

SGP The GEF
Small Grants
Programme



tlholego
village

Ecological Design, Building and Construction Demonstration Project

(SAF/04/03)

SGP / Rucore Project Final Report

September 2008



The project aims to demonstrate energy efficient, low-cost building design particularly suited for adaptation to climate change in South Africa. The homes incorporate both active and passive solar design, on site sanitation, water recycling and food security gardening. This project aims to promote the dissemination of accessible, sustainable, climate-friendly technologies within the North West Province of South Africa.

Launched in 1992 as a programme of the Global Environment Facility (**GEF**), the Small Grants Programme (**SGP**) supports activities of non-governmental and community-based organizations in developing countries towards climate change abatement, conservation of biodiversity, protection of international waters, reduction of the impact of persistent organic pollutants and prevention of land degradation while generating sustainable livelihoods.

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This report was compiled by Paul Cohen and David Christer on behalf of the Tlholego Village and the Rural Educational Development Corporation (Rucore) for the SGP (2008).

1. Introduction

For South Africa to adapt to sustainability challenges, local economic, social and environmental solutions must be found and developed. Within a changing climate context this may require amongst other factors, linking innovation with community development, and awareness of global realities in relation to local knowledge and experience.

Specifically this work focuses on sustainable construction and the benefits this has in adapting to climate change. It will primarily involve building local capacity; raising public awareness of climate change and energy conservation and efficiency issues; and demonstrating and disseminating appropriate technologies and measures. The project may also illustrate the comparative cost of suitable technologies for communities by supporting applied and participatory research and development.

A key factor is to encourage self-sufficiency through the development of local solutions for meeting basic needs such as shelter, water, food, energy, health, security and jobs. Maximising the use of locally available resources and knowledge can assist this aim.

This report outlines the work of the Tlholego Village in developing a holistic approach to community development over the past 18 years and promotes the application of construction systems in the creation of sustainable communities and livelihoods. Although the material presented in this proposal is based on the development of the Tlholego Village, this is a model that supports a broader application within a wider framework of sustainability.

1.1 Project Background

This project was originally conceived under the Climate Change Focal Area of the GEF's Small Grants Programme and initiated between the SGP and the Tlholego Village, a project of the Rural Educational Development Corporation (Rucore) in 2004/5.

Aims

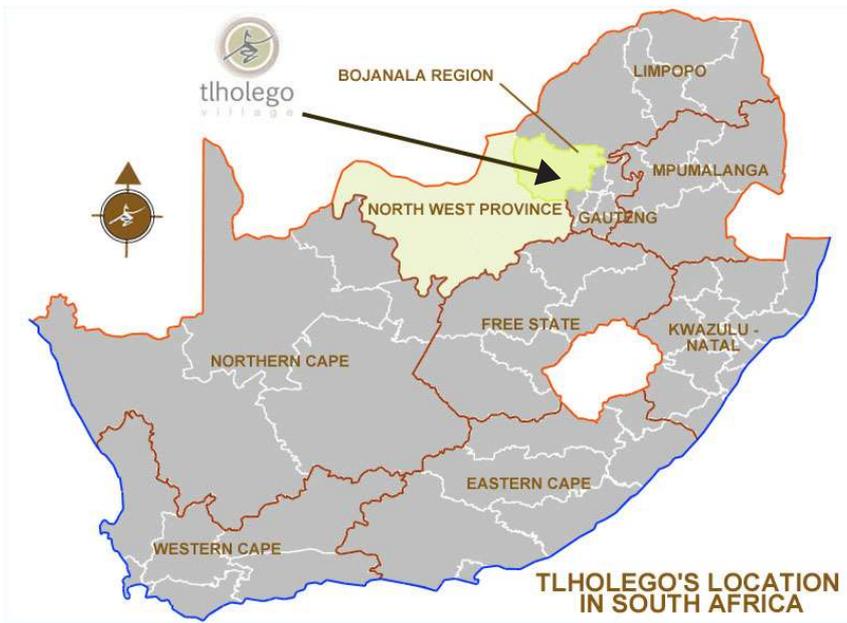
The overarching aims of the project are to:

- o **Promote** accessible, sustainable, climate-friendly technologies and measures throughout the Bojanala District Municipality, of the North West Province.
- o **Build** local capacity and raise public awareness of climate change and energy conservation and efficiency issues.
- o **Illustrate** the comparative cost of suitable technologies for communities by supporting applied and participatory research and development.

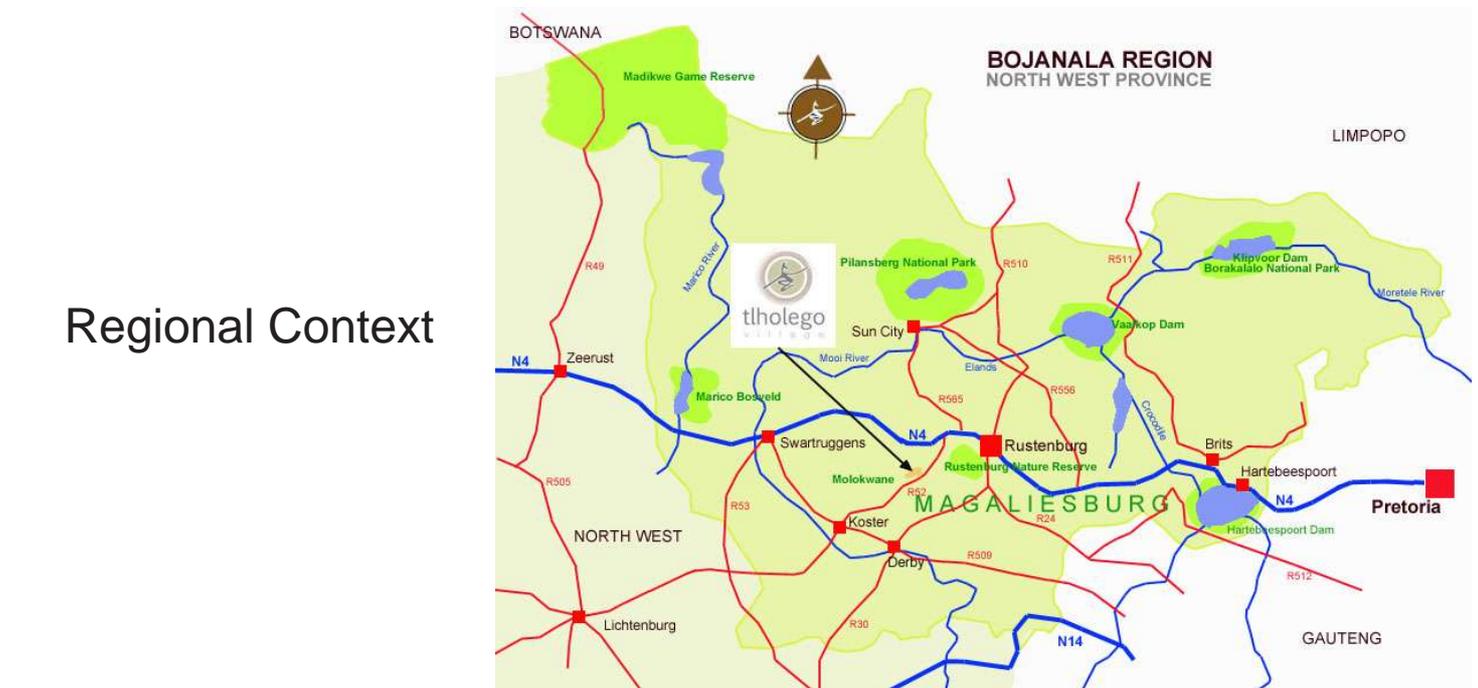
Objectives

The main project objectives are to:

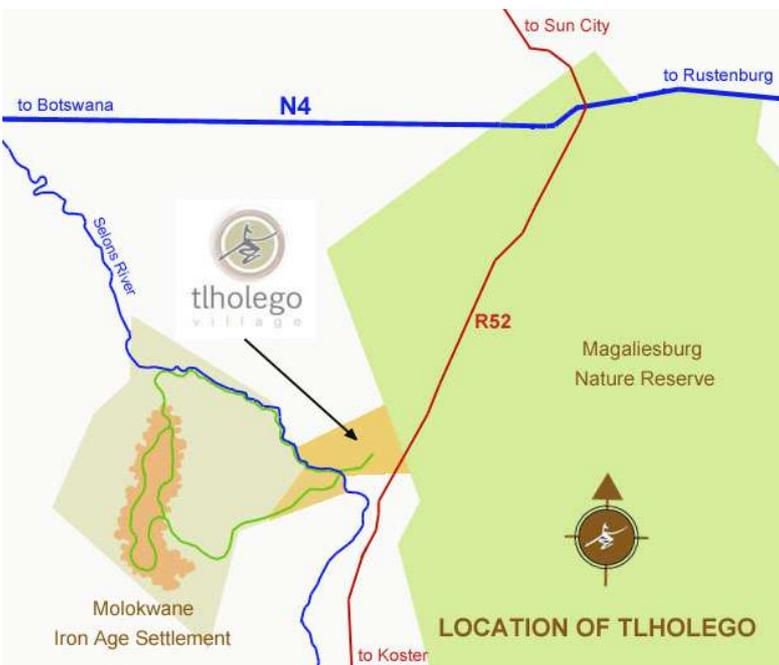
- o **Expose** local communities, officials, and decision makers to ecological design and construction methodology, practically demonstrating the components of a sustainable living environment.
- o **Develop** the biological aspects of the living environment including water management, permaculture food security gardening, small animals systems and vegetable production.
- o **Develop** a replicable sustainable livelihood settlement model, and prepare recommendations for larger scale implementation under comparable socio-economic and environmental conditions.



National Context



Regional Context



Local Context

Outputs

The expected outputs are:

- o **Design:** An ecologically advanced housing design, drawing its inspiration from indigenous form and providing an integrated solution for family sustainability.
In order to create a viable and desirable model, investment includes the costs for innovation. These initial research and development costs would be recovered through the benefits of wide scale replication.
- o **Construction:** The retrofitting of an existing substandard housing structure incorporating the latest in passive solar design, energy saving technology, water recycling and on-site sewage treatment.
The construction of a new dwelling, incorporating the latest in passive solar design, energy saving technology, water recycling and on-site sewage treatment.
- o **Workshops:** Political leaders, officials, community leaders, community members, development agencies, NGOs, and CBOs from the Bojanala Platinum District will be exposed to the sustainable building design and construction methodology and associated benefit through participatory workshops and exposure to the construction process.
- o **Communication:** Reports and communication documents will be made available which include skills transfer and empowerment strategies designed for replication of the project in applicable environmental and socio-economic circumstances.



A view of the Magaliesburg Mountain Range from Tlholego

2. Tlholego

The Tlholego Ecovillage was established in 1991 to address the challenge of rural sustainable development. The name Tlholego is a Setswana word meaning “creation from nature”.

Tlholego is situated on 150ha of land near Rustenburg in the Northwest Province of South Africa, and is strategically placed between the Magaliesburg Nature Reserve and the Molokwane Iron-Age heritage site. Tlholego lies within the platinum rich region of Bojanala where traditional livelihoods are competing with the rapid rate of development and urbanisation.

Tlholego has attracted thousands of visitors who seek inspiration for innovative approaches to sustainability challenges. The centre has evolved through a process of practicing, learning and teaching sustainable approaches to community development in a changing world. A “Living and Learning Centre” has been established at Tlholego to inspire both previously disadvantaged farm workers and urban dwellers towards

adopting more integral and sustainable lifestyles.

Tlholego works with leading organisations and professionals from Southern Africa and around the world to develop and refine their understanding and implementation of sustainable communities and rural livelihoods. Tlholego's main areas of experience relate to sustainable construction (housing and village planning) as well as related community self-reliance technologies including permaculture. As this report deals primarily with energy efficient construction technology this is where the focus will lie, whilst recognising the importance of support functions for sustainable communities that include, amongst other factors, food security and sustainable agriculture.

2.1 Sustainable Building Technologies

In 1994, the founding residents of Tlholego began their practical training in sustainable building technologies. A series of experimental buildings were constructed over the following two years. These included traditional 2000-year-old Tswana designs using earth and thatch as well as buildings constructed from large earth-filled bags with fired-brick dome roofs. Locally available and recycled materials were used for foundations, walls, floors and roofs.

In 1996, after accumulating experience with these methods, work began in partnership with Brian Woodward to develop the Tlholego Building System (TBS), a sustainable housing system for South Africa. Woodward is a world leader in low-cost owner-built housing, based in Earthways, Australia.

2.2 Eco-Homestead Workshop

An Eco-Homestead Design Workshop facilitated by Joseph Kennedy, from New College, California was held at Tlholego in November 2003. Joseph Kennedy is an eco-architect and an expert in natural building and ecological design. At the workshop a preliminary plan was drawn up for the expansion of the village to 22 units with provision for future development. The plan provided for tree planting and communal park areas, a community hall and cookhouse, a pre-school facility, a children's playground and an area for communal worship. Provision was made for the growing of indigenous medicinal plants and the planting of a woodlot to provide structural timbers and wood for fuel. Agro-forestry is planned along the northern boundary of the village.

2.3 Training

Over the years Tlholego has invested a large portion of its resources in establishing a training infrastructure. Tlholego has focused on mentoring programs, practical training programs, skills development and capacity building - mainly in sustainable construction and organic farming.

Tlholego has hosted many workshops and events relating to sustainable rural development in partnership with experts and organisations from around the world.

2.4 SGP / Tlholego Partnership

The SGP supports activities of non-governmental and community-based organizations in developing countries towards climate change abatement, conservation of biodiversity, protection of international waters, reduction of the impact of persistent organic pollutants and prevention of land degradation while generating sustainable livelihoods.

Tlholego has experience in the following areas:

- Traditional building systems
- Sustainable low cost housing technology (TBS)



tlholego
VILLAGE

- Planted Zone
- Wild / Planted Zone
- Residential
- Future Residential
- Commercial / Communal
- Parking

- Main Road
- Secondary Roads
- Paths
- Nature Trail



TLHOLEGO Village - Zoning Plan

To Tlholego Centre

- Eco-homestead design
- Organic farming and sustainable agriculture
- Water management
- Renewable energy
- Waste management
- Indigenous Knowledge (IK)

Based on their common areas of interest and expertise, a partnership was formed between the SGP and Tlholego (through Rucore - Rural Educational Development Corporation) in 2004/5 to further develop sustainable rural livelihoods through the implementation of improved construction systems.

Before covering the project proposals it is important to describe in more detail two areas of research that have been conducted at Tlholego that have a direct impact on the project. These are the research work in developing the Tlholego Building System and the design of the Eco-Homestead.

3. The Tlholego Building System (TBS)

The Tlholego Building System (TBS) forms the basis of this report. The TBS is a high quality and low cost housing solution that is well suited, but not exclusive, to the owner/builder. The building system provides a holistic approach to construction that has many benefits with regard to climate adaptation and self-reliant community infrastructure.

3.1 Introduction

The development of the Tlholego Building System started in 1996 when Tlholego entered into a partnership with Brian Woodward, from Earthways, Australia. The aim of the TBS was to offer a flexible, owner built, low cost, high quality, sustainable housing system for South Africa, as an appropriate alternative to what was currently available. A more effective approach to sustainable construction has been recognised in relation to the limitations within the national Government's low cost housing subsidy scheme and the utilisation of conventional building techniques and materials.

The Tlholego Building System (**TBS**) combines the principles of sustainable building with natural waste treatment and the permaculture approach for designing food self-reliance to produce an appropriate housing solution. Although the system was originally conceived to address the low end of the housing market, it is in fact applicable to all sections of the housing market. It is also flexible enough to accommodate conventional building materials.

In 1996 the Tlholego Development Project constructed a 4 room, 45 sq.m. house (TBS prototype 1) on its site where, the material costs were estimated to cost approximately R10,000. A 60 sq.m 6 room house (TBS prototype 2) is currently under construction. A third unit (TBS prototype 3) of 26 sq.m. has been built, with the option of extending it to a 4 room, 46 sq.m. house.

3.2 Conventional Low Cost Housing Systems

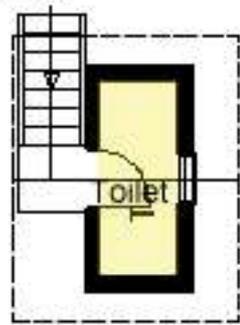
Most low cost housing systems achieve cost efficiency by using standard house design and standardised minimum cost materials. The efficiencies of scale (i.e. the production of large numbers of these standard design houses) are also used to minimise costs.

Governments and housing authorities generally accept these techniques as the best methods of producing low cost housing en masse. Large building companies and building material supply companies also like

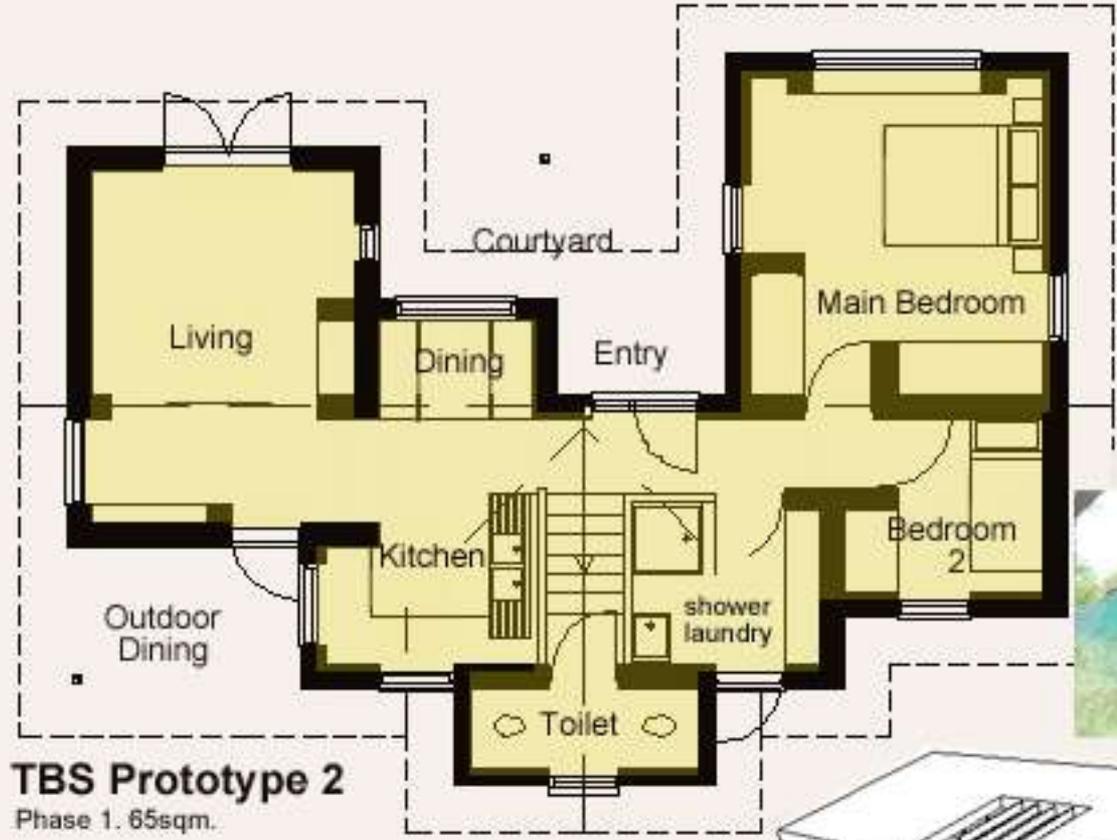


TBS Prototype 1

Phase 1: 45 sqm. Phases 1+2 54sqm.



Tlholego Building System (TBS)



TBS Prototype 2

Phase 1. 65sqm.



TBS Prototype 3

Phase 1 26sqm / Phases 1+2 47 sqm



this approach as it often equates with maximum profit through repetition.

3.3 Tlholego Building System Background

Most low cost houses produced are usually very low in thermal, environmental and aesthetic qualities. The thermal problems created by these designs can lead to major lifetime costs for heating and cooling both for the user and the environment. There are often low levels of satisfaction with the houses (often as a result of the houses being too small), from the end users, who are usually not consulted in the design process, let alone given alternatives. Often additions at a later date are not planned for and can be difficult.

The usual approach when developing a low cost building system is to choose conventional materials and techniques, which result in the largest floor area for a given amount of money. Components of a conventional building that are not considered essential are dispensed with.

The Tlholego Building System has resulted from a different approach that determines the minimum size and quality requirements necessary for a family home in South Africa. Ways are then investigated on how to construct this minimum house for the money available.

Tlholego's objective was to build a 4 roomed 45sq.m passive solar designed family home with shower, laundry, kitchen area, damp proofing, termite protection, insect screening, high quality surface finishes, on-site waste treatment and electricity in each room. Many of these components are not even included in large high cost houses in South Africa. The price limit was set at R8 000 when it was constructed in 1996, this was the 'top structure' portion of the 'site and services' approach.

From the inception of TBS the owner building option was chosen because of the cost savings it achieves. By selecting labour intensive but low cost techniques the material costs were reduced even further. Further savings could be achieved on a large project where group purchasing and economy of scale would apply.

3.4 An Innovative low cost, housing system

The TBS system aims to produce low cost housing without the deficiencies of the conventional model, while significantly addressing environmental and resource problems not usually considered in South African low cost housing. The TBS system incorporates flexibility, owner building, passive solar design, local materials and articulated walling.

o Flexibility

Conventional Low cost housing systems and flexibility are usually seen to be mutually exclusive. Cost constraints are often said to dictate standard designs and standardization of materials. This need not be the case. Limits can be set to the degree of flexibility, within a range of low cost alternatives for each element of the building. The TBS system offers choices from an expandable range of low cost alternatives for each element of the building, i.e. footings, walls, floors, roofs, windows, doors etc. Being expandable the system allows for the addition of extra alternatives, as new materials, new building techniques, or new building standards are developed.

If the cost implications of the different alternatives are clearly spelt out, then the owner/builder can make an informed choice, within a certain cost structure. This choice may be between different materials, based on cost or availability. The choice may be between quality or quantity - a larger, lower quality house or a smaller, higher quality house.

Further, by utilising a range of structurally stable wall shapes this offers the potential for anyone with

minimal design training to assemble house designs to suit particular situations, using the TBS articulated wall concept. The articulated method of construction facilitates phased construction or the extension of the unit at a later date as resources become available.

o Owner Built

The idea of using the sweat equity (labour) of the end user of the building (with local community support), to reduce costs is not new. It is generally recognised that up to 50% of the building costs can be saved by owner building even using conventional materials. The degree to which savings can be made is dependant on the skill of the owner builder and / or the degree of skill needed for particular building material or techniques.

Choosing materials and techniques particularly suited to the owner builder (i.e. easy to use or learn to use) will increase the amount of money saved. The size of cost savings can also be increased by the careful selection of locally available low cost materials that can be made or collected by the owner builder. While this building system is ideally suited to the owner builder, it is equally well suited to support the development of small and micro enterprises.

o Solar Design and Thermal Mass

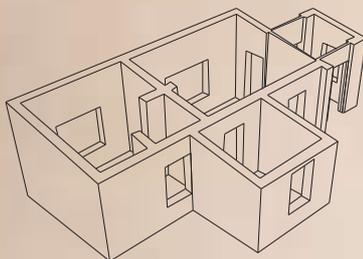
By introducing the design principles of passive solar design a house with a good thermal performance can be achieved. One of the basic principles of passive solar design is the use of wall materials of high thermal mass in order to mediate the extremes of temperature. These high thermal mass materials include burnt brick, concrete, stone, and earth, often referred to as masonry. These materials are usually susceptible to movement caused by site settlement or expansion or contraction of foundation materials.

o Conventional Wall Design

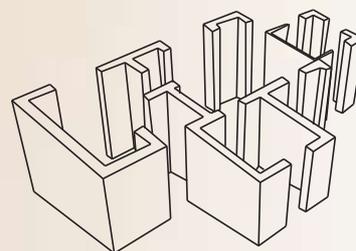
Conventional buildings using masonry are usually built with continuous interconnected walls with window and door openings being considered as holes in this continuous wall system. This type of building can lead to cracking problems in these materials particularly above doors, and above and below windows. In housing built for the middle to high income groups attempts are usually made to minimise this cracking by using large and expensive footing systems designed to reduce the effects of site movement. In low cost housing, footings are often minimal or none existent to reduce costs. Because of this there is a reluctance to use masonry materials in low cost housing as the materials themselves are seen to be expensive and they also require expensive footings.

o Articulated Wall Design

Another way to construct buildings using masonry is to use a system of wall articulation. This is where all door and window openings are designed as units which are the full height of the walls. Using this system no masonry is used above windows and doors. Masonry materials may be used below windows as long as they are not bonded into the walls either side (i.e. use a vertical joint).



Conventional Wall Design



Articulated Wall Design

If walls are kept to less than four meters in length, in most site situations, this system can eliminate the problem of cracks forming in masonry. The use of high cost footing systems can therefore be avoided. This is particularly useful when using mud brick masonry because independent walls can be finished quickly and individually protected from erosion before the roof is constructed. With an articulated walling system it is important to ensure all walls are structurally stable. In some cases this may mean the use of buttresses. By judicious placing and sizing of these buttresses there are opportunities to incorporate furniture, such as shelves or cupboards, into the wall recesses is possible.

3.5 TBS – Climate Change Advantages

The Tlholego model (including the TBS system) addresses the key objectives to ameliorate issues related to climate change and social upliftment, namely:

- Poverty eradication
- Changing unsustainable patterns of production and consumption
- Protecting and managing the natural resource base for economic and social development

The TBS system works to ensure the judicious use of resources and the minimisation of waste. Activities such as rainwater harvesting, local sourcing of materials and food, waste management and composting therefore form an integral part of the TBS system.

The TBS building design is based on passive solar design principles, which include optimum orientation, building mass for thermal storage, appropriate materials and construction technologies to provide more energy efficient and livable buildings.

The embodied energy in the construction of TBS houses is far less than in conventional buildings as the natural earth materials do not have to go through energy intensive fabrication processes associated with the manufacture of conventional building materials. A TBS unit has less embodied energy in the construction stage, is energy efficient during its occupancy and if demolished all the materials can be recycled. The TBS system is therefore less evasive and results in a far smaller carbon footprint throughout the building's lifecycle.

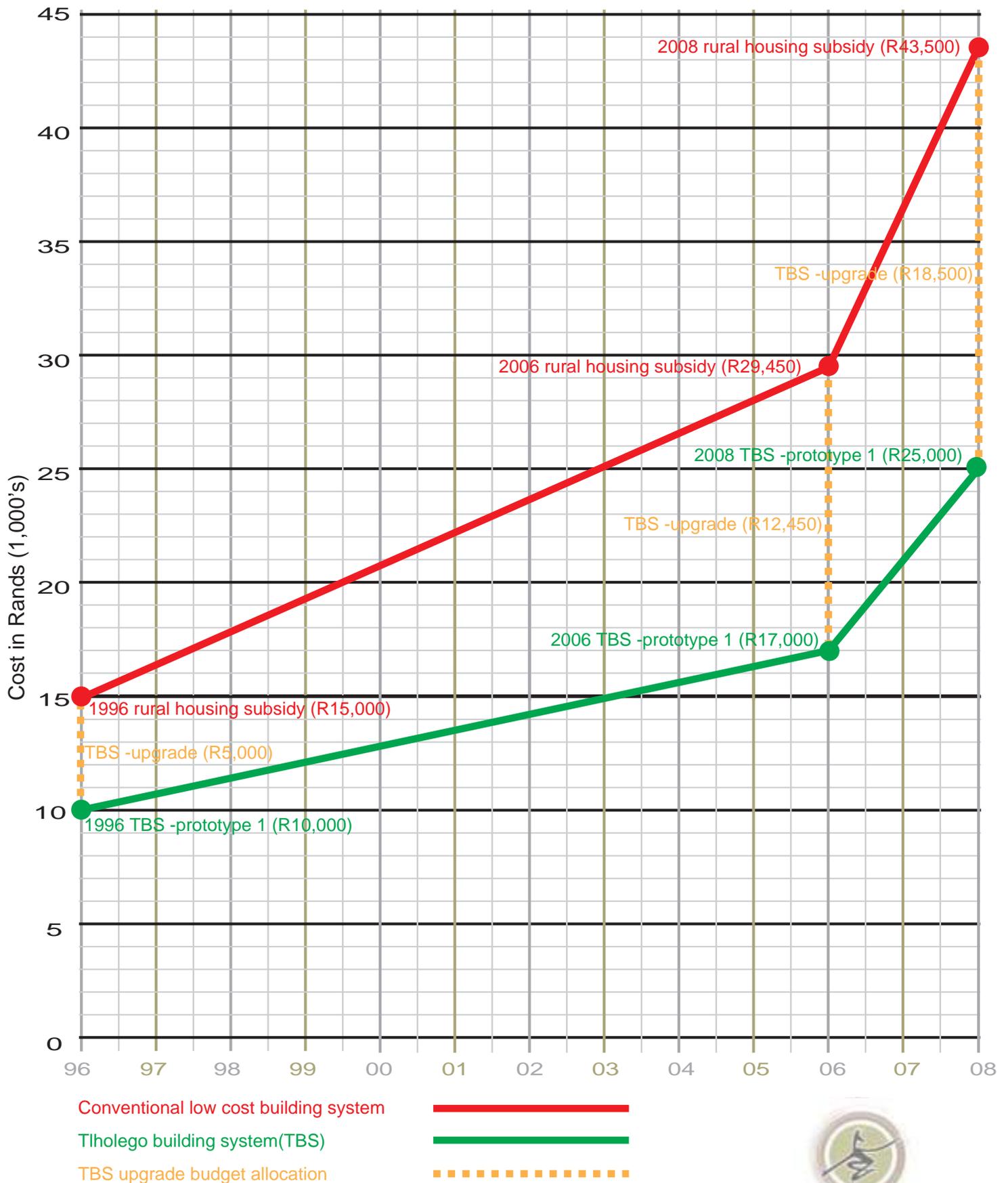
By Maximising the use of local skills, labour and materials the TBS system reduces transportation costs and the resultant environmental impact while developing a local skill and resource base that can be accessed for future building and maintenance.

3.6 TBS - Cost Advantages

Based on the accumulated information to date a general cost comparison was conducted to compare the costs of contemporary low cost building options such as RDP Housing with the TBS system. This was then related to the applicable government rural housing subsidy for a 40 sq. metre house.

In 1996 the Rural Housing Subsidy was R15 000 at a time when the TBS prototype 1 (45 sq. metres) was built for a basic cost of R10 000. This left a budget of R5 000 to upgrade the base unit, which was already attaining a higher standard of construction than a standard RDP house, as it had implemented passive solar design for energy efficiency and allowed more flexibility in the size and layout of the unit.

In 2006 the rural housing subsidy had been increased to R29 450 when the calculated price of a base TBS unit was R17 000. This left a remaining budget of R12 450 for the upgrading and retrofitting of the unit which allowed for better finishes, added security, solar heaters or a larger unit. Within the available subsidy a better quality and a larger unit could be built than using conventional building materials and methods.



Cost / Quality Comparisons between TBS and Conventional Low Cost Building Systems (based on a 40 sq.m.house)

In 2008 the rural housing subsidy has increased again to R43 500 and the estimated cost of a TBS (prototype 1) unit has risen to R25 000, leaving a budget of R18 500 for the building upgrade.

This cost saving is possible because of the TBS systems reliance on the use of locally available materials (earth-bricks, stone etc.) and the use of sweat equity or self-build. The TBS system does utilise conventional building components and materials such as roof sheeting, doors, windows, electrical units and plumbing, which means that it is also prone to market forces and inflation but not to the same extent as conventional building methods.

To ensure that an appropriate support structure is in place to assist self-builders, adequate training should be provided. Tlholego is consulting with tertiary institutions to establish accredited training and qualifications in sustainable construction. The completion of the cluster village and further expansion of the larger village will provide adequate opportunities for capacity building and skills development in this field of low cost housing. The principles adopted in the construction of a single dwelling can be applied to a larger community context to support a viable ecologically informed infrastructure.

4. Eco-Homestead

The groundwork that was done on the planning of the main Tlholego Village and Eco-Homestead has been expanded to reinforce the aims of this project to create a sustainable community. The revised Eco-Homestead design shows how the property can be developed to maximise the land available to generate an income and to be self sufficient in food production and energy provision. These principles can be directly applied to the project demonstration village, which is central to this report.

The Eco-Homestead has been designed for residents from Tlholego village (Sethanye and Mating Nakedi) for plots (lots 10 & 11) in the centre of the expanded village. They wanted to maximise the full potential of their land. Preliminary plans were drawn up of their proposed dwelling and a scheme was prepared for the development of the 2 sites, utilising appropriate technologies and permaculture principles.

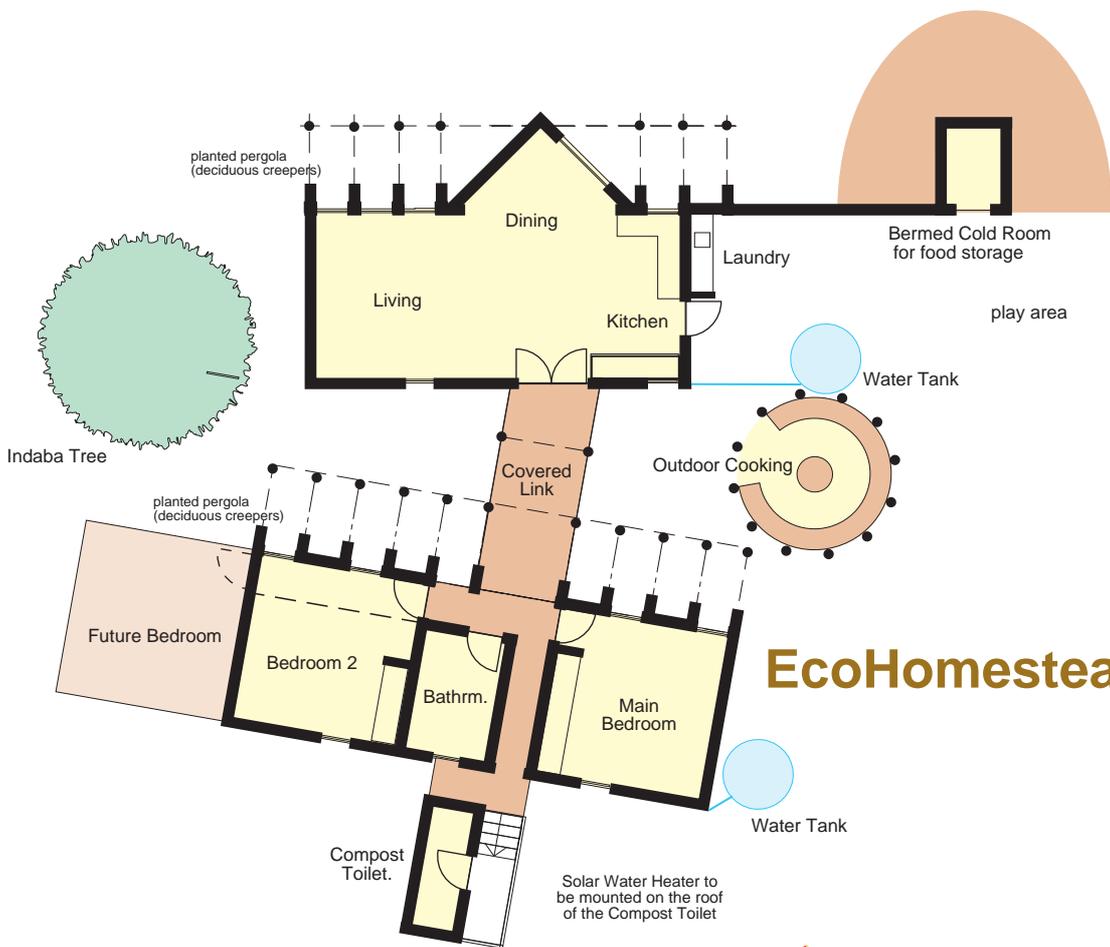
In the Department of Housing feasibility study on appropriate technologies and indigenous knowledge systems (2006), it is stated that the purpose of housing in a rural context is not just to provide a place to live as in the urban areas but it also has to provide the family with a sustainable livelihood. To achieve this aim the land available must be wisely utilised to provide a suitable dwelling, productive agriculture and income generating opportunities.

4.1 The House Design

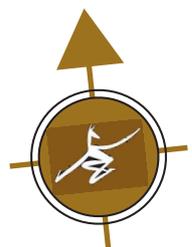
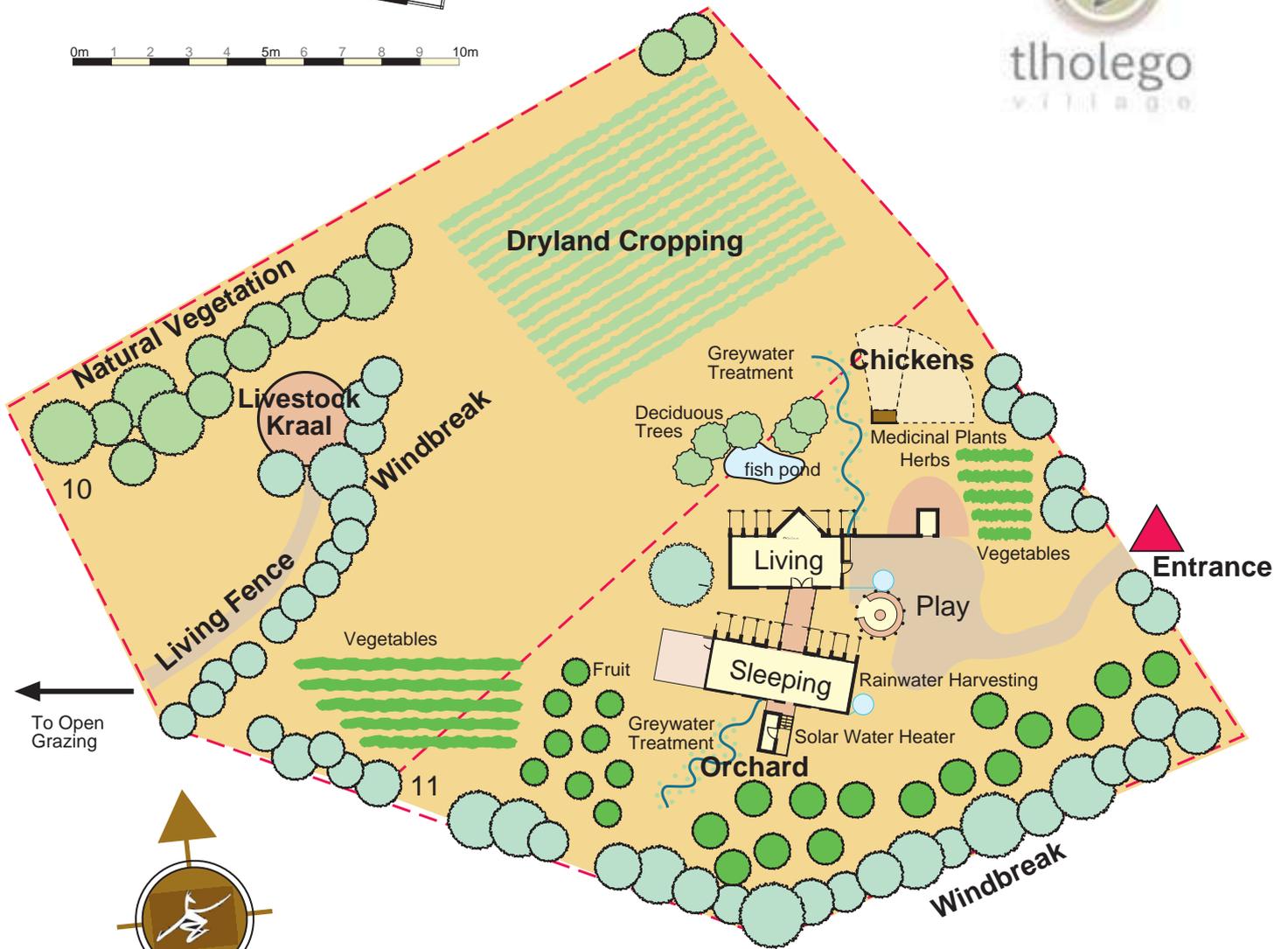
The Nakedi Homestead was designed using traditional layout principles which provide indoor / outdoor living options to accommodate the requirements of the immediate and extended family. In keeping with traditional homesteads it is a collection of separate buildings around outdoor living areas.

The house consists of two main buildings, a living unit to the north and a bedroom / bathroom unit to the south. The two buildings are linked by a covered walkway. The main living space is orientated 15° east of north to maximise the benefits of passive solar design, and limit the intense afternoon sun from the west.

Pergolas are built along the north elevations and are covered with deciduous creepers to shade the house in summer and allow the sun to enter the house in winter. Existing trees help to provide additional protection as well as suitable spaces for outdoor gatherings and meetings.



EcoHomestead Dwelling 1.



TLHOLEGO Village - EcoHomestead (on Plots 10 + 11)

Although a small kitchen has been provided inside the open plan living space, the Nakedi's requested an outdoor cooking area for every day use in good weather as well as for larger gatherings.

A laundry area has been designed outside the kitchen and a free-standing compost toilet is positioned south of the bedroom / bathroom unit. Provision has been made to build an additional bedroom at a later stage.

Rainwater will be harvested from the two roofs and stored in two water tanks, which will serve the kitchen and bathroom and be used for watering the garden. Greywater from the bathroom, laundry and kitchen will be directed for use in the gardens.

A below-ground cold room, next to the kitchen, has been provided for food storage. This earth-covered storeroom will maintain a regular temperature throughout the year and especially useful for food preservation and energy saving in times of increased heating.

4.2 Utilisation of the Land

To maximise the productivity of the site various agricultural activities have been suggested. Tree planting will be used as windbreaks while providing a source of fodder and fuel. Close to the dwelling vegetable gardens, herbs, and medicinal plants will be cultivated (some under shade netting to ensure better yields and protection for extreme climate events). A fruit orchard will be planted south of the dwelling.

To the north of the property land has been set aside for chickens, dryland cropping and a cattle kraal. The cattle will spend the day open grazing and will be brought back to the kraal at night.

Tree Planting.

Over the years many trees have been planted around Tlholego for shade, as wind breaks, for their fruit, fuel wood or to protect the soil. Woodlots have been planted with honey locust and black locust trees to produce fencing timber and firewood. Black locust is highly valued as firewood for efficient wood burning stoves as it burns slowly at a high heat with very little visible smoke or flame. The black and honey locusts are also rapid growing and are resilient to a variety of soil and climatic conditions. With fertilizer prices rising, the importance of black locust as a nitrogen-fixing species is also noteworthy.

This Eco-Homestead, together with the development of the cluster village will serve as a demonstration and testing project to assist in establishing specific guidelines for the future development of the village. It will afford an opportunity to develop appropriate solutions pertinent to climate adaptation in this particular location and further afield

5. Project Proposal

5.1 Project Overview

In response to the aims of the project to promote and disseminate accessible, sustainable, climate-friendly technologies and measures throughout the Bojanala District Municipality, it is necessary to develop the applicable technologies that can be applied in the region. Much of the groundwork has already been covered in the development of the TBS construction system, in conjunction with experience gained in eco-homestead design, sustainable livelihoods planning, indigenous knowledge systems (IKS) and permaculture self-reliance systems



Lapa



Roof Construction



Cookhouse



Housing



Composting Toilet



Building Workshop



Tswana Lapa



TBS type 2



TBS type 1

Sustainable Building Technology



The local community is involved in training, capacity building and awareness raising of climate change, energy conservation and efficiency issues. This has resulted in confidence assisted in the endeavour to promote the technologies and to aid in the training process.

The main focus of the project is therefore to develop the existing village at Tlholego into a fully functioning sustainable community that addresses important issues relating to appropriate construction technology and sustainable livelihoods. The partnership with the SGP has made it possible to take this next logical step in investigating improved solutions to infrastructure development and livelihoods. Initially the technologies will be applied to the Bojanala District but there is much scope to expand into other rural (and urban) communities.

One of the primary objectives of the project is to expose local communities, officials and decision makers to ecological design and construction methodology and to practically demonstrate the benefits and components of a sustainable living environment. The completion of the model village at Tlholego will aid and fast track this process, by enabling visitors and participants to engage in the building process and to experience the advantages firsthand. This process will also build capacity in water and waste management, permaculture food security gardening and sustainable energy technologies.

The village will provide a replicable sustainable livelihood settlement model and will allow for a larger scale implementation under comparable socio-economic and environmental conditions.

The proposed outputs of this project will be to build an ecologically advanced and affordable housing unit that supports an integrated solution for family sustainability. Three options will be developed and will include the following:

- Existing substandard housing in the village will be upgraded to meet acceptable ecological housing standards with regard to passive solar design, energy saving technology, water recycling and on-site sewage treatment.
- Existing TBS units will be refined to address minor concerns in the present design. These improvements in the TBS design will be incorporated into two new TBS units that will be built.
- Previous design work at Tlholego on eco-homesteads will be developed and incorporated into the design of the cluster village.

The project objective is for the housing units within the village to function within a support structure that will create a viable rural community. Cooperation will be vital in achieving this objective.

5.2 Project Location

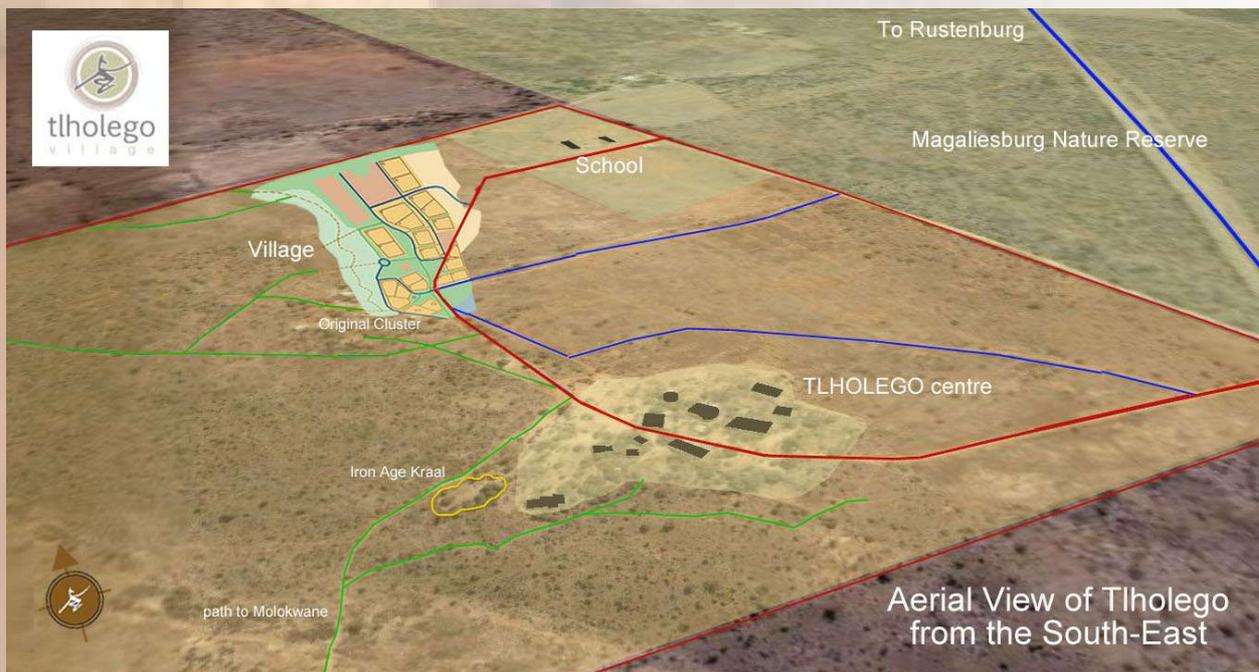
The existing cluster village will be the location for the project. The context of the village is indicated on the aerial photograph of Tlholego. This shows the existing Tlholego Training Centre in the foreground with the proposed village development a few hundred metres to the north on the road to the Tshedimosong Primary School in the background. The project village cluster is located to the south of the proposed main village development. The original village consists of 5 dwellings within 7 plots clustered around a central communal area.

The village was chosen as it allows all major design aspects of the project to be addressed. Within the existing village cluster are:

- 3 substandard units, which require upgrading

- 2 TBS units, which require minor improvements
- 2 empty stands on which the newly upgraded TBS units will be built.

This will create a first complete cluster of seven ecologically designed units that vary from a substandard upgrade to a purpose-built TBS unit. Together the seven units will form the initial demonstration village that will showcase the various technologies and principles required to support a sustainable community.



5.3 The Village Cluster

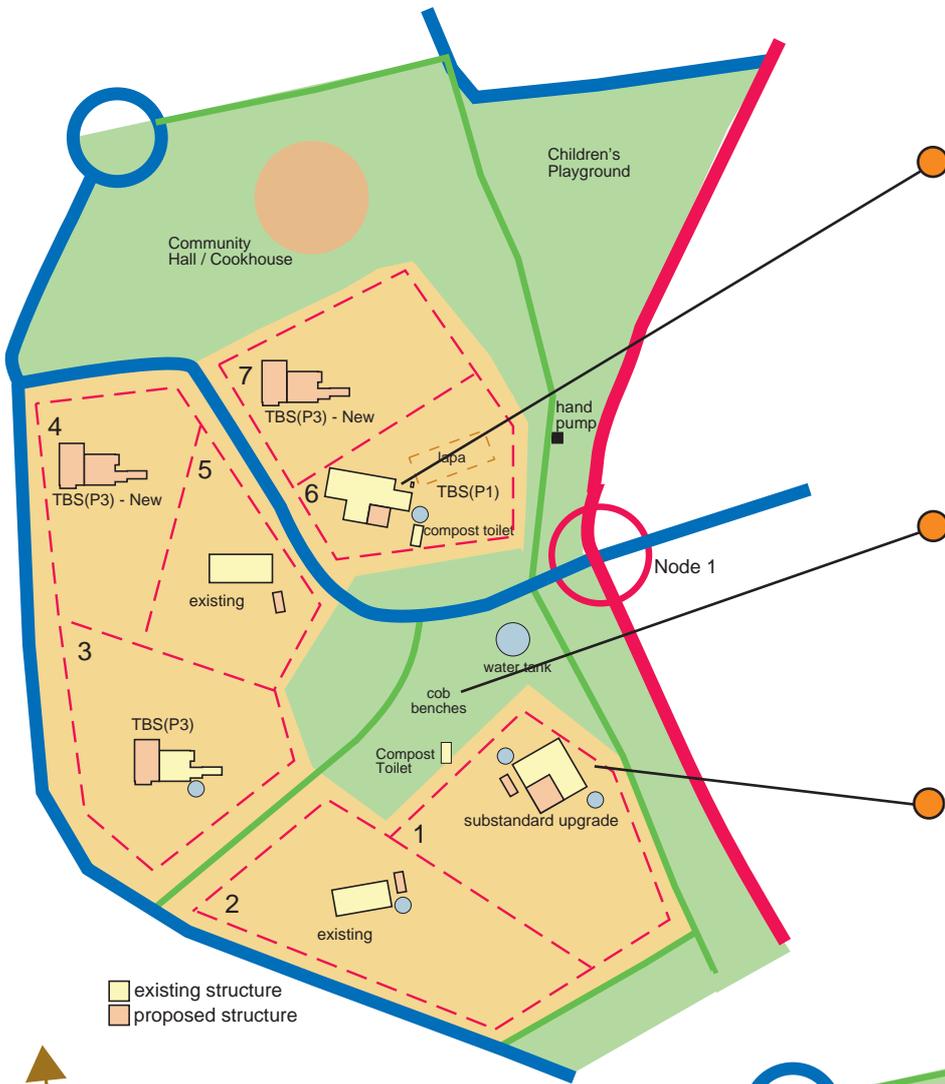
The objective is to upgrade and develop the existing village cluster to create a community hub that appropriately addresses issues relating to:

- sustainable housing
- climate change adaptation
- energy provision
- food security
- job creation

The initial priority will be the upgrading of the substandard units and completion of the original village cluster of 7 units. Improvements will be made to the 2 existing TBS units and 2 additional TBS units will be built.

Experience gathered from the completion of the original cluster will be applied to the construction of phase 2 of the village development which consists of a further 15 plots. Additional land located between the village and the school has been allocated for future growth, to bring the final complement within Tlholego Village to 36 units.

Based on Tlholego's experience in Sustainable Rural Development, relevant guidelines have been adopted to facilitate the creation of an appropriate village model. This is summarized in the diagram below.



TBS prototype 1 - Plot 6



Cob Bench - communal area



Substandard Unit - Plot 1



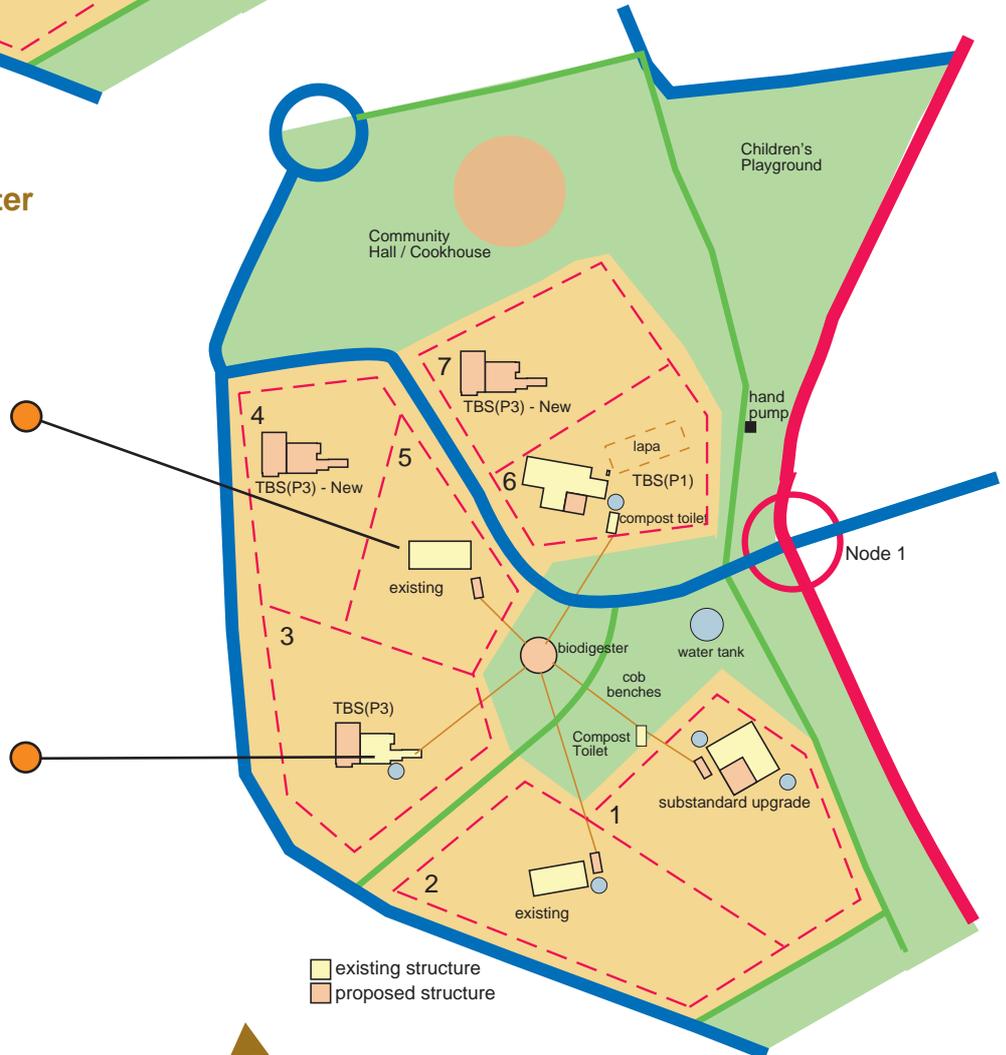
TLHOLEGO Village - Original Housing Cluster
(using individual Composting Toilets)



Substandard Unit - Plot 5



TBS prototype 3 - Plot 3



TLHOLEGO Village - Original Housing Cluster
(using central Biodigester)

5.4 Tlholego Sustainable Construction

The Tlholego Sustainable Construction framework (wheel) was developed to provide a graphic summary of the essential elements relating to sustainable construction. The concept of sustainable construction extends beyond the objective single dwelling and provides a general support mechanism for a healthy and viable community development process.

In the Tlholego example, the hub of the wheel is represented by the single dwelling that is located within the village cluster. The village cluster then lies within the larger village or town context. This can be replicated on a local, regional and national basis and the system can be adapted to similar scenarios outside of South Africa.

Initially Tlholego's primary influence will be within the Bojanala district in which it is situated, although it has relevance for implementation wherever there is a need for housing and climate adaptation. The Tlholego construction system can be adapted to provide suitable housing for higher income communities whether rural or urban. It provides an improved, practical and cost effective alternative to RDP housing by encouraging community involvement in the design, construction and maintenance.

The following elements are important to the success of the Tlholego construction system, which incorporates the TBS as the building technology.

- o **Energy Efficiency** – energy efficiency is enhanced by the introduction of passive solar building design practices (orientation, materials) and the use of renewable energy (solar, wind, bio-digesters). Solar water heaters have been installed on several of the buildings. Solar energy will be increasingly put to use as more affordable and efficient technologies become available. CFLs have replaced all standard light bulbs.

- o **Local Food Production** – provides an important supply of fresh and nutritious food primarily for food security purposes. Suitable food crops should be chosen to suit the local conditions. Some of the successful crops grown at Tlholego include: spinach, potatoes, onion, sweet potatoes, squash, butternut, carrots, tomatoes, peppers, green beans, pumpkin, chilies, garlic, beetroot and artichoke. The growing of local food using organic methods incorporates the use of perennial plants, including shrubs and trees for medicinal and food purposes, and these types of farming systems also sequester carbon.

- o **Water and Sanitation** – water as a critical resource must be used judiciously. Provision for rainwater harvesting is through guttering and rainwater tanks that are installed to all units. Land contouring, tree planting, groundcover and the building of swales (on contour channels) achieve additional rain collection and storage. Compost toilets, which require no water for safe management of human waste, are currently provided. Bio-digesters are also being installed as a valuable source of methane gas for cooking and to provide nutrients for bio-productivity.

- o **Technology and Training** – a key to the sustainability of the construction system is to constantly monitor the performance of the applied building technologies and to improve and adapt where required. Training is essential to ensure skills transfer and capacity building at the local community level (and beyond). Tlholego, as a technology and training centre, is working in conjunction with other organisations and tertiary institutions to further develop its sustainable building technologies.

- o **Health and Wellbeing** – a healthy community is a motivated and productive community. Tlholego

recognizes the importance of instilling self-worth; through promoting self-sufficiency, a healthy lifestyle, income generating projects, safe and secure housing and a local food supply. The HIV/AIDS pandemic has brought into focus the importance of supporting community wide processes, child-centred planning and a strong connection to the value of a healthy environment.



TLHOLEGO SUSTAINABLE CONSTRUCTION FRAMEWORK



o Waste equals Resource – wasteful practices cost money and are often harmful to the environment. Tlholego encourages reuse and recycling practices. Composted toilet waste is used for tree planting and vegetable waste is converted through animal systems into compost for food gardens. Waste separation at source simplifies this process.

o Local Economy – it is essential that the construction system makes financial sense and is affordable. This can be achieved by optimising the use of locally available resources such as skills, labour, energy and materials. It is important to promote self-sufficiency as well as an entrepreneurial spirit in the building

of a healthy and resilient local economy.

o **Culture and Community** – it is important to include all existing values, perspectives and skills available locally in the building of a sustainable community. Indigenous Knowledge Systems (IKS) as well as modern technologies are equally important in understanding and shaping local solutions to local problems.

o **Biodiversity** – the sustainability of a community is related to the health of the environment in which it is located. Enhancing biodiversity and the preservation of natural habitats is therefore encouraged through implementation and monitoring programs. Enhancing agro-biodiversity, for similar reasons, is also encouraged.

o **Transport** – inappropriate and poorly managed transport options lead to increased costs (financial and environmental). Locally based businesses reduce the need for daily commutes. The use of public transport is encouraged and shared vehicle rides help provide adequate transport. Alternatives to fossil-fueled transport are being investigated and for short distances pedal-power and donkey drawn vehicles are presenting themselves as viable options.

5.5 Substandard Unit Upgrading

Although there are three substandard dwelling units in the original village cluster, only the existing dwelling on plot 1 will be discussed in detail in this report. Solutions for this unit will be applied to the two other dwellings on plots 2 and 3.

The existing L-shaped, 3 room building is a hollow concrete block structure with a low-pitch corrugated iron roof. The 2 primary facades of the building face north-west and north-east respectively, these are the only facades with windows. The only door is to the rear of the building facing the south-west. A small corrugated iron cooking structure is located about 20 metres away from the main structure.

Substandard issues to be addressed

- o The roof pitch is too low and is prone to leaking
- o The walls and roof are not insulated which results in overheating in summer and excessive cold in winter
- o There is no shading to prevent direct sunlight entering the building in summer
- o The entrance door is not sheltered
- o The kitchen is not integrated into the building and creates problems in inclement weather
- o There is no provision for the harvesting or storage of rainwater off the roof
- o There is poor natural ventilation
- o There is no electricity in the building
- o There is no water provision to the building
- o There is no toilet in the dwelling

The house is not ideally orientated in accordance with passive solar design principles and the building is generally of a low standard. It is therefore debatable whether the existing building should be upgraded or whether it should be demolished and the salvaged materials be incorporated into a new structure. It was decided after carefully weighing up the pros and cons that it would be preferable to retain and upgrade the existing structure, as it would be the more affordable of the 2 options, and will cause the least disruption to the occupants. It will also act as a test case for future upgrading and renovation.



existing roof anchor - barbed-wire around a rock



Upgrading of a Substandard House in the Original Village Cluster (on plot 1.)



Northern View showing increased roof pitch, shading pergolas gutters and rainwater tanks and new NW facing window.



North-West aerial view showing the kitchen extension and new composting toilet

South-East view showing new covered entrance with kitchen (with volcano boiler) and shower room (behind screen), gutters and rainwater tank are also shown

Existing view from the South-East





Upgrading
of a Substandard
House in the
Original Village
Cluster (on plot1.)



North-East elevation showing increased roof pitch; shading pergola, gutters and rainwater tank



South-West view showing new covered entrance with kitchen (with volcano boiler) and shower room, and new composting toilet. Rainwater is harvested and stored in 2 rainwater tanks.

existing
outdoor kitchen



To address the identified short-comings of the existing structure the following improvements are proposed:

- The existing roof would be increased to a slope of 15°, this will necessitate the removal of the roof sheeting and roof beams while the ridge and side walls are increased in height. Before the corrugated sheet roofing is fixed in place, a reed ceiling will be installed on which will be laid a 100mm layer of cob insulation. The roof cavity above the ceiling will be ventilated to prevent heat build-up in summer.
- New windows are to be added to the north-west and south-west elevations to add light and improve the ventilation in the building. The small window near the entrance door will provide a visual link with the new outdoor living area.
- Pergolas will be built to shade the windows on the North-west and North-east elevations. Deciduous creepers will be planted over the pergolas to provide shade in summer, while allowing sun penetration in winter.
- The area outside the entrance door will be covered with a corrugated sheet roofing to match the new roof. This will provide shelter to the entrance and provide accommodation for a new outdoor kitchen and shower room. A wash-tub will be installed in the shower room for general washing purposes and for laundry.
- Gutters will be installed to the North-east and South-west elevations for the collection of rainwater which will be stored in 2 rainwater tanks.
- Low-level ventilation openings will be installed to the south of the building to generate the natural circulation of cooler air.
- The dwelling will be linked to the existing Eskom power-line to provide electricity, although options will be investigated to ensure that there are affordable and alternative energy sources that are not solely dependent on the Eskom grid. These options will include solar and bio-digesters.
- Water will be sourced from the new rainwater tanks. Hot water will be provided by the volcano boiler, which will be installed above the outside fireplace in the new kitchen.
- A compost toilet will be built with the option of linking the toilet to a communal bio-digester at a later stage.

5.6 Application of TBS

The Tlholego building system (TBS) has been successfully tried and tested over the past 12 years and offers a viable advancement in appropriate, low cost housing. TBS provides a high standard, energy efficient building that has a low carbon footprint during the construction phase and during the lifetime of the building. It utilises locally available building materials, skills and labour which significantly reduce the cost of the building. The building system is flexible to allow for a variety of plan layouts that can be based on the particular needs of the owner/builder. It therefore affords a sound environmental, social and financial solution to the housing shortage in South Africa. It is a system that can be successfully applied to both the rural and urban context. Tlholego is in discussion with local authorities and mining companies to investigate how the TBS can assist in addressing their current and growing housing shortages.

The TBS system requires the support of a training facility to disseminate the required building skills. This facility will be established at Tlholego and will provide accredited training courses and practical workshops.

The next logical stage is to extend the TBS from a stand-alone unit to being a stimulus within a village cluster that facilitates sustainable livelihoods. The proposal is to develop the original village cluster at Tlholego as a demonstration and training project. This will be an opportunity to investigate how to:

- upgrade the existing substandard units to meet acceptable, energy efficient living criteria
- improve on the TBS technology
- develop the village cluster to support sustainable livelihoods and establish a model which can be replicated
- integrate appropriate indigenous knowledge (including indigenous technical knowledge)
- adapt and mitigate the negative affects of climate change

5.7 Upgrading of the TBS units

The Tlholego Building System (TBS) units provide high quality housing that utilise locally available natural materials that minimise the carbon emissions during the construction and lifetime of the building, and therefore have substantial environmental benefits over conventional housing. It has proved to be an appropriate and durable option for sustainable rural housing.

To date the following 3 TBS proto-type housing options have been developed.

- Prototype 1. - 45 sq. m. with free-standing composting toilet (with additional room - 54 sq. m.)
- Prototype 2. - 65 sq. m. with integrated composting toilet
- Prototype 3. - 26 sq. m. with attached composting toilet.(with additional 2 rooms - 47 sq. m.)

The building technology has evolved and been improved based on the performance of the earlier units. The buildings have performed well regarding climate control, energy efficiency and waste reuse and disposal.

The following issues are to be addressed

- The units are presently vulnerable to burglaries as there is no security over the windows and so a suitable solution is required.
- The present solution (using ant-caps) to prevent the ingress of termites has proved to be inconvenient and labour intensive and an alternative solution is sought.
- The present wall finish could be improved in appearance and durability.

Security

To improve the general security around the periphery of the Tlholego property it is suggested that the area be fenced and that ostriches are introduced to act as "watchdogs" to deter intruders, while also providing a local food and income source. The village will be planned in housing clusters to enable effective neighbourhood surveillance. Various low-cost deterrents to secure the actual dwellings are being investigated. These include the growing of spiky plants under the windows such as prickly pears or sisal, these will have the dual benefits of providing fruit and fibres while improving security.

A preferred and more permanent solution will be to improve the window security by installing burglar proofing. The burglar proofing will be made from pre-manufactured welded mild steel (8mm diameter) reinforcing mesh (@ 200mm centres). This will be built into the masonry prior to the installation of the glass and window frames. The use of pre-manufactured steel mesh results in :

- Easier site control and less skills required on site
- Quicker installation compared to that of conventional security systems.
- Better finishing and regular spacing

The reinforcing mesh comes in panels of 6.0m. x 2.4m. and the window sizes will be designed in standard

modules to minimise wastage.

Timber Treatment

The present solution to prevent the ingress of termites into the houses is to install a galvanized iron ant-cap (on plastic d.p.c.) around the external walling approximately 150mm above ground level. Although this has proved successful it is a labour intensive exercise and the profiles have to be bent off-site to ensure accuracy. An easier option to the ant-caps is to use treated timber.

South African plantation timber is not durable and requires treatment to protect it against fungi and insects. The preservative options currently available are:

- CCA (copper, chrome, arsenate)
- Boron
- TBTO (lindane)
- Creosote

CCA and creosote are the most cost effective options with CCA the most widely used. CCA undergoes stringent testing and has to adhere to SABS standards and it is considered safe and not harmful to the environment. It is therefore intended to utilise CCA treated timber in future units in lieu of the ant-caps that were used in the earlier TBS houses. Boron treatment is another option that will be investigated for suitability and cost effectiveness.

Wall Finishes

To improve on the durability and appearance of the mudbrick external walls, the new TBS units are to be finished with a durable lime render. Various natural colourants will be tested to provide the desired wall colours.

5.8 Community Participation

Empowerment is a crucial factor that makes development sustainable; it implies a shift of control towards the people who actually do the core work.

The transfer of skills and knowledge resulting from community participation is critical to the rapid development of human capacity upon which the implementation of sustainable construction is dependent.

Through community collaboration the building can become a joint community effort. The building is no longer seen as just an end result or a product but rather as a process of empowerment, which can become the basis of sustainable development. Through direct involvement in the design and construction process, local communities can rapidly become empowered and skilled.

The greatest potential for a building project to become a vehicle of community empowerment lies in its ability to build capacity through skills transfer on a variety of levels. To improve living conditions on a broader scale and enable members of disadvantaged communities to become more self-sufficient, the provision of training and human resource development must be conceptualised on a broader and more systematically organised level. It should also address food security, energy efficiency, waste disposal and economic livelihoods. Training should be open to the general community and not restricted to those directly involved in the building process. To ensure a more effective involvement of informed community participants in the future, it is suggested that workshops be organised for the children so that they can appreciate the need for sustainable solutions and prepare the groundwork for future development.



African potato



Artichoke



Medicinal Plants



Butternut



Beetroot



Squash



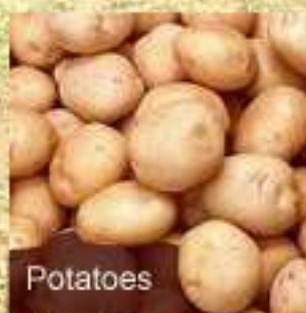
Edible Flowers



Garlic



Herbs



Potatoes



Camomile



Olives



Pumpkin



Pomegranates

Sustainable Food Security

Capacity building can also be made more effective through improved communication and collaboration among the local government authorities, mining organisations, local training organisations and educational institutions. It is with this in mind that Tlholego is building partnerships with prospective role players in the Rustenburg area.

6. Future Plans

The overall objective of the Tlholego village is to promote an integral approach to sustainable development in South Africa that is guided by our national integrated sustainable rural development strategy, government policies on climate change, sustainable rural development and the millennium development goals.

By empowering rural communities to take a leading role in enterprise and community development, we are in effect building the foundations for a healthier future. Tlholego's focus on livelihoods based on sustainable construction, organic farming and enterprise rooted in community development is about finding solutions to the challenges of sustainability and development in South Africa. In this way these proposals hope to provide unique solutions for sustainability that are adapted to African life conditions.

To achieve these aims it is vital to realise the full potential of utilising the TBS technology within a larger ecologically informed infrastructure to provide and support the creation of viable, self-sufficient rural (and urban) communities. This is best achieved by establishing a working example of a sustainable rural village that demonstrates the practical advantages of directly involving the local community in the design and construction process and the importance of following sound environmental, economic and social principles.

The provision of RDP housing is an unsatisfactory short-term solution to the country's housing shortage, as it doesn't address the long-term social needs of its occupants; it is a system that allows limited flexibility and produces inadequate accommodation that is not energy efficient. Many RDP houses are poorly constructed and are not a viable investment.

A more sustainable alternative is urgently sought and the Tlholego model can address many of the shortfalls in the RDP system while also establishing a healthy and productive community. In promoting the Tlholego model the following initiatives are proposed:

- o **Workshops** will be organised for local government and industry to demonstrate the benefits of implementing the Tlholego model on providing a sustainable ecologically based housing infrastructure and community building.

- o **Partnerships** will be established with government, local mining companies, industry and NGO's to further the implementation of sustainable rural development.

- o **Training** - Tlholego will be developed as a leading innovative and appropriate training and technology centre. Emphasis will be placed on the promotion and utilisation of indigenous knowledge systems and affordable appropriate technologies.

- o **Funding** will be sourced and work will commence on the upgrading and completion of the Tlholego village cluster. The completion of the cluster will provide valuable opportunities for training and capacity building, and provide a valuable working example of the benefits of implementing low cost and sustainable

housing and livelihood solutions.

- There will be a phased development of the main village to its full complement of approximately 36 units. The development will include communal facilities including a community hall and cookhouse, a pre-school, a church hall and a children's playground.



TBS Unit under construction

In Conclusion

The groundwork has been done regarding the development of an appropriate low cost housing solution in the TBS construction system. The system has been tried and tested and improved over the last 12 years and has been shown to be a high quality, flexible and cost effective solution in the provision of sustainable low cost housing. In addition to providing a durable energy efficient home it also involves the community in the design and construction of the dwelling and the extended cluster or village with the aim of empowering the community and extending their skills base to create sustainable livelihoods.

It is now essential to complete the village cluster so that the Tlholego construction principles can be applied and tested. The TBS model has proved a success as a free-standing structure. It is now necessary to extend the principles to support a larger community infrastructure. This will provide a valuable demonstration project, which will inform future low cost, high quality residential developments both in the rural and urban context.

To realise these aims Tlholego must partner with other important players to secure the necessary cooperation and resourcing that is necessary to complete the project and to apply the technology in a wider context.

There is clearly a vast demand for an affordable housing option to that which is provided by current RDP housing options. The TBS / Tlholego model provides a viable option that engenders self-sufficiency and

a higher quality of life for both individuals as well as collectives. At the same time the TBS is an important technology in terms of climate adaption at a local community level as well as for lowering of greenhouse gas emissions at the global scale.

In South Africa today, some of our most pressing problems include those of poverty, social and economic inequalities, environmental degradation and volatile financial markets. For the past 18 years Tlholego has been developing solutions to these challenges and is now in a position to address these concerns in a far greater context. Through the formation of appropriate partnerships, Tlholego aims to further its technological advancement and capacity building programs through practical working real life examples in our local communities.

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