Makana Municipality
Local Environmental Action Plan
Comprehensive Audit Report
Part III: Domestic Energy, Solar Power and Waste Management
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1. USE OF DOMESTIC ENERGY IN MAKANA WITH EMPHASIS ON FUELWOOD

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1.1 EXECUTIVE SUMMARY

The energy sector in South Africa has both first world and third world elements. On the one hand South Africa produces and consumes over 60% of the electricity on the African continent and is the twelfth highest carbon emitter in the world. One the other hand, almost half of South African households use fuelwood energy to a greater or less degree. Even with the substantial household electrification programmes in the last ten years and one of the lowest electricity prices in the world to local consumers, most newly electrified households continue to use fuelwood because they cannot afford the appliances and/or the monthly costs.

A household energy audit was conducted in Riebeeck East, Alicedale and Grahamstown East. Households were selected randomly from municipal survey maps. At each randomly selected household a pre-prepared structured interview schedule was conducted in either Xhosa or Afrikaans, whichever was the home language of the respondent.

Most households in Makana use a variety of energy forms within the domestic setting. Electricity is the primary and preferred source for lighting. This is backed up with candles during times when the electricity power is interrupted, or when households cannot afford to buy electricity, especially towards the end of the month. Paraffin is also used instead of candles, and is commonly used by houses as yet unelectrified.

In terms of cooking, paraffin and electricity are dominant forms within households in Alicedale and Grahamstown East, whilst in Riebeeck East fuelwood is second to paraffin. Many users of fuelwood in Grahamstown East said that they used it relatively irregularly, either for recreational braais, or for brewing of traditional beer and at traditional ceremonies.

1.2 INTRODUCTION

Internationally, and in southern Africa the poorest and most vulnerable communities and households use of fuelwood with only limited use of other energy forms. Remote rural communities still rely extensively on fuelwood. With increasing modernity and household income, there is a shift towards more modern fuels such as paraffin, gas and electricity, but not to the total exclusion of fuelwood. In South Africa, over half the households still use fuelwood. Mean annual consumption is approximately 3 – 4 tonnes per user household, with a national gross direct-use value of R 3 - 4 billion annually. Fuelwood trading also provides jobs and income. Within the wider southern African region approximately 60% of total energy need is met through fuelwood or charcoal, and the absolute number of people using biomass fuels in southern Africa is expected to increase by as much as 50% within the next 25 years (Biggs *et al*. 2004).

We used a questionnaire survey to study the use of domestic energy in Makana with emphasis on fuelwood. Our study attempted to answer the following questions:

1. What energy forms do households use in Makana?
2. What are the patterns in fuelwood use in Makana?
3. What is the perceived availability of fuelwood?
4. What is the value of fuelwood used?

1.3 METHODS

A household energy audit was conducted in Riebeeck East, Alicedale and Grahamstown East. Households were selected randomly from municipal survey maps. So far 171 households have been interviewed, 34 in Riebeeck East, 61 in Alicedale and 76 in Grahamstown East. At each randomly selected household a pre-prepared structured interview schedule was conducted in either Xhosa or Afrikaans, whichever was the home language of the respondent.

1.4 RESULTS AND DISCUSSION

1.4.1 Household energy forms

Most households in Makana use a variety of energy forms within the domestic setting (Table 1). Electricity is the primary and preferred source for lighting. This is backed up with candles during times when the electricity power is interrupted, or when households cannot afford to buy electricity, especially towards the end of the month. Paraffin is also used instead of candles, and is commonly used by houses as yet unelectrified.

Table 1. Proportions (%) of households using different energy forms for lighting, cooking and heating.

	Riebeeck East			**Alicedale**			**Grahamstown East**		
	Lighting	Cooking	Heating	Lighting	Cooking	Heating	Lighting	Cooking	Heating
Electricity	91	27	6	97	84	8	84	71	1
Paraffin	41	82	15	48	80	56	33	88	74
Candles	56	0	0	61	0	0	47	0	0
Fuelwood	0	77	82	0	69	56	0	41	28
Dung	0	24	6	0	0	0	0	1	0
Residues	0	3	3	0	2	0	0	3	0
Dry batteries	6	0	0	7	0	0	3	0	0
Gas	0	0	0	0	5	0	1	9	1

In terms of cooking, paraffin and electricity are dominant forms within households in Alicedale and Grahamstown East, whilst in Riebeeck East fuelwood is second to paraffin. Many users of fuelwood in Grahamstown East said that they used it relatively irregularly, either for recreational braais, or for brewing of traditional beer and at traditional ceremonies.

1.4.2 Fuelwood use

Of those households using fuelwood, daily household and per capita consumption was highest at Alicedale and lowest at Grahamstown East (Table 2). The greater household consumption at Alicedale can seemingly be explained by the larger household size, but not so the per capita consumption. The frequency of fuelwood collection trips per week is highest in Riebeeck East. Estimated yearly demand by fuelwood users was highest at Riebeeck East because of the greater frequency of use, and least in Grahamstown East.

Table 2. Consumption of fuelwood amongst user households (mean ± SE), excluding those who use it only for rituals a few times per year.

		Riebeeck East	Alicedale	Grahamstown East
No. of people per hh[1]		3.8 ± 0.37	4.9 ± 0.28	4.5 ± 0.22
No. of fuelwood collection trips per week	summer	2.0 ± 0.4	1.0 ± 0.2	1.8 ± 0.2
	winter	3.4 ± 0.5	2.7 ± 0.3	2.4 ± 0.2
No. of days per week on which fuelwood is used per using hh	summer	2.8 ± 0.5	1.6 ± 0.3	1.0 ± 0.3
	winter	4.5 ± 0.7	5.0 ± 0.6	2.0 ± 0.4
Daily hh fuelwood use when using (kg)		11.4 ± 1.5	15.0 ± 2.3	5.0 ± 0.6
Daily fuelwood use per capita when using (kg)		3.4 ± 0.9	3.6 ± 1.6	1.4 ± 0.3
Calculated yearly demand (kg) (assuming winter is 135 days)	per hh	2 038	2 235	357
	per capita	536.3	456.1	79.3

[1]hh is abbreviation for household

1.4.3 Availability and accessing fuelwood

There was a strong gradient in fuelwood accessibility between the three towns, with the most rural (Riebeeck East) having the least developed fuelwood markets, the least respondents complaining that fuelwood was declining, and the shortest time per collection trip (Table 3). In contrast, residents of Grahamstown East mainly buy fuelwood. Of those that collect, most stated that it was harder now than a few years ago, and the mean duration of a collection trip was one hour longer than at Riebeeck East. A significant factor perceived to be causing local declines in fuelwood is a change in land use. At Alicedale, the new estate development has cut people off from harvesting areas. In Grahamstown East new housing developments are frequently in wooded areas, which are lost when building commences.

Table 3. Availability of fuelwood in Makana.

	Riebeeck East	**Alicedale**	**Grahamstown East**
Only buy fuelwood (%)	10.3	28.6	61.4
Both collect and buy fuelwood (%)	55.2	31.6	9.1
Only collect fuelwood (%)	34.5	40.8	29.5
Time taken to per collecting trip (hr)	3.1 ± 0.3	3.6 ±1.5	4.1 ± 0.4
Proportion (%) saying it is harder to find fuelwood now than 5 yrs ago	22.7	73.3	73.3
Why harder now (% of respondents offering an opinion):			
• Lands fenced off for new developments or housing	Sample too small	85.7	33.3
• Too many people cutting fuelwood	Sample too small	9.5	33.3
• Other	Sample too small	4.8	33.3

1.4.4 Expressed advantages and disadvantages of using fuelwood energy

Overall, a greater number of advantages than disadvantages were reported (Table 4). The most frequently expressed advantage was that fuelwood is a free energy source, or that it is cheap when compared to other sources. This is also related to its importance as a fall back when cash is scarce preventing the purchase of electricity or paraffin. Almost one-third of respondents also felt that it

makes particularly good heat compared to other sources. These need to be weighed against the disadvantage expressed by one-quarter of respondents relating to the fact that the smoke from fuelwood fires is smelly and dirty and it stains clothes and paintwork.

Table 4. Advantages and disadvantages of using fuelwood as an energy source (% of respondents expressing an opinion across all three towns).

Advantages	% respondents	Disadvantages	% respondents
It is free or cheap compared to other energy	42.2	The smoke makes clothes and walls dirty and smelly	25.0
It makes a good heat	29.6	It is scarce to find	13.0
It is good for tradition	12.1	It is dangerous	12.9
It saves the use of electricity or paraffin	10.4	The smoke is poisonous	7.8
The heat lasts a long time	9.6	It is hard work to collect it	4.3
It has many uses, for cooking, heating and traditional	7.8	One can be attacked and raped when collecting it	3.4
It is very good for baking	7.0	The smokes irritates neighbours and can cause fights	2.6
It is a useful fallback when we run out of electricity or paraffin	4.3	It is no use in wet weather	0.9
It is safe	3.4	It shows others that you are poor	0.9
It is quick	3.4	It is expensive	0.9
Can use more than one pot on the fire	0.9		
It is important for males to meet around a fire	0.9		

1.4.5 Value of fuelwood use

The most common unit of sale for fuelwood was a 50 kg sack. No empirical measurements of the weight of the 50-kg sack have yet been made in the study area, but using extrapolations from other studies it is probably approximately 35 kg. This equates to a fuelwood unit price of 24c/kg in Riebeeck East, 28c/kg in Alicedale and 47c/kg in Grahamstown East (Table 5). Thus, the gross, annual, direct-use value of fuelwood used by households in these three towns is R489, R626 and R168, respectively. This is only slightly lower than the reported monthly expenditure on electricity in Riebeeck East (R43 per month) and Alicedale (R77 per month), but significantly lower than electricity purchases in Grahamstown East (R61 per month). Thus, the availability of fuelwood is a significant resource for poorer households. This direct expenditure on electricity represents approximately 6 – 7.6% of mean household cash income. There are, however, a few households for which it represents over 20% of monthly cash income.

Table 5. Direct-use value of fuelwood compared to expenditure on electricity in Makana.

	Riebeeck East	Alicedale	Grahamstown East
Mass of fuelwood used per hh per year	2 038	2 235	357
Price of 50 kg sack (Rand)	8.44 $\pm$ 0.81	9.79 $\pm$ 1.21	16.50 $\pm$ 2.95
Unit price (Rand/kg) (*assuming a 50 kg sack contains 35 kg of fuelwood)	R0.24	R0.28	R0.47
Gross, annual direct-use value of fuelwood per hh (Rand)	489.12	625.80	167.79
Monthly expenditure on electricity per hh (Rand)	42.79 $\pm$ 7.64	76.69 $\pm$6.31	60.93 $\pm$ 7.14
Monthly expenditure on electricity as a % of estimated total household cash income	6.3 $\pm$ 1.4 (range = 0.7 – 21.9)	7.6 $\pm$ 0.9 (range = 1.0 – 36.4)	5.9 + 0.7 (range = 0.5 – 25.0)

2. FEASIBILITY STUDY OF THE USE OF SOLAR AND PASSIVE ENERGY IN THE MAKANA MUNICIPALITY

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2.1 EXECUTIVE SUMMARY

Enough energy from the sun radiates the earth in a single day to power the world's population for 27 years. Solar energy is a form of renewable energy constantly provided by the sun. It may potentially play a very important role in meeting general electricity needs. Solar-powered electricity generation is clean, renewable, and produces no greenhouse gasses or hazardous wastes whilst in operation and it has therefore been noted as an important form of energy use.

The main forms of solar energy use are photovoltaic (PV) cells or modules, and passive solar energy. The aims of our study were to investigate the feasibility of implementing solar power systems and solar water heaters in Grahamstown. In addition, we aimed to investigate the feasibility of increasing the passive energy characteristics of houses. We also wanted to determine the current forms of energy used by the population. We conducted literature reviews and then interviewed a number of households in the formal area, electrified, informal area and non-electrified informal area.

The demand for solar panel systems and solar water heaters
The demand for solar panels was not high with 11 out of 30 households in the formal area, 10 out of 26 households in the electrified informal area and 4 out of 26 households in the non-electrified informal area wanting one. In addition the prices people were prepared to pay varied greatly. Only 25% of people in the formal area stated that they would be willing to pay the full price for the solar panels and this percentage decreased dramatically in the informal electrified and again in the informal non-electrified areas.

There was a large interest in the formal areas for solar water heaters with 28 out of 30 households expressing interest in them and out of these almost 50% were willing to pay the full price. In the electrified informal area the number of people who expressed interest dropped to 16 out of 26 and peoples' willingness to pay the full price was far lower. In the non-electrified informal area only 7 out of 26 households were interested.

Perceptions of the advantages and disadvantages of solar panel systems and solar water heaters
In the non-electrified informal areas people's biggest concern with solar panels was that they did not believe that they would work on cloudy days. The unknown factor was also a big reason for not wanting solar panels because not many people had ever heard of them before. The concerns with solar water heaters were expense, the weather and the possibility of theft and vandalism.

In the electrified informal area disadvantages stated for solar water heaters included expense, theft and vandalism, the weather, the unknown factor and not enough space in their homes. For solar panels expense, theft and vandalism and the weather were the biggest disadvantages mentioned. Numerous people believed that if an instalment payment system was introduced then it would make solar panel use economical in the long run.

In the formal area there is a strong perception that solar water heaters are economical and good value for money in the long run. A few people were concerned with theft, expense and vandalism. For solar panels the main concern was expense and concern over them not being powerful enough. Advantages mentioned included the possibility of environmental and economical benefits.

Current energy use in Grahamstown and solar energy as an alternative
Solar panels can make the largest difference in replacing other energy sources used for lighting as lighting requires relatively low input. The use of solar panels in both the formal and informal areas can potentially reduce environmental damage through the lowering of emissions produced during the production of electricity. When it comes to energy resources used for cooking, solar energy cannot make a difference as it is not powerful enough. With heating, many people used fuelwood in the informal area. Although solar water heaters could be used to heat water, this will have a limited environmental benefit as alien species are mainly used for fuel wood. Fuelwood smoke can, however, be hazardous to human health and thus implementing solar water heaters could improve peoples' living conditions.

The passive energy characteristics of houses in the formal and informal areas
We conducted a survey of eight different criteria that are synonymous with energy efficient houses. We found that the houses in the formal area had better energy efficiency in comparison to those in the informal area. If the energy efficiency of homes in the informal area were improved, this would reduce the need for energy.

2.2 INTRODUCTION

Enough energy from the sun radiates the earth in a single day to power the world's population for 27 years (EPA, 2004). Solar energy is a form of renewable energy constantly provided by the sun and as such, it may potentially play a very important role in meeting general electricity needs (Goswami *et al.*, 2004). Solar-powered electricity generation is clean, renewable, and produces no greenhouse gasses or hazardous wastes whilst in operation (EPA, 2004) and it has therefore, been noted as an important form of energy use. Due to solar energy systems offering significant protection to the environment, they should be used wherever possible to achieve a "sustainable" future (Kalogirou, 2003). This concern for future energy sources and the environment have led to worldwide interest in the use of solar energy. The main forms of solar energy use are photovoltaic (PV) cells or modules, and passive solar energy (EPA, 2004).

2.2.1 Solar panels

PV cells convert solar energy into electrical energy (Eskom, 2004). A standard solar panel is composed of thirty-six cells connected in series to produce an operating voltage of twelve volts (Eskom, 2004). This is connected to battery banks, which store excess electricity during periods of high sunshine, and from which electricity can then be drawn when sunshine is limited. PV cells require high levels of direct sunshine and the annual 24 hour global solar radiation average received by South Africa doubles that of Europe (U.S. Department of Energy, 2004) making South Africa an ideal place for solar power. Additionally, these panels produce no air pollution, hazardous waste or noise whilst in use (EPA, 2004).

The possible benefits of this energy source for South Africa and the Makana region include access to electricity in remote areas by rural electrification projects that use solar panels. The benefits of such projects would extend to institutions such as schools and clinics and therefore, result in further development of these areas. Solar panels can be used almost anywhere in South Africa, particularly for low energy requirements. While there is a possibility that the installation of solar panels may currently be limited by costs, the good news is that emerging developments in solar technology have the potential to reduce the capital costs of solar panels by 50% (Goswami *et al.*, 2004).

2.2.2 Passive solar energy

Passive solar heating and cooling (hereafter referred to as passive energy) represent an important strategy for displacing traditional energy sources in buildings (Miller, 2002). Passive solar techniques make use of the steady supply of solar energy by means of building designs that carefully balance their energy requirements with the building's site and window orientation (Anon. 1, 1997). The term "passive" indicates that no additional mechanical equipment is used, other than normal building elements (Anon. 1, 1997). The advantage of this form of solar energy is in providing energy savings of up to 40% without significantly adding to construction costs and features (Baird, 1993). It is one of the least expensive and most environmentally friendly methods of improving the energy-efficiency of structures (Baird, 1993).

All passive techniques use building elements such as walls, windows, floors and roofs in addition to exterior building elements and landscaping, to control heat generated by solar radiation (Anon. 2). Solar heating designs collect and store thermal energy from direct sunlight (Anon. 2). Passive cooling minimizes the effects of solar radiation through shading or generating airflows with convectional ventilation (Anon. 1, 1997).

Poor households in South Africa spend a large proportion of their income on energy services, up to 35% of their incomes, for lighting, cooking and heating their houses (Klunne, 2002a). Apart from the high cost of the energy, indoor heating which is mostly done using coal and wood causes indoor pollution (Klunne, 2002a). Designing houses with energy efficiency in mind can dramatically reduce the amount of energy needed to keep a house comfortable. Generally, low-cost housing in South Africa is of a low quality with inferior thermal performance characteristics. With limited additions or costs the low-cost housing in South Africa can be transformed into being energy-efficient.

Klunne (2002a) describes eight construction techniques that can increase a houses' thermal capacity, namely: orientation of the house, building materials, positioning and size of glazing, roof overhang, ceilings, insulation, flooring and shared walls. These are outlined below.

1) *Orientation of the house*. A house in the southern hemisphere should face towards a geographic north (±15°) in order to obtain solar benefit. Houses which point north have most of their windows facing north and would have the least heat gain in summer and the least heat loss in winter.

2) *Building materials*. Appropriate building materials such as materials with a high thermal mass store heat during the day and release it slowly at night. The current trend in South Africa is to use hollow cement blocks and cement which both have a reasonable heat capacity. Alternative materials such as earth bricks have a much higher capacity but these are often rejected due to being perceived as inferior materials.

3) *Day-lighting*. Optimising natural sunlight through windows during daylight hours so that heat gain is minimized in summer and heat loss is minimized in winter is a potentially useful technique. Solar radiation transmitted through glass converts to heat when it strikes materials, such as concrete floors, and then is re-radiated as heat. The size of glazing should be approximately 20% of the total floor area on the northern side of the house for "solar collection". Another technique used in colder climates is double-glazing. However, this technique is expensive and not necessary in most of South Africa.

4) *Roof overhang*. The northern orientation of houses should be coupled with a roof overhang on the northern side of the house designed to the summer and winter angles of the sun. The size of the roof depends on the roof geometry but should be about half a metre in length to shade the northern windows from the summer sunrays and to allow the winter sunrays in. Roof overhangs should be combined with a strip of grass or vegetation around the house to prevent the surface from warming up.

5) *Ceilings*. Ceilings have the ability to trap air, which ensure a reduction of heat flow into or out of the house. As a result the house is cooler in summer and warmer in winter.
6) *Insulation*. There are various methods of insulating a house. Building a cavity wall (two parallel walls with an air gap between) is seen as the most effective but is most expensive. Another method is to plaster walls, or to use panels (also called construction boards).
7) *Flooring*. Floor material should be of high thermal mass, such as concrete, bricks or clays, to trap heat and solar radiation coming through the windows during the day and release it slowly during the night.
8) *Shared walls*. Shared walls either in the form of a row of houses or semi-detached houses, save on the cost of the housing shell as well as on energy consumption. When units share walls, they provide more insulation against heat loss in winter and heat gain in summer. In South Africa at the moment it is seen as improper to have houses that are joined, as one must be able to walk around his house to call it his house. In some areas this view is changing which will aid in constructing energy-efficient houses.

2.2.3 Solar water heaters

A solar water heater uses the sun's energy rather than electricity or gas to heat water, which reduces monthly electricity bills (Block & Harrison, 2001). When installed properly, solar water heaters are more economical over the life of the system than heating water with electricity (Block & Harrison, 2001).

There are a number of solar water heater designs. These include pumped systems, integral collector storage systems, and thermo-siphon systems (Block & Harrison, 2001). The pumped system relies on a PV cell powering a small electrical pump which circulates water through a solar collector and into a storage tank (Block & Harrison, 2001). The solar collector generally is an insulated metal box, which has water flowing through tubes attached to a black metal absorber plate which absorbs heat from the sun and diffuses this heat into the water (Block & Harrison, 2001).

The integral collector storage system is similar to the above system. However, water within the system is circulated by pressure from city or well water (Harrison & Tiedeman, 1997). As water is needed within a house, the water flows into the solar collector and is heated. It then flows into a hot water auxiliary tank from which it is stored or drawn for use (Harrison & Tiedeman, 1997).

Thermo-siphon systems work on a different principle to the above systems. Here, the water flows naturally between the solar collector and the storage tank (Telecom Techniques, 2004). The flow of water within the system works on convection principles where the water is heated in the solar collector and then rises into the integrated storage tank. Cooler water in the storage tank sinks down into the collector thus replacing the heated water (Telecom Techniques, 2004). Water is drawn from the integrated tank. The solar collector is comprised of vacuum tubes. The vacuum in the tubes acts like a thermos flask and therefore, it prevents heat from radiating back into the air at night and increases the efficiency of the collector (Telecom Techniques, 2004). This is the system which we investigated in our study.

2.2.4 Eskom's current policy on solar energy

The SABRE-Gen wing of Eskom is currently considering ways of integrating solar energy production into grid-connected and off-grid applications (SABRE-Gen Energy, 2004; U.S. Department of Energy, 2004). A main area of grid-connected focus is on the development of a 100 MW solar power station near Upington and the development of associated technologies (SABRE-Gen, 2004).

Eskom is currently testing and evaluating off-grid solar energy systems to determine their performance, reliability and sustainability for use in schools and clinics in remote areas (Eskom, 2004). This includes the development of low cost solar water heaters (Eskom, 2004). In 1998, Eskom, in conjunction with Shell Solar South Africa, launched a project to electrify 50 000 low-cost housing units with solar energy (Energy Information Administration, 2003). By the end of 2000, an estimated 30 000 people had benefited from the 6000 homes that had been electrified with solar home systems (Energy Information Administration, 2003). Additionally, Eskom is conducting research into a local industrial manufacturing plant of PV cells in South Africa (Eskom, 2004).

2.2.5 What the South African government is doing the field of solar power

The new White Paper on the energy policy of the Republic of South Africa (Department of Minerals and Energy, 1998) notices the worldwide trend of renewable energy development and its implementation. It states that "renewable resources generally operate from an unlimited resource base and, as such, can increasingly contribute towards a long-term sustainable energy future", noting solar energy as particularly attractive (Department of Minerals and Energy, 1998). The White Paper aims to redress previous policy, which neglected poor communities noting that the provision of electricity and energy is essential for the development of society (Department of Minerals and Energy, 1998). The Rural Schools Electrification Programme (Department of Minerals and Energy, 2004) includes solar energy in its plan to electrify rural schools. The Department of Minerals and Energy is looking for ways to redirect funding towards increasingly environmentally favourable development projects (Department of Minerals and Energy, 1998). These projects include Solar Home Systems for powering individual homes, solar water heaters and solar cookers (Department of Minerals and Energy, 2004). Many of these developments have been in conjunction with other governments or organisations. In 2002, the South African and German governments signed a financing agreement to electrify 30 000 household in the North West and Eastern Cape (Energy Information Administration, 2003).

Additionally, key foci of Integrated Development Plans (IDP's) are projects that raise the standard of living of people in rural and remote areas by endorsing the use of alternative energy sources such as solar power (Department of Minerals and Energy, 1998). Recently, a French-based company, Electricite de France (EDF) and Total, following along these lines, agreed to provide solar home systems to 15 000 rural homes in Kwazulu-Natal (Energy Information Administration, 2003).

While there are many solar energy projects that have been implemented or are being implemented it must be noted that many of these are not successful (Klunne, 2002b). Since 1994 there have been three independent programmes to electrify rural schools and clinics using solar panel systems (Klunne, 2002b). These programmes managed the massive task of electrifying 2340 schools and 200 clinics (Klunne, 2002b). However, due to theft of components, vandalism and a lack of skilled persons capable of making repairs only 19% of the systems in schools and 69% of the systems in clinics are still working (Klunne, 2002b). In retrospect, the greater incidence of theft and vandalism at schools was due to their vulnerability over holidays. The most vulnerable part of the systems in terms of maintenance was found to be batteries which broke and could not be replaced (Klunne, 2002b).

We studied the feasibility of using solar and passive energy in the Makana Municipality, taking into account current utilization and acceptability within the region, and generic information of these systems. This information will give the Makana Municipality a basic understanding from which a community vision regarding solar and passive energy may be developed. The objectives of our study were to:

1) determine the present forms of energy used within the Makana Municipality and the purposes for which they are used.

2) determine the advantages and disadvantages of implementing, utilizing and maintaining solar and passive energy systems in peri-urban and urban socio-economic groups already connected or not connected to the national power grid.
3) provide these groups with this information and establish their perceptions towards solar and passive energy.
4) assess the impacts that the implementation of solar and passive energy would have on the environment.
5) make recommendations regarding the feasibility of solar and passive energy in the Makana Municipality.

2.3 MATERIALS AND METHODS

All household interviews we conducted conformed to standard ethical practices.

2.3.1 Current energy use

See the section on use of domestic energy in Makana by Shackleton and Gambiza.

2.3.2 Solar energy use

The two ways of harnessing solar energy that we researched were solar panel systems (defined as a collection of photo-voltaic cells which convert solar radiation into electrical energy) and solar water heaters (defined as a device which makes direct use of solar radiation to heat water). We considered each of these separately.

2.3.2.1 Advantages and disadvantages of solar panel and water heaters

We gathered information on solar panels by looking at available literature and case studies. This information included the economic and environmental aspects. We determined the costs of solar panels and water heaters from their manufacturers.

2.3.2.2 Public perceptions of solar power and water heater systems amongst households

A questionnaire survey was carried out on randomly selected households from the formal area, electrified informal area and the non-electrified informal area of Grahamstown. We focussed on gaining their perceptions of solar panels and water heaters, and possible demand. We determined the price people were prepared to pay. Additionally, these households were questioned on their monthly electricity bills and household size to gain a better understanding of the reasons behind their views.

2.3.2.3 Energy-efficient housing design (passive energy)

We considered case studies and other relevant literature to get an understanding of passive energy and its related benefits. From this information, we formulated a checklist which was used to determine the degree to which houses were constructed with energy-efficiency in mind.

2.4 RESULTS AND DISCUSSION

2.4.1 Solar panels

Few people in both the informal and formal areas wanted solar panels because the cost was prohibitive. In the formal area eleven of the thirty people interviewed wanted a solar panel system

(Table 1). However, the price people would pay varied greatly from R1 000 to R16 000. Of the thirty people interviewed in the formal area, 21 gave us their acceptable price for a solar panel system. Only about 25% of these people were prepared to pay the full price and about 50% were prepared to pay R10 000. Therefore, even in the formal area cost appears to be a prohibitive factor to the implementation of solar panel systems.

Table 1. The demand for solar devices in three areas of Grahamstown.

Formal area (sample size, n = 30)						
Item	**Price (Rands)**	**Demand (n)**	**Demand (%)**	**Acceptable price range(n)**	**Mean acceptable price (n)**	**SD**
Solar panel system	15740	11	36.7	1000 - 16000 (21)	8129 (21)	5032.1
Solar water heater	3495	28	93.3	1000 - 7500 (27)	3270 (27)	1410.0
Electrified informal area (sample size, n = 26)						
Solar panel system	15740	10	38.5	100 - 16000 (16)	5417 (16)	3778.9
Solar water heater	3495	16	61.5	50 - 3495 (19)	1500 (19)	962.5
Non-electrified informal area (sample size, n = 26)						
Electricity		23	88.5			
Solar panel system	15740	4	15.4	500 - 15740 (4)	4960 (4)	7279.0
Solar water heater	3495	7	26.9	100 - 5000 (9)	1172 (9)	1589.6

In the electrified informal area ten of the twenty-six people interviewed wanted a solar panel system. This demand is similar to that in the formal area. In the electrified informal area, people's acceptable prices for a solar panel system ranged between R100 and R16 000. In contrast, the demand for solar panel systems was much lower in the non-electrified informal area. Here, only four of the twenty-six people interviewed wanted a solar panel system. Acceptable prices ranged from R500 to R15 740. As is shown by these acceptable price ranges, cost was also a prohibitive factor in the informal areas.

2.4.2 Solar water heaters

Solar water heaters were quoted at a price of R3495 and were more accepted in the formal area than the informal area in Grahamstown (Table 1). In the formal area, 28 out of the 30 households interviewed were interested in and in favour of the solar water heaters, which was a 93.3% approval rate. The mean accepted price was R3270, which was close to the initial price offered to them. Households suggested prices ranging from R1000 to R7500. As with solar panel systems this is again a large variability in the price people are prepared to pay. However, unlike solar panel systems, a high proportion (50%) of the people who wanted one was prepared to pay the full price.

The electrified informal area had a 61.5% approval rate, with 16 out of the 26 households interviewed showing interest (Table 1). The mean accepted price of R1500 was a lot lower than in the formal area. There was interest shown in this informal area but cost was the major inhibiting factor, as the price range put forward by the households ranged from R50 to R3495.

The informal areas without access to Eskom electricity were the least in favour of the solar water heaters (Table 3). The mean accepted price was R1172 with a price range of R100 to R5000. Only 7 out of the 26 households interviewed showed interest in the solar water heaters.

The formal areas could mostly afford to purchase a solar water heater, and would benefit with the long-term decrease in their monthly electricity bill, as the average monthly bills per household was R561. This was the major reason for their interest. Households in the informal areas with Eskom power would be more interested if the initial price was a lot lower, as their income could not support such a large down payment and would prefer to pay off the solar water heater in monthly instalments if this option was available to them. The monthly price for the water heater would need to match their current electricity bill, which averaged at R95, for them to afford it. Households in the informal area with no Eskom power did not show much interest as they did not have access to electricity and were not currently paying an electricity bill and did not see much use in the water heater. Most could not afford it even if instalments were an option.

2.4.3 Perceived advantages and disadvantages of solar panels and water heaters

In the non-electrified informal area people's biggest concern about solar panels was the weather, as people did not believe that they would work on cloudy days (Table 2). A number of people also believed that lightening and rain would adversely affect and damage the solar panels. The unknown factor is also a large concern as a lot of the people interviewed did not know these systems and how they work. This leads on to the next factor, which is the perception that the panels are unreliable which is not true and reflects lack of knowledge of these systems. Interestingly, not many people quoted expense as a major factor for not wanting the panels which was a major reason in the other two areas that we studied. This may be due to the fact that people in the non-electrified informal area cannot afford it and so price was not an issue for them. It must be noted here that not all interviewees stated reasons for wanting or not wanting the various forms of solar energy.

Table 2. Reasons for and against the use of solar panels and solar water heaters in the informal non-electrified areas, Grahamstown (n = 21).

Reasons	**For solar panel**	**Against solar panel**	**For solar water heater**	**Against solar water heater**
Expense		3		2
Unreliable		4		
Theft/vandalism		2		1
Weather		6		
Unknown		4		1
Space				1
Economical			4	
Environmental				
Low maintenance				
High maintenance				
Limited output				
Aesthetics				

In the electrified informal area a number of people believed solar water heaters were more economical than using Eskom power to heat water (Table 3). They stated expense, theft and vandalism, the weather, the unknown factor and not enough space in their homes as the reasons for not wanting these systems.

Table 3. Reasons for and against the use of solar panels and solar water heaters in the informal electrified areas, Grahamstown (n = 21).

Reasons	For solar panel	Against solar panel	For solar water heater	Against solar water heater
Expense		9		3
Unreliable				
Theft/vandalism		8		3
Weather		9		3
Unknown		2		2
Space				3
Economical	7		7	
Environmental				
Low maintenance	3		1	
High maintenance				
Limited output		1		1
Aesthetics				1

The main reasons for not wanting the solar panels in the electrified informal area were expense, theft and vandalism and the weather, mainly cloudiness and rain. A number of people stated that if they could pay in instalments then they would purchase the panels as they believed they were more economical in the long run and required less maintenance than other forms of energy.

Amongst people in the formal area there was a strong perception that solar water heaters are economical and good value for money in the long run (Table 4). However, a few people were concerned about their expense, theft and vandalism, the weather and the amount of space people have.

Table 4. Reasons for and against the use of solar panels and solar water heaters in the formal area, Grahamstown (n = 33).

Reasons	For solar panel	Against solar panel	For solar water heater	Against solar water heater
Expense		15		6
Unreliable		2		1
Theft/vandalism		8		2
Weather		7		1
Unknown		2		1
Space				
Economical	7		20	
Environmental	2		4	
Low maintenance	3		2	1
High maintenance		3		
Unreliable		2		1
Limited output		5		1
Aesthetics		2		

The main concern over solar panels in the formal area was expense. This was because the panels have a fairly low output, which was noted by five people, and people in the urban areas would need the most expensive system to power the many appliances in their homes. The other main concerns were again theft, vandalism and the weather. A few people, however, also noted that solar panels would be economical over time and required low maintenance. An interesting point was that a few people raised the issue of environmental concern as a reason for wanting a solar panel or solar water

heater. This was not mentioned by either of the groups interviewed in the informal area and can be attributed to the different levels of environmental awareness amongst the three groups and also their priorities.

2.4.3 Current energy use in Grahamstown and the potential of solar energy as an alternative

As lighting does not require a large amount of electricity, solar panels are ideal for replacing the other energy types in the informal area. Solar panels could also improve peoples' quality of life as the use of energy such as paraffin and candles can be potentially hazardous and harmful.

The average monthly cost of electricity in the formal area was R561 compared to R95 in the informal area. However, the population of the informal area is far greater than that of the formal area. The use of solar panels in both these areas could reduce the amount of electricity needed and therefore potentially reduce environmental damage through the lowering of emissions produced by the production of electricity.

For heating one would require an expensive solar panel system with a high output. Most people in the informal area cannot afford this system. The Makana Municipality could subsidise the system to make it more affordable. Fuel wood contributes a large proportion of energy used for heating in the informal area. Fuel wood used in the informal area consists mainly of invasive species (Sutherland *et al*., 2004). Therefore from an environmental stand-point solar panels will have little environmental benefit as the use of fuel wood is not impacting on indigenous forest resources (Sutherland *et al*., 2004). This is mainly due to the proximity and extent of the current invasive wood reserves rather than the actual preference for invasive tree species. Despite the minimal environmental impacts from fuel wood harvesting, the cost to human health (e.g., indoor pollution from fires) cannot be ignored. Thus, solar energy could play an important role in improving the quality of life for people in the informal area.

The solar panels that were mentioned in this study cannot be used to substitute the above mentioned forms of energy for cooking, as they do not have sufficient output. The use of other energy forms such as gas stoves could reduce the dependence on more hazardous energy types such as paraffin and fuel wood.

2.4.4 The passive energy characteristics of houses in formal and informal areas

The passive energy characteristics of houses in the formal and informal areas of Grahamstown are given in Table 5. Differences between houses in formal and informal areas are clear. It is generally believed that low-cost housing in South Africa is low quality with poor thermal performance characteristics. The most obvious difference is evident with regard to the degree of high thermal capacity of the building materials that is used. Most of the houses in the formal area are built of high thermal capacity materials while those in the informal area are not. In addition houses in the informal area would benefit from being built north-facing. A house that is situated in the southern hemisphere (any house in South Africa) should ideally face towards a geographic north (±15°) in order to obtain the maximum solar benefit (Klunne, 2002a). This causes the least heat gain in summer and the least heat loss in winter (Klunne, 2002a). More houses in the informal area should be built to take advantage of this natural solar energy especially during winter.

Table 5. Passive energy characteristics of houses in formal (n = 36) and informal (n = 41) areas of Grahamstown.

Characteristic	Formal area		Informal area	
	Yes	No	Yes	No
North facing	16	20	11	30
High thermal capacity building material	27	9	1	40
North facing windows	18	18	26	15
Roof overhang and grass around house	18	18	0	41
Ceilings	34	2	11	30
Insulation in ceilings	13	23	6	35
Shared walls	3	33	1	40

The incorporation of passive energy elements into housing provision in South Africa is fundamental. Northern orientation of houses should be coupled with roof over hangings combined with a strip of grass/vegetation around the house. This would help keep the house cool during summer by reducing the amount of sunlight entering the house. Ceilings also play a critical role in achieving a thermally efficient low-cost housing as they have the ability to trap air and reduce heat flow into or out of the house (Klunne, 2002a). In addition, wall insulation and floors represent important components in achieving thermal efficiency in houses. Flooring should be of high thermal mass (i.e. concrete, bricks or clay) to trap heat and solar radiation coming in through the windows. The economical, social and environmental benefits that are related to the utilisation of passive energy are of great importance and should be incorporated on a larger scale in the planning and implementation of housing provision.

2.4.5 Limitations of the study

A problem encountered when administering the questionnaires was that many people had little knowledge of what solar devices were. In this way their opinion would therefore be shaped almost entirely by what we told them about the advantages and disadvantages. We therefore had to be careful not to give a biased view towards either the advantages or disadvantages.

For determining the public's perception of solar water heaters certain questions could have been added to the existing questionnaire. Included could have been questions over whether or not the interviewee has a geyser and if not what they use for heating water. This would have given us a better idea of what the solar water heater would have been replacing and how much they would be saving.

When questioning people who did not have electricity, instead of asking them how much their monthly electricity bill was as we did for those with electricity, we could have asked them how much they spend on other energy sources such as paraffin. This would have given us a better understanding of how much money people are currently spending on energy sources and therefore help us to determine how much they would save from using solar energy. Even for those with electricity we could have also asked them how much they spend on other energy sources. Many people especially towards the end of the month stop using electricity and start using candles and paraffin. This would have given us a better idea of the full expenditure people have on energy, making our comparisons between solar energy and electricity more accurate. However, some of these issues were covered in the domestic energy use survey by Shackleton and Gambiza.

The sample size in all three areas should have ideally been bigger especially in the informal electricity and non-electricity areas where our sample size was lower than that of the formal area. We initially aimed for 30 interviews in each of the three areas.

2.4.6 Recommendations

The Makana municipality should consider the following activities to improve the quality of life of its residents.

1) Concentrate on electrifying the non-electrified area with Eskom electricity.
2) Promote the use of solar panel systems in the formal area.
3) Promote the use of solar water heaters in all areas, using subsidies in the informal area.
4) Educate people on the benefits of solar energy in terms of associated energy savings and environmental well-being.
5) Integrate passive energy designs into the government housing and into building regulations using incentives.

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3 WASTE MANAGEMENT, SANITATION, WATER SERVICES AND INDUSTRIAL ENVIRONMENTAL MANAGEMENT

Sustainable Environmental Technologies CC, Farley, E., Grant, T., Rose, C., Lindsay, K. & Parker, S.

3.1 EXECUTIVE SUMMARY

The current status of waste management, sanitation, water services and industrial environmental management in Makana Municipality has been investigated as part of the Local Environmental Action Plan (LEAP). The most common observations are that littering and illegal dumping occur throughout urban areas in Makana Municipality. This not only affects urban areas themselves, in terms of health and aesthetics, but also greatly affects property values and the quality of rivers and streams around the towns. This has a dramatic effect on the ability of rivers and streams to sustain biodiversity.

The municipal skips serve to contain waste to be collected in limited areas. These are, however, often badly sited and waste spills out of skips due to animals and people searching for recyclables. These skips are also meant for garden refuse only but are used extensively for general refuse.

Three permitted landfill sites exist in Makana namely, Grahamstown, Alicedale and Riebeeck East. The Grahamstown landfill site is the largest and produces leachate which is controlled by two dams downstream of the site. The biggest issue at this site is that there are people living on and around the site, some of which are permanent residents, others are reportedly 'hiding' and using the leachate water for domestic purposes. Alicedale and Riebeeck East sites are very small and both burn waste as part of permit conditions. This is not the ideal means of disposal of waste due to the release of greenhouse and other noxious gases during burning.

The municipality has recorded that approximately 39500 m^3 of vegetable waste is disposed of in the Grahamstown landfill site annually. A project has been started through the Centre for Entrepreneurship at Rhodes to turn this waste into compost.

Two recycling businesses operate in Grahamstown only, namely: Grahamstown Recycling and Eastern Cape Bottle Buyers (ECBB). These businesses are often marginal and need community and municipal support to remain viable.

Hazardous waste is of little concern in Makana Municipality due to the lack of heavy industries. However, light industries and other institutions produce various types of hazardous waste and the disposal methods of these substances have been investigated. Although in many cases the disposal methods of hazardous waste were adequate, in a number of sites improper disposal methods were being undertaken. Noteworthy hazardous waste observed at the Grahamstown Landfill Site includes sewage sludge, animal carcasses and abattoir waste. There is currently no other means of disposal of such wastes.

In Makana Municipality not all households have the RDP sanitation standard according to Census 2001 figures. The municipality has embarked on a "bucket system eradication programme". However, this is estimated to take a number of years. The major environmental problem that occurs with this system is when collections are late many people dispose of sewage on streets or in stormwater drains leading to negative health and environmental impacts.

In Makana Municipality there are two sewage treatment works in Grahamstown and one in Alicedale. Current disposal methods of hazardous sludge pose a major environmental hazard as there is a possibility that sewage sludge is getting back into the river systems after treatment. On

average the Grahamstown Disposal Works has achieved the General Limits for most parameters tested over the last four years. Mayfield STW has a sludge drying system which leads to large volumes of hazardous sludge which presents disposal problems. It was found that there is no co-operation between the institutions which test the treated effluent. This has created a situation in which information is not shared and no coherent database of treatment works function exists.

There is no database available on water resources for developments in Makana Municipality. According to the Census 2001, 10% of households in Makana Municipality fall below the RDP levels. Only 22% of people have water inside their houses. In Grahamstown, the water is purified at the Waainek and Jan Kleinhans purifications works. In Alicedale, water is purified in a plant close to the Bushman's river on the west side of town. Riebeeck East's water is obtained from boreholes and is not treated.

Industrial Environmental Management practices were investigated. It was found that the larger corporately owned businesses and franchises often have environmental policies and codes of practice in place. The extent of compliance to these codes of practice is unknown.

The industries most in need of industrial environmental management are those which have hazardous waste and toxic waste waters. These include dry cleaners, tanneries, printing shops, garages and restaurants. All these industries require some level of training on appropriate waste handling and disposal methods. There is potential for co-operation between various businesses to have waste exchanges with existing waste recycling companies in Port Elizabeth or elsewhere. Many businesses also seem open to being audited for compliance to local and national environmental standards and legislation. Bylaws for trade effluents are currently being drafted. Bylaws on correct waste disposal practices should also be promulgated.

Air quality is not an issue currently but this will have to be monitored by the municipalities in future, especially to comply with updated legislation (not yet promulgated) and to take advantage of international protocols (Kyoto). To date, no bylaws exist for the control of emissions which affect air quality or zonation of businesses which produce emissions.

3.2 INTRODUCTION

The current status of waste management, sanitation, water services and industrial environmental management in Makana Municipality has been investigated as part of the Local Environmental Action Plan (LEAP). The purpose is to develop a realistic picture of these aspects of environmental management in the municipal area. This will help with the formulation of action plans to address key issues but also create a record against which future developments in managing these issues can be measured. The information gathered during this phase was obtained by doing site visits and interviews as well as going through municipal records, 2001 census data and getting the public's input via numerous stakeholder meetings. This report outlines the situation on the ground and identifies gaps in information which will require more detailed, full-scale investigations beyond the scope of the LEAP.

Abbreviations
CBD – Central Business District
DME - Department of Minerals and Energy
DWAF – Department of Water Affairs and Forestry
EBRU – Environmental Biotechnology Research Unit
ECBB – Eastern Cape Bottle Buyers
GDW – Grahamstown Disposal Works

LDV – Light Delivery Vehicle
LEAP – Local Environmental Action Plan
MOP – Mayfield Oxidation Ponds
AEP – Alicedale Evaporation Ponds
RDP – Reconstruction and Development Plan
SET – Sustainable Environmental technologies
STW – Sewage treatment works
VIP – Ventilated Improved Pit Latrine

3.3 WASTE MANAGEMENT

Waste management is a broad term for a group of activities which involve dealing with waste produced by the general public and industries. Broadly waste management can be broken down into a number of elements namely:

- collection and transportation
- prevention
- minimisation
- treatment
- disposal

The National Waste Management Strategy has outlined the government's commitment to tackling issues surrounding waste management. Waste management is an issue that is currently being tackled all over the world, this is because poor waste management leads to environmental pollution, health hazards, flooding as well as loss of resources which otherwise could be used to generate wealth. Good waste management on the other hand can uplift communities by ensuring that people live in a healthy and clean environment. Good waste management can also lead to job creation and business opportunities through recycling and resource recovery.

3.3.1 General waste management issues in Makana Municipality

Littering and illegal dumping were common throughout urban areas in Makana Municipality. Site specific key issues within the area of littering and illegal dumping are described in detail below.

[ID Collage]
(Picture 1: Illegal dumping observed in and around Makana Municipality)

The Bloukrans River and its tributaries and storm drains in Grahamstown were choked with rubbish at numerous site visits throughout the year. This poses a high risk to the river health and biodiversity. This also causes infrastructural problems such as clogging of drains and subsequent flooding, as well as impacting on the efficiency of sewage treatment works. The health of water users may then be affected by poorer water quality as a result of this decreased efficiency. Resources are wasted as teams of municipal employees spend time after each rainstorm unclogging rubbish-choked drains. This time should be spent more productively maintaining infrastructure. Downstream water users are impacted upon by subsequent decreased water quality. Poor water quality affects irrigation of crops downstream and causes other clogging of pipes and pumps with litter, especially plastic.

[Drains pics]

Caption [Drains collage] (Picture 2: Litter in drains and in the streams and rivers)

Illegal dumping and littering has been identified as an issue throughout Makana Municipality urban areas (Grahamstown, Alicedale, Riebeeck East). The occurrence of illegal dumping is especially prominent in the Grahamstown areas of Sun City, Hoogenoeg, Scott's Farm and eDakeni as well as in the Kowie Ditch (Bloukrans River), Matanyana River and eDakeni tributary. All of these areas are characterised by high poverty levels. Many garden skips in these areas were being used for general waste. In addition, in Grahamstown many garden skips are in a poor state, rusted and with large holes, adding to litter problems. People were observed scavenging in the skips for recoverables such as bottles while throwing non-valuable waste out of the skips in the process. Animal scavenging also adds to the spread of refuse out of the skips.

A number of skips are poorly positioned alongside watercourses, which leads to overflowing and windblown refuse in the streams. The worst example of such positioning was observed on the banks of the Kowie Ditch in Albany road near the taxi rank. A large amount of refuse is dumped in this area surrounding the skip and animals including donkeys, dogs and goats were observed scavenging in such skips. This further aggravates the spreading of the waste into the streets, stormwater drains and streams. Another poorly positioned skip is in Oatlands North right next to a wetland system which is home to birdlife essential to river health.

Illegal dumping was observed on most Commonage areas. This decreases the value of the land for grazing and recreational uses as well as the surrounding properties. In general, it also has a negative visual impact on the entire area.

[Commonage litter]

Caption [Commonage Litter] (Picture 3: Litter and illegal dumping spoils the aesthetic of the commonage and green areas)

Many skips were full or overflowing, which suggests that the municipality may not have capacity for regular collection. A number of skips were not at designated sites resulting in illegal dumping at the sites. A major problem with the use of skips is that the high sides make disposal of large quantities or heavy items of garden or domestic refuse difficult unless the end doors are left open. However, as mentioned earlier, open doors allow animal scavengers access to the waste, which not only spreads litter, but is also bad for the health of the animals. An example of a good solution to this situation was observed in Somerset Heights where a ramp built alongside the skip position allowed easy dumping into the skip while keeping large animals out. This solution would, however, be costly to implement throughout Makana.

[Skips and dumping sites]

Caption [Skips and dumping sites] (Picture 4: Skips not properly managed and dumping sites without skips are unsightly and lead to wind blown litter. This also creates a situation in which illegal dumping becomes the typical backdrop)

3.3.2 Access to waste collection services

In the 2001 census data, three levels of refuse collection are recorded, namely 'kerbside,' 'communal' and none. There is some degree of overlap in municipal data, particularly between communal refuse collection and households classified as having no collection services. This is confusing and there is uncertainty as to what the municipality calls communal versus none.

According to municipal records provided, not all households within the three towns in Makana Municipality are provided with refuse collection services. In Alicedale, 17 households out of a total of 868 were shown to be unserviced. In Riebeeck East, 30 out of 414 households remain unserviced and in Grahamstown, 6.4% of households are currently recorded as having no refuse collection. This equates to a total of 920 households with a further 1969 households on the communal refuse collection system. Although approximately 10% of all households in Grahamstown, Riebeeck East and Alicedale have access to 'community' refuse collection points, most skips seen were signposted as garden refuse skips. Separate skips for domestic refuse only were not apparent.

[Garden skips pics]

Caption [Garden skips pics] (Picture 5: Skips are for garden refuse only but no alternative skips were apparent in most areas. This leads to the use of garden skips for all refuse)

Public dustbins are only located in the CBD areas as well as within Rhodes University campus. This leads to widespread littering, especially at busy areas such as taxi ranks, pick up/drop off points and along main thoroughfares and roads. Street sweepers currently operate only within CBD areas within Makana Municipality. All these factors contribute towards illegal dumping and wind blown litter and the associated environmental and health impacts. On interviewing members of the public on attitudes towards littering, it was found that many people are hoping the municipality will provide more jobs to clean up the litter. The large cost of cleaning up illegal dumping, unclogging drains and the social cost, money which could be used in uplifting of communities was most often not considered by the interviewees.

3.3.3 Landfills and dump sites

Landfill sites and dump sites are places which municipalities use for disposing of waste. The planning and management of these sites is crucial for ensuring that their impact on land, water resources, air and aesthetic aspects are minimised. The Environmental Conservation Act stipulates that any site used for dumping or disposal of waste needs to be licensed. The government has published guidelines through the Department of Water Affairs and Forestry on the minimum requirements for licensing, commissioning and operation of such sites. These guidelines stipulate how to go about site selection, site construction as well as the operational requirements of landfill sites. As part of this report, the guidelines will be used as the reference point for sound management of the three sites in Makana Municipality.

3.3.3.1 Grahamstown landfill site

Grahamstown Municipal landfill site is classified as G: M: B+ meaning that it is permitted to handle General waste; is of medium size and has significant leachate (runoff) production. Landfill operation must comply with minimum requirements as stipulated by DWAF. The landfill site is situated in an old kaolin quarry northwest of Grahamstown and has an approximate lifespan of another 50 years at current disposal rates. For the year 2002 to 2003, 25 180 m^3 of domestic refuse, 38 580m^3 of garden refuse and 6190 m^3 of building rubble was dumped. Adequate cover material is

reportedly available. The site has a leachate containment pond which is used to spray the landfill site to suppress dust.

There are a number of issues surrounding the operation of the landfill site which are of key concern. There is no access control to the site which means that there is no control of what is dumped at the site. This results in the uncontrolled dumping of putrescibles (decayable matter other than garden refuse) and other hazardous waste without the knowledge or control of the site operator. This may also lead to an underestimation of current dumping rates and landfill lifespan. Numerous site visits to the landfill were conducted and at no time was there any sign of leachate spraying for dust suppression as stipulated in the permit conditions and municipal records. It was difficult to determine whether cells are being constructed according to the guidelines.

Another major concern is the people living on the dump site as well as squatting in the bush in the surrounding area near the dams constructed to catch and contain leachate draining from the landfill. The people access the leachate containment dams for their water needs and this is a cause for great concern due to the strong possibility of the presence of heavy metals, carcinogens and bacteria meaning that the water in these dams is not fit for human use. Chronic health problems including cancers may result from the consumption of such leachate.

Poor or insufficient fencing results in significant amounts of windblown refuse littering surrounding sites. This was a major concern raised by the neighbouring property owner of the riding school. The property value has not only been significantly decreased but the windblown litter also has a large negative impact on business and the safety of clients. Windblown litter causes horses to spook, sometimes bolting, throwing their riders and even running into traffic. This is a major concern with many of the riders being children. Windy conditions cause so much windblown litter in the area that riding events have to be cancelled. This results in loss of revenue not only to the riding school from provincial and national events, but also to other Grahamstown businesses. Further loss of revenue occurs when potential clients and horse owners are put off by the littered environment which riding school employees struggle to keep under control.

The dumping of ostrich offal results in strong odours being blown across the properties surrounding the landfill site when this waste is left uncovered for a prolonged time such as over the weekends. Better site management and waste covering will go a long way to reduce wind blown litter as will regular removal of windblown refuse from the fences. No formal on-site salvagers operate although informal ‘picking’ does occur by the people living on the surrounding land. This practice is discouraged by site operators and Makana Municipality.

There is no evidence of the methane gas recovery project which was started by Dr. la Trobe in 1990. This project consisted of a system of pipes to collect biogas from the dump feeding a modified motor vehicle engine. This engine was attached to a generator for electricity. The revival of this project could be linked to carbon credit system of the Kyoto protocol. At WasteCon 2004, run by the Institute of Waste Management of Southern Africa, experts recommended that municipalities should start to prepare for the ratification of the Kyoto protocol by planning projects. Projects to capture biogas from landfill and sewage treatment works as well as cleaner technologies which would decrease greenhouse gas emissions would be able to seek funding from first world countries interested in carbon trading. Further details of this will be expanded upon later, should a project of this nature be considered. Note that stricter management of landfill site cell construction and closure will have to take place for a gas recovery scheme to be successful.

3.3.3.2 Alicedale

Alicedale has a G: S: B- site (General: Small: insignificant leachate production) at the Western end of the town. The site is located in an old stone quarry. The site has a life span of 15 to 20 years at current disposal rates. This life expectancy may decrease due to current development plans and increased disposal rates. Burning of waste occurs once a week and no leachate problems were apparent. The burning of waste should be discouraged because this puts carcinogens, carbon dioxide, as well as other greenhouse gases into the atmosphere. Alternatives to burning should be investigated as this is particularly important with respect to the Kyoto protocol and CO_2 emission reduction.

[Alicedale Dump]

Caption [Alicedale Dump] (Picture 6: Alicedale disposes of its waste in a landfill situated in an old quarry near the station. Rubbish is burnt once a week and often continues to smoulder for long periods)

Issues of concern are again lack of access control; no cover material is available to bury non-flammables and though the burning of waste is a DWAF permit concession for this landfill, refuse continues to smoulder which causes air pollution in the form of carcinogens, odours and could present a fire hazard. Current landfill operation will have to be reviewed in light of recent development in the Alicedale and surrounds and the potential increase in quantities of refuse. No salvaging occurs at present although there are plans for future recycling.

3.3.3.3 Riebeeck East

The site is permitted as a G: C: B- (General: Community sized: insignificant leachate production). It is located outside town on the Eastern side and is surrounded by grazing land. Waste collection is done in a LDV (bakkie). No leachate is produced. Key issues identified for this site are: there is no access control and fences need improving to keep out the animals from the surrounding area. Again, burning of waste is a permit concession for this landfill, but smouldering refuse could present a fire hazard to surrounding farmlands and burning refuse causes air pollution in the form of carcinogens and greenhouse gases. No salvaging occurs and there is a relatively large quantity of scrap metal on site which could be recovered and sold.

3.3.4 Waste management and recycling

Good waste management and recycling go hand in hand. The more waste that can be recycled, the less waste has to be handled and disposed of in the landfill sites. Recycling is a growing business which has the potential to create jobs. As technology for recycling of materials improves, more and more waste types could be recycled and ultimately landfill sites will only be used for the unrecyclable wastes. This will mean that waste management will cost the municipality less and business opportunities will be maximised.

3.3.4.1 Recycling in Makana Municipality

Two recycling businesses operate in Grahamstown only, namely: Grahamstown Recycling (Sean Haydock) and Eastern Cape Bottle Buyers (ECBB). There are also a number of scrap dealers in Grahamstown. Grahamstown Recycling recycles paper and cardboard. ECBB recycles all glass except sheet glass and automotive glass. Recycling of these items occurs via recycling bins and collection by the recycling companies themselves. Although these are private enterprises, the continued and increased support by the community and the Municipality would allow the businesses to expand and create jobs. This is an area where responsible waste management practices

at household and workplace level can uplift the community directly while contributing to creating a cleaner more sustainable environment in Makana. Some restaurants recycle cooking oil by giving it to Port Elizabeth-based paint and varnish companies which fetch the oil. Motor oil is also collected from some of the larger garages and workshops by an oil recycling company which sends a truck from Port Elizabeth. Car batteries are collected by some scrap dealers for recycling.

[Recycling bins]

Caption [Recycling bins] (Picture 7: There are numerous paper and bottle recycling bins around Grahamstown CBD and Grahamstown West suburbs.)

There is currently no recycling of tins, cans and plastics although there are markets for these items. There are many reasons why recycling is not more prominent in Makana Municipality. According to public opinion, there is not enough incentive for household participation in recycling or for informal collectors of recyclable goods. For goods such as paper and tins, cans etc. prices for recycled goods are not high enough for informal recyclers to make an adequate living. Although interest has been expressed by established recycling agencies in Grahamstown for larger scale recycling, as yet no feasibility studies have been undertaken to assess the viability of recycling of general waste. The Centre for Entrepreneurship at Rhodes University reviewed business plans for recycling, finding that recycling is often not a viable business. However, many municipalities country-wide have successfully implemented recycling projects, were revenue from recycling subsidises general waste management and helps to create additional jobs.

There are no facilities for recycling at landfill sites in Makana Municipality and there are too few recycling bins which are often used for general waste. There is currently no formal sector recycling in Grahamstown East. A community group, Mzam'omhle Waste Collection Group, expressed interest in setting up a recycling initiative which would mainly focus on the collection of aluminium cans. Access to the markets, price and the baling and transport of the cans to the nearest transfer station in Port Elizabeth presented the major obstacle as the group currently does not have any way of accessing start-up capital for the project.

The recyclable or recoverable waste observed in Makana Municipality is listed below. Not all of these are currently being recycled.

- Plastic (bottles, bags, general PVC packaging products)
- Glass bottles
- Paper
- Metal scrap
- Green waste
- Kitchen waste
- Electronics parts
- Tyres
- Oils and greases (motor and cooking)
- Car Batteries

Some of the wastes that are not recyclable are:

- Polystyrene packaging*
- Food packaging*
- Window pane glass
- Windshields
- Building rubble
- Some hazardous substances (e.g. cell phone and long life batteries)**

[*]Note: New technologies and developments revealed at WasteCon 2004 showed that the recycling of polystyrene and similar food packaging is now possible.

[**]Internationally, technologies for recycling electronic waste are being developed and this is being brought to South Africa by a company called Sky Africa, although there is no certainty as to what kinds of electronic waste will be recycled.

3.3.4.2 Information gaps in terms of recycling

To thoroughly identify and quantify the benefits that recycling can offer the following information must be obtained:

- The amount of material being recycled compared to the amounts of waste being produced.
- The markets for current recycled waste and the markets for other materials that are not being recycled at present.
- The transport costs for getting recycled goods to the nearest buyers.
- The estimated costs of collection of potential recyclable materials.
- Assistance, funding or alternative arrangements that can make recycling easier or more economically viable.

An extensive feasibility study, similar to that which has been carried out in other municipalities, should be undertaken to gather the information required to increase recycling in Makana Municipality.

3.3.5 Hazardous waste

Hazardous waste consists of chemicals, chemicals containers and substances that have been identified as being somehow harmful to people and/or the environment. Examples are transformer fluid, oils, medical waste and sewage sludge. Some hazardous substances are used in our households, for example, certain electronic goods. Other hazardous substances are used in laboratories, factories and the motor industry for various purposes.

In South Africa there are very few hazardous waste sites. Currently there are three sites in the Nelson Mandela Metropol area, namely Aloes 1, 2 and temporary. There is also one site in Uitenhage at Koedoeskloof. The Department of Water Affairs and Forestry has developed guidelines on how to deal with various types of hazardous waste. These have categorised the various kinds of hazardous waste and outline the acceptable disposal methods for each category. Correct disposal practices of hazardous wastes are closely linked to effective industrial environmental management.

3.3.5.1 Hazardous waste in Makana Municipality

Hazardous waste is of minor concern in Makana Municipality due to the lack of heavy industry. However, various types of hazardous waste are produced by industries and other institutions and the disposal methods of these substances need to be investigated further and remedied where necessary. The issues of highest concern surrounding disposal practices of hazardous waste materials and hazardous material containers is the lack of awareness of the very serious health and environmental consequences of incorrect disposal methods.

In a study undertaken by students in the Department of Environmental Science at Rhodes University, the following hazardous wastes were observed and the associated disposal practices noted.

- Putrescible waste, for example carcasses from abattoirs end up at the municipal landfill sites which can lead to spread of disease and odours.

- Fuels, oils and greases from workshops and petrol stations end up in rivers, soils and ground water due to improper disposal, leaking tanks and lack of control measures for example bund walls, grease traps and oil drains. In some cases in Grahamstown, cooking oils are being sent to Port Elizabeth paint and varnish companies for recycling and many garages have systems for safe disposal of oil.
- Medical waste must be incinerated due to its highly infectious nature. All clinics are required to transport their own waste to Settlers hospital for incineration. Incorrect disposal poses a high risk to all people or animals that come into contact with the waste.
- Electronic waste often contains heavy metals and hazardous organic compounds. Small quantities will end up in the municipal landfill from domestic refuse; there is no other alternative at this stage.
- Transformer fluid from high voltage electricity substations is highly toxic and should not be disposed anywhere in the municipality, but returned to the supplier. Containers used for transformer fluid should under no circumstances be used for other purposes, given away or disposed of in the landfill.
- Toxic wastewaters from abattoirs, tanneries and washwater from workshops and garages currently go to the municipal sewage works. This can enter rivers and streams from leaking, pipes storm water and run-off. Pre-treatment before release into municipal sewers should become standard practice for these wastewater streams according to individual and combined toxicities.
- Dry cleaning chemicals are highly toxic to humans and the environment but at the time of investigation no environmental disposal practices were in place. Empty chemicals containers were given away to use for water storage etc. Such dangerous practices must be stopped immediately and business owners made aware of the serious environmental and health implications of the chemicals with which they work.
- Sewage sludge is classified as infectious waste because of bacterial content and high concentration of nutrients. This can enter streams and rivers and cause eutrophication, the process by which a body of water becomes rich in dissolved nutrients, thereby encouraging the growth and decomposition of oxygen-depleting plant life and resulting in harm to other organisms. Sewage sludge also poses a hazard to people working at sewage plants and animals grazing within the area.
- Laboratory chemicals of varying toxicity can enter the ecosystem and cause damage if proper procedures for disposal are not followed. In most cases these are being sent to WasteTech. However, few industries wash hazardous chemicals down the drain, mostly because of lack of awareness and lack of alternative means of disposal.
- Fertilizer production and warehousing can cause eutrophication in the immediate surroundings and areas receiving runoff or wastewater. Fertilizer companies in Makana no longer manufacture fertilizers on site but have only distribution warehouses.
- Expired pharmaceuticals should be returned to pharmacies to avoid misuse and avoid toxic chemicals such as antibiotics entering the ecosystem. Antibiotics can kill the useful bacteria in the environment and sewage treatment systems.

The above wastes have been identified by deduction from municipal records, interviews and site visits. Many of these wastes occur in most municipalities country wide and as such are common issues in terms of hazardous waste. Though the DWAF guidelines do make provision for domestic hazardous waste disposal in domestic landfill sites, there is still a problem with safe disposal in smaller municipalities.

Noteworthy hazardous waste observed at the Grahamstown landfill site includes sewage sludge, animal carcasses and abattoir waste. It is acknowledged that there is no simple and cost effective means of disposing of hazardous wastes in Makana Municipality and the use of the landfill site,

though not ideal, is the only means of containing these wastes to minimise environmental exposure. Ideally, specially designed skips could be purchased from WasteTech for hazardous wastes, which could be shipped to hazardous waste disposal sites.

Industries around Grahamstown were also investigated to determine how hazardous wastes are disposed of at source. Industries that were targeted were those which use hazardous chemicals in their processes and for cleaning. At many places hazardous chemicals are being washed down the drains, including recyclable waste such as oils and greases. Some of the larger petrol stations and workshops are required to recycle by their corporate environmental policies. Many are serviced by Oilkol, an oil recycling company, which periodically sends a truck from Port Elizabeth to collect used oil. Other office and workshop waste is also separated at source but, apart from paper which is collected by Grahamstown Recycling, all other waste ends up in the landfill. This constitutes wasted effort on the part of the company and wasted resources on the side of the municipality. The many smaller private garages and workshops do not have environmental practices surrounding oil disposal and most of this enters drains, polluting storm water. Soaps, cleaning fluids and any other substances entering sewers (apart from stormwater drains) will end up at the sewage works where these chemicals cause bacterial kills in the sewage works compromising performance.

3.3.6 Vegetable waste and compost

In Makana Municipality as in all other areas, large quantities of vegetable waste are produced every year. Vegetable wastes are any kind of waste which consists of plant material. The primary source of this waste is from gardens and farming. Good examples are grass cuttings and hedge clippings. Though this waste is often disposed of in the landfill sites, it is potentially valuable as a good source of material for compost making.

[Garden skip compost]

Caption [Garden skip compost] (Picture 8: Many garden skips in Makana Municipality are filled with mostly garden refuse, but virtually all are also being used for domestic refuse.)

3.3.6.1 Composting in Makana Municipality

The municipality has recorded that approximately 39500 m^3 of vegetable waste is disposed of in the Grahamstown landfill site annually. This presented an opportunity for either a composting business or a vermiculture business using the local giant earthworm species found in Makana District. (Vermiculture is the use of specially bred worms to convert organic matter into compost). Not only would this decrease quantities of waste to landfill but this would also be a good example of utilising local biodiversity to solve what is currently a waste problem.

In recognition of the opportunity and value that garden waste presents, a composting project has recently been set up through the Rhodes University Centre for Entrepreneurship, Mzam'omhle Waste Collection Group and Sustainable Environmental Technologies, with funding from the Carl and Emily Fuch's Foundation and the support of Makana Municipality. All garden waste can now be taken to the composting site located near the dump site. The project also receives municipal skips which do not have excessive domestic waste mixed into the garden refuse.

In Grahamstown the municipality has provided numerous garden skips all over town. It appears that many people use these for their garden waste. In most instances, however, the skips are also being used for other waste that should be kept separate so that the garden waste can be used for composting, and time and capacity is not wasted separating out the domestic refuse. To help ensure the viability and success of the Mzam'omhle Composting Project in Grahamstown, separate skips

need to be provided for communal refuse collection so as to keep refuse out of garden skips as well as an increased degree of awareness and community commitment around the value of separating garden and domestic refuse.

[for compost; compostmaking]

Caption: [for compost; compostmaking] (Picture 9: Mzam'Omhle community group has started turning garden refuse into compost.)

Apart from this initiative, some farmers also sell kraal manure and the Grahamstown Riding School sell horse manure to gardeners.

3.3.7 Sanitation

Sanitation is the broad term for an activity which involves removing, treating and containment of sewage. This includes pit latrines, night soils (bucket system) and flush toilets. Sanitation also encompasses treatment of sewage to make it less hazardous to humans and the environment.

3.3.7.1 General sanitation issues in Makana Municipality

Primary concerns raised at public meetings were:

- eradication of the bucket system;
- access to public toilets;
- quality of water leaving sewage works (effluent quality);
- maintenance and paving of sewers and storm water drains;
- disposal of sewage sludge, and
- livestock kraals within residential areas.

Sewage treatment works are situated in the Bloukrans valley, in Mayfield and Alicedale.

3.3.7.2 Access to sanitation

All South Africans have the right to have adequate sanitation. This is defined as having a minimum of access to a ventilated pit latrine (VIP), according to RDP standards. Sanitation in South Africa can be divided into the following categories; flushing toilets to septic tanks, flushing toilets to sewers, ventilated pit latrines, pit latrines, chemical toilet, bucket latrines and no access. In Makana Municipality not all households have the RDP sanitation standard according to census 2001 figures. The census showed how many households have access to sanitation and at what level. In Makana Municipality 3% of households have no sanitation at all and approximately 25% use bucket latrines. In total 45% of households do not have sanitation at required levels. However, according to census 2001 this figure could be as high as 55% in Makana Municipality (Table 1). Makana Municipality disputes these figures as exaggerated and outdated but no other statistics were available at the time of publication. A major problem with VIP toilets in Grahamstown is the unsuitability of the underlying geology. High clay content in the soil means that excess liquids cannot percolate through the soils as per the VIP design. This leads to poor functioning of the toilets, odours and rapid filling. Many alternative and more suitable technologies exist which should be thoroughly investigated before mass installation of flush toilets or VIPs.

Table 1. Number of households on the various types of sanitation systems showing the percentage of households below the RDP level of VIP. (Source: Census, 2001)

Toilet type	No. households	% of total
Flush toilet (connected to sewerage system)	6 155	34
Flush toilet (with septic tank)	502	3
Chemical toilet	30	0.2
Pit latrine with ventilation	1 425	8
Pit Latrine without ventilation	2 557	14
Bucket latrine	5 391	30
None	2 106	12
Total no. households below RDP levels	10 054	55

3.3.7.3 Sewage treatment works

Sewage treatment works (STW) are used to treat waterborne sewage, black water from bowsers (honey suckers) and bucket latrines. This can be as simple as a ponding system or large treatment plants with highly technical systems. In Makana Municipality there are two sewage treatment works in Grahamstown and one in Alicedale. Riebeeck East relies on septic tanks and pit latrines. The proper management of these sites is essential to ensure that sewage water does not impact negatively on rivers and downstream users. In the past, poor sewage treatment, or lack thereof, has caused devastation to farming communities as well as river health. The entire citrus farming community downstream of Grahamstown was decimated due to the poor water quality in the past. As part of the LEAP the sewage treatment works have been assessed to determine whether treatment is adequate and if any interventions can improve the performance and hence improve the associated environmental and social impacts.

Certain aspects or parameters of the sewage water must be monitored according to the size and daily flow rate of the sewage treatment works. The monitoring requirements are laid out in Section 21 (f) and (h) of the National Water Act (Act 36 of 1998). These parameters are given limits, known as General Limits, which must be achieved before finally releasing the treated effluent into a water course (see Table 2). A more detailed outline of the monitoring of the sewage treatment works is outlined in the LEAP Monitoring Framework.

Grahamstown disposal works

The Grahamstown STW is situated on the south east side of Grahamstown in the Belmont valley. The STW is designed to treat 4 Ml (4000 m^3) per day with the treated effluent flowing into the Bloukrans River. This STW consists of a trickle-filter and anaerobic digestion system. The biggest problem with this kind of system is the disposal of the dried sludge. Note that this is classified as hazardous waste as it is infectious waste. Current disposal methods are to simply throw the dried sludge over the side of the drying beds where it has the potential to re-enter the Bloukrans River during heavy rains. This would then counteract the treating of the sewage as the sludge contains high nutrient levels, harmful bacteria (*E. coli*) and possibly even heavy metals. Current disposal methods of this hazardous sludge pose a major environmental and social impact. Correct disposal methods for sludge must be investigated and implemented or at the very least the sludge must be disposed of in an area where it cannot enter watercourses or ground water.

Effluent quality is tested monthly by the Department of Water Affairs and Forestry and analysis done at an accredited laboratory in Port Elizabeth. The results are, however, difficult to come by and not always consistent in the parameters that are tested. The following information was obtained from DWAF for the Grahamstown Disposal Works for the last four years (Table 2).

Table 2. Effluent quality at the Grahamstown disposal works.

Parameter	GDW average	General Limit
pH	7.5	5.5-9.5
Chemical Oxygen Demand (C.O.D.)	78.3	75
P. V. (O. A.)	8.5	10
Suspended Solids	13	25
Electrical Conductivity	165.39	250
Sodium (Na)	190.7	90
Nitrate (NO_3) & Nitrite (NO_2) as Nitrogen (N)	12.1	15
Ammonia (NH_3)	6	3
Phosphorus (total)	7.5	15
Faecal coliforms	25032.1	1000
Heavy metals	0.0431	1

On average the Grahamstown Disposal Works has achieved the General Limits for most parameters tested. The three notable exceptions are chemical oxygen demand, sodium (salt) concentration. These can all have devastating effects both in-stream and on water users. High chemical oxygen demand causes low oxygen availability to river fauna causing decreased biodiversity and river health which has a knock on effect to the riparian (surrounding) ecosystems. Sodium is a particular concern to farmers using the water for irrigation as salt build-up in the soil decreases soil quality and productivity. The general standards for faecal coliforms are for 10 km downstream of the treatment works which means that a count of 25 032 below the GDW is excellent as counts are often in the millions at the outlet of STWs.

Caption: [Effluent Quality] (Graph 1: Average performance of the Grahamstown Disposal Works over the past 4 years.)
Caption: [Effluent Quality] (Graph 2: Average performance of the Grahamstown Disposal Works over the past 4 years.)
Caption: [Effluent Quality] (Graph 3: Average faecal coliform count in the final effluent of the Grahamstown Disposal Works over the past 4 years.)

An outline of the quarterly testing done by the Nelson Mandela Municipal Metropol's Water Reclamation Officer is also presented. This gives an indication of the points at which samples are taken along the process and provides a comparison of raw sewage to final effluent quality which enters the Bloukrans River. Note that these figures are the results of a single quarterly test. Testing for phosphorus and coliforms was not done, although legally these tests are required.

Table 3. Results of a quarterly effluent quality analysis of the Grahamstown disposal works.

Sample Identification	Raw Sewage	Final Effluent	Final filtered	General Limit
pH	6.9	7.3	-	5.5-9.5
Conductivity at 25°C (mS/m)	-	137	-	-
Total dissolved solids @ 180°C	-	906	-	-
Chloride as Cl	221	-	251	-
Nitrate + Nitrite as N		0.8		15
Ammonia as N	61	14	-	3
Chemical Oxygen Demand	973	79	78	75
Permanganate value (4hr)	53	12	12	
Total solids (%)				
Suspended solids	440	34	-	25
Volatile matter				

The municipal budget reflects that more houses are to be connected to the waterborne sewage system that feeds this plant. This may require upgrading of the STW to handle additional loads.

Mayfield Oxidation Ponds

The Mayfield Oxidation Ponds are situated on the north east side of Grahamstown in the Mayfield area. A series of ponds receive sewage via sewers as well as buckets and bowsers (Honey Sucker). The effluent from this STW is used to irrigate the commonage below the ponds. The valley in which the STW is situated is in the Botha's River catchment. The runoff from this irrigated area ends up in a dam which Makana Brick and Tile (Grahamstown Brick) uses. This STW has a sludge drying system which leads to large volumes of hazardous sludge which presents disposal problems.

[Mayfield Collage]

Caption [Mayfield Collage] (Picture 9: Mayfield STW showing ponds with aerators, sludge, buckets and inlet)

Although DWAF samples the final effluent which is used for irrigation, these figures were not available at the time of writing this report. Municipal records of testing were unobtainable. The main hazard of irrigating with effluent is the spread of diseases to humans and animals that eat the plants in the irrigated area. If this water is to be used for growing vegetables, strict regulation of water quality must be maintained. There is currently no cultivation of crops in the irrigated area but it is used for grazing. It is not known whether medicinal plants are harvested from the area. The problem of sludge disposal is not as severe as with the Grahamstown Disposal Works, but the implications are the same. Before additional housing and waterborne sewerage is added to the Mayfield ponds, the Makana's City Engineers should take into account the current handling capacity of the system and plan for an upgrade in anticipation of increased flow rates.

Alicedale Evaporation Ponds

Alicedale has a STW on the east end of town adjacent to the Bushman's River. This consists of a series of ponds and services Kwanonzwakazi, Transriviere and the Alicedale CBD by bowser (Honey Sucker). According to the unit manager this site is currently running over capacity and must be upgraded if more houses are to be put on the system. At the time of the site visit the ponds were overflowing into a channel that leads to the Bushman's River. The STW was designed to perform as evaporation ponds with no effluent. The increase in the number of households on waterborne sewerage without a corresponding increase in handling capacity at the ponds has caused a potentially environmentally disastrous situation as sewage with high nutrient loading, bacterial counts, salts and chemical oxygen demand may be entering the Bushman's River. The polluting of the river with low quality effluent causes eutrophication, algal blooms, death of sensitive fish and invertebrate species and general destruction of the ecosystem. The upgrading of the STW at Alicedale is vital to improve the surrounding environment and decrease odours especially in light of the new developments which will result in additional loading to an already overloaded system. The Alicedale ponds were designed as evaporation ponds and it was only due to the LEAP investigation that the DWAF became aware that these ponds were beyond capacity and releasing effluent into the environment. There are, therefore, no monitoring data for this STW and the extent of impacts on the environment cannot be determined from this study.

[Alicedale STW collage]

Caption [Alicedale STW collage] (Picture 10: Alicedale STW showing clogging at inlet with refuse, poor performance of ponds, showing filling up of ponds with sludge and overflow to the Bushman's River.)

Riebeeck East
Currently all houses are either on septic tanks, soak-aways or ventilated improved pit latrine (VIP). There are plans to introduce a waterborne sewage system if sufficient groundwater is found.

3.3.8 Livestock issues in residential areas

The issues of livestock in Makana are largely dealt with in the section on livestock. However, wastes of these livestock and the consequences of over 3 000 stock units kept in residential areas in Grahamstown alone must be mentioned here. These animals graze on the commonage by day and return to kraals next to owner's houses in the evening. This not only causes odours and flies and poses a health hazard to residents, but also is a threat to the nearby streams and rivers as runoff carries nutrient-rich manure to these after rains. An associated issue is that nutrients are being removed (by grazing) and deposited in high concentrations in the kraals. This does not allow for a natural cycle of nutrients. This will ultimately cause soil infertility or soil depletion on the commonage. Kraal manure, however, also presents an underutilised resource. Umthathi Training Programme is running an ongoing education programme on how to make compost using kraal manure and garden waste.

3.3.9 Water services

By the constitution of South Africa, all South Africans have the right to safe and clean water. The RDP level for water services is that everybody must be able to access a standpipe (water tap) within 200 m of their dwelling. Water is also necessary for industries and thus development and growth of the town must take place within the context of water availability. In terms of the LEAP this section deals with source directed controls and does not address water quality and quantity in rivers, groundwater and dams. These aspects are addressed under the section on water resources (see Part I of the Comprehensive Audit report).

3.3.9.1 Water supply

Currently there are no data on water resources available for developments in Makana Municipality. This is alarming considering the rate of development in Grahamstown and Alicedale as well as the expanded IDP programmes to put more houses on water borne sewage in Grahamstown. It is vital that an assessment of water quantity available for development, including a study of hydrogeological conditions be completed so that new developments can be planned in line with water available. This will help prevent a potentially disastrous situation in which developments are approved and water cannot be supplied and furthermore, water resources are stressed beyond their natural limits, more detail is expanded on this topic in Part I of the Comprehensive Audit report.

3.3.9.2 Access to water in Makana Municipality

According to census 2001, 10% of households in Makana Municipality fall below the RDP levels. Also 10% have the minimum standard of a standpipe within 200 m. Only 22% of people have water inside their houses. In Grahamstown the water is purified at the Waainek and Jan Kleinhans purifications works. The Waainek site is currently being upgraded. However, the details of this upgrade were not available at the time of preparing this report. A detailed outline of the monitoring of the water quality is outlined in the LEAP Monitoring Framework.

In Alicedale, water is purified in a works close to the Bushman's River on the west side of town. Alicedale's water comes from the New Years Dam. A member of the public raised the concern that a landowner near the dam allows sewage to flow into the veld, which could enter the dam during rainy conditions.

Riebeeck East obtains its water from boreholes. Currently there is a project to drill more boreholes to provide more water for the town. It has been reported that water quality is variable. However, no issues have been raised by the public regarding water in Riebeeck East.

3.3.10 Industrial environmental management

Industrial environmental management is the term used to describe how industries and businesses deal with their environmental impacts. Certain kinds of industries have, in the past, caused severe environmental impacts, many of which we are only becoming aware of now. Industrial environmental management practices have been developed over the past couple of decades to help deal with these issues. An example of industrial environmental management is a mining company which replaces the soil and vegetation after mining has ceased in a particular area. In South Africa there are laws which companies must comply with to effectively manage their environmental impacts. Companies that are defined by the law as having impacts on the environment are required to monitor the impacts and take actions to prevent or reduce the impacts. Many large companies do this by implementing standardised management systems such as ISO 14000. Smaller industries often do not have the resources to implement such systems and environmental management tends not to be a structured process but rather depends on the degree to which the management is committed to environmental management and has knowledge of environmental laws as well as best practice.

3.3.10.1 Industrial environmental management issues identified within Makana Municipality

The following issues have been identified in consultation with members of the public as issues which need further attention:

- Licensing or permit requirements for industries and the enforcement thereof
- Environmental Management Programme Report compliance assessment
- Funding of rehabilitation of old and abandoned quarries
- Underground storage tank testing at petrol stations
- Wash water treatment or disposal practices of dairies, abattoirs and tanneries
- Oil and grease disposal practices at garages and other industries
- General environmental management practices or lack thereof of industries in Makana Municipality
- Formation of waste/environmental management clubs
- Creating environmental ethic within industry.

3.3.10.2 Types of industries in Makana Municipality with significant environmental impacts

Mining and quarrying

There is a small amount of mining and quarrying in the Makana Municipality. Clay is mined for brick making and for industrial minerals. Quarrying for blocks or sand occurs sporadically. Presently the mining companies are required to complete Environmental Management Programme Reports before starting to mine. These reports detail how they intend to minimise environmental impacts and rehabilitate excavations. They must also secure finances to enable implementation of these reports.

Makana Municipality contains numerous disused kaolin mines and quarries. Many of these were established before the legal requirements were promulgated and as such, can only be rehabilitated by extensive outside funding (government, NGO etc).

Tanneries
There are currently seven known tanneries and taxidermists operating in Makana Municipality. The environmental management of tanneries is aimed at limiting odours and to the treatment of wastewaters which may contain a whole host of hazardous chemicals used in the tanning process. Through the public meeting, it became apparent that some tanneries are treating their wastewater before discharging to the sewers while others have no treatment system in place. Although all tanneries were invited to a meeting to discuss current practice and effective environmental practices, there was some reluctance and representatives of only two tanneries attended. Little accurate information could thus be obtained regarding the environmental practices of the other tanneries in Makana. A later visit to one of the tanneries revealed that although there is no environmental policy, limited environmental training is carried out for employees working in the effluent treatment section.

Abattoirs
There are numerous abattoirs operating in Makana Municipality. Abattoirs have nitrogen-rich wastewaters as well as petruscible solid waste, both of which can be hazardous in significant concentrations. All abattoirs are required to be licensed by law. Although invited to a meeting held for industries to discuss environmental management, no one from the sector attended and no information was obtained on the environmental management practices of abattoirs. Waste from one abattoir is removed by the Municipality and thus becomes the responsibility of the Municipality to dispose of it correctly. There are currently 18 abattoirs and butcheries operating in Makana Municipality.

Chemical industries and laboratories
In Makana Municipality there are a limited number of industries that fall into this category. The universities and educational institutions have laboratories that produce hazardous wastes. Fertilizer companies in Makana no longer manufacture fertilizer and only have distribution warehouses where there is little waste. Rhodes University has a number of departments laboratories which produce hazardous wastes. These make use of the services of WasteTech to remove hazardous materials. Biological waste and glassware is incinerated. The University is currently developing a more comprehensive waste management plan to deal particularly with hazardous waste streams and recyclables.

Petrol stations, garages and dairies
In Makana Municipality, as in many other areas, numerous petrol stations, workshops and garages occur within the towns. If environmental impacts are not managed correctly, these industries can cause severe damage to the environment if petrol, oil and grease, classed as hazardous substances, are allowed to move into the environment where they can pollute rivers, soil, groundwater and cause harm to humans, fauna and flora. For that reason it is important that these businesses manage their environmental impacts proactively and conduct environmental training for all staff. It is thus important that these businesses are included in environmental education and action plans for the district. Out of four garages and workshops interviewed in Grahamstown, all had environmental policies drawn up by the head offices of the corporation. No smaller workshops were surveyed. Despite these environmental policies, no environmental training has taken place and only two have oil collected for recycling.

Lack of proper environmental management of garages and repair workshops is most evident after heavy rain. Currently, downpours in Grahamstown cause a noticeable washing out of oils and greases from the storm drains into the Bloukrans River. This concern was raised by the farmers downstream from Grahamstown who cannot use the first flush of water down the river after a significant amount of rain due to the oils and greases that are washed from the town. The large quantities of litter washed down also cause blockages in irrigation pipes and pumps. Another

important consideration of garages and dairies is the wash waters they produce. Garages which offer car washes will produce soapy waters which are not a problem as long as this water moves into municipal sewers. Dairies also need to have effective environmental management systems as washwaters can have high organic loading (high chemical oxygen demand) as well as significant amounts of chemical disinfectants. This can disrupt the functioning of sewerage works if disposed of in municipal sewers or impact negatively on ecosystems by killing beneficial organisms, changing water chemistry and causing eutrophication.

Miscellaneous
Other industries not listed above can also have environmental impacts. These industries include dry cleaners, ceramic industries, farming, printing and photographic operations. There are three dry cleaning operations in Grahamstown. On interviewing one of the laundries, it was evident that no environmental management was taking place. Dry cleaning chemicals are highly toxic but were being disposed of in drains and containers were given to farmers. This practice has not only severe environmental implications, but also severe health hazards to those using the containers.

Education around health and environmental impacts and correct disposal methods for all chemicals used in all processes is essential for the health of the people and the environment in Makana. Disposal options must also be made known and available and cooperation between industries which produce similar wastes could reduce costs to individual companies. Simple environmental management strategies would go a long way to addressing best practices, particularly for the handling and disposal of hazardous chemicals and wastes.

3.3.11 Air quality

All South Africans have the right to clean air. This means that the air we breathe must be free from contaminants such as carcinogens, dust and smoke. In South Africa primary air pollutants are caused by indoor wood fires and industrial activity. Air quality is regulated through the Atmospheric Pollution Prevention Act. Industries which have been identified as causing air pollution are required to register with the Chief Air Pollution Control Officer. In Makana Municipality the major sources of air pollution are indoor fires. Other sources include brick factories, coal burning, dry cleaners and refuse burning. A major consideration for air quality is the investigation into the possibility of carbon trading. The Kyoto protocol has caused renewed interest in cleaner technologies, recovering methane and biogas from landfills and sewage treatment works. This is expanded on under the section on landfills. Projects to reduce emissions could become more economically viable as first world countries are becoming interested in funding emissions-reducing projects in order to claim carbon credits. Potential projects include:

- Composting
- Landfill gas capture
- Biogas from sewage treatment works
- Use of integrated algal ponding for sewage treatment
- Replacement of older technologies with cleaner technologies
- Reduction of burning of refuse in smaller towns

3.4 REFERENCES

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Makana Municipal Records

Integrated Development Plan for Makana Municipality

Stakeholders and members of the community.