CHAPTER THREE

BASELINE DOCUMENTATION

_TABLE OF CONTENTS TOWARDS A BASELINE

3.1 _SUSTAINABLE DEVELOPMENT

Economic dimensions of sustainability:

_Creation of new markets and opportunities for sales growth
_Cost reduction through efficiency improvements and reduced energy and raw material inputs
_Creation of additional added value

Environmental dimensions of sustainability

_Reduced waste, effluent generation, emissions to environment
_Reduced impact on human health
_Use of renewable raw materials
_Elimination of toxic substances

Social dimensions of sustainability

_Worker health and safety
_Impacts on local communities, quality of life
_Benefits to disadvantaged groups e.g. disabled

Sustainability represents a balance that accommodates human needs without diminishing the health and productivity of natural systems. The American Institute of Architects defines sustainability as “ the ability of society to continue functioning into the future without being forced into decline through exhaustion or overloading of the key resources on which that system depends.” (Mendler 2000)

While environmental and economic sustainability is the goal, sustainable design is the means we as designers have to contribute to that goal. Sustainable design moves away from extractive and disposable systems that are energy intensive, resource inefficient, and toxic toward cyclical, closed-loop systems that are restorative, dynamic, and flexible.

3.2 _COMMUNITY

3.2.1 SUSTAINABLE COMMUNITIES

A sustainable community revolves around the interconnectedness of society, economy and environment. According to Maureen Hart (2003; pg 1), a sustainable community is one in which

. . . the economic, social and environmental systems that make up the community provide a healthy, productive, meaningful life for all community residents, present and future. Sustainable communities acknowledge that there are limits to the natural, social and built systems upon which we depend.

A traditional view of community viewed its parts as separate and unrelated, and the quality of life was measured as such. The sustainable view toward community embraces all the components and views them as a whole; a system that functions on the reliability of its parts: the economy exists within society, and both the economy and society exist within the environment.

Apart from the aspects of a society above, one of the most important aspects to a sustainable community is the participation of all elements of society in decision-making processes. Local governments can help their communities to become more sustainable, but they cannot do it without a mandate from, and the participation of the local community.

Sustainability must be community-led and consensus-based because the central issue is will, not expertise; only a community-based process can overcome the political, bureaucratic and psychological barriers to change. But citizen-led processes must be complemented by top-down government support because it is still only governments that have the regulatory powers to secure the transition to sustainable development

(National Round Table on the Environment and the Economy)

The following twelve principles, proposed by the Ontario Round Table on Environment and Economy, encompass the social, economic, environmental and decision-making aspects of sustainable communities:

3.2.2 MODEL PRINCIPLES FOR SUSTAINABLE COMMUNITIES

A sustainable community is one which:

1. *Recognizes that growth occurs within some limits and is ultimately limited by the carrying capacity of the environment*
2. *Values cultural diversity*
3. *Has respect for other life forms and supports biodiversity*
4. *Has shared values amongst the members of the community (promoted through sustainability education)*
5. *Employs ecological decision-making (e.g., integration of environmental criteria into all municipal government, business and personal decision-making processes)*
6. *Makes decisions and plans in a balanced, open and*

flexible manner that includes the perspectives from the social, health, economic and environmental sectors of the community

7. *Makes best use of local efforts and resources (nurtures solutions at the local level)*
8. *Uses renewable and reliable sources of energy*
9. *Minimizes harm to the natural environment*
10. *Fosters activities which use materials in continuous cycles. And, as a result, a sustainable community:*
11. *Does not compromise the sustainability of other communities (a geographic perspective)*
12. *Does not compromise the sustainability of future generations by its activities (a temporal perspective).*

3.2.3 _PRINCIPLES OF SUSTAINABLE DESIGN

Understanding Place
Inhabit without destroying
solar orientation
Preservation of the natural environment
access to public transportation

Connecting with Nature
inner city or natural setting
Brings life
informs us of our place within nature

Natural Processes
regenerate rather than deplete

Environmental Impact
evaluating the site
embodied energy
toxicity of the materials
energy efficiency of design, materials and construction techniques
recycling building materials

Embracing Co-creative Design Processes
consultants, engineers and other experts early in the design process
Local communities

Understanding People
sensitivity and empathy

3.3 _SUSTAINABLE CONSTRUCTION

Definition: "The creation and responsible management of a healthy built environment based on resource efficient and ecological principles"(SABD)

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"Architecture presents a unique challenge in the field of sustainability. Construction projects typically consume large amounts of materials, produce tons of waste, and often involve weighing the preservation of buildings that have historical significance against the desire for the development of newer, more modern designs." -- The Earth Pledge (http://www.earthpledge.org/)

Sustainable construction is based on:

- minimising non-renewable resource consumption
- enhancing the natural environment
- eliminating or minimising the use of toxins

Sustainable building strives for integral quality including economic, social and environmental performance. Therefore, the rational use of natural resources and appropriate management of the building stock will contribute to saving scarce resources, reducing energy consumption (energy conservation), and improving environmental quality. (SABD)

Five objectives for sustainable buildings:

- Resource Efficiency
- Energy Efficiency (including Greenhouse Gas Emissions Reduction)
- Pollution Prevention (including Indoor Air Quality and Noise Abatement)
- Harmonisation with Environment (including Environmental Assessment)

Integrated and Systemic Approaches (including Environmental Management System) (SABD)

TABLE 3: ISSUES FOR CONSIDERAION FOR SUSTAINABLE CONSTRUCTION PRACTICES

Theme	Environmental	Economic	Social
Sub-theme	- Global - Local and site - Internal	- Construction - Materials - Infrastructure	- Equity - Community
Issues	- Climate change - Resources - Internal environment - External environment - Wildlife	- Profitability - Employment - Productivity - Transport and utilities - Building stock value	- Poverty - Minorities - Inner cities - Transport - Communications

Construction Methods and Materials

- local craftsmen and materials.
- environmental damage should not be permitted.
- Non-toxic, renewable or recyclable, and environmentally responsive building products are available to use when specifying materials.

Construction Process Program

- For developers, construction contractors, and maintenance workers that covers materials, methods, testing, and options.
- Organization and sequencing of construction. Maintenance and operations staff to be involved in the construction program and participate in the development of an operations manual.

Construction Limits and Landscape Features

- To be fenced and protected
- All topsoil from construction area should be collected for use in site restoration.
- Flexibility in revising construction plans should be allowed to change materials and construction methods based on actual site impacts.

Native Landscape Preservation/Restoration

- Preservation of the natural landscape is less expensive and more ecologically sound than restoration.
- Noxious or toxic plant materials should not be used adjacent to visitor facilities.
- plantings of native materials to control exotics should be used.
- Water for new plantings can be provided by locating plants in drainage swells or using temporary irrigation.

Visitor Safety and Security

- protect visitors from natural and manmade hazards.
- The design should consider safety from climate extremes; visitors may be unaware of natural hazards, including intense sun, high wind, heavy rainfall, etc
- Various challenge levels in site facilities should be provided to accommodate all visitors, including visitors with disabilities.

artificial lighting limited to retain natural ambient light levels - light fixtures to limit impacts while providing a basic sense of security

3.4 _SUSTAINABLE URBAN DESIGN

Principles of sustainable urban design

- Principle 1: Increasing Local Self-Sufficiency
- Principle 2: Human Needs
- Principle 3: Structure Development Around Energy-Efficient Movement Networks
- Principle 4: The Open Space Network
- Principle 5: Linear Concentration
- Principle 6: An Energy Strategy

Principle 7: Water Strategy

[Barton, H., 1996]

TABLE 4: ISSUES FOR CONSIDERAION FOR SUSTAINABLE URBAN DESIGN

Landform/Microclimate • Topography • Light-colored surfacing • Vegetative cooling • Wind buffering/ channeling • Evaporative cooling	Site Design • Solar orientation • Pedestrian orientation • Transit orientation • Micro climatic building/siting	Infrastructure Efficiency • Water supply and use • Wastewater collection • Storm drainage • Street lighting • Traffic signalization • Recycling facilities
Land-Use • Use density • Use mix • Activity concentration	Transportation • Integrated, multimode street network • Pedestrian • Bicycle • Transit • High-occupancy vehicles • Pavement minimization • Parking minimization/siting	On-Site Energy Resources • Geothermal/ groudwater • Surface water • Wind • Solar • District heating /cooling • Cogeneration • Thermal storage • Fuel cell power

3.5 _SUSTAINABLE TRANSPORTATION

Integrating land-use, transport and environmental planning is important to *minimise the need for travel* and to *promote efficient and effective mode of transport*, including walking. There are four principal ways to influence transport system efficiency and energy consumption:

- urban and land-use planning;
- modal mix (cars, trucks, rail, air, etc.);
- behavioral and operational aspects (occupancy of vehicles, driver behavior, system characteristics); and
- vehicle efficiency and fuel choice.

Pedestrianisation is to restrict vehicle access to a street or area for the exclusive use of pedestrians. It provides a pleasant and safe environment for pedestrians, and is ideal for venues for shopping, social and cultural activities, such as street markets and fairs.

FIG 3.5.1 Rail transportation is regarded as one of the most sustainable forms of movement

3.6 _SOCIAL ISSUES

3.6.1 INDOOR ENVIRONMENT AND OCCUPANT COMFORT

- Indoor air quality
- Visual quality
- Acoustic quality
- Noise control

Controllability of systems

Healthy Buildings

Building ecology refers to the constructed environment inside a building as it relates to human health. Building ecology is concerned with indoor air quality, acoustics, and daylight. Building ecology is effected by a number of constituents: overall building tightness, heating, cooling and ventilation systems, interior finishes, adhesives, cleaning, and maintenance.

Indoor Air Quality

The air inside buildings has been measured to be worse than the polluted air outside. Building elements, particularly new building elements, "offgas" or emit chemical compounds. Adhesives, paints, particleboard, carpeting, vinyl flooring, and furnishings can contribute significantly to the airborne contaminants found inside new buildings.
The facility design team shall design a building that promotes indoor air quality through the selection of nontoxic and least toxic building materials and through the design of mechanical and electrical systems that circulate and evenly distribute fresh, clean air.

The steps to promote good quality indoor air are:

1. Minimize the sources of off gassing. Select low- or zero-VOC (volatile organic compound) paints and adhesives.
2. Provide a source of clean fresh air.
3. Design good ventilation into habitable rooms.
4. Design a good air filtration system.
5. Choose low-VOC emitting furnishings.
6. Choose nontoxic cleaning products.
7. Regularly clean high-humidity areas so mold and mildew can't develop.
8. Monitor the facility for leaky pipes and roof leaks.

Acoustics

The acoustic performance of a space can contribute to an occupant's feeling of well being. Unwanted noise can create conditions that make it difficult to concentrate. Consider acoustically isolating a building from its environment if that environment is too noisy. Acoustic nuisances include mechanical system noise, plumbing noise, and electrical noise. Acoustic privacy, that is the ability to speak without being overheard, is desirable but rarely achieved in environments that use systems furniture.

The Value of Daylight

Daylight is an important factor in a building's environmental performance. If properly used, daylight can reduce electrical demand, reduce cooling requirements, and contribute to improved occupant performance.

The quality of environments in and around buildings have been shown to have a direct impact on health, happiness and productivity of people. Healthier, happier, more effective and people contribute to sustainability by being more efficient and therefore reducing resource consumption and waste. However the quality of this environment needs to be achieved with minimal cost to the environment (Gibberd 2003; SBAT).

Lighting

All work and living environments must well daylit. Day lighting control and glare is to be minimised to ensure that no spaces require constant electrical lighting. Recommended lux levels for interior lighting is given in TABLE 5.

Ventilation

Required ventilation can provided by natural means, where mechanical ventilation used in buildings can be minimised or even abandoned altogether. Mechanical and passive systems can be designed to work in conjunction with each other to provide god results with little or no energy.

Noise

Noise levels limited in work and living environments to acceptable levels.

Views

All living and work areas have access to a view out. All users located in 6m or less from a window.

Access to green outside

Access to green outside spaces should be available.

TABLE 5: RECOMMENDED LUX LEVELS FOR INTERIOR LIGHTING

TYPES OF SPACES	LUX
Circulation areas	
Corridors, passageways:	100
Lifts (passanger)	150
Stairs	150
Escalators	150
External covered ways	30
ENTRANCES	
Halls, lobbies, waiting rooms	150
Enquiry desks	500
KITCHENS	
Food stores	150
Working areas	500
Canteens, dining areas	200
Servery	300
OUTDOOR AREAS	
Controlled entrances/ exits	150
Entrances/ exits	30
STAFF ROOMS	
Changing, locker, wc etc	150
Cleaning rooms	150
STORES	
General	150
CAR PARKS	
Underground	30
Multistory	
Parking floors	30
Ramps	50
ASSEMBLY HALLS	Auditoria
Theatres and concert	100
Cinemas	50
Multipurpose	100-500
Foyers	75
LIBRARIES	
Shelves	150
Reading tables	300
Reference library	500
SCHOOLS	
Assembly halls, general	300
Platform/ stage	special
Teaching spaces (general)	300
Lecture theatres	
General	300
Chalk board	500
Demo tables	500
Art rooms	500
Laboratories	500
Workshops	300
OFFICES	
General	500
Deep plan general	750
Business machine and typing	750
Conference	750
Executive offices	500
Banking halls	
Working spaces	500
Public spaces	300
Computer rooms	500
Drawing offices	
Drawing boards	750
SHOPS	
Conventional with counters	500
Wall displays	500
Self service	500
Supermarkets	500
Hypermarkets	500-1000
Showrooms	500
General	500
Arcades and circulation	100-200

3.6.2 _INCLUSIVE ENVIRONMENTS

"Buildings can be designed to accommodate everyone, or specially designed buildings need to be provided. Ensuring that buildings are inclusive supports sustainability as replication is avoided and change of use supported". (Gibberd 2003; SBAT)

Public Transport

Building is located 100, or less metres to disabled accessible public transport

Routes

All routes between and within buildings of a smooth and even surface (ie easily navigable by wheelchair)

Changes in level

Changes in level between or within buildings are catered for with appropriate ramps of 1:12 fall by use of the elderly and disabled, as well as the provision of lifts.

Edges

All edges ie between walls and floors and stair nosings must be clearly distinguished through the use of contrasting colour (For visually impaired)

Toilets

Required number of disabled toilets provided

3.6.3 _ACCESS TO FACILITIES

"Convention living and working patterns *requires regular access to a range of services. Ensuring that these services can be accessed easily and in environmentally friendly ways supports sustain*ability by increasing efficiency and reducing environmental impact." (Gibberd 2003; SBAT)

Childcare

Childcare provided in building development or can be catered for within a 1km radius of the building

Banking

Banking services (ie ATM) provided in building

Retail

Grocery, items required on a day to day basis available in building or close by (within 3km). Informal and formal trade allows for the provision of daily goods to be purchased readily

Communication

Postal, telephone or email facilities provided in the building.

Residential

Home, for occupants of the building is within 12km. Ease of access to the area is maintained through effective transport facilities of the precinct, as well as the presence of nearby residential areas.

3.7 _ECONOMIC ISSUES

3.7.1 _LOCAL ECONOMY

The development of a particular area can stimulate growth of the economy whilst providing employment opportunities and contribute to the development of local skills and resources. For the development to maintain a sustainable approach, it should adopt the following principles in order for its success:

Local contractors

Contractors based within 40km of the building/refurbishment should carry out 80% of the construction. This figure should be a mixture of a skilled to unskilled labour force, whilst allowing the opportunity for training programmes and educational tasks to take place.

Local building material supply

80% of construction materials: cement, sand, bricks etc must be produced within 200km of site. The adaptive use of the existing rail on the site can be used to minimise transport needs, whilst limiting the number of construction vehicles to and from the site

Local component manufacturer

80% of building components ie windows and doors should be produced locally (within 200km)

Outsource opportunities

Opportunities created and provision provided for small emerging businesses. This includes outsourcing catering, cleaning services and security as well as making space and equipment available for businesses to use for retail, education etc.

Repairs and maintenance

All repairs and maintenance required by the building (including servicing of mechanical plant) can be carried out by contractors within 200km of site.

Efficiency of Use

Effective and efficient use of buildings supports sustainability by reducing waste and the need for additional buildings. The use of space is very important, and should be minimised to control costs.

Useable space

Non-useable space such as bathrooms, plant rooms and circulation should not make up more than 20% of total area. Some spaces can also be adaptive, that they be used for more than one function when necessary.

Occupancy

Building and all working/living spaces should be occupied for an average equivalent minimum of 30 hours per week to ensure efficiency.

Space use

Use of space intensified through space management approach and policy such as shared work spaces ie 'hot-desking'.

Use of technology

Communications and information technologies used to reduce space requirements ie video conference, teleworking etc.

Space management

Policy to ensure that space is well used. This may include regular audits, or space management system that charges space to cost centres.

3.7.2 _ADAPTABILITY AND FLEXIBILITY

Most buildings can have a life-span of at least 50 years. It is likely that within this time that the use of the building will change, or that the feasibility of this will be investigated. Buildings that can accommodate change easily supports sustainability by reducing the requirement for change (energy, costs etc) and the need for new buildings. (Gibberd 2003; SBAT)

Vertical dimension

Structural dimension (Floor to underside of roof, or slab of the floor above) should be a minimum of 3m. This ensures ease of change, good depth for future services, as well as comfortable environment for occupants for visual, acoustical, as well as thermal qualities.

Internal partitions

Internal partitions between living/work spaces are non-load bearing (ie non-load bearing brick /block or plasterboard partitions) and can be 'knocked-out' relatively easily.

Services

Easy access provided electrical, communication and (and HVAC, where appropriate) in each useable space. Provision made for enabling easy modification of system (ie addition subtraction of outlets)

3.7.3 _ONGOING COSTS

Maintenance

Specification and material specification for low maintenance and or low cost maintenance should be implemented at initial design stages to ensure their availability and guarentees. All plant and fabric have a maintenance cycle of at least 2 years. Low or no maintenance components (ie windows, doors, plant, ironmongery etc) should be selected. Maintenance can be carried out cost effectively and efficiently, with access to hard-to-reach areas provided for cleaning etc..

Security / care taking

Measures must be taken to limit the requirement and costs of security. This should include mixed-use development to ensure that occupied neighbouring buildings overlook the buildings and spaces. Another useful system would be to ensure that some activities be placed in such as way that they either reuse spaces at night, or facilities are located such that the building is always occupied.

Insurance / water / energy / sewerage

Costs of insurance, water, energy and sewerage should be monitored. Consumption and costs must be regularly reported to management and users. Policy and management to reduce consumption (ie switching off lights on leaving building spaces) implemented, whereas passive systems can be used for the control of energy-saving, such as polar voltaic cells that control ventilators or supply night-lighting through energy-efficient controls.

Disruption and 'downtime'

Electrical and communication services, HVAC and plant located where they can be easily accessed with a minimum of disruption to occupants of building. This should be the maximising of access to this from circulation areas (rather than work/living areas) and lift-off panels at regular intervals to vertical and horizontal ducting.

3.8 _ENVIRONMENTAL ISSUES

3.8.1 _ENVIRONMENTAL ARCHITECTURE

Five principles of an environmental architecture (Thomas; 1992):

- ***Healthful Interior Environment***. All possible measures are to be taken to ensure that materials and building systems do not emit toxic substances and gasses into the interior atmosphere. Additional measures are to be taken to clean and revitalize interior air with filtration and plantings.

- ***Energy Efficiency***. All possible measures are to be taken to ensure that the building's use of energy is minimal. Cooling, heating and lighting systems are to use methods and products that conserve or eliminate energy use.

- ***Ecologically Benign Materials***. All possible measures are to be taken to use building materials and products that minimize destruction of the global environment. Wood is to be selected based on non-destructive forestry practices. Other materials and products are to be considered based on the toxic waste out put of production.

- ***Environmental Form***. All possible measures are to be taken to relate the form and plan of the design to the site, the region and the climate. Measures are to be taken to "heal" and augment the ecology of the site. Accommodations are to be made for recycling and energy efficiency. Measures are to be taken to relate the form of building to a harmonious relationship between the inhabitants and nature.

Good Design. All possible measures are to be taken to achieve an efficient, long lasting and elegant relationship of use areas, circulation, building form, mechanical systems and construction technology. Symbolic relationships with appropriate history, the Earth and spiritual principles are to be searched for and expressed. Finished buildings shall be well built, easy to use and beautiful.

TABLE 6: ENVIRONMENTAL ISSUES FOR CONSIDERATION

DESIGN	SITING & LAND USE	MATERIALS	EQUIPMENT	JOB SITE & BUSINESS
Smaller is better	Renovate older buildings	Avoid ozone-depleting chemicals in mechanical equipment and insulation	Install high-efficiency heating and cooling equipment	Protect trees and topsoil during site work
Design an energy-efficient building	Create community	Use durable products and materials	Install high-efficiency lights and appliances	Avoid use of pesticides and other chemicals that may leach into the groundwater
Design buildings to use renewable energy	Encourage in-fill and mixed-use development	Choose low-maintenance building materials	Install water-efficient equipment	Minimize job-site waste
Optimize material use	Minimize automobile dependence	Choose building materials with low embodied energy	Install mechanical ventilation equipment	Make your business operations more environmentally responsible
Design water-efficient, low-maintenance landscaping	Value site resources	Buy locally produced building materials		Make education a part of your daily practice
Make it easy for occupants to recycle waste	Locate buildings to minimize environmental impact	Use building products made from recycled materials		
Look into the feasibility of "gray water"	Provide responsible on-site water management	Use salvaged building materials when possible		
Design for durability	Situate buildings to benefit from existing vegetation	Seek responsible wood supplies		
Design for future reuse and adaptability		Avoid materials that will give off gas pollutants		
Avoid potential health hazards: radon, mold, pesticides		Minimize use of pressure-treated lumber		
		Minimize packaging waste		

Based on the objectives of the Building Research Establishment's Environmental Assessment Method (BREEAM)

The principles are:

- demolish and rebuild only when it is not economical or practicable to reuse, adapt or extend an existing structure;
- reduce the need for transport during demolition, refurbishment and construction and tightly control all processes to reduce noise, dust, vibration, pollution and waste;
- make the most of the site, e.g. by studying its history and purpose, local micro-climates and the prevailing winds and weather patterns, solar orientation, provision of public transport and the form of surrounding buildings;
- design the building to minimize the cost of ownership and its impact on the environment over its life span by making it easily maintainable and by incorporating techniques and technologies for conserving energy and water and reducing emissions to land, water and air;
- wherever feasible, use the construction techniques which are indigenous to the area, learning from local traditions in materials and design;
- put the function of the building and the comfort of its occupants well before any statement it is intended to make about the owner or its designer. That is, make it secure, flexible and adaptable (to meet future requirements) and able to facilitate and promote communications between staff;
- build to the appropriate quality and to last. Longevity depends much on form, finishes and the method of assembly employed as on the material used.
- avoid using materials from non renewable sources or which cannot be reused or recycled, especially in structures which have a short life;
- (SABD)

3.8.2 _ECOLOGICAL BUILDING

This movement aims to create environmentally friendly, energy-efficient buildings and developments by effectively managing natural resources. This entails passively and actively harnessing solar energy and using materials which, in their manufacture, application, and disposal, do the least possible damage to the so-called ‘free resources’ water, ground, and air.

A building can be compared to the qualities of an organism when one relates the effects of the environment to a building itself. An organism makes use of immediately and local materials to construct itself, and does so with economy and efficiency. The same strategies when used in developemtn can minimise glovbal and local impacts on resources.

The organism adapts to its environment through instinctive reaction and an evolutionary process od generations. Through the ability to rationalise and mechanise, humans have the ability to adapt psychologically and physically in a matter of hours, but with little instinct for harmony with the environment.

The organism however, maintains a harmonious relationship with its environment by establishing a balance between its needs and available resources. Similarly, the ecologically sensitive design adjusts demands, lifestyles and techniologies to evlove a compatible balance with the natural and cultural systems within its environment.

TABLE 7: ENVIRONMENTAL ISSUES FOR CONSIDERATION

Environment		Building Fabric		Building Technology	
Air	Free air - Natural ventilation - Wind force - Energy content Stack effect Solar energy, diffuse radiation Solar energy, direct radiation	Facade and roof	-Transparent insulating material -Photovoltaic -Absorber surface -Storage masses -Planted surfaces -Rainwater -Daylight elements - Collectors	Cooling energy	**Direct** - Electrically driven chiller - Absorption chiller - Gas-motor driven chiller - Cooling towers - Tandem systems **Indirect** - Cold storage in building - Cold storage in terrain - Bore holes
Soil	Aquifer - Heat storage - Cool storage Groundwater - Cold energy - Heat energy Earth/rock - Geothermal cooling - Heat energy	Construction	-Storage masses -Passive solar absorber -Heat exchanger elements -Night cooling by outside air	Heat energy	Direct - District heating - Boiler (gas, oil, coal, biogas, condensing) - Electric boiler (with storage) Indirect - Solar thermal system - Combined heat and power (CHP) - Heat pumps - Flue gas heat exchanger
Water surfaces	Lake/ River/ Sea - Pump water or greywater - Heat energy - Cold energy	Atria	-Green zones -Evaporative cooling -Passive solar energy -Heat buffer	Electrical energy	Mains supply - Commercial power supply utilities Self supply - Combined heat and power (CHP) - Emergency generator - Photovoltaic - Tandem system - Wind energy generator
				Water	Pure water - Public supply (drinking, cooking) Greywater - Waste water (condenser water, flushing, cleaning) Rainwater - Flushing, cleaning, cooling

3.8.3 _GREEN BUILDING

Green Building architecture considers all the resources that are involved in the design, construction and performance of a building throughout its entire life-cycle, involves resolving many conflicting issues and requirements, and each design decision has environmental implications.

Measures for green buildings can be divided into four areas:

- Reducing energy in use
- minimizing external pollution and environmental damage
- Reducing embodied energy and resource depletion
- minimizing internal pollution and damage to health

In turn, “Green design” emphasizes a number of new environmental, resource and occupant health concerns:

- Reduce human exposure to noxious materials.
- Conserve non-renewable energy and scarce materials.
- Minimize life-cycle ecological impact of energy and materials used.
- Use renewable energy and materials that are sustainably harvested.
- Protect and restore local air, water, soils, flora and fauna.
- Support pedestrians, bicycles, mass transit and other alternatives to fossil-fuelled vehicles.

Most green buildings are high-quality buildings; they last longer, cost less to operate and maintain, and provide greater occupant satisfaction than standard developments

3.8.4 _ENERGY

Responsible energy use is fundamental to sustainable development and a sustainable future. Energy management must balance justifiable energy demand with appropriate energy supply. The process couples energy awareness, energy conservation, and energy efficiency with the use of primary renewable energy resources.

3.8.4.1 The thermal performance of buildings

Most of the energy consumed by commercial buildings is devoted to **heating, cooling** and **lighting**. Sustainable design affords opportunities to reduce these loads while increasing the comfort and productivity of the occupants. The sun can provide light wherever possible. Solar heat that is retained by masses of concrete and masonry can reduce the demand on the HVAC (Heating Ventilation and Air Conditioning) system. Sustainable design considers all the structural elements and mechanical systems of a structure and optimizes how they work together in a productive whole.

The thermal performance of a building may be defined as the result of the process whereby the design, layout, orientation and construction materials of the building modify the prevailing outdoor climate to create the indoor climate. In a house this is generally perceived by the occupants in terms of the extent to which the house seems cool in the heat of summer and warm in cold winter weather, taking into account the amount of heating or cooling required to create comfortable thermal conditions.

3.8.4.2 Understanding Heat transfer

With buildings, we refer to heat flow in a number of different ways. The most common reference is “R-value,” or *resistance* to heat flow. The higher the R-value of a material, the better it is at resisting heat loss (or heat gain). U-factor (or “U-value,” as it is often called) is a measure of the flow of heat--thermal transmittance--through a material, given a difference in temperature on either side.

Thermal performance can be expressed in numerical or quantitative terms in various ways. The information evaluated is aimed to arrive at:

- maximum indoor temperatures in summer
- the amount of energy required to maintain a minimum temperature throughout the winter months

The energy required to maintain a minimum temperature (16 °C) throughout the winter months is expressed in kWh/m2 year.

3.8.4.3 Heat absorbing capacity and thermal insulation

Two properties of a building have a major influence on its thermal performance: its heat absorbing capacity and the thermal resistance of its shell. The values for each of these varies from one construction material to another (eg burnt clay bricks, timber, steel, concrete, etc) and the way in which the material is used (ie cavity or solid walls, single or double glazing, etc).

The heat absorbing capacity of a building element depends partly on its mass and the density of the material from which it has been made. The greater the density and hence the mass of the external and internal walls, the more heat can be absorbed.

The insulating properties of a material or building element depend on the extent to which it limits the transmission of heat through it. The ability of a building component such as a wall to transmit heat is expressed as the U-value of the component.

The U-value of building components is defined as the amount of heat transmitted in watts per square metre per degree Celsius difference in temperature between air on one side of the component and air on the other side of the component. The U-value, therefore, takes into consideration the thermal transmittance of both surfaces of the component as well as the thermal transmittance of individual layers and air spaces that may be contained within the component itself.

The heat absorbing capacity and the insulating property of each material used determines the heat storage capacity of a building.

The relative importance of each of these properties in providing a pleasant indoor thermal environment depends on the climate of the area in which the building is erected. In cold and cool climates, buildings with low U-values (ie where heat will not pass through the external walls and roof to the outside easily) will be easier to heat and to maintain at comfortable thermal levels than buildings with high U-values.

In dry areas with wide diurnal variations in outdoor temperatures, a building with a greater heat storage capacity will tend to even out the effect of the outdoor fluctuations in temperature by absorbing and storing heat during the day without passing much of the heat to the inside of the building, but gradually losing heat to the indoor and outdoor environment at night.

TABLE 8: TYPICAL U-VALUES OF WALLS

TYPE OF CONSTRUCTION	U-VALUE (W/m² °C)
270 mm thick imperial brick cavity wall (110-50-110) plastered on the interior face	1,7
230mm thick imperial brick solid wall plastered on both sides	2,1
150 mm thick hallow concrete block wall bagged on both sides	3,2
140mm solid concrete brick plastered externally	3,7
82mm thick insulated lightweight wall: steel frame clad on both sides with 9mm thick unpressed fibre-cement sheets and the 64mm space between sheets filled with mineral wool insulation	0,6
82mm thick insulated lightweight wall: steel frame clad on both sides with 9mm thick unpressed fibre-cement sheets and 25mm thick mineral wool insulation in 64mm space between sheets	1,0

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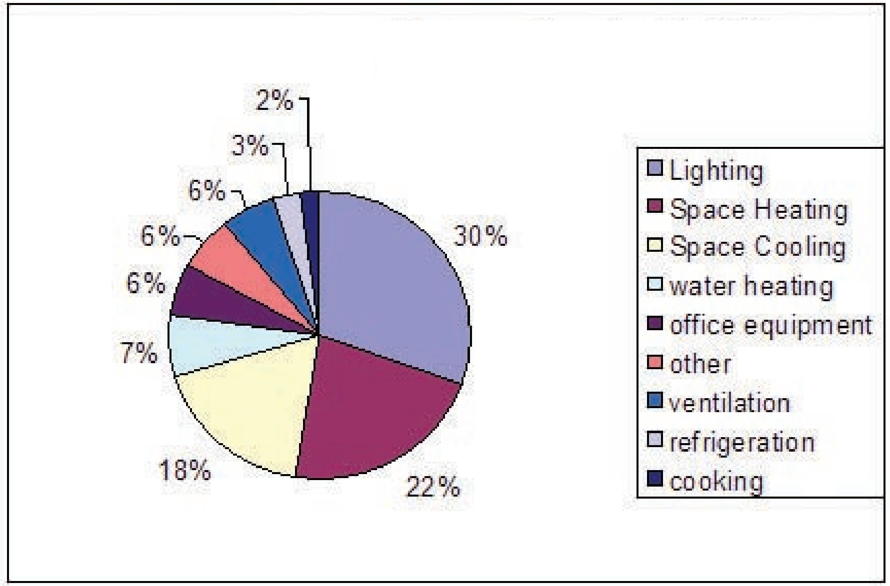
3.8.4.5 Commercial and Industrial Building Use of Energy

Lighting 31%
Space Heating 22%
Space Cooling 18%
Water Heating 7%
Office Equipment 6%
Other 6%
Ventilation 6%
Refrigeration 3%
Cooking 2%

Source: *U.S. Energy Information Administration*

TABLE 9: ENERGY USE IN BUILDINGS



3.8.4.6. Energy Efficiency

The benefits from the energy-efficient siting and design of buildings are economic, social and ecological. Typically, heating and cooling load reductions from better glazing, insulation, efficient lighting, daylighting and other measures allows smaller and less expensive HVAC equipment and systems, resulting in little or no increase in construction cost compared to conventional designs. Simulations are used to refine designs and ensure that energy-conservation and capital cost goals are met; and to demonstrate compliance with regulatory requirements.

3.8.4.7 Renewable Energy

Alternative energy sources:

primary renewable energy resources

- sun, wind, and biogas conversion.

Solar applications range from hotwater preheat to electric power production with photovoltaic cells. Wind-powered generators can provide electricity and pumping applications in some areas.

3.8.5 _WATER

The principles of sustainable design apply, without reservation, to all types of climates. In an park or tourism development, where health considerations are paramount, water issues center on providing safe drinking, washing, cooking, and toilet flushing water

Water is required for many activities. However the large-scale provision of conventional water supply has many environmental implications. Water needs to be stored (sometimes taking up large areas of valuable land and disturbing natural drainage patterns with associated problems from erosion etc), it also needs to be pumped (using energy) through a large network of pipes (that need to be maintained and repaired). Having delivered the water, a parallel efforts is then required to dispose of this after it is used, ie sewerage systems. Reducing water consumption supports sustainability by reducing the environmental impact required to deliver water , and dispose of this after use in a conventional system (Gibberd 2000; SBAT).

Rainwater
Rainwater is harvested, stored and used.

Water use
Water efficient devices

Grey water
Grey water (water from washing etc) recycled (to flush toilets or water plants)

Runoff
Run off reduced by using pervious or absorbant surfaces. Hard landscaping minimised, previous surfaces specified for car parking and paths.

Planting
Planting has low water requirement (indigenous species)

TABLE 10: WATER CONSERVATION METHODS

Toilets	Urinals	Wash hand basins	Shower	Outside and garden	Clothes Washers	Water supply	Rain water and grey water
1)Low flush toilets -Dual flush toilets (3/6 litres) -Vacuum or compressed air toilets 2) Cistern displacement devices 3) Waterless toilets -Composting toilets (heated or unheated) -Incinerating toilets	Urinal controls (infrared, radar, autoflush) Waterless urinals	Push taps Flow control, self closing Tap flow regulators	Shower mixers Water saving showerheads Self closing shower system	Water control	Water saving washers Control & usage	Auto shut off and pressure regulators	Rain water recycling systems Grey water recycling systems

3.8.6 _SITE DESIGN

Site design is a process of intervention involving the location of circulation, structures, and utilities, and making natural and cultural values available to visitors. The process encompasses many steps from planning to construction, including initial inventory, assessment, alternative analysis, detailed design, and construction procedures and services.

3.8.6.1 Factors

The programmatic requirements and environmental characteristics of sustainable tourism development will vary greatly, but the following factors should be considered in site selection:

- **Capacity -** for structures and human activity based on the sensitivity of site resources and the ability of the land to regenerate.
- **Density -** concentration versus dispersal.
- **Climate -** human comfort/ protecting the facility from climatic forces
- **Slopes -** costly construction practices. soil erosion, loss of hillside vegetation, and damage to fragile wetland and marine ecosystems.
- **Vegetation** avoid habitat fragmentation and canopy loss.
- **Views -** critical and reinforce a visitor experience. maximize views of natural features and minimize views of visitor and support facilities.
- **Natural Hazards -** consideration of precipitous topography, dangerous animals and plants, and hazardous water areas/ controlled access
- **Access to natural and Cultural Features -** maximize pedestrian access to resources and recreational activities. Low impact development is the key to protecting vital resource areas.
- **Traditional Activities -** compatible with traditional agricultural, fishing, and hunting activities/ responsive to the local economy.
- **Energy and Utilities -** connections to offsite utilities and spatial needs for onsite utilities. potential for alternative energy use: solar- and wind-based energy systems.
- **Separation of Support Facilities from Public Use Areas -** Safety, visual quality, noise, and odor separated from public use and circulation areas.
- **Proximity of Goods, Services, and Housing -** availability of goods and services and the costs involved in providing them.

3.8.6.2 Site Access

- pedestrian, transit systems, private vehicles
- Road Design and Construction
- Other Access Improvements

Core Site Access

3.8.6.3 Utilities and Waste Systems

- **Utility Systems:** Development requires sanitary facilities for human waste and provisions for water, electricity, gas, heating, cooling, ventilation, and storm drainage that will not adversely affect the environment and will work within established natural systems. Careful planning and design is required to address secondary impacts such as soil disturbance and intrusion on the visual setting.

- **Utility Corridors:** utility lines should be buried near other corridor areas that are already disturbed, such as roads and pedestrian paths and not be located in desirable viewsheds or over landform crests.

- **Utility System Facility Siting:** reducing scale, dispersals of facilities, and the use of terrain or vegetative features to visually screen intrusive structures. Odor and noise are strong nuisance factors that must be addressed by location and buffering. Also, the insulation of mechanical equipment that can have acoustical impacts should be considered.

- **Night Lighting:** limit night lighting to the minimum necessary for safety. Low voltage lighting with photovoltaic collectors should be considered as an energy-efficient alternative. Light fixtures should remain close to the ground, avoiding glare from eye level fixtures

- **Storm Drainage:** to regulate runoff to provide protection from soil erosion and avoid directing water into unmanageable volumes. Removal of natural vegetation, topsoil, and natural channels that provide natural drainage control should always be avoided. An alternative would be to try and stabilize soils, capture runoff in depressions (to help recharge groundwater supply), and re-vegetate areas to replicate natural drainage systems.

- **Irrigation Systems.** Restoration projects should consider the use of ultraviolet-tolerant irrigation components laid on the surface of the soil and removed when native plants have become established. Irrigation piping can be reused on other restoration areas or incorporated into future domestic hydraulic systems. Captured rain water, recycled grey water, or treated effluent could be used as irrigation water.

- **Waste Treatment.** It is important to use treatment technologies that are biological, nonmechanical, and do not involve soil leaching or land disposal that causes soil disturbance. Constructed biological systems are being put to use increasingly to purify wastewater. They offer the benefits of being environmentally responsive, nonpolluting, and cost-effective

3.8.6.4 Site-Adaptive Design Considerations

site components should respond to the indigenous spatial character, climate, topography, soils, and vegetation as well as compatibility with the existing cultural context.

3.8.6.5 Natural Characteristics

important to understand natural systems and the way they interrelate in order to work within these constraints with the least amount of environmental impact

- **Wind** cooling aspect / “natural” air conditioning

- **Sun -** provide shade for human comfort and safety in activity areas (e.g., pathways patios). Use natural vegetation, slope aspects, or introduced shade structures. natural light and solar energy are important considerations to save energy and showcase environmental responsive solutions.

(continued on next page)

- **Rainfall -** Rainfall should be captured for a variety of uses (e.g., flushing toilets, washing clothes). Wastewater or excess runoff to be channeled and discharged for groundwater recharge and limit soil erosion. Natural drainage-ways protect the environment as well as the structure.

- **Topography -** Topography can potentially provide vertical separation and more privacy for individual structures. Changes in topography can also enhance and vary the way a visitor experiences the site by changing intimacy or familiarity. Protection of native soil and vegetation

- **Geology and Soils -** Soil disturbances to be kept to a minimum to avoid erosion of soils and discourage growth of exotic plants.

- **Vegetation -** Exotic plant materials are disadvantages to healthy native ecosystems. Sensitive native plant species need to be identified and protected. Existing vegetation to encourage biodiversity and to protect the nutrients held in the biomass of native vegetation.

- **Visual Character -** Natural vistas to be used in design whenever possible. use native building material, blend structures within the vegetation, and work with the topography.

3.8.6.6 Cultural Context

Local archeology, history, and people are the existing matrix into which visitation must fit. Sustainable principles seek balance between existing cultural patterns with new development. Developing an understanding of local culture and seeking their input in the development processes can make the difference between acceptance and failure.

- **Archaeology -** archeological survey prior to development to preserve resources. they can be incorporated into designs as an educational or interpretive tool. If discovered during construction activities, work should be stopped and the site reevaluated. Sacred sites must be respected and protected.

- **History -** Cultural history should be reinforced through design by investigating and then interpreting vernacular design vocabulary. Local design elements and architectural character should be analyzed and employed to establish an architectural theme for new development.

- **Indigenous Living Cultures -** Cultural traditions should be encouraged and nurtured. A forum should be provided for local foods, music, art and crafts, lifestyles, dress, and architecture, as well as ameans to supplement local incomes (if acceptable). Traditional harvesting of resource products should be permitted to reinforce the value of maintaining the resource.

3.8.6.7 Designing with climate

In a hot dry climate, sun protection is essential (we need shade, and pale surfaces to reflect the sun's radiation). Shading can reduce glare and reflected heat from these pale surfaces from eaves, verandas and from vegetation. Trees are Nature's own evaporative coolers - perfect for the dry climate, if water supply permits. Trees will also filter blowing dust from the air

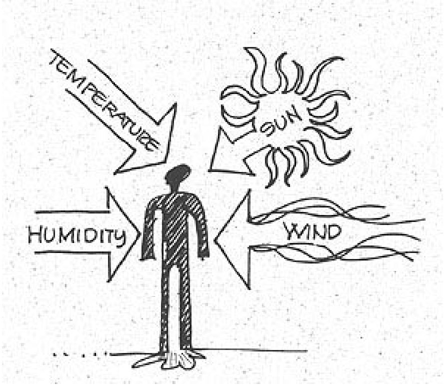


FIG. 3.8.6.7.1 The natural elements that affect a persons environment

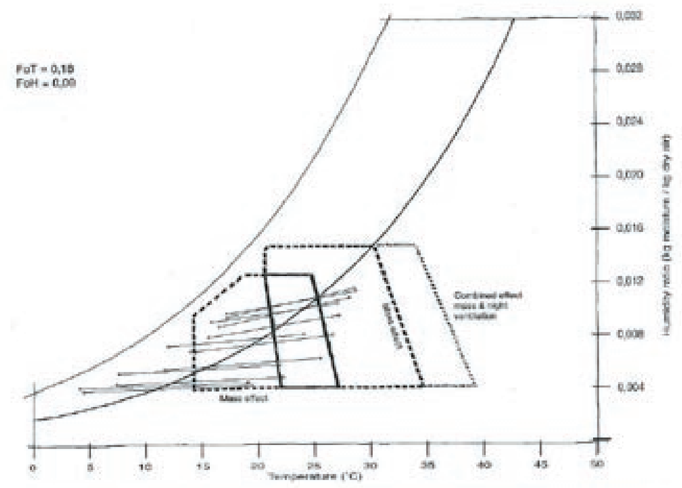


FIG. 3.8.6.7.2 Psyshronomteric chart showing the enlarged comfort zone obtained by supplying thermal mass to the structure. The combined effect of ventilation and thermal mass is also shown. Night structural cooling is optional.

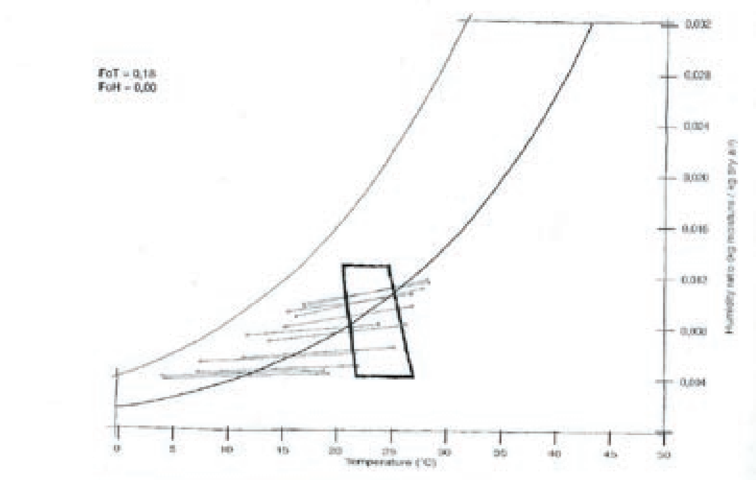


FIG. 3.8.6.7.3 Psyshronomteric chart showing the comfort zone's position relative to the climatic lines - Pretoria

3.8.7 _MATERIALS

3.8.7.1 Embodied Energy

"The quantity of energy required by all the activities associated with a production process, including the relative proportions consumed in all activities upstream to the acquisition of natural resources and the share of energy used in making equipment and other supporting functions. i.e. direct plus indirect energy."

Embodied energy is all the energy required to extract, manufacture and transport a building's materials as well as that required to assemble and 'finish' it. As buildings become increasingly energy efficient, the energy required to create them becomes proportionately more significant in relation to that required to run them.

Some modern materials, such as aluminum, consume vast amounts of energy in their manufacture. The common building material with least embodied energy is wood, with about 640 kilowatt-hours per ton (most of it consumed by the industrial drying process, and some in the manufacture of and impregnation with preservatives). Therefore, the greenest building material is wood from sustainably managed forests. Brick is the material with the next lowest amount of embodied energy, 4 times (X) that of wood, then concrete (5 X), plastic (6X), glass (14X), steel (24X) and aluminum (126X).

A building with a high proportion of aluminum components can hardly be green when considered from the perspective of total life cycle costing, no matter how energy-efficient it might be. From the perspective of embodied energy, every building, no matter what its condition, has a large amount of energy locked into it. This is yet another factor in favor of conserving and restoring old buildings, and for designing long life, loose fit buildings that easily accommodate change. Also, because the energy used in transporting its materials becomes part a building's embodied energy, this is an incentive to use local materials, thus helping the building to be embedded in place.

The energy input required to quarry, transport and manufacture building materials, plus the energy used in the construction process, can amount to a quarter of the 'lifetime' energy requirement of a very energy-efficient building. To reduce embodied energy, without compromising longevity or efficiency:

- re-use existing buildings and structures wherever possible (provided their energy costs in use can be reduced to an acceptable level).
- design buildings for long life, with ease of maintenance and adaptability to changing needs
- construct buildings and infrastructure out of local and low-energy materials where possible
- reduce the proportion of high rise, detached or single-storey developments
- design layouts which minimise the extent to roadway and utility pipework per dwelling

TABLE 11: EMBODIED ENERGY OF SOME MATERIALS

MATERIAL	EMBODIED ENERGY MJ/ kg	EMBODIED ENERGY MJ/m³
Aggregate	0.1	150
Straw bale	0.24	91
Soil-cement	0.42	819
Stone (local)	0.79	2030
Concrete block	0.94	2950
Concrete (30Mpa)	1.3	3180
Concrete precast	2.0	2780
Lumber	2.5	1380
Brick	2.5	5170
Cellulose insulation	3.3	112
Gypsum wallboard	6.1	5890
Particle board	8.0	4400
Aluminium (recycled)	8.1	21870
Steel (recycled)	8.9	37210
Shingles (asphalt)	9.0	4990
Plywood	10.4	5720
Mineral wool insulation	14.6	139
Glass	15.9	37550
Fibreglass insulation	90.3	970
Steel	32.0	251200
Zinc	51.0	371200
Brass	62.0	519580
PVC	70.0	93620
Copper	70.6	631164
Paint	93.3	117500
Linoleum	116	150930
Polystyrene insulation	117	3770
Carpet (synthetic)	148	84900
Aluiminium	227	515700

Note: Embodied energy values are based on several international sources – local values may vary. These values are to be used as a guide only.

TABLE 12: SAMPLE INFORMATION REQUIREMENTS FOR SUSTAINABLE BUILDING MATERIALS

Environmental Performance	Technological Performance	Resource Use Performance	Socio-Economic Performance
Impacts on Air Quality	Durability	Energy	Occupant Health/ Indoor Env'l Quality
• Carbon Dioxide	Service Life	• Embodied	• VOC Outgassing
• Hydrocarbons	Maintainability	• Operational	• Toxicity
Impacts on Water Quality	Serviceability	• Efficiency	• Susceptibility to bio contamination
Impacts on Soil Quality	Code Compliance	• Distributional	Appropriateness for:
Ozone Depletion Potential	R-value	Degree of Processing	• Scale
Site Disturbance	Strength	Source Reduction	• Climate
Assimilability	Constructability	Materials	• Culture
Scarceness		• Renewable	• Site
Impacts during Harvest		• Recycled/ Recyclability	Economics:
Processing Impacts		• Reused/ Reusability	• Contribution to Economic Dev't.
		• Renewability	• Cost
		• Local/Transport Distance	• Labor Skill Requirements
		• Packaging Requirements	• Labor Amount Requirements

3.8.8 _WASTE

"Waste - a resource in the wrong place" -- An old Chinese proverb.

3.8.8.1 Waste Management Strategies

- Waste prevention
- Recyclying construction and demolition materials
- Architectural reuse (include adaptive reuse, conservative disassembly, and reusing salvaged materials)
- Design for material recovery (durability, disassembly, adaptive reuse)

3.8.8.2 Waste hierarchy:

- Sustainable development
- Prevention
- Reduction
- On-site reuse
- On-site recovery
- Off-site reuse
- Off-site recovery

Landfill

3.8.8.3 Recycling and Reuse

Raw materials and new components used in buildings consume resources and energy in their manufacture and processes. Buildings accommodate activities that consume large aomounts of resources and products and produce large amounts of waste. Reducing the use of new materials and components in buildings and in the activities accommodated and reducing waste by recycling and reuse supports sustainability by reducing the energy consumption and resource consumption.

Toxic waste
Arrangements made for the safe disposal / recycling of toxic/harmful substances ie batteries, printer toners, vehicle oil.

Inorganic waste
Arrangements for sorting, storage and pick up of recyclable waste.

Organic waste
Recycled on site ie compost

Sewerage
Contribution to mains sewerage from toilet minimised through use of compost toilets, and other 'local' systems

Construction waste:
Construction waste minimised through design careful management of construction practices. Design limits wastage by designing to comply with modular dimensions of materials etc

3.8.9 _PROCESS

"Solving the environmental issues of the 21st century will require new approaches, not only in the measurement of progress, but also in the means of achieving it. We must improve the way we do business together by promoting teamwork instead of accepting confrontation." Final Report of the Pennsylvania 21st Century Environment Commission

3.8.9.1 Planning Process

- Site selection and planning
- Budget planning
- Capital planning
- Programme planning
- Building operation
- Maintenance practices
- Renovation
- Demolition

3.8.9.2 Design Process

- Client awareness and goal setting
- Green vision, project goals & green design criteria
- Team development
- Well-integrated design
- Resource management
- Performance goals

3.8.9.3. Operation & Maintenance

- Commissioning of building systems

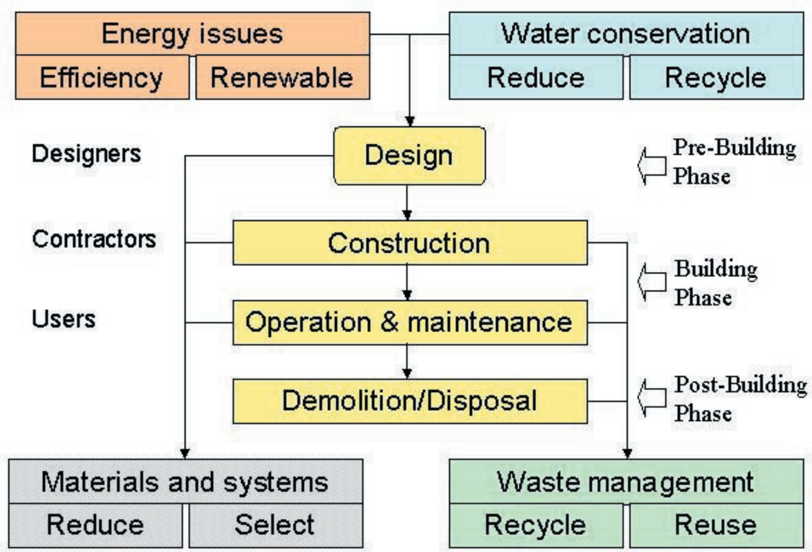


TABLE 12: Basic breakdown of the project process