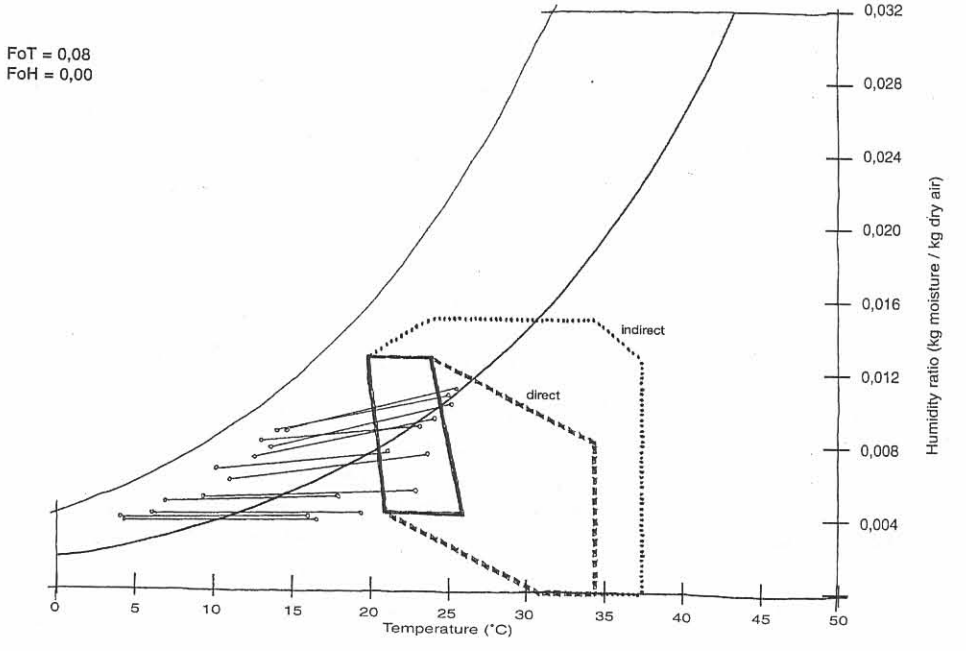

Fig. 6.12.9 – Psychrometric chart with evaporative cooling. 12,0 % of direct evaporative cooling is effective.

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6.13 Climatic zone – Northern Transvaal

6.13.1 Background

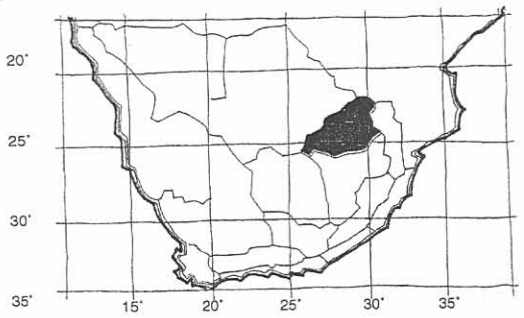

Fig. 6.13.1 – Climatic zone – Northern Steppe.

Location

25,8° to 30,7° East and 22,0° to 25,9° South.

Towns in region

Louis Trichard, Pietersburg, Pretoria

Description of zone climate

Distinct rainy and dry seasons exist with a large daily temperature variation and strong solar radiation. Humidity levels are moderate.

6.13.2 Climate

Temperature

The maximum diurnal variation occurs in July. The average monthly diurnal variation is 13K.

Humidity

The average monthly relative humidity level is 59%.

Wind

Summer winds are predominantly east-north-easterly to east-south-easterly. Winter winds are predominantly south-westerly with a fair amount originating from the north-east.

6.13.3 Comfort zone

Temperature

Summer temperatures extend approximately 3K above the comfort zone. Winter temperatures extend to approximately 15K below the comfort zone.

Humidity

Humidity levels are moderate and are not considered problematic.

6.13.4 Planning

Urban

Protection of pedestrians by trees, arcades or canopies. South facades of street receive high radiation during summer and should be tree lined.

Plan form

Winter and summer requirements differ. The winter demands include a compact plan form, a well-insulated envelope, and solar gain is desirable.

Table 6.13.1 – Climatic data for Pretoria

Jan	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ave
Maximum average monthly temperature (°c)	28,6	28	27	24,1	21,9	19,1	19,6	22,2	25,5	26,6	27,1	28	24,81
Minimum average monthly temperature (°c)	17,4	17,2	16	12,2	7,8	4,5	4,5	7,6	11,7	14,2	15,7	16,8	12,13
Average monthly amplitude (K)	11,2	10,8	11	11,9	14,1	14,6	15,1	14,6	13,8	12,4	11,4	11,2	12,68
Average monthly relative humidity (%)	58,0	59,5	60,0	59,5	55,0	53,0	50,0	46,0	45,0	49,5	54,0	56,5	53,83
Average monthly rainfall (mm)	136	75	82	51	13	7	3	6	22	71	98	110	56,17
Rham 72	74	76	78	76	75	71	64	61	64	68	70	75	70,75
Rhpm 44	45	44	41	34	31	29	28	29	35	40	43	44	36,92

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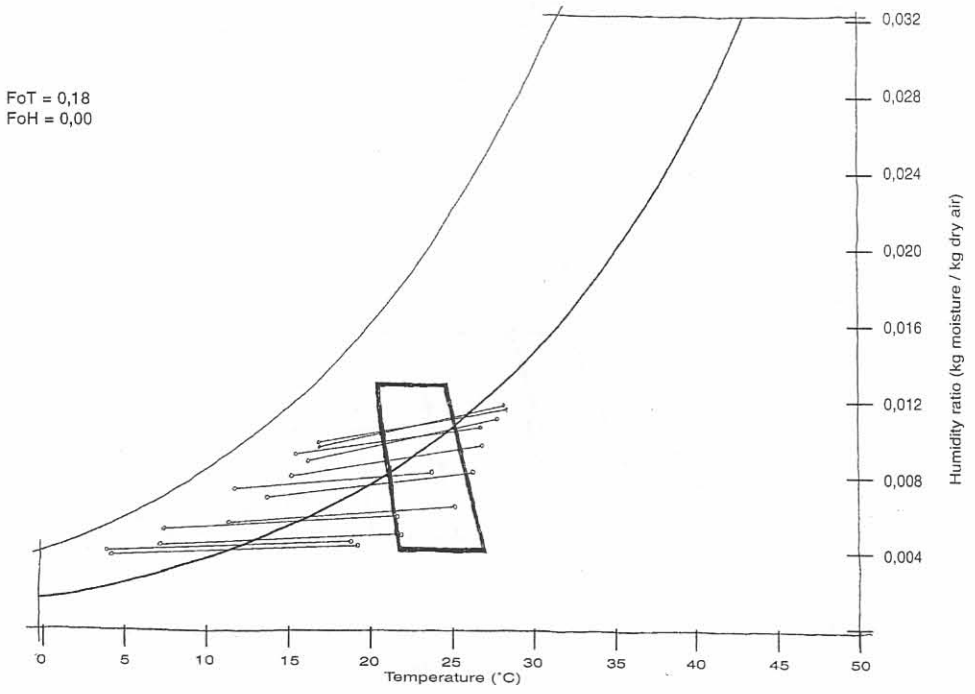


Fig. 6.13.2 – Psychrometric chart showing the comfort zone's position relative to the climate lines – Pretoria.

Position of functions

External spaces should provide shade in summer for outdoor activities. Place buffer zones west and south.

Rain protection

It will be convenient to shield entrances from sporadic thunderstorms.

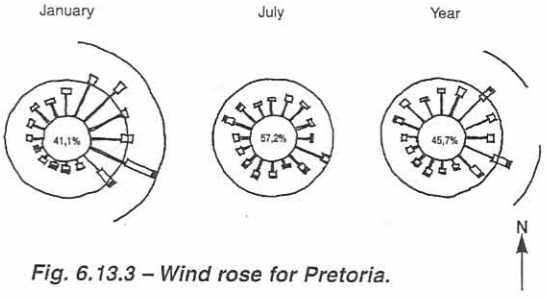


Fig. 6.13.3 – Wind rose for Pretoria.

6.13.5 Building envelope

Mass

Thermal mass is effective for approximately half of the under heated period and the entire overheated period. Thermal mass is also advisable especially in inland areas where the daily temperature swing is larger than 13K. It can be provided by massive floors, roofs and internal partitions. It is effective for approximately half of the under heated period and for the entire overheated period.

Insulation

Lightweight insulated roofs are feasible in this region provided that walls and floors give thermal mass.

Properties of materials

External surfaces should be light coloured or reflective to minimize solar heat gain in the overheated period.

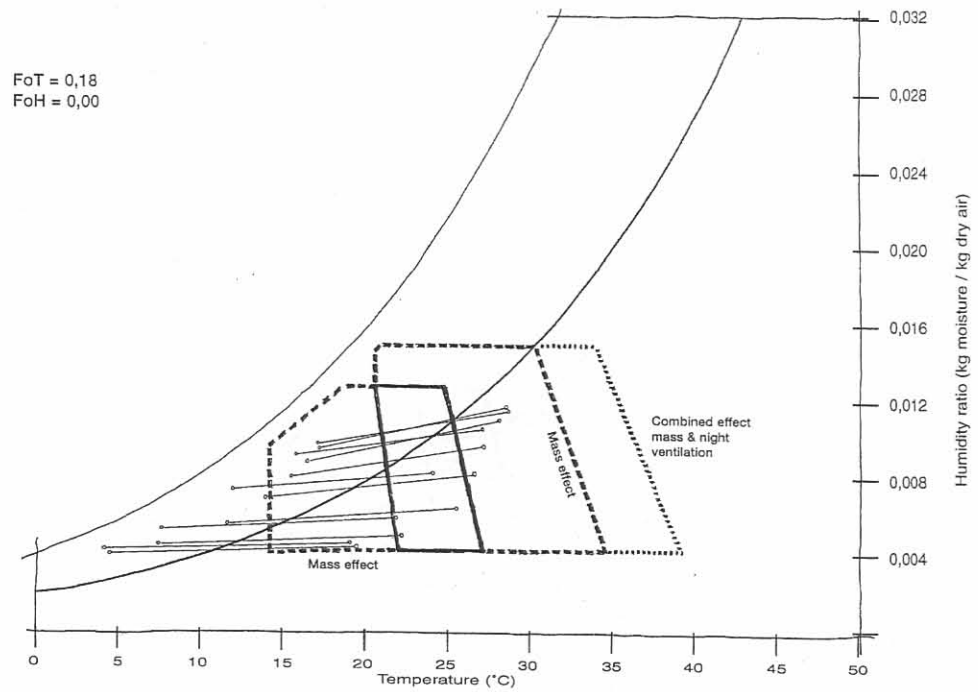


Fig. 6.13.4 – Psychrometric chart showing the enlarged comfort zone obtained by supplying thermal mass to the structure. The combined effect of ventilation and thermal mass is also shown. Night structural cooling is optional.

6.13.6 Solar control

Sun angles

It is recommended that summer sun be screened and winter sun be allowed to penetrate.

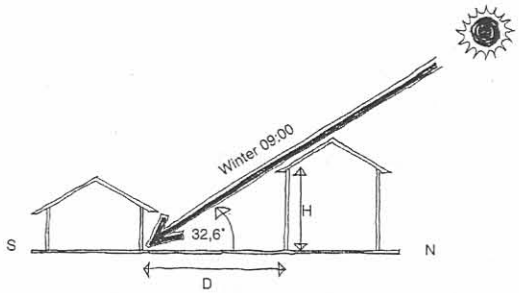


Fig. 6.13.5 – Solar access for building spacing in Pretoria. D=1,5 H

Equatorial window

An equatorial window equal to 21,2 % of the floor area is effective for the entire winter period.

6.13.7 Ventilation

Ventilation is effective for the overheated period. Night ventilation can be used to compensate insufficient mass.

6.13.8 Management

Opening of windows if night ventilation is feasible.

6.13.9 Systems

Evaporative cooling

Direct evaporative cooling is effective for most of the overheated period.

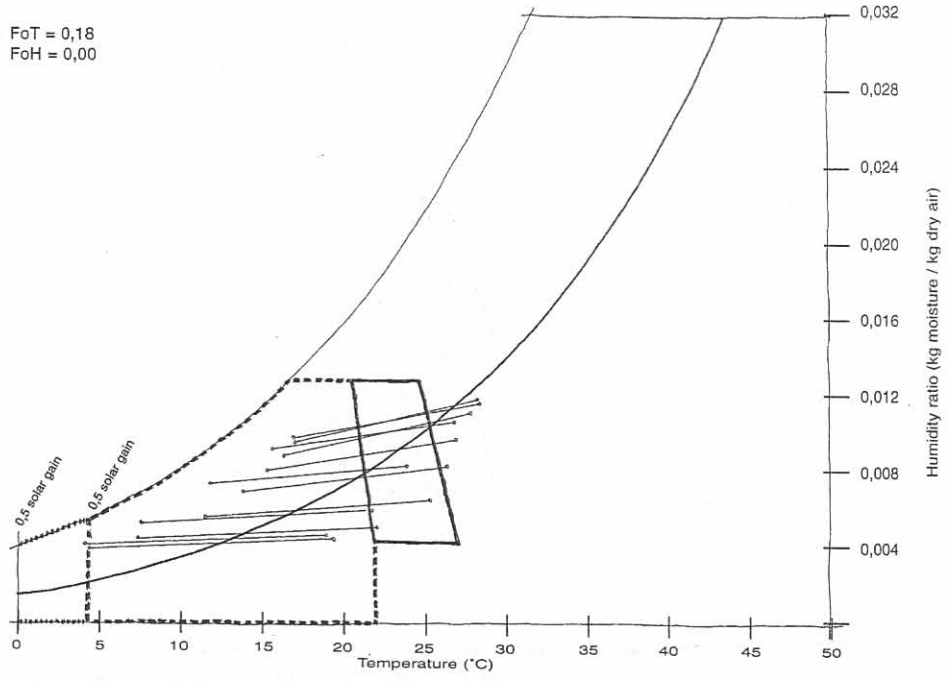


Fig. 6.13.6 – Psychrometric chart with equatorial window with efficiencies of 0,5 and 0,6 sized 21,2% and 18,9% respectively of floor area.

Active

Airconditioning is not a necessity, but the building function may require it.

Mechanical

Mechanical ventilation may be necessary to achieve the required ventilation rates.

Table 6.13.2 – 12:00 sun angles for Pietersburg, Louis Trichard and Pretoria

Vertical sun angle at 12:00 solar time			
	Latitude (South)	Solstice (21 Mar/23 Sept)	Winter (22 June)
Louis Trichard	23,86°	66,14°	42,64°
Pietersburg	23,64°	66,36°	42,86°
Pretoria	25,77°	64,23°	40,73°

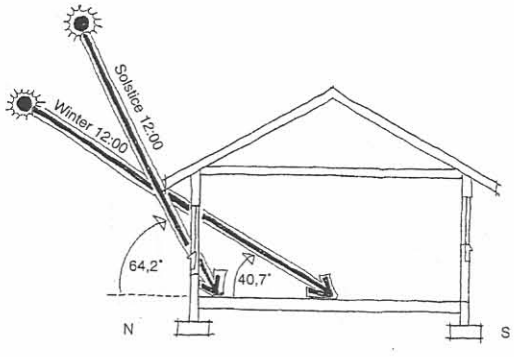


Fig. 6.13.7 – Roof overhang, window height and positioning for Pretoria.

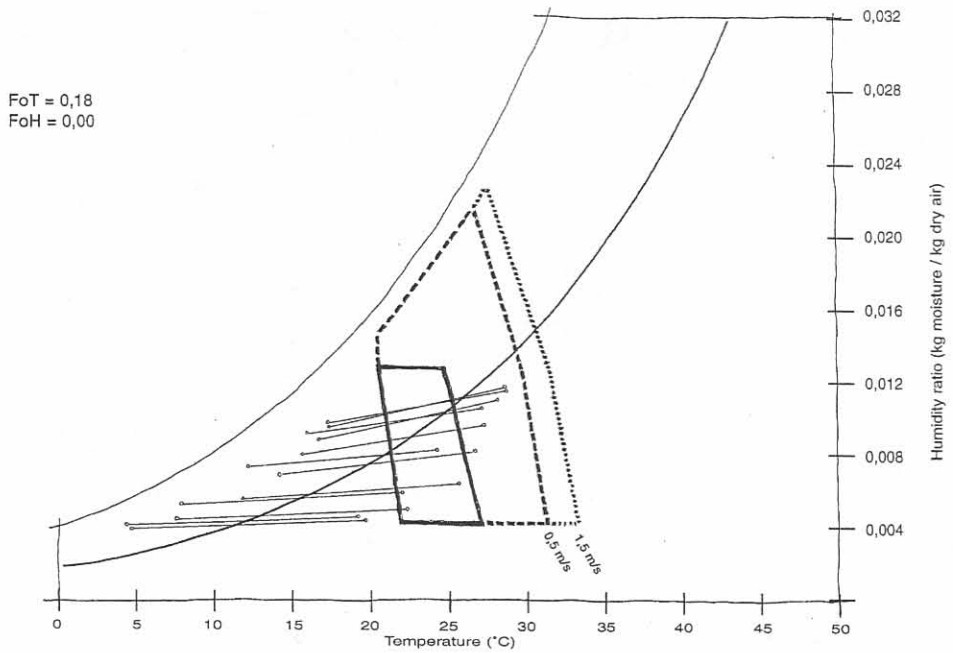


Fig. 6.13.8 – Psychrometric chart with ventilation. A minimum requirement is 67,9 % of the effect of 1 m/s required to deal with the worst case summer condition.

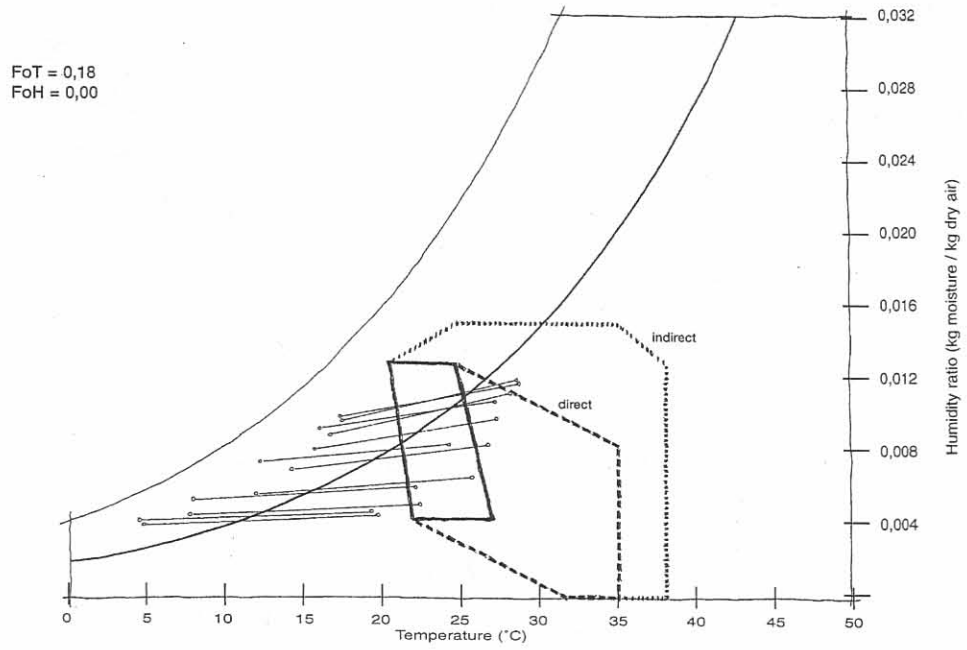


Fig. 6.13.9 – Psychrometric chart with evaporative cooling. Direct evaporative cooling is not quite sufficient.

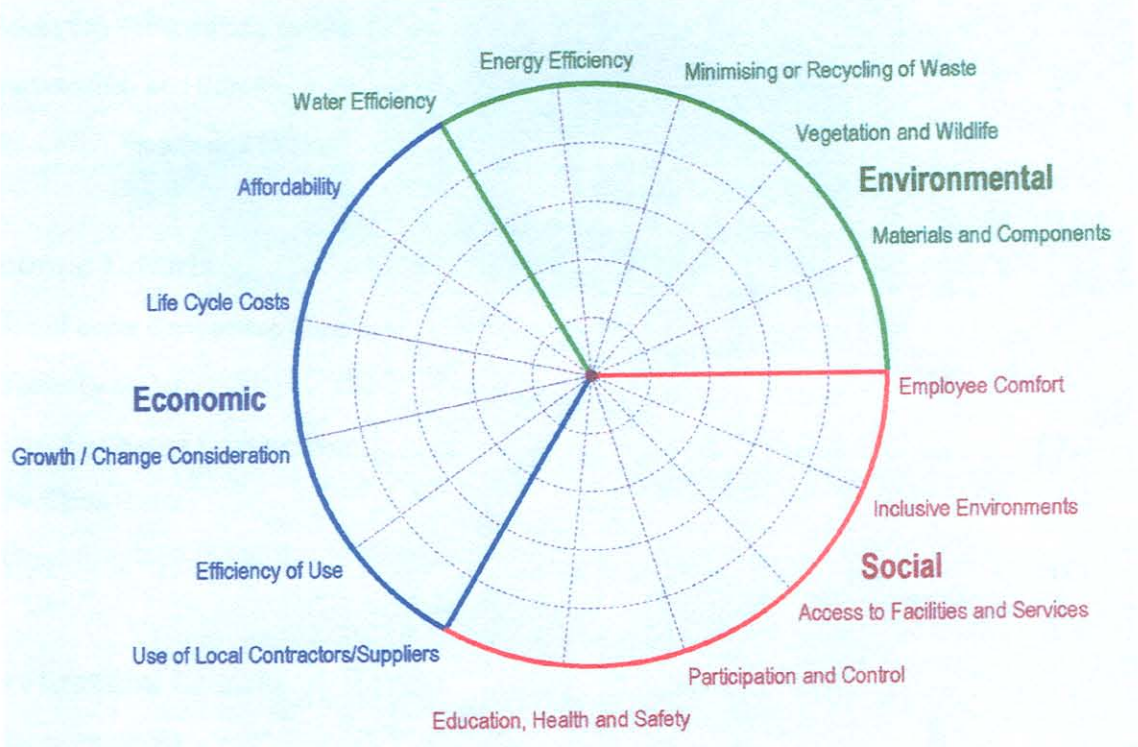
APPENDIX 3

A comparison of on-site waste disposal methods (City of Austin 1998:website)

ISSUE	COMPOSTING TOILET	SEPTIC TANK TREATMENT	AERATION PLUS CHLORINATION
Destroys viruses	yes	no	uncertain
Destroys beneficial bacteria	no	no	Uncertain but regrow later
Destroys harmful bacteria	yes	no	Will regrow later
Destroys parasitic worms, except nematodes (roundworms)	yes	no	no
Destroys nematodes (roundworms) only	unsure	no	no
Destroys protozoan cysts (including Giardia and Entamoeba)	yes	no	unlikely
Reduces phosphorus pollution	yes	no	no
Reduces nitrogen compound pollution	yes	To some degree	yes
Creates carcinogenic thrihalomethanes	no	no	yes
Creates residual sludge	yes	no	no
Requires chemicals to be added	no	no	yes
Maintenance-free period	3 months	3 months	Constant supervision
Requires de-sludging	15-20 years	1-4 years	6 months - 4 years
Health risk if mechanical failure occurs	low	high	medium
Degree of water conservation	high	low	low

APPENDIX 4
The prototype SBAT (CSIR 2001)

Sustainable Building Assessment Tool
Detailed Evaluation Results – SBAT Diagram



Sustainable Building Assessment Tool

Target Criteria Descriptors

Social Criteria

Employee Comfort

Inclusive Environments

Access to Facilities and Services

Participation and Control

Education, Health and Safety

Economic Criteria

Use of Local Contractors/Suppliers

Efficiency of Use

Growth / Change Consideration

Life Cycle Costs

Affordability

Environmental Criteria

Water Efficiency

Energy Efficiency

Minimising or Recycling of Waste

Vegetation and Wildlife

Materials and Components

Sustainable Building Assessment Tool

Detailed Evaluation Results - Social

Employee Comfort

- [ ] Natural lighting
- [ ] Natural ventilation
- [ ] Low noise
- [ ] Views (all work positions min 6m from external window)
- [ ] Access to amenities: WC, refreshments (tea making point)

Inclusive Environments

- [ ] Easy access to disabled friendly public transport
- [ ] All routes in and between buildings smooth and even (ie wheelchair accessible)
- [ ] All changes in levels routes in and between buildings include ramps with 1:12 fall, hand rails and/or lifts
- [ ] Required number of disabled accessible WC(s) available
- [ ] Edges (ie between walls and floors) and stair nosing clearly distinguished with contrasting colours

Access to Facilities and Services

- [ ] Creche
- [ ] Banking
- [ ] Shops
- [ ] Communication Facilities (Post, Public Telephone, email)
- [ ] Government / tax / licensing information

Participation and Control

- [ ] Personal control over light, temp and ventilation levels
- [ ] Users involved in design / construction process
- [ ] Users involved in the design, refurbishment of their spaces
- [ ] Users able to adapt their spaces to suit themselves (ie furniture / privacy)
- [ ] Space and / or equipment shared with local community

Education, Health and Safety

- [ ] Space available for group training sessions/access to learning packages
- [ ] Fully compliant with fire escape requirements
- [ ] Access to Sports facilities
- [ ] Access to nutritous food (restaurant, vegetable gardens etc)
- [ ] Materials used, screened for hazardous compounds (ie VOCs)

Sustainable Building Assessment Tool

Detailed Evaluation Results - Economic

Use of Local Contractors/Suppliers

- [ ] 80% of construction carried out by contractors within 20km of site
- [ ] 80% of construction materials obtained from within 40 km of site
- [ ] 80% of components (windows, doors, etc) and furniture made within country
- [ ] Space / outsource opportunities provided for small businesses
- [ ] All repairs/maintenance/cleaning of building can be carried out by contractors within 40km of building

Efficiency of Use

- [ ] Space Management System ie charged to cost centres
- [ ] Proportion of useable space to non usable space (Circulation, WCs storage) min 80%
- [ ] Patterns of occupance
- [ ] Efficient space use measures: shared workspaces (ie hotdesking)
- [ ] Use of ICT to reduce space requirements (email, video conferencing etc)

Growth / Change Consideration

- [ ] Floor to ceiling / underside of slab height min 3000mm
- [ ] Non structural internal partition walls
- [ ] Modular, loose furniture
- [ ] Services strategy
- [ ] Structural strategy

Life Cycle Costs

- [ ] Maintenance costs
- [ ] Cleaning
- [ ] Security / caretaking
- [ ] Insurance / water / energy / sewerage
- [ ] Plant / component replacement

Affordability

- [ ] Design: highly 'buildable', simple shapes
- [ ] Procurement: costs reduced through donations, community involvement, partnerships
- [ ] Construction: phased or built as shell with finishes to follow
- [ ] Operation: costs shared with other users
- [ ] Use neighbouring space / facilities rather than duplicate

Sustainable Building Assessment Tool

Detailed Evaluation Results - Environmental

Water Efficiency

- [ ] Rainwater harvesting
- [ ] Water efficient devices: low flush WCs and urinals
- [ ] Greywater reuse
- [ ] Minimising runoff: absorbant external surfaces
- [ ] Low water demand landscaping

Energy Efficiency

- [ ] Located near public transport / all users within walking distance (4km)
- [ ] Passive environmental control system for ventilation
- [ ] Passive environmental control systems for heating and cooling
- [ ] Low energy appliances / fittings
- [ ] Solar control

Minimising or Recycling of Waste

- [ ] System for recycling
- [ ] System for reusing
- [ ] Sewerage
- [ ] Provision for dangerous toxic waste
- [ ] Systems set up to minimise/reuse waste produced during construction process

Vegetation and Wildlife

- [ ] Use of a 'brownfield' site
- [ ] Range of plants
- [ ] Range of habitats provided
- [ ] Effect on neighbouring buildings: light etc (buildings kept apart minimum 10m for 1 s, 15m for 2s+)
- [ ] Minimal ext inputs required for maintenance of landscaping (ie ferlizers/ pesticides)

Materials and Components

- [ ] 80% of materials have low embodied energy
- [ ] No material / component used manufactured through process which harms the environment
- [ ] All materials / components produced using only renewable energy sources
- [ ] 80% of materials and components for the buildings recycled / refurbished
- [ ] 80% materials and components from renewable resources