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City of Cape Town Green Building Guidelines

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Green Building – also known as eco-design, environmentally friendly or sustainable building - aims to create living and working environments that are comfortable and attractive without negatively impacting on human health or the natural environment. Green building enables sustainable living; is locally appropriate; and uses resources efficiently in the positioning, design, construction, renovation, operation and eventual demolition of buildings.

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2) Sustainable options for developers (low-income urban) (Sustainable Energy Africa)
3) Sustainable landscapes, practices and guidelines (City of Cape Town)
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7) Integrated Waste Management (IWM) Policy (City of Cape Town)

1. INTRODUCTION AND OBJECTIVES

The City of Cape Town's Energy and Climate Change Strategy, underscores the City's determination to ensure access to affordable, clean, and secure sources of energy to underpin sustainable economic development and to protect our environment. This coincides with the global agenda to tackle climate change by reducing greenhouse gas emissions, as well as the demand for energy.

Rapid urbanisation is contributing to a growing demand for energy in the City. There is an urgent need to reduce the energy and other resources consumed in the construction and use of buildings, as well as to improve the efficiency of urban planning.

The aim of the Green Building Guidelines for the City of Cape Town is to actively promote resource efficient construction of new or renovated buildings in Cape Town to minimise the negative environmental impacts of the built environment, while maximising positive social and economic impacts.

Incorporating principles of sustainability into the lifecycle of buildings including materials, manufacture, design, construction and operation enables designers and developers to minimise the environmental impact of a development at little or no cost. Many sustainable interventions actually save money through lower water and electricity bills, less maintenance and the improved health of inhabitants. Green buildings also save the externalised environmental and social costs we all bear.

Although this document is currently a guideline, in the long-term the City will work towards design manuals and legislation to ensure the implementation of green buildings. The Green Building Guidelines document is aligned with the Green Building Council of South Africa, which has incorporated the Green Star Rating system of the Green Building Council of Australia. It is envisaged that the City of Cape Town will incorporate the Green Star Rating system in the future.

2. PRINCIPLES

The definition of a principle in this context is an 'acceptable norm of conduct' to assist with implementing the objectives. The overarching principle for this guideline is **sustainability**, which is defined in the Brundtland Report (1987) as: 'ensuring sustainable management of all resources used so that we will meet the needs of the present without compromising the ability of future generations to meet their own needs.'

The following inter-related principles, which are discussed below, are intrinsic to the Green Building Guidelines:

- Local appropriateness
- Conservation of the natural environment
- Resource efficiency
- Lifecycle approach
- Zero Waste
- Use of renewable resources
- Sustainable procurement
- Local production for local use
- Human health and wellbeing
- Monitoring and evaluation
- Positive legacy

It is essential that these principles are implemented in the planning, design, operation, maintenance and eventual demolition of developments and are not seen as 'add-ons' but rather as an integral part of the design and construction process with the ultimate goal being the promotion of a more sustainable lifestyle.

2.1 Local appropriateness

Buildings should address the social, economic and cultural context within which they are situated. The community that a development will serve should be involved from the beginning to ensure that the project responds appropriately to the local context and creates sustained benefits for the community in the long-term.

2.2 Conservation of the natural environment

Green building implies an environmentally sensitive approach to the design and construction of the built environment, and an approach which aims to conserve the natural resources and ecosystems which sustain life on planet earth.

Cape Town has a very rich biodiversity and as such the importance of the local ecosystems should be recognised. Providing natural green areas on a site, even on rooftops, can contribute to green corridors in the City's open space system that provide food and paths for wild species to move. This is important in assisting fauna and flora to adapt to climate change.

Environmental and historical conservation measures outlined in Environmental Impact Assessments (EIAs) and related processes must be enforced and used to inform the overall design. Develop Environmental Management Plans (EMPs), Operational Management Plans (OMPs) and Landscape Plans to guide the construction and operation of buildings to reduce negative impacts.

2.3 Resource efficiency
Energy and water efficient technologies, management systems and behaviour, must be promoted in all aspects of planning, construction, operation, and maintenance of buildings.

2.4 Lifecycle approach
Decisions about the design of a building and the specification of the materials from which it is made must take the entire lifecycle of these products into consideration in order to select the best overall option. For example, a particular product may be very benign in use, but have created extremely toxic by-products during manufacture.

A lifecycle approach also aims to reduce 'embodied' energy and water. This is the energy or water that was used in the process of manufacturing and transporting the materials all along the production and retail chain, before being used in the building. Materials which are less processed and manufactured closer to the construction site are more sustainable as these have lower embodied energy. Metals have very high embodied energy because they require large amounts of energy to mine, smelt and process them. These should be used where their strength, recyclability and maintenance benefits may be more important. Plastics which also have extremely high embodied energy cannot be re-used and recycled endlessly like metals. Plastics generally release toxic chemicals into the environment during manufacture and use.

2.5 Zero Waste
Green building should aim to achieve zero waste in the construction and operation of the built environment. This requires the application of the zero waste approach during the planning and design phases. The zero waste approach emulates nature where discarded resources are re-used elsewhere, so that all resources (including physical materials, water, energy, and money) are constantly cycled and put to use in the system. Applying zero waste means designing products and processes to avoid creating waste during their lifecycle; reducing the volume and toxicity of waste and materials, and conserving and recovering all resources for composting, re-use and recycling rather than burning or burying them in a landfill. Zero waste aims to eliminate any solid, liquid or gaseous wastes that harm people or ecosystems. [1]

2.6 Use of renewable resources
Resources and materials that can be constantly renewed through natural and biological processes are preferable to resources from non-renewable sources that cannot be replaced when consumed, such as mined materials and fossil fuels. However, designers must also avoid specifying materials harvested from threatened species and ecosystems, for example many species of tropical hardwoods. Make use of certification systems to verify that materials are sourced from sustainably managed areas.

Promote the use of renewable energies in the manufacturing of building products and in generating the energy used in buildings.

2.7 Sustainable procurement
The goods and services procured in the planning, operation, management and maintenance of buildings must be sustainable. This includes involving appropriate expertise and specifying products that have a minimal negative effect on the environment through the course of their lifecycle. When procuring products also analyse the impact of their packaging and negotiate for these to be delivered in sustainable alternatives. Procure local products and services as a mechanism for local job creation.

2.8 Local production for local use

Products and materials sourced and manufactured in the vicinity of a development reduce the energy embodied in transporting materials for long distances to the site. Furthermore, using local materials boosts the local economy, and promotes job security for people living in the area.

2.9 Human health and wellbeing

Developing healthy environments for people to live, work, and play in should be a primary goal in designing and constructing the built environment. Avoiding the hidden impacts of toxic emissions from materials in the indoor environment and during their manufacture needs particular attention. Sick building syndrome (SBS) is a combination of ailments (syndrome) most often occurring in sealed commercial buildings with highly processed furnishings. A 1984 World Health Organisation (WHO) report on the syndrome stated that up to 30% of new and remodelled buildings worldwide may be linked to symptoms of SBS.

2.10 Monitoring and evaluation

It is essential to gather information on the impact of green building interventions to raise awareness and share learning. Monitoring systems should be designed from the outset so that these are an integral part of the construction and operation process.

Building managers and homeowners play a big role in ensuring the optimal performance of green building systems, through monitoring and adequate maintenance. A full operational manual should be compiled to assist inhabitants to use and maintain green buildings appropriately.

2.11 Positive legacy

Managers should ensure that both the short and the long-term impacts of decisions and actions lead to sustainability. Interventions should also help to raise public awareness and encourage behavioural change.

3. IMPLEMENTATION GUIDELINES

This section provides practical guidelines for the implementation of green buildings. Each section provides an overview and specific recommendations that should be implemented where possible.

3.1 Site selection

3.1.1 Greyfield and Brownfield redevelopment

A Greyfield site is 'any site previously developed with at least 50% of the surface area covered with impervious material.' [2]

Greyfield redevelopment of disused sites, such as old factories and commercial buildings, helps to avert urban sprawl rather than clearing new areas in natural environments. Developers benefit by having fewer development restrictions. Redeveloping a degraded area can improve its environmental performance, if the area is designed with environmentally sustainable gardens and buildings.

A Brownfield site is a 'property, the expansion, redevelopment, or re-use of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant.'[3]

Brownfield redevelopment can offer opportunities for purchasing prime land cheaply, however, the cost of site rehabilitation needs to be taken into account. Redevelopment of severely degraded land can be a difficult process, as it is likely that cleanup operations have to be carried out before building can begin and the full extent of contamination may not be known upfront. There is no regulatory body dealing with Brownfield sites, and standard procedures for cleanup operations have not yet been established.

3.1.2 Compact urban development

Compact development involves increasing the density of development in urban areas to limit urban sprawl and the amount of agricultural or undisturbed land that is lost to building. This also saves the cost of extending service infrastructure such as roads, electricity, telecommunications, water and sewerage to outlying areas. Urban densification benefits the people who will be using the new development, they will be required to commute less than if it was built on the urban periphery. High density development along main transport routes also can increase the viability of public transport systems. There are, however, proven downsides to high-density urban configurations where there are high levels of unemployment.

3.1.3 Access to transport networks

Transport uses 58.4% of the energy consumed in Cape Town and contributes to 28.2 % of the city's carbon emissions.[4]

The apartheid legacy of dormitory suburbs located far from amenities and opportunities impacts heavily on the amount of energy used for transport. A site located far from work opportunities, amenities and access to transport networks, specifically public transport, places an unfair burden on people living there and increases their environmental footprint. Access to public transport should be considered as a key factor for site selection and has been included in the Sustainable Building Assessment Tool (SBAT) designed by the CSIR[5].

3.1.4 Recommendations for site selection

- The redevelopment of a Grey- or Brownfield site is generally favoured above the development of a Greenfield site
- Appropriate rehabilitation needs to be done on degraded sites to reduce any negative environmental and health impacts
- Compact urban development should be supported to reduce urban sprawl and make efficient use of infrastructure
- Appropriate Environmental Impact Assessments (EIAs) need to be done
- The influence that topography and soil conditions of a particular site have in relation to implementing sustainable interventions should be taken into account when selecting a site.
- Access to amenities and public transport should be taken into account when selecting a site

3.2 Design phase

3.2.1 Establish a knowledgeable team

Establishing a team that is familiar with the principles of environmental sustainability and green building is perhaps the most important aspect of sustainable building. It is important to provide information, and even training, to ensure that all parties (such as engineers, architects, demolition and construction workers including sub-contractors) understand the reasons for developing a site in a sustainable manner, as they would then be more likely to participate fully in the process.

It is also essential to have good project management in place to ensure that all the necessary procedures and guidelines are followed correctly. This will not happen without a designated, experienced team leader or implementing agent that has the authority and the power to control payments if work is not done in accordance with the required standards.

3.2.2 Efficient site planning

Careful site planning can ensure that the proposed buildings placed on site will have minimal negative effects on the environment, while maximising its efficiency.

The first step of site planning should be to analyse how a site relates to the surrounding neighbourhood and broader context. Find out what development and design guidelines are already in place, including recommended building densities for the area.

Good site planning optimises natural features and open spaces while achieving the requirements of the building, to enhance biodiversity. If possible, ensure that the site contributes to the development of green corridors. Placing the building in a certain position on site can enhance the natural functioning of a larger ecological network and contribute to creating a more inhabitable urban environment. Avoid placing buildings where they will have a negative impact on significant natural features and existing flora and fauna, mature trees, animal habitats and wildlife paths.

Analyse how to make the best use of the microclimate, topography, streetscape and views while responding to dynamic elements like wind, water flows through the site and potential threats like fire. Buildings should be positioned to make maximum use of natural resources for lighting and ventilation. Avoid placing buildings in a way that will jeopardise the ability of surrounding sites to access views and light.

In urban environments and settlement areas, buildings should contribute to the creation of safer and pedestrian friendly surroundings. Place pedestrian entrances and lively frontages onto the street and green the streetscape. Windows and entrances should be placed to provide surveillance over the street and other public spaces to enhance safety and security.

3.2.3 Efficient building design

The floor plan of any building should be designed to avoid wasted space, which also wastes materials, however, one must be careful not to compromise the 'liveability' of the building by creating unpleasant spaces. Generous common areas make for more habitable buildings.

The rooms that are used most, such as living rooms and kitchens, should be on the northern side of the building, so that they are naturally light and warm. Rooms such as bathrooms and storerooms should be placed so that they screen unwanted western sun or placed to prevent heat loss from south-facing walls.

A compact plan exposes less wall area to the outside, reducing the heat lost from the building. Compact houses are attached rather than separate, and double or multi-storey, rather than single storey.

If possible, the people using or living in a building should have a say in the way it is designed.

3.2.4 Passive solar design

Passive solar design uses building orientation, solar energy, natural convection and the inherent properties of materials to naturally heat and cool a building. Passive solar design operates on the principle that as sunlight enters a building it can be reflected, absorbed or transmitted, depending on the properties of the building materials used. A passive solar design building can achieve greater energy efficiency and save money in heating and cooling operational costs. By using natural light and ventilation instead of air conditioning, the running costs of the building can be reduced while also creating a more comfortable and healthy indoor environment.

The following are aspects of passive solar design. Refer also to the section on energy efficiency, which contributes to passive solar design.

3.2.5 Orientation and shading

In South Africa the major temperature challenge that is faced by developers is overheating due to the high temperatures experienced in summer months. The challenge for Cape Town is to create buildings that are comfortably cool in summertime while maintaining an environment that is warm in winter, without requiring expensive and environmentally unsustainable air conditioning. Therefore, all new buildings should be elongated along an east-west axis, with large windows on the north side of the building. This means that during winter months the north side of the building will receive the greatest amount of sunlight, during the morning and early afternoon, thus warming the interior and allowing the building to be naturally ventilated and lit.

However, to prevent overheating in summer months windows should be shaded. Window awnings or roof overhangs must extend far enough to block incoming radiation from summer sun, which is high in the sky, while still allowing the lower winter sun to penetrate the windows. Deciduous trees and vegetated trellises can also be used to shade windows in summer.

Buildings should also be orientated to accommodate the wind. It should prevent strong winds entering, but allow gentle breezes to naturally ventilate the building. It should also be positioned so as not to create wind tunnels.

3.2.6 Energy efficient building materials

All building materials transmit energy in different ways. Some are good conductors of heat (corrugated iron), some prevent heat passing through and are good insulators (cardboard, wood and glass fibre) and some can store heat well (clay brick, concrete, stone and water).

These properties of materials are used in different ways in the walls, roof, ceiling and floor of a house to keep a building warm in winter and cool in summer. To make the best possible choices about energy efficient building materials, you need to understand their properties, on their own, and how they should be used in combination.[6] For example, a roofing material with high reflective properties will contribute to a cooler interior. However, the same roofing material might also be a good conductor of heat, in which case it should be used with a ceiling material which is a good insulator (see heat sinks below).

Investigate the embodied energy of materials during their extraction and manufacture, and how they will contribute to using energy when the building is used and maintained. In general, to reduce the amount of embodied energy in a building and save on costs, specify materials that have had little processing; don't require extra finishes; and are made as close to the building site as possible to cut down on transport. Use materials with high embodied energy when their properties such as strength or longevity are critical. For example, use fired bricks for weatherproofing on the outside of a building and unfired clay bricks for internal walls. Cement blocks are hollow so less resources such as sand, stone and cement are used and the hollow area can be filled with soil-crete (cement stabilised soil) to increase its thermal efficiency.

Specify second-hand materials which save natural resources including energy. Include provisions for re-using or recycling demolition waste in tender documentation for the building contractor.

Design the building to minimise the natural weathering and degradation of the building, for example:

- Cover the entrance area
- Specify drip edging
- Provide adequate roof overhangs
- slope backfill to divert surface water away from the building

3.2.7 Ceilings and insulation

Insulation in the ceiling and walls assists in keeping a home warmer in winter and cooler in summer (see the section on energy efficiency for more detail).

Low income houses with ceilings and insulation burn 26% less coal than un-insulated homes in winter. This translates into less money being spent on energy for heating, less air pollution and lower incidence of respiratory disease. [7]

3.2.8 Heat sinks

Certain building materials, including concrete, masonry and water, have a high 'thermal mass', which means that they can store heat. A basic principle of passive solar design is to make use of these materials to absorb and store heat during the day, thereby keeping the building interior cooler. At night when the outside temperatures drop this heat is released, warming up the interior of the building. This helps to offset the dramatic day time temperature changes that are often experienced in Cape Town.

Walls and floors constructed from concrete for these purposes are termed 'thermal mass' walls and floors. Certain rules apply to making use of thermal mass:

- Thermal mass materials should not exceed 15 cm in thickness
- For every square meter of north facing glass, use 680 kg of masonry or concrete, or 150 litres of water for thermal mass
- Ideally, thermal mass materials should be evenly spread throughout work and living spaces and not concentrated in isolated areas
- Thermal mass floors should be left uncarpeted if possible, or fitted with rugs instead of wall-to-wall carpets which would insulate the floor from absorbing heat. Modern concrete and stone finishes are attractive and often don't need carpeting to be aesthetically pleasing
- The colour of thermal mass walls and floors is not important unless one is trying to increase the heat gained from direct sunlight

Thermal mass can also be achieved by building co-joined homes, which work well in South Africa where large differences between day and night temperatures are experienced.

3.2.9 Natural and traditional building materials and methods

Before industrialisation, people built with natural materials that were available in the area. Examples of traditional building materials include, amongst others:

- Abiotic: Earth material such as stone, rock, gravel, sand and clay
- Biotic: Wood, bamboo, reeds, or animal-based organic stabilisers such as cow dung

Unique building methods and forms developed over time that were suited to the culture and context in which people lived. Many of these natural building methods are being revived and adapted to current use because they create healthier environments, use less fossil fuel to make, and transport is often much cheaper.

Examples of natural building methods include, amongst others:

- Straw-bale construction
- Cob, adobe and mud brick construction
- Rammed earth construction
- Stone construction
- Thatched roof

Sundried or cement stabilised earth bricks are an alternative to conventional clay or cement bricks. They save energy because they are not fired and also result in houses that have excellent thermal mass. You cannot use topsoil, which is rich in decomposing organic material, for making earth bricks.

3.2.10 Design according to standard sizes of construction materials

Many construction materials such as plywood, tiles, wooden beams and particleboards are produced in standard sizes. Cutting of such materials to fit designs results in producing waste in the form of off-cuts. By designing buildings so as to minimise cutting of standard-sized products, a dramatic reduction in waste volumes and cost can be achieved.

3.2.11 Integrated planting and roof gardens

Gardens that are integrated with buildings provide an opportunity for recreation and gardening in urban areas where space is limited. Urban gardens provide food, avoiding the 'food miles' involved in transporting food over long distances, and a habitat for wildlife. Planting that is integrated with buildings can shade and insulate buildings from temperature changes and reduces the heat island effect in cities.

Gardens can be created on roof tops and in living walls (vertical gardening) which use much less space. When implementing roof gardens check that the roof is designed to hold the weight of containers with wet soil, which is very heavy. Hydroponics and other lightweight methods can expand the possibilities of rooftop gardening by reducing the need for soil.

3.2.12 Economic impact

Although this aspect is mentioned last, it is definitely the most important aspect when considering the design or refurbishment of a building. Unfortunately the link between the capital costs and the operational costs of a building is seldom considered.

Capital costs are usually about 20% of the operational costs of a building over the lifetime of the building.

It is essential that, in addition to costing the construction, cost-benefit analysis be done to determine the long-term cost implications of different construction options while decisions are being made about their design.

A strong and diversified local economy is important for sustainability. This can be supported by using local contractors, building materials, and components such as fittings and furniture and supporting local businesses during construction and maintenance.

*3.2.13 **Recommendations for the design phase***

- Do a cost-benefit analysis of the long-term implications of the different design options being considered, which take the operating and maintenance costs into account
- Support the local economy through using local contractors, building materials, fittings and furniture
- Establish a knowledgeable team who will support the process of implementing a green building
- Do effective site planning to ensure that the development impacts positively on the existing natural and urban context, taking broader planning and design guidelines into account. Consider natural features including the microclimate, wind, topography, soil conditions, and established features such as trees. Consider densities; block design and streetscape character from an urban design perspective
- Position buildings to gain maximum benefit from light and views, while reducing noise and pollution. Create human-scale and vibrant urban spaces, using appropriate setbacks and greening
- Design the floor plan of a building to maximise functionality and take into account the microclimate of the site
- Invest in passive solar design and structural interventions that make use of sunlight and natural convection to heat, cool, light and ventilate buildings

- Ensure that buildings are elongated along an east-west axis, with large windows on the northern side of the building, where appropriate
- Ensure that roof overhangs are constructed to block incoming radiation from summer sun, which is high in the sky, while still allowing the lower winter sun to penetrate the windows
- Use appropriate building materials in the right combination taking into consideration their unique thermal qualities so that the building can be cool in the summer and warm in winter
- Use building materials that are natural, less processed and require no additional finishes as this reduces the amount of embodied energy in a building and saves on costs
- Incorporate design features that minimise the natural weathering and degradation of the building
- Use natural and traditional building materials and methods
- Design according to standard sizes of construction materials to reduce wastage
- Consider the implementation of a roof garden, and other integrated planting, where appropriate

3.3 Construction phase

3.3.1 Soil conservation

3.3.1.1 Conserve topsoil

Topsoil is the most important component of soil, as it is this portion which is rich in organic materials and seed stock. The presence of good topsoil is a prerequisite for the growth of healthy, strong vegetation.

It can take 50 to 1000 years to form one centimetre of topsoil.[8]

In order to limit the loss of topsoil during construction, every construction site should have a soil erosion control plan in place. Topsoil loss occurs when plants have been removed in order to build and the soil is washed away by rain, or blown away by wind. This reduces the productive capacity of the land and can also impact negatively on rivers or lakes in the area, through the build-up of sediments in these water systems. Erosion control measures include temporary and permanent planting, fencing, mulching and earth dikes.

If construction includes excavating or grading, the topsoil should be saved for later use by removing and stockpiling it. A minimum of 10 cm of topsoil depth should be removed over the entire site. Topsoil must be kept separate from overburden. Materials should be stacked in the order in which they were removed, in order to facilitate easy replacement. After construction is finished the topsoil should be replaced and re-vegetated, to ensure that it is not washed away by rain. Re-vegetation can be achieved through seeding or planting of seedlings.

Topsoil stockpiles must be stabilised to ensure that they are not blown away. This can be achieved through temporary planting, fencing and mulching. If temporary planting is to be used, seeds should be sown within 30 days of the stockpile formations. Straw bales can be used, but care must be taken to ensure that alien plants are not transplanted via the straw.

3.3.1.2 Reduce soil compaction

Heavy earth moving machinery and other vehicles are primary causes of soil compaction on a construction site. If soil becomes too compacted, water is unable to penetrate the surface, causing faster run-off during rains and eventual erosion and difficulty in establishing plants. In order to prevent soil compaction wooden planks or mulching can be placed in areas where vehicles are most often used.

3.3.2 *Recycle construction and demolition waste*

During the demolition of buildings large amounts of waste are created in the form of bricks, doors, window frames and other items which can be re-used in a new development. Re-use of these items offers developers an opportunity to cut down on both materials and waste disposal costs. Recycled concrete bricks are available from many major brick suppliers, and are effective substitutes for more conventional types of brick.

It is envisaged that over time, a demolition plan will have to be submitted prior to the demolition of a building to ensure that all the re-useable materials and rubble is incorporated in the new building or sold on to demolition companies to avoid waste going to landfills. Include requirements for careful demolition for recycling purposes in the tender documentation.

3.3.3 Use sustainable materials and products

The design team should specify sustainable materials where the lifecycle impacts on human health and environment have been considered. However, contractors can also contribute by sourcing materials from suppliers that make an effort to be more sustainable.

Investigate the environmental performance of bulk material manufacturers and suppliers and choose those that follow best practice in terms of pollution control, rehabilitation of mining operations etc. For example, the Aggregate and Sand Producers Association has an 'About Face' programme, which carries out an environmental audit of its members. This is available to the public at www.aspasa.co.za.

Another concern in the construction industry is the over-harvesting and extinction of species, such as hardwoods. Timber products used in construction and decorating must be sourced from sustainable forest plantations, or from alien vegetation clearance projects. Developers must ensure that protected and endangered tree species are not exploited for building materials.

One of the ways to do this is through the Forest Stewardship Council (FSC) which is a voluntary, market driven, certification and trademark system that allows customers to choose products that promote responsible management of the world's forests. Suppliers and purchasers can check that their specified product is FSC certified in several ways. In all cases the invoice of the supplier should clearly state that FSC certified timber was supplied. The chain of custody certificate number should be included on all product invoices, although the product may not physically carry the FSC trademark. To verify the FSC certificate number, review the FSC certificates list or the certificates database. If you do not find the certificate number please contact the International FSC Centre via their website www.fsc.org.

3.3.4 Buy local

A lot of fossil fuels are consumed when building products are transported over long distances, especially if the product is a heavy material such as brick or steel. Use local materials from the closest possible supplier to reduce carbon emissions associated with transportion.

3.3.5 Recommendations for the construction phase

- Ensure that every construction site has a soil erosion control plan in place in order to limit the loss of topsoil during construction
- If excavation or grading occurs during construction, ensure that topsoil is removed and stockpiled in order to guarantee that it is protected and replaced
- Avoid unnecessary soil compaction on a construction site as it has negative environmental impacts on the soil and vegetation
- Re-use and recycle demolition and construction waste to reduce the waste to landfill and strive for Zero Waste
- All wood products which are used in the construction of buildings should be sourced from sustainable forest plantations, or from local alien vegetation clearance projects, with certification from the Forest Stewardship Council (FSC)
- Source bulk and non-renewable materials from suppliers that implement best practice in reducing the impacts of resource extraction, mining and manufacturing.
- Source materials and products locally where possible

3.4 Sustainable resource management

3.4.1 Energy efficiency

Reducing the energy consumption of a building not only saves the environment, but will also save on the running costs of the building. By designing energy efficient or renewable energy options into a building, the demand for electricity during peak consumption times is reduced, delaying the need to build new power stations.

Below are some ways to reduce energy consumption.

3.4.1.1 Insulation

Perhaps the most important component of energy efficiency in any building is insulation. Properly insulated ceilings and walls mean that indoor spaces are less vulnerable to temperature fluctuations, remaining cooler in summer and warmer in winter than non-insulated spaces, often eliminating the need for air conditioning during much of the day. Furthermore, if air conditioning or heating is needed during peak hours or extremes of temperature, the conditioned air will remain at a comfortable temperature substantially longer in an insulated space, thus saving on a building's energy bill.

3.4.1.2 Ceilings

The installation of a ceiling is the most cost effective energy efficiency measure as most heat is gained or lost through the roof, especially if it is constructed from a conducting material like corrugated iron. This is particularly important to consider in low-cost housing developments. Although eliminating ceilings may be cost-effective, in the long-term it creates an unnecessary energy burden on the occupant.

3.4.1.3 Air ventilation

Locate and size windows to prevent draughts while making the best use of prevailing winds and the natural convection of air to ventilate the building. Eliminate or minimise the need for air conditioning by making use of passive solar design techniques (see section 3.2.4).

Where air conditioning cannot be avoided, it is important that a qualified professional accurately determines the size of the air conditioner required, as oversized air conditioners are inefficient and energy intensive. A smaller air conditioner can often be installed in buildings that have adequate thermal insulation, thus saving on electricity costs. If a large space needs air conditioning, a central unit which services a number of rooms or floors is more energy efficient than using many single room units. However, individual preferences in thermal comfort levels must also be considered. These systems must be checked regularly to ensure that the ducts are not leaky, as this reduces the energy efficiency of the unit. Only air conditioners with a seasonal energy efficiency ratio (ratio of the seasonal energy output to the seasonal energy input) of 10 or more should be used.

A properly sized and energy efficient air conditioner can reduce electricity bills by between 20 and 40%.

3.4.1.4 Tight construction

It is important to ensure that a building is constructed so that it is tightly sealed. This means that doors and windows must be properly fitted and sealed, and there should be no cracks in the construction that allow unwanted airflows in and out of the building. In windy situations consider building an entrance hall with two doorways to prevent draughts.

3.4.1.5 Electricity

Using energy efficient electrical installations is one of the cheapest and easiest ways to reduce energy costs and thus improve the economic and environmental performance of existing developments. Newer equipment is often more energy efficient than old equipment. Choose appliances such as energy efficient geysers, stoves, and zero-CFC based refrigerators. Although these may initially be more expensive, in the long-term they reduce electrical costs and environmental impacts.

Wind turbines and photovoltaic (PV) cells can be used to independently generate renewable electricity but this is generally quite costly. It is better to store the excess electricity that is generated in the national electrical grid, rather than using batteries which contain toxic chemicals and heavy metals that are a problem to dispose of.

An alternative that is not commonly used in SA is the purchasing of Tradable Renewable Energy Certificates (TRECs). A TREC is a unit that represents the ‘environmental friendliness’ of electricity that is generated from resources such as biomass, wind and solar energy. Any ESKOM user can buy ‘green energy’ by purchasing TRECs to the value of the electricity they need.

3.4.1.6 Lighting

The use of **natural daylight** instead of artificial lighting is obviously the most sustainable and efficient way of saving energy. Ensure that living and work spaces have an acceptable level of illumination without using artificial lighting during the day time by designing windows and skylights that are orientated to maximise the natural light without glare or overheating. Reflective and angled ceilings will also bring more light deeper into a building.

Artificial lighting should be designed to create brighter areas where tasks are being performed and more ambient light should be designed for elsewhere. Controls such as dimmers and motion sensors reduce energy consumption, while ensuring that there is light when it's needed.

Energy efficient light bulbs can substantially reduce energy costs.

Compact fluorescent light bulbs (CFLs) use less than one quarter of the energy required to power a conventional light bulb for the same amount of time, and last 10 times longer. Each CFL will save between 500 kg and 1 ton of carbon dioxide (CO_2) emissions in its lifetime.

Although they currently still cost more than a conventional light bulb (R15 to R50) the amount of money spent on replacing light bulbs is reduced. CFLs last for around 10 000 hours, where a conventional incandescent bulb lasts on average just 1000 hours. Some limitations that need to be considered when using CFLs are:

- On/off cycling: CFLs are sensitive to being switched on and off frequently and this reduces their rated lifespan
- Dimmers: not all CFLs can be used on dimmer switches. They can be used with a timer or a three-way fixture (note: some manufacturers, such as Philips, have recently introduced 'dimmable' CFL bulbs to the market, so this limitation is being addressed)
- Outdoors: CFLs can be used outdoors, but should be covered or shaded from the elements. Low temperatures may reduce light levels (check the package label to see if the bulb is suited for outdoor use)
- Retail lighting: CFLs are not spot lights. Retail store display lighting usually requires narrow focus beams for stronger spot lighting. CFL's are better for area lighting
- Hazardous waste: CFLs contain small amounts of mercury. Although the mercury poses no threat while in the bulb, mercury is a problem for the environment

Although CFLs have these handling and disposal issues, the large energy savings of CFL bulbs compared to incandescent light bulbs is of greater overall environmental benefit.
Another new technology which is even more efficient than CFLs is light emitting diodes (LEDs). They do a variety of different jobs and are found in all kinds of devices. Among other things, they form the numbers on digital clocks, transmit information from remote controls, light up watches and tell you when your appliances are turned on. Collected together, they can form images on a jumbo television screen or illuminate a traffic light.

Unlike ordinary incandescent bulbs, these LED bulbs don't have a filament that will burn out or get unusually hot. They are illuminated solely by the movement of electrons in a semi-conductor material. LED-based lighting is highly efficient when measured by its light output per unit of power input, and they last very long. LEDs are currently more expensive than conventional technology, and can only be used as directional lighting because they cast light in one direction at a narrow angle compared to an incandescent or fluorescent lamp. However, this technology is improving constantly.

Using efficient lighting is another method by which large energy savings can be achieved. Fluorescent lights are the most energy efficient option in large communal spaces, such as office buildings, and produce a more natural coloured light than ordinary incandescent lighting. Modern fluorescent lights which use electronic ballast are not prone to the annoying flicker and hum of older fluorescents, and can provide a well-lit and comfortable working space.

Street lights are a significant component of bulk service costs, and impact on the quality of the development. Centralized high-mast lighting is more expensive per erf to install and operate than other options. The most efficient street lighting options are CFL or LED streetlights attached to the electricity reticulation poles, which can be powered by grid electricity or solar photovoltaic (PV) panels.

3.4.1.7 PV panels

Solar photovoltaic (PV) panels generate electricity from sunshine. A panel could produce around 70 Watts at 12 volts for roughly 6 or 7 hours per day (about 0.4kWh/day). A complete off-grid system includes a battery to store PV-generated electricity for night time use, and a regulator to protect the battery from over-charging or over-discharging. These components should all be matched to one another. PV panels may be connected in series or parallel for larger systems, depending on the electricity requirements. Connecting PV systems to the national or local grid though two-way metering has not yet been widely implemented in Cape Town or South Africa, but is certainly being considered for the future.

3.4.1.8 Water heating

Solar water heaters are, simply, roof-mounted water panels that operate by heating water in black pipes using the power of the sun. Other more complex systems using vacuum tubes, for example, are also available. Solar water heaters are usually fitted with electricity back up.

Solar water heaters can save 20% - 40% of normal electricity use, and pay for themselves in 3 to 5 years. Financing a solar water heater through a bond translates into immediate monthly cost savings for a householder.

Geyser blankets and pipe insulation can be made from any heat resistant insulating material that is wrapped around the geyser and hot water pipes. Modern geyser cylinders are unlikely to need a geyser blanket, but any geyser or piping that feels warm to the touch is losing heat and needs insulation. A vertical geyser is significantly more energy efficient than a horizontal geyser.

Installing geyser blankets and insulating all hot water pipes, can save 5 - 10% of the energy used to heat water.

Geyser timers are devices which are installed on household geysers and operate by switching the geyser on and off at specified times, thus providing hot water only when it is needed. All solar water heaters with electricity back-up should be fitted with a timer in order to ensure best use of the sun's power.

A geyser timer can save up to 30% on monthly electricity bills, paying for itself within a year.

3.4.1.9 Recommendations for energy efficiency

- Install properly insulated ceilings
- Place and size windows to make optimal use of natural light, winter heating and ventilation without creating draughts, or gaining too much heat in summer or losing heat in winter
- Avoid the use of air conditioning, or at least ensure that the correct size is installed and that use of the unit is minimised

- Use air conditioners with a seasonal energy efficiency ratio of 10 or more (ratio of the seasonal energy output to the seasonal energy input)
- Ensure that the building is constructed so as to be tightly sealed, to prevent unwanted air flows. Doors and windows must be appropriately sized and fitted with seals
- Energy efficient electrical installations should be used
- Ensure that artificial lighting is designed so that light is focused where necessary, such as brighter areas where tasks are being performed and more ambient light elsewhere. Avoid the use of 'up-lighting' to reduce light pollution
- Ensure that energy efficient light bulbs, such as CFLs or LEDs, are used where possible.
- Consider the installation of independent renewable electricity generators such as PV panels or wind turbines
- Reduce the electrical energy used to heat water by installation of solar water heaters, or at least geyser blankets, pipe insulation and a geyser timer

3.4.2 Water efficiency

In anticipation of projected growth and the effects of global warming, the City of Cape Town has passed two new by-laws which promote good water demand management practices. The contents of the Water By-law and Wastewater and Effluent By-law, promulgated on 1st September 2006, should be noted and fully incorporated in design and management of buildings. These by-laws incorporate most of the restrictive measures introduced during previous dry spells in the region. In short, the new by-laws include the following regulations:

- No watering of residential gardens between 10:00 and 16:00
- Hosepipes must be fitted with automatic self-closing devises
- No automatic top-up systems fed from a potable (drinking) water source may be used to supply swimming pools and ponds
- No person may hose down a hard-surface or paved area using potable water, without getting prior written notice from Council
- Potable water may not be used to damp building sand and other building materials to stop them from being blown away
- The maximum flow rate from a tap installed in a wash hand basin may not exceed 6 litres per minute
- Toilet cisterns may not exceed 9.5 litres in capacity
- No automatic cistern or tipping tank may be used for flushing a urinal
- Major water users (using more than 3 650Kl per annum), excluding multiple dwellers' units, must conduct an annual water audit
- Commercial car wash industries must recycle a minimum of 50% of the water used in their operations
- No person supplied with water in terms of this by-law may sell such water without written permission or special agreement

Any water wastage or pollution should be reported immediately to the Water Services technical operations centre on 0860 10 30 54.[9] (Duven – perhaps put in a box?)

3.4.2.1 Stormwater control

Hard surfacing in urban environments increases the volume and speed of stormwater contributing to water contamination, flooding and removal of topsoil, which is washed into the sea. Design surface drainage to slow down stormwater and facilitate recharging of the ground water. Where space allows, channel stormwater to retention ponds and soak-aways where it can seep into the ground. Replace hard surfaces with permeable paving on pathways and parking areas. This can be attractively planted in the spaces between the pavers, and helps to mitigate the urban 'heat island' effect. Mulch garden beds (spread a layer of bark or other organic material over the soil) to prevent evaporation and a hard and impermeable crust developing on the soil, which makes it harder for plants to grow.

3.4.2.2 Water-wise landscaping

Use indigenous plants suited to the Western Cape, as these are hardier and weather tolerant. Group plants that have similar water requirements to avoid over-watering. Unless a garden is going to be used for sports or as a play area, avoid large areas of lawn that require extra water. Plant fine Kweek (*Cynodon dactylon*) or *Paspallum sp.* grasses, or indigenous Buffalo grass (coastal regions) in areas where lawns are required. Traditional lawns (such as Kikuyu grass) should be avoided where possible. Buffalo grass also tends to require a fair amount of water during the summer.

Use water saving irrigation systems such as bubblers and drip irrigation to reduce the water that is lost by evaporation. Drip nozzles should have a low level focused spray to reduce evaporation and focus water where it is needed. Water can also be saved by using irrigation timers that limit watering to early evening and morning. Moisture and weather sensors can further reduce consumption by only watering when needed.

3.4.2.3 Rainwater harvesting

Harvesting rainwater for household use, saves using potable water on tasks that do not specifically require it, such as gardening, cleaning or flushing toilets.

To set up a simple system harvest water from the roof via a gutter down-pipe leading into an enclosed plastic or ferro-cement tank. A mesh over the top of the down-pipe keeps leaves out. Silt will still enter the rain tank. To prevent this being a problem locate the tap from the tank at least 50 mm above the bottom. Raise the tank about 300 mm above the ground in order to provide a little pressure.[10]

3.4.2.4 Plumbing layouts

Design the layout of the plumbing system to avoid creating a 'dead leg' in the hot water system, where a long pipe runs from the water heater to a supply point. This wastes a lot of cooled water while waiting for the hot water to discharge, it also wastes energy.

Ensure that the optimum pipe size and water pressure is used. A pressure reducing valve (PRV) can be installed at a point nearest to where the supply enters the building to ensure that all water supplies in the building are balanced.

3.4.2.5 Water-wise installations

All plumbing installations in new or renovated buildings should be chosen with water efficiency in mind and must have SABS/JASWIC approval in accordance with the by-law requirements (refer to section 4.1.8 for heating of water).

By simply using low-flow devices (taps, showerheads) and water efficient appliances (washing machines, dishwashers) savings of up to 50% can be achieved.

- Water-wise showers

All showers should be fitted with low-flow showerheads to reduce the amount of water used during showering. However, these showerheads must still allow water to flow at a comfortable rate for the user because low-flow showerheads only work efficiently with a balanced pressure geyser (refer to section 4.1.8 for heating of water).

- Water-wise Taps

All indoor taps should be fitted with aerators. These simple devices can be fitted onto most standard household taps, and aerate the water, thus increasing its efficiency while reducing the flow and thus the amount of water used.

Metering taps, which have a timer to deliver a pre-determined, but adjustable, quantity of water when operated, should be used in public buildings and outside taps and showers to prevent taps being left on or dripping.

3.4.2.6 Grey waste water systems

Grey waste water is used water that comes from basins and baths as opposed to black water, which comes from toilets. Grey water can be re-used to flush toilets, or can be filtered to irrigate gardens. There are many ways to recycle grey water, such as having a pipe that feeds water from the basin into the toilet cistern, to simple gravity systems that use plants to filter the water, and sophisticated commercial systems that can clean water for large developments.

3.4.2.7 Water-wise toilets

Water used for the flushing of toilets is commonly delivered using one of two mechanisms:

- Cistern tanks with internal flush mechanisms. This stores 9-11 litres of fresh water, which is flushed into the toilet bowl when the mechanism is activated
- Flush valves deliver a preset amount of water regardless of the amount required. The flush valve is typically used in commercial buildings and public ablutions, and requires a nominally higher water supply pressure to operate than domestic units. Poor maintenance and incorrect adjustment often lead to water being wasted in these installations[11]

It is preferable for all flush toilets to have cisterns fitted with duel-flush or multi-flush mechanisms. A multi-flush mechanism will only flush while the mechanism is held down, allowing the user to control the amount of water needed and prevent unnecessary flushing. Similarly, all urinals should be operated by a manual flush mechanism, as automatic flush systems are wasteful of water.

3.4.2.8 Alternative sanitation options

- Composting toilets

Composting toilets offer a more ecological way of dealing with human waste. They use no water, making use of natural decomposition and air flows to dry and recycle the waste into garden compost. There are a number of commercial composting toilets available locally or one can build one's own. There are several different compost toilet designs, including a single composting chamber, twin vault systems (where the use alternates from one to the other) and urine diversion toilets that separate the urine for use as a fertiliser or disposal in a soak-away. Composting toilets do away with expensive sewage reticulation and treatment, and are therefore highly cost effective. However, a grey water recycling system or regular sewage connection will still be necessary for shower, basin, bath, laundry, kitchen sink and other 'waste' waters.

- Reed bed systems

These are 'constructed wetlands' that treat waste water and sewage by creating a mini ecosystem, where the reeds and micro-organisms in their root systems clean the water flowing through the bed. Reed beds can process both black and grey water and even some industrial effluents. Building and installing such systems requires specialist expertise.[12]

- Biolytix

If a Biolytix system is installed, then the grey and black effluent from a building is channelled into a Biolytic filter, which consists of a peat filter inhabited by earth worms and inoculated with micro-organisms. The solids are digested by these tiny organisms in an aerobic environment, which results in treated water that has retained the primary nutrients (nitrogen and phosphorus) for re-use as a natural organic fertiliser for irrigation purposes.

- Biogas digesters

Biogas is the gas produced when organic matter including manure, sewage sludge, municipal solid waste, biodegradable waste or any other biodegradable feedstock, is decomposed by micro-organisms under anaerobic conditions (without oxygen). Biogas is comprised primarily of methane and carbon dioxide. Small scale biogas digesters can be built for a cluster of houses, and are especially practical because they accommodate flush toilets and produce a pathogen-free liquid fertiliser and gas that can be used for cooking and heating. However, better gas yields are obtained when farm animal waste is included in the digester.

3.4.2.9 Recommendations for water efficiency

- Ensure that only water efficient devices such as low-flow taps, low-flow showerheads, washing machines and dishwashers are used
- Ensure that all toilets are low volume (9.5 litres or less), with dual-flush or multi-flush
- Ensure that public buildings and outside taps and showers are fitted with metering tap buttons, which have set timers to prevent taps being left on or dripping

- Design the layout of the plumbing system to avoid long pipe runs between the geyser and supply points
- Reduce hard surfacing to encourage rain water to seep back into the ground rather than being carried away into the sea by drainage systems
- Design paved areas so that water run-off is slowed down and where possible use soak-aways and permeable paving that allows water to filter into the ground
- Ensure that the optimum pipe size and water pressure is used. A pressure reducing valve can be installed at a point nearest to where the supply enters the building to ensure that all water supplies in the building are balanced
- Encourage rainwater harvesting and the re-use of grey water where appropriate. However, ensure that the local ecological system is not polluted and that it is managed correctly
- Encourage the use of indigenous planting and efficient irrigation methods, such as drip irrigation
- Consider the use of a pool blanket to reduce water loss through evaporation
- Introduce waterless sanitation and alternative grey-water systems that clean black and grey water, while providing useful by-products such as fertiliser and biogas

3.5 Waste minimisation and management

For every kilogram of product on shop shelves 36 kilograms of waste has already been produced.[13]

The City of Cape Town's draft Integrated Waste Management By-law should be noted and fully incorporated.

Green building should aim for Zero Waste in all aspects of planning, constructing, using and maintaining the built environment. The first step is to avoid creating waste. If this is not possible waste should first be re-used and then recycled (remanufactured) rather than being dumped in a landfill. Hazardous waste, for example, old asbestos cement products, must be safely handled and disposed of in licensed facilities to prevent environmental and health impacts.

Zero Waste can guide waste minimisation strategies. Zero Waste starts by changing production and distribution systems to emulate the closed loop systems found in nature. Applying Zero Waste requires that unsustainable and toxic materials that cannot safely feed new production cycles are phased out.

The design phase is a critical time for making decisions that impact on waste. This includes specifying materials that have resulted in minimal waste during their production, and that will result in minimal waste during the construction, maintenance and demolition of the building. Tender documentation should ensure that demolition and construction processes will be managed to reduce waste. Building rubble can be used, for example, as sub-grade for driveways, rather than being dumped. Old doors and windows can also be re-used which saves on costs and the environmental impact of using virgin materials. Waste management systems that facilitate separating waste at source for composting, re-use and recycling must be built into the design of a building.

3.5.1 Recommendations for waste reduction

- Aim for and promote Zero Waste in the planning, operation, management, maintenance and demolition of a building. Zero Waste emulates the closed loop processes found in nature, taking a 'cradle –to –cradle' approach to designing products and buildings
- Build waste avoidance into the process at a design phase, by specifying products and materials that have less wasteful production processes and don't create wasteful emissions during construction, maintenance and demolition of a building
- Ensure that all buildings that are to be demolished compile a demolition plan, outlining how the building material and rubble will be used to avoid waste to landfills
- If waste is created, consider how this can firstly be re-used and then recycled to recover the value invested in these materials, rather than losing this value when the resource is dumped in a landfill or incinerated
- Provide waste compactors in buildings where large amounts of waste are created to reduce landfill air space and transport costs for removal of waste
- Facilitate the separation of waste at the source for composting, re-use and recycling when designing waste management systems. The building management plan should encourage people to recycle their waste

3.6 Urban landscaping

Please refer to the document 'Sustainable landscapes, practices and guidelines' (included on this CD) for details on how to achieve sustainable urban landscaping design and management.

3.7 Human health and comfort

3.7.1 Heating, ventilation and air conditioning (HVAC)

Proper ventilation is vital for the health and comfort of a building's occupants. Fresh air prevents bacteria and pollutants from building up in the air. It is preferable that windows can be opened so that users control the level of outside air coming into the building. Windows should also be positioned to aid the airflow through a room or building, without causing draughts. In areas where windows are inappropriate extractor fans should be installed.

Old air conditioners that are going to be re-used should be thoroughly checked to ensure that they don't use CFC-based refrigerants, which are largely responsible for depleting atmospheric ozone. Also avoid materials which use CFCs or HCFCs in their production, such as plastic foamed materials.

3.7.2 Sick Building Syndrome (SBS)

This is a combination of ailments (such as headache, eye, nose and throat irritation, cough, itchy skin, dizziness, nausea, fatigue and difficulty in concentrating) typically associated with modern office and commercial buildings, although SBS has also occurred in residential buildings. A 1984 World Health Organisation report, found that up to 30% of new and remodelled buildings worldwide may be linked to symptoms of SBS. Symptoms occur while one is in a SBS building and clears up once one has left the building.

Factors contributing to SBS include combinations of some or all of the following:

- Indoor air pollution caused by chemicals off-gassing from processed materials and finishes
- Artificial fragrances, such as dryer sheets
- Poor or inappropriate lighting (including absence of or only limited access to natural sunlight)
- Poor heating or ventilation
- Microbial contamination of HVAC
- Bad acoustics
- Poor ergonomics
- Electro-magnetic radiation from equipment (e.g. computer monitors, photocopiers, etc.)
- Chemical and biological contamination

A 'sick building' results in high levels of employee sickness or absenteeism, lower productivity, poor job satisfaction and high employee turnover. Green buildings aim to eliminate SBS.

3.7.3 Indoor air quality

Although most people are aware of the negative impacts of air pollution, few consider the serious health impacts of unclean or contaminated air indoors. Maintaining good indoor air quality is an essential part of creating comfortable and productive living and work environments.

3.7.3.1 Allergens

Special attention should be given to creating a home and garden that are low on the allergens which can cause asthma and other allergies. Most people with asthma are affected by the allergen produced by dust mites, particularly in humid climates. Design buildings to avoid materials and fittings that gather dust. For example, avoid fitted carpets and pelmets and use angled skirtings.

3.7.3.2 Volatile organic compounds

Office machinery and many modern materials contain and emit high levels of volatile organic compounds. These products include, but are not limited to, paint and other wall treatments, particleboards (especially those with formaldehyde glues), chemically treated and varnished wood, carpets, photocopiers and fax machines and chemicals used in cleaning materials. Emissions from these products can cause headaches, eye, throat, nose and skin irritations, nausea and dizziness. Symptoms typically disappear when the sufferer leaves the affected building or area.

Although there are no official guidelines for indoor air quality, developers should make every effort to reduce the use of materials with volatile organic compound emissions. This may involve using natural wood finishes or paints (which are commercially available) and limiting the use of particleboards. Organic cleaning products are also available which do not contain harmful chemicals.

3.7.3.3 Microbial and bacterial growth

Microbial growth inside buildings is largely due to damp conditions inside a building, and badly maintained air conditioning systems. These damp conditions allow funguses (such as mildew) and bacteria to breed, creating an unhealthy environment for those working or living in the building. Illnesses and symptoms associated with such conditions include allergies, upper respiratory tract infections and irritations, asthma, bronchitis and pneumonia, and Legionnaire's disease, which can be fatal.

Microbial growth can be prevented by regularly cleaning and servicing air conditioning equipment and ducts. Rising damp and associated fungal and bacterial growth can also be prevented by using breathable paints so that water cannot accumulate under the paint surface.

3.7.4 Fire

Fire blankets and extinguishers must be provided. Avoid halon-based fire extinguishers due to their negative impact on the ozone layer. Solvent-free and flame retardant building materials should be used where possible. Electric cables made from 'low burn' materials should be fitted as low burn materials don't give off toxic fumes if they ignite (fire-fighters have found that in the case of a house fire, occupants are often harmed by toxic fumes from furnishings rather than the fire itself).

3.7.5 Recommendations for human health and comfort

- Reduce the risk of sick building syndrome (SBS) through natural ventilation, natural light, good acoustic and ergonomics, etc.
- Ensure that microbial growth is prevented by regularly cleaning and servicing air conditioning equipment and ducts
- Prevent damp conditions that lead to microbial and bacterial growth by ensuring exteriors are properly sealed and drained. Rising damp and associated fungal and bacterial growth should also be prevented by using breathable paints so that water cannot accumulate under the paint surface
- Avoid building and decorating materials (such as paint, varnished wood, carpets, etc.) which may emit high levels of volatile organic compounds. Rather use natural wood finishes or paints (which are commercially available) and limit the use of particleboards
- Ensure that no CFC-based air conditioners are used
- Encourage the use of organic cleaning products which do not contain harmful chemicals.
- Provide fire blankets and extinguishers
- Use solvent free and flame retardant building materials
- Ensure that electric cables made from 'low burn' materials are fitted to avoid any toxic fumes during a fire

3.8 Visual mitigation measures

The previous chapters in this section refer to practical design solutions which aid in achieving green buildings. However, consideration should also be given to the visual impact of these solutions, especially in visually sensitive areas such as urban conservation areas, heritage buildings and sites, scenic drives, etc. For more information on designing in heritage areas refer to the heritage brochures available at the City of Cape Town's Urban Conservation Unit.

3.8.1 Recommendations for the mitigation of visual impacts

- Ensure that green building roof structures, such as solar panels, solar water heaters etc., are placed on the rear part of a building so that these are not visible from the road
- Where roof structures cannot be on the rear side of the building, position these to have a minimal effect on the façade of the building
- Place pipes and down pipes inside the roof or at the back of the building and paint these the same colour as the building
- Ensure that no structures, besides the chimney, protrude beyond the apex of the roof
- Position rainwater tanks to the rear part of the building and, if possible, screen with vegetation
- Bury grey water tanks underground in a less used vicinity of the site. Cover these with an appropriate cover, which is accessible but safe for a person to walk on

4. ANNEXURE A: NATIONAL LEGISLATION REGULATING THE BUILT ENVIRONMENT

4.1 National Building Regulations and Standards Act (Act 103 of 1977)

The National Building Regulations and Building Standards Act (Act 103 of 1977), is the enabling Act under which the National Building Regulations are made. Most of the powers required by a local authority in the process of enforcing the regulations are contained in the Act including:

- the prohibition of the erection of any building without prior approval of the local authority;
- the enabling of a local authority to take action in a case where it considers any building or earthwork to be objectionable in some way;
- the empowering of a local authority to take action when no work has been done in a period of more than three months on a building under construction;
- when a building becomes dilapidated or when any building or earthworks becomes dangerous in any way;
- permitting the occupation of buildings normally only after the issuing of a 'certificate of occupancy' by the local authority;
- the authorising of the local authority to enter any building or land at any reasonable time to determine whether the owner of the building or land complies with any provision of the Act or any condition imposed by the local authority in terms of the Act;
- enabling the local authority to permit a deviation or grant an exemption from any
- regulation except one which may concern the strength and stability of the building;
- provision for a local authority to obtain a court order to stop work on any building where such work is unauthorised or does not comply with the provisions of the Act;
- the granting of permission for a local authority to charge rates, taxes, fees or other monies in respect of any building or land or the examination of plans, etc., in terms of this Act;
- the indemnification of the local authority against any loss, damage, injury or death resulting from the way a building is erected, altered or demolished;

The Act stipulates that any proposed new building by-law must be submitted to the Minister for approval before it is promulgated and that any new by-law not so approved is void.

Section 17 of the Act establishes the framework within with the Minister may make regulations.

The framework is largely framed around administrative matters, the protection of property and the general safety, health and convenience of the public in so far as they relate to the erection of buildings and of users and occupiers of buildings. Section 17 contains no reference to energy efficiency.

South Africa's building regulations are based on the Nordic model. Objectives are captured in the Section 24 of the Bill of Rights of the Constitution of South Africa (Act 108 of 1996) and the Act itself. Functional statements are provided in the National Building Regulations issued in terms of the Act. The regulations make reference to SANS 10400 (the application of National Building Regulations) as one of the means by which the functional regulations may be satisfied.

SANS 10400 (1990) contains some quantitative performance requirements (level 3) and provides performance-based methods and deemed-to-satisfy rules for the design of elements on the assumption that such elements are built in accordance with good building practice. SANS

10400 (2004) addresses these shortcomings and introduces two user performance levels in a limited number of building occupancies. SANS 10400 (2004), when read in conjunction with the Building Regulations, will provide a performance-based four level regulatory system for building control in South Africa.

4.2 Building regulations and Agrément South Africa1

Building standards in South Africa are governed by the National Building Regulations. These are functional regulations. They specify how the building must perform but do not prescribe how this may be achieved. Compliance with the regulations is facilitated in the case of conventional building methods, by the provision of deemed-to-satisfy rules that are set out in SANS 10400 code of practice for the application of the National Building Regulations.

Neither the National Building Regulations nor SANS 10400 makes any reference to thermal performance or energy usage although the application of the deemed-to-satisfy-rules will result in buildings with a performance that could be construed as satisfying an implied minimum standard.

SANS 10400 makes provision for acceptance of innovative construction methods, materials or techniques, as complying with the National Building Regulations by means of evaluation and certification by Agrément South Africa. Insofar as housing is concerned Agrément evaluation includes an assessment of the likely:

- thermal performance;
- energy usage; and
- risk of condensation occurring

in houses that are built with the system and materials that are the subject of evaluation.

A computer simulation method produces values relating to these aspects. The programme was specially developed for Agrément South Africa. It evaluates the dwellings as a whole taking account of:

- climatic zone wherein the dwelling is situated;
- ventilation rate;
- occupancy rate;
- size and shape of the dwelling;
- plan, orientation and fenestration of the dwelling;
- thermal mass of building materials used and solid or hung floor;
- colour of external finishes; and
- roof shape and eaves overhang.

A standard Agrément evaluation compares the values obtained for the house in the application with those of a conventionally built reference house2 in three climatic zones that are regarded as representative of the variations in climate familiar to the population of South Africa, namely Cape Town, Durban and Johannesburg.

1 The Agrément certification concept has its origin in France. The French building industry in the 1960s, identified the need for an organisation that would protect the public against unsuitable building methods. As a result, they invested in certifying products by means of technical examinations that guarantee the use of satisfactory and durable building techniques. Agrément certification enables innovative construction products to be assessed. The Board Agrément South Africa is a body operating under the delegation of authority of the Minister of Public Works and is mandated to certify fitness-for-purpose of a non-standardised product, material or component and/or the acceptability of the related non-standardised design.

2 The performance of the reference house is superior to the construction that has become common in government funded housing where the residents are, as a general rule, unable to afford the cost of heating. The walls of these dwellings are normally constructed of 140 mm thick solid concrete bricks or hollow concrete blocks, the external walls finished with a cement based coating. Roofs are built without ceilings. Obviously the programme and its input can be adjusted to change what constitutes a reference house and standards can be prescribed if so desired.

4.3 Housing Consumers Protection Measures Act (Act 95 of 1998)

The Housing Consumer Protection Measures Act3 (Act 95 of 1998) provides inter alia, for warranty protection against major structural defects in new homes, and the establishment of technical standards in and the regulation of the home building industry. This Act in effect requires that all contractor-built housing in South Africa be built in accordance with its Home Building Manual by home builders who are registered with the National Home Builders Registration Council (NHBRC).

This Act also requires that financial institutions lend money and that government makes available housing subsidies to housing consumers only if they are satisfied that the home builder is registered with the NHBRC and that the home is or will be enrolled with the NHBRC.

The Act provides for a fine in an amount not exceeding R25 000 or imprisonment of up to a year in respect of every director, trustee, managing member or officer of a home builder who knowingly permits a contravention of the Act in respect of each charge.
The objects of the Council as set out in the Act are, inter alia, to:

- represent the interests of housing consumers by providing warranty protection against defects in new homes;
- regulate the home building industry;
- provide protection to housing consumers in respect of the failure of home builders to comply with their obligations in terms of this Act;
- establish and to promote ethical and technical standards in the home building industry;
- improve structural quality in the interests of housing consumers and the home building industry;
- promote housing consumer rights and to provide housing consumer information;
- communicate with and to assist home builders to register in terms of this Act: and assist home builders, through training and inspection, to achieve and to maintain satisfactory technical standards of home building.

The Act in effect:

- Mandates the NHBRC to ensure that protection is also afforded to the poorer sector of the South African housing market, namely the subsidy sector.
- Mandates the NHBRC to assist home builders to be trained in technical standards.
- Challenges the NHBRC to disseminate information and to promote and uphold housing consumer’s rights in a cost effective manner.
- Introduces a penal code for transgressors.

The Act was been implemented in a phased manner, the key actions associated with each phase being as follows:

- Phase 1: Establish the NHBRC as a statutory body.
- Phase 2: Activate the scheme in the above R20 000 category of the home building industry.
- Phase 3: Extend the scheme to the subsidy-only category of the home building industry.

3 The Act defines a major structural defect as a defect which gives rise or which is likely to give rise to damage of such severity that it affects or is likely to affect the structural integrity of a home and which requires complete or partial rebuilding of the home or extensive repair work to it, subject to the limitations, qualifications or exclusions that may be prescribed by the Minister.

Several regulations have been promulgated. Regulation 1406 establishes the NHBRC's technical requirements for the structural strength and stability, serviceability, fire, materials, drainage and storm water disposal in respect of a home. It also sets out the terms and conditions for registration; the minimum and maximum amounts payable from the fund; and limitations, qualifications and exclusions from the deemed warranty.

Energy efficiency falls outside the ambit of the Act.

Footnotes

1) Institute of Zero Waste in Africa (IZWA), Muna Lakhani, zerowaste@iafrica.com
2) National Association of Homebuilders (2004). NAHB Model Green Home Building Guidelines. Available online at: http://www.nahbrc.org/greenguidelines/index.asp
3) U.S Environmental Protection Agency (2005) Brownfields Clean up and Redevelopment. Available online at: http://www.epa.gov/brownfields/index.html
4) State of Energy in South African Cities (2006). Sustainable Energy Africa.
5) CSIR; Sustainable Building Assessment Tool, www.csir.co.za
6) The New Energy Book, Sarah Ward (2008), ISBN 978-0-620-40184-5, published by Sustainable Energy Africa
7) Eco Village Design Manual, The Johannesburg EcoCity Initiative; Michelle Nel and Annie Sugrue, page 5
8) Eco Village Design Manual, The Johannesburg EcoCity Initiative; Michelle Nel and Annie Sugrue, page 6
9) City of Cape Town, Water Demand Management Department; www.capetown.gov.za
10) Eco Village Design Manual, The Johannesburg EcoCity Initiative; Michelle Nel and Annie Sugrue, page 7
11) CSIR; Green Buildings for Africa - water efficient fittings, www.csir.co.za
12) Manifesto for Green Architecture, Andy Horn, www.ecodesignarchitects.co.za/manifesto.htm, page 8.
13) Thorpe B (1999). Citizen's Guide to Clean Production. Lowell: The University of Massachusetts)

Cape Town's natural environment is known for its beauty and biodiversity, providing essential resources and offering natural assests on which much of our economy depends.

Our rich history of people and their culture, religious, political and economic practices has given us a particular and precious heritage in Cape Town.

Cape Town has an impressive and constantly evolving urban environment. We need to create a more equitable and harmonious living environment.

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