Stellendale Village Carbon Footprint

1. Background information:

The purpose of this document is to provide motivation for the approval of the subdivision and rezoning of Stellendale Extension 2 based on the carbon footprint of the proposed development.

Stellendale 2 in Kuilsrivier is anticipated to ultimately consist of 987 homes and apartments and will form an extension of Stellendale Village. All the specifications and finishes used for this study were based on the Stellendale Village and a site inspection was done at the show house. Application has already been made to the City of Cape Town for the sub-division and rezoning of Stellendale 2.

> *Your carbon footprint is the estimated amount of carbon dioxide (CO_2) created through your daily actions, such as when you drive your car, fly, buy food, heat your homes and enjoy your usual lifestyle. The average annual carbon footprint for a South African household is about 13 tons of CO_2. A carbon footprint is different than an ecological footprint which is based on consumption of natural resources in global hectares.*

It should be noted that the calculations are based on the construction of the unit and not the actions of the residents who would ultimately be living in the unit. It considers the material, design and efficiency of specifications. A home owner's guideline will however also be provided and regulated through the Home Owner's Association.

2. Process:

The first step was to do a carbon footprint for Stellendale 2. The purpose of this was to **determine the base line** and **consider the mitigating factors**.

The second step was a workshop where the professional team provided their input and suggestions into the initial analysis during a workshop. This was followed by a **cost comparison** considering the different options.

The third step is a revised carbon footprint based on the outcome of the information above and gives **recommendations** as well as an **implementation plan**.

The main elements considered were energy (mostly electricity), water, insulation and finishes, as well as landscaping and transport.

3. Motivation:

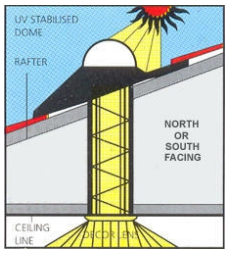
The following specifications and finishes were considered as mitigating factors in the reduction of the carbon footprint of the development.

3.1 Energy:

Lights: There are eight lights in the standard unit, which operate approximately 150 hours per month. When changing from an incandescent light (60W) to a compact fluorescent light (11W) the energy usage for the whole development is expected to drop from 71 to 13 Mega Watt hours (MWh) per month. The phasing in of LED lights should be considered as they are even more efficient and becoming more cost effective.

The use of natural light helps to reduce the need for artificial light and orientation of large windows on the northern side of the building also helps to reduce the need for heating the room during winter. The downside is that the high density restricts the ideal orientation of large windows, but the density is a necessity to ensure economy of scale for this project.

Although the use of roof overhangs could assist with the thermal quality of the buildings, this should be measured up against the cost of the eves, the density of the units and the building lines. Bearing this in mind it was decided by the architects to not provide roof overhangs, but to still try and use natural light where possible.



Skylights: They are ideal for small areas, hallways, pantries, toilets, walk-in wardbrobes etc. The skytube has an acrylic dome top attached to a metal flashing, suitable for most roof types. The tube is made of highly polished aluminium, giving a high density of reflected light. This was proposed as an alternative if orientation of the units cannot be done effectively, but is not seen as essential.

Street lights: High Pressure Sodium (HPS) Vapour lamps are recommended above Mercury Vapour laps. Although Mercury lamps might be a bit cheaper, the use of mercury has a negative impact on the environment and is not advised. The HPS light might burn for 20 years, but the light output drops after 3 years and would need to be replaced to ensure appropriate usable light levels. HPS lamps are quite efficient—about 100 lm/W, up to 150 lm/W, when measured for photopic lighting conditions. They have been widely used for outdoor lighting such as streetlights and security lighting.

HPS lamps do have several drawbacks. The main one is the colour of the light produced and the poor colour rendition index. The orange light of the lamp is absorbed and not reflected by green foliage, and at low light levels it can be harder to distinguish detail under HPS lamp.

In addition, the ballasts on low wattage HPS lamps (35 to 100 watts) are relatively energy-intensive; iron-core ballasts on low wattage lamps can consume up to 20 per cent of the total wattage applied to the lamp. Lastly, as HPS lamps age, their power requirements increase; when new, a 50W HPS lamp may consume 45 watts, while at the end of its life, it may consume 60 or 65 watts.

"Twin arc" HPS lamps are a relatively new development, and further increase the reliability and life of HPS lamps, which some manufacturers now claim can extend out to 50,000 hours. A twin arc lamp has a second arc path. As only one of the two arc paths operates at any time, the second arc path acts as a backup should the first arc fail. The longer life of twin arc lamps could mean less frequent batch replacements of lamps. (http://www.iclei.org/index.php?id=6664)

Cooking: A stainless steel under counter oven (Bosch HEN 100250E) and solid plate stainless steel hob (NCM 615A01) is currently being provided as a standard fixture (R3758). An alternative is providing a stainless steel gas hob with an electric oven (R5358), or a freestanding gas oven and hob in stainless steel (R5694) or white (R3824). The additional cost would be between R460 and R2336 if a 9kg gas bottle (estimated at R400) is included.

The use of a gas oven and hob will relieve the direct pressure on the electricity grid (from 3000w to 1500w), but it is essential that appropriate provision of gas is available. Another concern is the perceived fear of the use of gas as it is not commonly used in South Africa. Although there is a slight increase in the capital cost per unit, the operational cost per unit will be lower.

Natural gas burns cleaner than other fossil fuels, such as oil and coal, and produces less carbon dioxide per unit energy released. For an equivalent amount of heat,

burning natural gas produces about 30% less carbon dioxide than burning petroleum and about 45% less than burning coal. Composed primarily of methane, the main products of the combustion of natural gas are carbon dioxide and water vapour, the same compounds we exhale when we breathe. Coal and oil are composed of much more complex molecules, with a higher carbon ratio and higher nitrogen and sulphur contents. This means that when combusted, coal and oil release higher levels of harmful emissions, including a higher ratio of carbon emissions, nitrogen oxides (NO_2), and sulphur dioxide (SO_2).

Coal and fuel oil also release ash particles into the environment, substances that do not burn but instead are carried into the atmosphere and contribute to pollution. The combustion of natural gas, on the other hand, releases very small amounts of sulphur dioxide and nitrogen oxides, virtually no ash or particulate matter, and lower levels of carbon dioxide, carbon monoxide, and other reactive hydrocarbons.

The use of fossil fuels for energy contributes to a number of environmental problems. Natural gas, as the cleanest of the fossil fuels, can be used in many ways to help reduce the emissions of pollutants into the atmosphere. Burning natural gas in the place of other fossil fuels emits fewer harmful pollutants into the atmosphere, and an increased reliance on natural gas can potentially reduce the emission of many of these most harmful pollutants.

Free cooking is another way to consider the reduction in electricity use through the use of hotboxes. A hot box can be used to cook rise, porridge, soups or stews that have been brought to boil on the stove. The hot box will keep the heat in and the food will continue to cook. It also provides greater nutritional content and improved taste and texture due to lower heat cooking. A hot box (R150) can be provided to each home owner as a "welcome gift" together with some information about the greening aspects of the project. On the overall project this initiative can reduce the energy usage by approximately 15 MWh per month. (www.thehotboxco.co.za)

Hot Water Geyser: Heating and cooling are the biggest users of electricity in our homes and the hot water geyser can use up to 50% of the electricity at home. A standard 150 litre/400 Kpa hot water cylinder is currently being provided and uses approximately 396 kWh of electricity per month. By installing solar water geysers the electricity consumption per unit could drop considerably and it is estimated to use only 132 kWh per month when back-up power is needed.

A centralised solar water heating system could be considered for the servicing of the flats if the cost is pro rata to the size of the flat (as is currently being done with flats which have a central water meter).

The additional cost of about R6000 per unit is quite high considering the price of the overall homes, but with the expected high increase in electricity the operational cost will be much lower. On the overall project the electricity could be reduced from 390 MWh to 130MWh per month on average, but better results are expected.

Geyser Timer: Currently no geyser timer is installed at Stellendale. By installing a geyser timer in each of the units (R300) the water is heater by only connecting the electricity at specified times. This prevents water being heated throughout the day for no reason. Savings can be remarkable, depending on your hot water use characteristics; up to 30 or 40%. Installation is very simple and quick, but must be done by a qualified electrician because it involves working with 220V AC circuits. It is recommended that this be a battery operated timer to avoid time loss during power outages.

Compared to the cost of a solar water heater, this option is much more economical and would still be quite effective. It could even be provided for solar water heaters if permanent electricity back-up system is supplied. The down side of this option is that the home owner could reset the system and the potential electricity saving would then be lost.

Summary: If all the above interventions are implemented as outlined above for all 987 units in extension two of Stellendale, then the electricity usage is estimated to reduce from 1030 MWh to 393 MWh per month. This will reduce the associated carbon emissions from 1112 kg to 424 kg per month. The additional cost for this is calculated at R8110 per unit or just over R8 million for all 987 units.

3.2 Water:

An audit was done on the water usage at the show house, which was compared to baseline data for other projects. The following was noted:

Taps and toilets: Although the general norm is still to install free flow taps, all the internal hand basin taps at Stellendale are installed with aerators. Standard shower heads also lead to a higher water usage while the adaptable shower mixer at Stellendale assist with water conservation. A single flush toilet uses an estimated 9.5 litres of water per flush, while the duel flush toilets only use 5 litres of water.

Layout: The ineffective layout of units often lead to a dead leg in the water system, but Stellendale units specifically advocate an efficient layout which helps to avoid a dead leg and thus saves water.

Rainwater harvesting: Although the use of rainwater tanks were considered, this was not feasible due to the rainfall patterns for the area and the high density of the development. The water is however naturally fed back into the ground water system through soak away's which work well in this specific sandy area.

Provision has already been made for a secondary water system to enable only ground water used for irrigation. Once the second phase at Stellendale is completed then a borehole pump will be installed and used for irrigation of the development (refer to the civil services design report for details).

Other: Designated car wash bays, each with a water trap, shall be provided per block of flats and other high density housing units. External taps at the community centre shall be placed indoors to avoid any water wastage.

Summary: In a comparison between the base line data and the interventions mentioned above, a single unit can save about 1.5 kilolitres of water per month. If these interventions are implemented through the whole second phase, then an estimated 1500 kilo litres of water could be saved per month, or over 18 thousand kilo litres per year compared to the base line data.

3.3 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 making substantial savings on a building's electricity bill.

External walls: Cavity walls are standard specifications for Stellendale and they use Maxis (R78.29/m2). Cape Brick (R135.80/m2) was considered as an alternative due to the low embodied energy in the brick with 96.5% recycled material, but the actual insulation would not differ much.

Windows: Anodised aluminium windows are standard specification for all Stellendale units and ensure very good insulation.

Pipe insulation: Copper pipes were used previously used for water reticulation, but the Stellendale specifications have now been changed to multi-layer Uni-pipe. Due to this the need for pipe insulation is reduced because the thermal qualities of the pipe itself.

> *UNIPIPE multi-layer composite pipe consists of an overlapped, longitudinally welded aluminum pipe with an inner and outer layer of high temperature-resistant polyethylene according to DIN 16833. All layers are permanently bonded together by intermediate adhesive layers. A special welding technique ensures high reliability. The aluminum thickness for UNIPIPE has been specially selected to meet compressive and flexural strength requirements (http://www.unipipe.co.za/).*

Thermal roof insulation: Thermal roof insulation is generally not provided, but it is being considered for phase two at Stellendale as part of the energy efficiency initiative. Based on an average unit size of 55m2 and a cost of R14.25/m2, the estimated additional cost per unit would be about R780.

> *ISOTHERM THERMAL INSULATION is made from 100% thermally bonded, people-friendly polyester. The polyester fibre is produced from recycled PET bottles. The soft texture of ISOTHERM insulation makes it easy to roll out and cut to size. Pleasant to touch, ISOTHERM is simple and safe to install. No loose fibres or itching. It is non-allergenic, non-irritant and resilient. Providing excellent thermal and acoustic insulation, ISOTHERM is ideal for use in both roofs and walls.*
>
> *ISOTHERM is rolled and packaged in branded clear plastic film, which carries the Agrément South Africa logo as proof of its accreditation. It is Non-Toxic with no chemical additives, no odour or emissions of volatile organic compounds. Tested for Flammabilty at the CSIR in normal over-ceiling installation, the spread of flame was pronounced "negligible". (www.isotherm.co.za)*

Summary: It is not so easy to have an exact measurement of the effect that the insulation will have on the efficiency of the building, but with the implementation of all the interventions indicated above the building should have good thermal insulation, which will reduce the need for additional heating and cooling.

3.4 Finishes:

The finishes at Stellendale were also considered as part of the footprint. The specification for Stellendale indicates that the exterior paint should be a super grade acrylic PVA (water based with few volatiles) such as Tusk Marmoran, while Plascon

Polvin is used internally. The wood sealer and varnish is Weather Guard, which is used for the external wood fences and gates. Although natural water-based masonry sealer and wall paints were considered, no suitable local paint or coating was found.

Hard landscaping is restricted where possible and permeable landscaping is encouraged to allow the rainwater to seep back into the ground again.

3.5 Landscaping:

The landscaping at Stellendale specifically required indigenous trees that only need watering while they are settling down (first three years), where after they get enough water through the underground water system. Irrigation is however provided for the kikuyu grass, which is planted to discourage hard surfaces and encourage natural drainage. Although an indigenous ground cover such as *suurvy* was considered, it was decided to rather plant kikuyu grass in the public area where there is a high flow of people and cars as it was more durable and practical.

The following suggestions are also made around the redesign or renovation of the landscape to reduce water requirements:

- Create areas protected from the drying wind: Planting of windbreaks will shield smaller plants in the lee of the windbreak from the drying effect of harsh summer winds.
- Shaded areas use and transpire less water than areas exposed to the sun: By providing shade to planting, e.g. under shade trees, it would be possible for plants to survive with much less water than if they were placed in the direct sun. (A trellis with or without a vine growing on it will provide shade and not use as much water as a growing plant.)
- Providing more mulch around plants will conserve water over the effective lifetime of the plants: By providing more treated growing media around the base of plants, as would be the case, the plants have a longer period of time to send out roots into the new growing media. In water short areas this extra investment to provide more and better initial growing material for the plant may be entirely justified.
- Irrigation control: Increase control over water application by installing mechanized sprinkler systems and tensiometers to e.g. after relatively short periods of time (e.g. 5 min), water begins to run off from a specific area, the automatic irrigation system can be set to allow for 5min of water and then

shut off. Once this water has been absorbed into the soil, the irrigation system would automatically be turned on again to complete the watering time.

- Often the irrigation of an area is easier and more efficient if the landscape design initially recognizes and accepts the limitations of conventional equipment and configurations.
- By arranging plants whose roots grow to different depths arranged together, planting along natural drainage channels and terracing, the water falling on the site is used and reused efficiently.
- By using bubblers for trees in turf areas, the deeper roots of the trees are reached.
- Grade parking areas to accept run off for the shade trees planted in the parking areas.
- Collect water on site for reuse on the site. Berming can be used to direct water back to the site.
- Mulching depth is important: When using mulch, the layer should at least be 25mm thick to be effective. Mulch keeps water in the soil and prevents it from evaporating back into the atmosphere. It also prevents and or retards the grow of weeds which competes for available moisture and nutrients
- Grading should be done to provide gentle slopes and should be done to keep water on the site or to direct it to where it is needed or wanted e.g. depress turf areas next to pathways and curbs, to hold water.
- Too narrow planting areas should be avoided, as they are difficult to water efficiently without wasting water on run off on the adjacent paving. Simplified planting can be more easily irrigated.
- Permanent saucers to catch water around trees on a slope will allow extra water for the needs of the tree.
- Use less turf and more decking or permeable paving and mulch.
- Zone areas for lower and higher water needs.
- Staggered buildings will provide shade and windbreaks.
- Landscape maintenance is important e.g. good weed control methods to reduce water use.
- Use as many and as large as possible trees in public open spaces and along roads to increase carbon dioxide consumption

The cost implications of these suggestions need to be considered.

3.6 Transport:

Although transport could be considered as an external factor to a new property development, it still played an integral part of Stellendale. The first factor that should be considered is that a higher density development can provide the numbers which

could support a public transport system. A public transport intersection is being proposed at the entrance to Stellendale.

In addition to this, the Home Owners Association is promoting car pooling for the residents and considering a shuttle to the school and station for phase 2.

3.7 General Comments:

- The waste is currently being removed by the municipality via door-to-door 240 litre wheelie bin collection. If a **recycling** project is requested by the residents then the home owners association could make provision for a central recycling point of certain dry recycling items (glass, paper/cardboard), but this would have to be well managed to avoid any health issues.
- Stellendale phase one has already proven itself as a good product, but it still needs to be **affordable** and caution should be taken that the strive towards a greener development does not impact negatively on the overall sales of the units due to increased costs as many of the units are bought as investments and not as a primary residence.
- With a larger mix of houses (large, small and flats) and starting at a lower price within the property market might make it more **financial viable**.
- It is felt that the product should rather not be **marketed** as a green product unless it truly is measured as a green product. Avoid any green washing, but try to implement as many interventions as possible.
- **ASDL lines** are provided to all the units with 24 hour access, which allows residents to have effective internet communication and encourage them to work from home from time to time.

4. Implementation:

The following provides a brief summary of the specifications and finishes recommended for implementation as mitigating factors in the reduction of the carbon footprint of the development.

3.1 Energy:

The following energy efficiency interventions need to be implemented:

Element	Specification
Residential lights	CFL or LED lights – use natural light where possible
Street lights	High Pressure Sodium (HPS) – consider twin arc
Cooking	Stainless sell gas hob with electric oven
Solar Water Geyser	150 litre solar water geyser (2.1m^2 collector)
Geyser Timer	Install regardless of type of geyser (battery timer)

4.2 Water:

The following water conservation interventions need to be implemented:

Element	Specification
Taps and toilets	Current standard specs are all in order
Layout	Dead leg avoided during design phase already
Rain water harvesting	Rain water feeds back into the ground water. Borehole with pump to be installed at later stage.
Car wash bays	Provide car wash bays with water trap for high density housing units.
Community taps	External taps at the community centre to be indoors.

4.3 Insulation:

The following insulation interventions need to be implemented:

Element	Specification
External walls	Current standard specs are all in order
Windows	
Pipes	Insulation not required as Unipipe is used instead of copper
Thermal ceiling insulation	Provide Isotherm Ceiling insulation

4.4 Finishes:

The following insulation interventions need to be implemented:

Element	Specification
External wall paint	Current standard specs are all in order
Internal wall paint	
Wood sealer	
Driveways	

4.5 Other:

Landscaping, transport, affordability and accessibility also needs to be taken into account as motivated above.

5. Conclusion:

This report is based on a carbon footprint study done for Stellendale Extension 2, based on the initial specifications used in extension 1 and specifically observed at the show house. The purpose of the study and the report is to consider different options and make recommendations around the best way forward to reduce the carbon footprint of the development, specifically relating to energy efficiency over the long term.

The recommendations take into account the most energy efficient option based on the most cost effective option, with cognisance of any negative impact on the environment of people living in the homes.
Although the implementation of these recommendations would have a significant cost implication for the developer, it will also have a significant reduction in energy demand and energy use. With the proposed tariff increase by Eskom these products will also be paid off over a relatively short period of time.

If these recommendations are implemented, then the overall energy consumption of the development will be reduced in comparison to the initial development specifications and other similar developments in this price range. It is recommended that this be taken into account when the electricity connection is being considered by the municipality.

Grace Stead *11 April 2008*
grace@steadfastgreening.co.za