

Scoping report for the state of waste management in and around Gaborone

Report prepared for the Japanese Government

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Acronyms

BCA	Botswana College of Agriculture
BHC	Botswana Housing Corporation
BNMPWWS	Botswana National Master Plan for Waste Water and Sanitation
BOD	Biological Oxygen Demand
BWP	Botswana Pula
CAR	Centre for Applied Research
CSO	Central Statistics Office (now SB or Statistics Botswana)
COD	Chemical Oxygen Demand
DWMP	Department of Waste management and Pollution Control
EIA	Environmental Impact Assessment
GCC	Gaborone City Council
GE	Green Economy
GWMP	Gaborone Waste Management Plan
GWWTW	Gaborone Waste Water Treatment Works
Ha	Hectare
ICP	International Cooperating Partner
ISWRM	Integrated Solid Waste Resource Management
ILWRM	Integrated Liquid Waste Resource Management
MSDP	Mogoditshane Sub-District Council
NGO	Non-Governmental Organisation
NOSSP	National On-site Sanitation Programme
RCDP	Revised Gaborone City Development Plan
SADC	Southern African Development Community
SD	Sustainable Development
SEA	Strategic Environmental Assessment
SHHA	Self-Help Housing Agency (SHHA)
SS	Suspended Solids
ST	Somarelang Tikologo
TEA	Trade Effluent Agreement
ToR	Terms of Reference
TT	Tshole Trust
TSDC	Tlokweng Sub-District Council
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
WUC	Water Utilities Corporation
WWTW	Waste Water Treatment Works

1 Introduction

This report gives an overview of the current waste management situation in and around Gaborone. Gaborone city is the capital of Botswana and it hosts the Secretariat of the Southern African Development Community (SADC). Therefore, Gaborone should be an example for other cities in Botswana and southern Africa. It is important that the city aspires to be 'green' in terms of management of its natural resources, including prudent waste collection, disposal and re-use and recycling.

The report reviews the current management interventions to address the city's waste management challenges and identifies key areas for improved waste management. The Japanese Government through its Embassy in Botswana contracted the Centre for Applied Research (CAR) to carry out the study with the intention to support sustainable waste management projects.

According to the Terms of Reference, the study comprised the following tasks:

- a. Assessment of the current situation and challenges regarding waste management;
- b. Review the current counter measures for the identified challenges;
- c. Identification of additional possible solutions; and
- d. Review possibilities for effective cooperation between stakeholders and the Japanese Embassy.

Despite serious data collection efforts over the period October 2012 to mid-January 2013 from the Gaborone City Council (GCC), the Tlokweng and Mogoditshane Sub-District Councils (TSDC and MSDC) as well as Gamodubu land fill, it has been impossible to compile a comprehensive, quantitative picture of the solid and liquid waste flows in and around Gaborone. The study used already published data and some additional data made available by the GCC and other stakeholders. *Development of a waste data record system should be a priority for supporting future waste management efforts.*

Gaborone's growing economy and population create a rising demand for goods and services provided by businesses, industries and Government. Waste generation is driven by economic growth, population growth and urbanization and consumption patterns. Consumers' attitudes towards waste management have also accelerated generation of waste in Gaborone and the country at large (Kgosiesele and Zhaohui, 2010 and Nagabooshnam, 2011). Currently, provisions for waste re-use and recycling are minimal due to limited infrastructure and lack of education and awareness. The institutional capacity to strengthen waste management is limited and the policy environment is insufficient. Later on in the report, these factors will be elaborated upon in more detail.

The study has the following limitations:

- a. Limited budget and duration. The study is primarily focused on identifying possible opportunities for Japanese assistance;
- b. Limited data and data inconsistencies between different sources. As a result, no long term trends could be established; and
- c. Stakeholders' responses were slow, partly because of the vacation period.

2 Waste cycle and the green economy

The study was carried out part time between November 2012 and March 2013. It is mostly based on a desk-top study, collected statistics and views of stakeholders and key resource persons (listed in Appendix 1). The literature review included policies, strategies, plans, programmes, past studies on waste management, statistics as well as research reports. Key resource persons were identified in central and local government, civil society and private sector. Interviews were undertaken and people were also contacted by e-mail or telephone particularly for follow ups on data and missing information. The study covers both solid and liquid waste¹, but emphasis is given to solid waste.

A stakeholder meeting was held in February 6th 2013 to discuss the waste management situation and agree on priority key areas and challenges with stakeholders.

The analytical framework used is a combination of the waste cycle with the ‘sustainable development’ and ‘green economy’ concepts. The cycle shows the flows of waste in the economy while sustainable development and particularly the green economy concepts emphasise the need to maintain Botswana’s natural resource base, eradicate poverty and to utilize the economic opportunities of waste (*waste as a resource*).

In-order to determine the characteristics of waste management and solutions, a waste cycle was developed and attempts were made to document the waste cycle (Figure 1 for solid waste). This cycle considers waste generation by type and source as well as waste collection and disposal in-terms of infrastructure used, site, methods adopted and the risks associated with current waste management practices. Additionally, re-use and recycling are assessed and what is required for re-use and recycling so as to improve waste management in the city. Waste is generated by the private sector, households and by government. Waste is collected by government (e.g. GCC and District Councils) and by private sector companies. It is legally disposed in landfills, but waste is also illegally dumped in and around Gaborone. Waste is mostly stored but some waste is incinerated at source (e.g. Princess Marina Hospital) and at the Gamodubu landfill. Construction waste is mostly dumped at Ledumadumane dumpsite. Re-use and recycling of solid waste occurs at source, by recycling companies and at the landfill. Ideally, the waste cycle can be quantified, e.g. figures can be attached to each arrow. As we shall see later, this has been largely impossible, and only fragmented and qualitative insights in the waste cycle could be developed. A similar figure for liquid waste (wastewater and oil) is shown in Appendix 2.

The waste cycle is embedded within the concepts of green economy (GE: UNEP, 2011; World Bank, 2010 & 2012) and sustainable development (SD: WCED, 1987). The GE concept may be viewed as an economic emphasis of sustainable development (UNEP, 2011). The overarching goal of green growth is to establish incentives or institutions that increase well-being by (World Bank, 2012):

- a. Improving resource management so as to boost productivity;
- b. Encouraging economic activity to take place where it is of best advantage to society;
- c. Encouragement of investments in renewable resources and associated economic sectors;

¹ This includes wastewater and waste oil.

- d. Use of technology and innovation to meet the above objectives; and
- e. Recognising the full value of natural capital as a factor of production along with other goods and services.

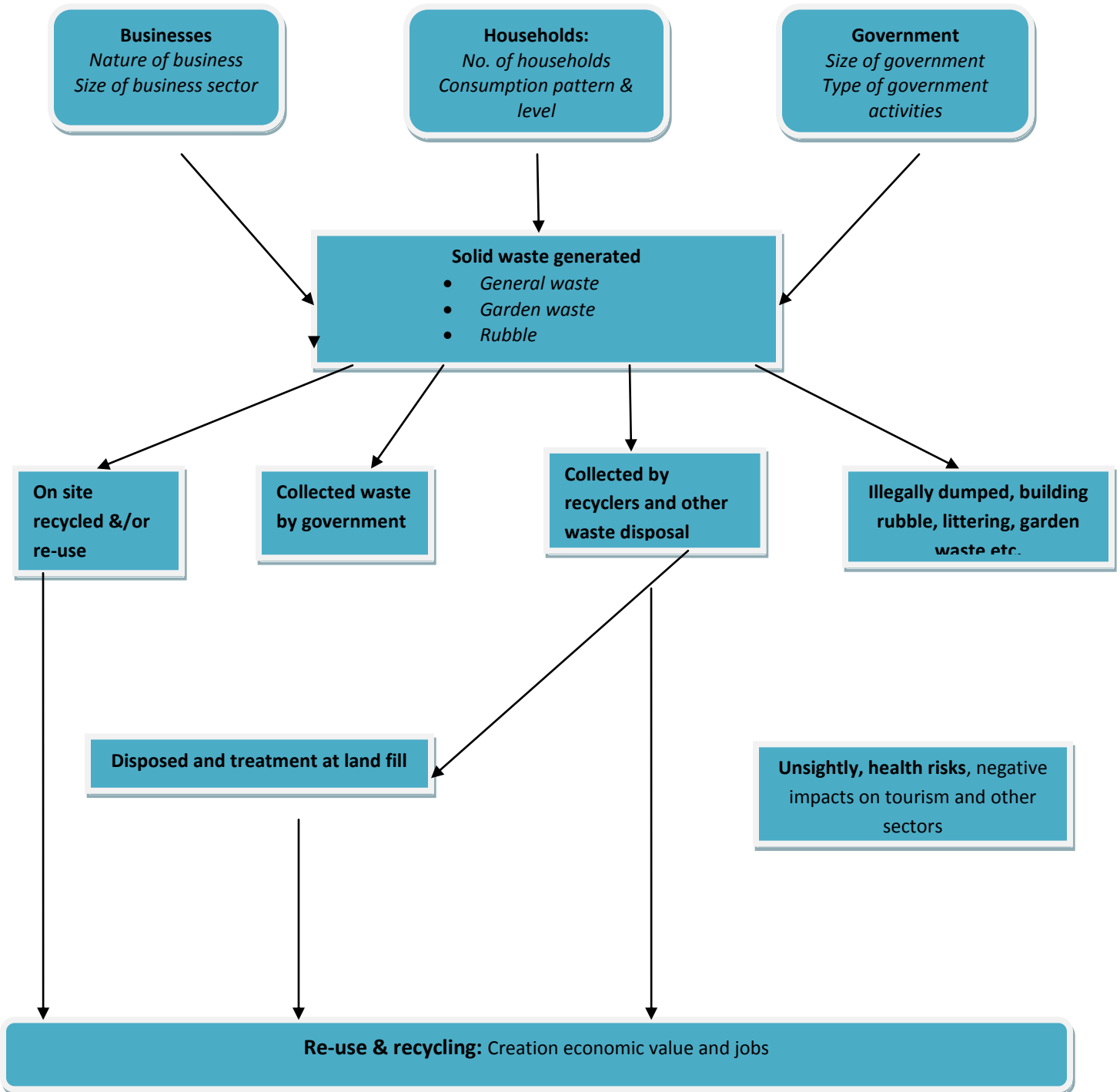
Green growth is essentially driven by increased investments in sectors that enhance natural capital and reduce ecological scarcities and environmental risks. For waste management, this means that waste should be viewed as much as possible as a capital asset for re-use and recycling, that waste management should be efficient and that resource users and polluters should pay conform the polluter-pays-principle and the user-pays-principle. The GE concept and natural capital approach were endorsed in the Gaborone Declaration adopted at the May 2012 Gaborone Summit on Sustainability in Africa. Ten African countries, international Collaborating Partners (ICP) and a number of large enterprises committed themselves to the development and implementation of a road map towards sustainability. A Botswana Green Economy case study recently carried out for the Commonwealth Secretariat argues that: *“Good opportunities exist to reduce resource wastage by reducing the losses in the water distribution networks, re-use and recycling of treated effluent and some solid waste (e.g. building rubble, cans, plastics, paper and bottles). Small scale recycling projects have the potential to create jobs and reduce poverty. There can be win-win situations with environmental and economic benefits”* (Setlhogile & Arntzen, 2012, p. 20).

Since the SD's inception in 1987, sustainable development's focus has changed and shifted in time, initially towards poverty reduction and social aspects, later towards global environmental issues and governance and most recently to economic issues. SD is commonly defined as *‘meeting the needs of the current population without jeopardising the ability of future generations to meet their needs’* (WCED, 1987). SD has four sustainability pillars, which are highly relevant for waste management: economic, environmental, social and institutional. These pillars have been used to identify the waste management issues and challenges.

The GE concept is driven by the need for behavioural change towards the environment and to develop policies that technologically innovative and environmentally sustainable. Poverty eradication be emphasized, and the GE is a means towards sustainable development. According to UNEP (2010), the GE is *“an economy that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities”* (UNEP, 2010, p. 5). Job creation, investments in renewable resources, re-use and recycling of non-renewable resources and creating economic value out of waste are essential components of sustainable waste management.

The study covers Gaborone and its adjacent villages of Tlokweng and Mogoditshane. The reasons for including both satellite villages is that their waste is dumped at the same land fill, the villages are spatially linked to Gaborone and illegal dumping of Gaborone waste in its surroundings is common. In other words, waste management issues cannot be meaningfully separated.

Figure 1: Solid waste cycle in Gaborone

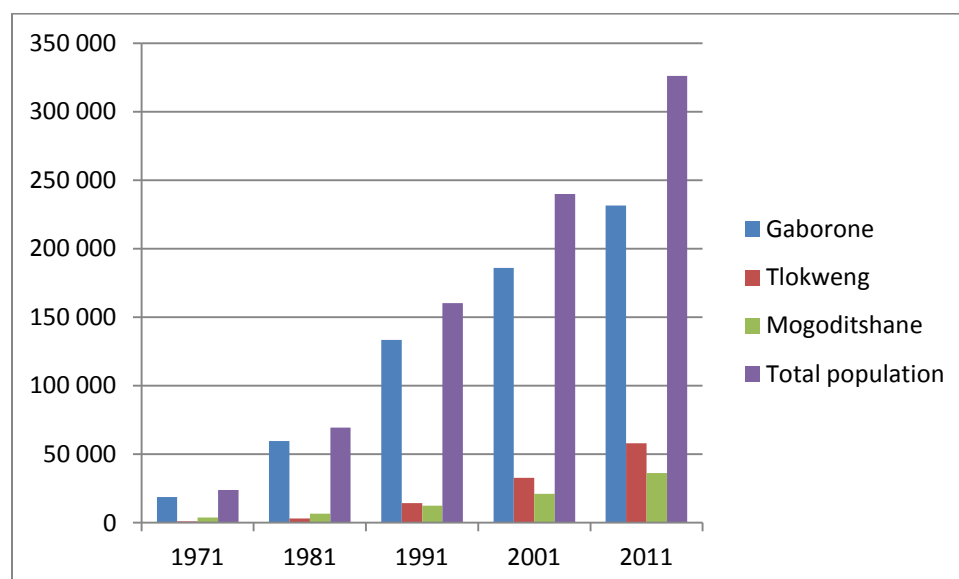


3 Gaborone's development

Gaborone's population has grown rapidly from a mere 18 799 in 1971 to 231 592 in 2011. If one includes satellite villages of Tlokweng and Mogoditshane, the population size was 325 994 in 2011. The city offers a wide range of economic opportunities (government and private sector), facilities (e.g. hospitals, university and airport) and amenities (e.g. shopping centres, game parks and cinemas). People from rural areas migrate to the city for job opportunities, leading to rapid urbanisation (growth rates of Gaborone, Tlokweng and Mogoditshane are resp.). The satellite villages are popular as land and house prices are high in the city.

The city's population and economic growth have led to a rapid increase in solid and liquid waste, but exact figures are not available. This has exerted considerable pressure on the responsible authorities, i.e. Gaborone City Council (GCC), Tlokweng Sub-District Council (TSDC) and Mogoditshane Sub District Council (MSDC). The rapid growth has led to capacity problems in the wastewater treatment works (GWWTW), requiring a significant expansion of its capacity, and it led to early closure of the landfill in Gaborone and a 25% higher than expected annual waste disposal at Gamodubu landfill. Moreover, it has led to a low household waste recovery rate in Tlokweng and Mogoditshane to illegal waste dumping.

Figure 2: Population trend in Gaborone, Mogoditshane and Tlokweng



Sources: Statistics Botswana; various Population & Housing Censuses.

In terms of access to water and sanitation, according to the 2009 Revised City Development Plan (RCDP; GCC, 2009), 49.2% of households in Gaborone have water in their yards², while the others rely on public standpipes. Standpipes are now being phased out. According to the same plan, 8 721 plots still use pit latrines and septic tanks and their maintenance costs are high and impacts heavily on the GCC. Storm water drainage problems, absence of interceptor drainage channels and blocked culverts by sediments

² More recent 2011 Population Census data on access to water and sanitation are not yet available.

are among the causes of build up areas. The expansion of the sewerage system to low income areas will improve sanitation and increase the volume of sewerage.

The GCC regularly collects solid waste from households and government. Waste from the private sector is collected by private companies. The collection frequency and reliability has decreased in recent years because of operational problems (Figure 3). This has led to an increase in illegal dumping and littering (as dogs tear plastic bags and pull down bins), which harms the image of the capital.

Figure 3: Uncollected solid waste in front of office³.



Most solid waste from Gaborone, Tlokweng and Mogoditshane is transported to Gamodubu landfill located near Gamodubu village at some 50 km distance from Gaborone. Tlokweng Sub-district Council also transports waste to the South East District regional land fill. The Glenn Valley landfill for garden waste was closed in 2011. Instead Ledumadumane dumping site⁴ is now operational and receives garden and construction rubble from Gaborone. Box 1 gives an overview of Gaborone's old landfill, which was used beyond its capacity and life time.

Box 1: History of disposal sites in Gaborone

Gaborone old landfill

The Gaborone landfill started operating in 1993 and replaced temporary waste disposal sites in Maruapula. The facility provided treatment and disposal to waste generated in Gaborone and satellite villages of Tlokweng, Mogoditshane, Ramotswa and Molepolole. It was located near the city centre, off Samora Machel Drive and adjacent to Fairgrounds Holdings in a 21.5Ha area. The landfill was also close to Notwane River hence greater environmental risks were apparent particularly groundwater pollution. By 2002, the landfill had reached its capacity and options for closure and a new landfill had to be sought. Additionally, there was an encroachment of cooperate offices and commercial entities in the area and often a stench and smoke were produced by the landfill. This was obviously not healthy and put even more pressure on the landfill to be relocated. It was meant to shut down in 2004 but due to insufficient funding and lack of alternative at the time, there were delays. It was then officially closed down in 2009 and paved way for Gamodubu landfill operations.

³ Photo taken March 2013.

⁴ The site is located in an unfenced enterprise zone with old burrow pits.

Most of the recycling waste initiatives are from neighbouring countries, mainly South Africa. A few private companies (e.g. Collect a Can and several oil recovery companies) and NGOs such as Somarelang Tikologo (ST) are involved but in a limited way and recycling and re-use rates are generally low (e.g. 10% for oil).

Wastewater is channelled through the sewer system to the Gaborone WWTW; trucks emptying pit latrines also bring inflows to the plant. The wastewater is treated and disposed in the Notwane River. A small portion is used for irrigation in Glenn Valley.

4 Situation analysis of waste management in Gaborone

This chapter describes the current waste management situation in terms of type of waste generated, amount of waste generated and collected, collection of waste, disposal and treatment of waste including the types of infrastructure and equipment used and spatial coverage. The analysis includes the issues and challenges incurred in this regard. It discusses solid waste (4.1), liquid waste (4.2) and the challenges (4.3). It follows the waste cycle (Figure 1) and uses SD and GE for its analysis.

A few key figures with respect to waste flows are presented in Box 2.

Box 2: Some key waste figures for Gaborone

Waste generated:

Gaborone: wide range of figures. Likely to be in the range of 125 000 to 200 000 T/annum.

Mogoditshane: no figures. Likely to be around 20 000 T/annum.

Tlokweng: no figures. Likely to be around 32 000 T/annum.

Waste composition: mostly households and construction waste/ rubble.

Waste collection:

Gaborone: figures vary enormously; ranging from 25 000 tons in 2010 to 252 000 tons in 2000.

Mogoditshane: Not known.

Tlokweng: Not known

Waste recovery rate:

Gaborone: over 90% from households; 100% from industries

Mogoditshane: 11.7% from households; unknown from private and public sector

Waste disposal:

Gamodubu: on average 88 000 T/annum for period 2009-2012 (designed for 65 000 T/annum); 49 800 T of waste originates from Gaborone (2010).

Ledumadumane: no figures available. It is estimated to be in the range of 100 to 125 000 T/annum.

Illegal disposal: unknown but significant.

Re-use and recycled:

Scrap metal: Not known. Wide range of recovery: 385 to 12873 T/annum in period 2006 – 2009.

Oils: recovery rate of around 11% of imported oil

Wastewater: re-use around 3.5% of outflow

Sources: Various

4.1 Solid waste management

4.1.1 The process of solid waste handling and management

Solid waste is often categorised into municipal solid waste and non-municipal solid waste. The non-municipal waste includes construction waste, wastewater sludge, mining waste and other industrial

solid waste (Nagabooshnam, 2011). The municipal waste includes household waste, waste from government and service sectors. The Waste Management Act of 1998 distinguishes four types of waste:

- a. Household or general waste. This is waste from any building used for the purpose of living accommodation, from a residential home or educational institution;
- b. Industrial waste. This is waste produced from any industrial activity;
- c. Commercial waste. This is waste from premises used wholly or mainly for the purposes of trade, business, sport, recreation or entertainment as well as government offices. It excludes waste from mining activities⁵; and
- d. Clinical waste. This is waste, arising from human or animal tissue, body fluids, drugs, excretions or other pharmaceutical products. It originates from hospitals, clinics, higher education institutions, and private practitioners and laboratories.

Other types of waste such as garden waste and construction waste and rubble are not stipulated in the Act but they are widely generated in Botswana and involve large volumes. Garden waste includes dead or pruned-off branches, twigs and fallen leaves (Japan Engineering Consultants, 2009). Garden waste may be burned on site, or separately placed outside yards for collection by the local authorities at a fee. Alternatively, individuals directly dump garden waste at the designated dumping sites.

Clinical waste differs in shape and condition and usually includes syringes and needles, used cotton wool, bandages and hand gloves. Clinical waste is usually packed in special plastic bags or containers and is protected properly accordingly to its various processes. Waste like syringes and sharp objects are carefully packed in a specially designed package such that there is no human contact while being collected for disposal. Other materials such as cotton, cloth and bandages are packed separately and sent to the landfill.

Waste generation

The amount of waste generated is determined by the population size, consumption patterns, living standards, the economic structure and size of the local economy. The sources of waste includes households, the private sector and government (see Figure 1). The exact amount of generated waste is unknown. Most available figures refer to collected waste. The amount of waste generated in the private and public sector is unknown.

Household waste is put in rubbish bins or in vinyl/polythene plastic bags. For collective housing, condos, government institutions and businesses, waste is placed in exclusive garbage use carts or containers for councils and private companies such as Skip-Hire, Daisy Loo and Cleaning Wizards to collect. The waste is generally not separated and different types of wastes are mixed up in the bins and plastic bags.

The clinical waste is collected by private companies and Councils.

For building rubble, companies usually make their own arrangements as to transporting it to the dumping site while some engage Councils at a certain fee. Illegal dumping is common around Gaborone, and poses a serious challenge.

Other waste such as batteries, electronics and cartridges are produced but these are not separately collected and given less priority. This differs from other countries (e.g. South Africa and The

⁵ Presumably included in industrial waste.

Netherlands) where shops tend to have collection facilities. Generally, there is no waste separation at source except in individual cases.

Waste collection

Waste is collected by local government and private companies. No data could be obtained for private waste collection (and disposal).

Local authorities (GCC, MSDC and TSDC) are responsible for collection of general waste, clinical waste and, in individual cases, garden waste. They only collect waste from households and government. GCC covers Gaborone, Phakalane, Gaborone North and Mokolodi while the two Sub-District Councils are responsible for collection of waste in Mogoditshane and Tlokweng respectively.

Interviews revealed that GCC collects from over 93 000 plots. In 2003, the recovery rate was 90% and it is likely that the rate has remained the same or has increased. In 2011, Gaborone had around 73 000 households. In Mogoditshane waste is only collected from registered⁶ households (around 5 300 out of a total of 12 234 households; Population Census 2011) but only 27% of these are covered. This gives a recovery rate of 11.7% (2011). No recovery figures were available for Tlokweng.

In the past, local authorities have sourced out waste collection from households to private companies. Now, private companies collect waste from the private sector. Several private companies also engage in the collection of waste while individuals can also dispose own waste at the landfill. About 948 waste carriers are registered with the Department of Waste Management and Pollution Control (DWMPC). Communities are also engaged by Councils to collect household waste. Currently, there are eleven community contracts (10 in Thamaga and 1 in Mogoditshane). Apparently, the collection frequency has improved, but funding is still a big challenge (pers. comm. Mrs. Senai).

Construction waste is collected after an application for collection is accepted by the council. However, some companies individually collect and dispose at dumping sites while some indiscriminately dispose the waste in open spaces. Private licensed collectors also engage in the collection and transportation of building rubble to dumping sites and the land fill.

Different types of equipment are used for waste collection. As mentioned earlier, waste may be placed in trash cans or large containers for collection. Vehicles used include compactors, top loaders, skip trucks, open bakkies and special vehicles for clinical waste. The GCC has a fleet of 20 vehicles for waste management, but only 7 to 10 vehicles are operational (efficiency of 35 to 50%⁷). In Mogoditshane, eleven vehicles are recorded and the fleet efficiency is around 50%. All councils experience a shortage of vehicles and fleet maintenance problems, leading to unreliable waste collection. Ideally, general waste should be collected twice a week; currently the collection is undertaken once a week and can be delayed by more than two weeks.

Waste disposal

Waste is disposed at Gamodubu landfill and at Ledumadumane dump site.

Gamodubu is a regional landfill, operated by the Kweneng District Council. The landfill started operating in September 2009 and serves Gaborone, Molepolole, Mogoditshane, Thamaga, Gabane and Tlokweng.

⁶ Registered households have to pay an annual sanitation fee of P, but many do not pay.

⁷ It was 19% in 2003 (GCC, 2003).

It has a design capacity of 65 000 tons, but it receives more waste than that at the moment (see section 4.3). The land area of the land fill is 80 ha, but currently only 30 ha have been developed. The planned lifespan of the landfill is 20 years, but the lifespan will be reduced by as much as 5 years if the design capacity continues to be exceeded. The following on-site facilities at the landfill are distinguished:

- a. Two computerized weigh bridges for trucks with a maximum of 30 tonnes. The weigh bridges are serviced twice every year;
- b. Two fully fledged incinerators for disposal of clinical waste and confidential waste;
- c. Five cells for disposal of general waste, excavated up to 1.5 metre level each. The cells are lined with a geo-membrane clay liner and pipes (drainage pipes) collecting leachate for disposal into an open sump. The leachate is sampled and analysed twice a year, mixed with one for storm water. The water evaporates or is used for dust suppression;
- d. One cell each for scrap metal, tyres, garden waste and rubble;
- e. Machinery: two landfill compactors, three tipper trucks to transport cover material (soil), one front end loader, one tyre cutter for shredding tyres, wood chipper, one bull dozer and a water bowser for dust suppression; and
- f. A stand-by generator and a fuel point.

The landfill is meant to receive general waste, clinical, scrap metal, tyres, garden waste and building rubble (Figure 4).

Figure 4: Some types of waste disposed at Gamodubu landfill



a. Scrap metal



b. Used tyres

According to GCC (pers. com), waste management fee is part of the service levy paid by plot owners in Gaborone. There are no designated charges solely for waste management. Garden waste is collected by GCC at a fee of BWP 400 per 7 ton truck. The GCC also collects waste soil or rubble from households at a fee of BWP 500 Pula per 7 ton truck. To evade paying these fees, many households dump waste at undesignated areas.

The KDC charges for waste disposed at the Gamodubu landfill. The fee structure is indicated in Table 1. At the end of each month the waste carriers are billed and payments are made at revenue offices in Mogoditshane and Molepolole. Revenue collection is, however, inconsistent and many bills are outstanding.

Table 1: Waste disposal tariffs at Gamodubu land fill

Waste Type	Waste Code	Cost per weight/volume (BWP)
Domestic waste	A	40/ton
Garden waste	B	60/ton
Medical waste	C	30/kg
Tires	D	50/ton
Scrap metal	E	60/ton
Soil materials	F	Free
Incineration ash	H	40/ton
Carcasses	I	40/ton
Condemned food stuffs	J	20/ton
Confidential documents	L	40/ton
Abattoir sludge	M	5.00/kg
E-waste	N	40/ton
Wood waste	P	40/ton
Glass	U	40/ton
Industrial waste	V	40/ton
Food animal products	W	1/kg
Recyclable tires	Q	N/A
Recyclable metals	R	N/A

Source: Kweneng District Council.

Most building rubble and some garden waste are presently disposed at Ledumadumane dump site near Gaborone. The dumping site is located on State Land bordering Sir Seretse Khama International Airport in the north. It was initially under the jurisdiction of the KDC but since 2012 it is under GCC's control. The site is on old burrow pits of 10 to 15 metres deep, and the objective of dumping is to rehabilitate the land resource. Since the designated land use is commercial free enterprise zone, in the long run the intention is to develop commercial entities in the area such as retail shops. Box 3 gives a description of activities at Ledumadumane dump site. Figure 5 shows that not only construction waste is dumped at the dump site. General (household) waste is also dumped.

Box 3: A summary of Ledumadumane dump site

Operations

The dumping site is meant to receive construction rubble but other types of waste such as general waste, garden waste, tyres and scraps are also dumped there. Most of the non-designated waste was dumped there before GCC took over. Companies and individuals are allowed to dump rubble at this site upon acquiring a rubble disposal permit from the Council. Some large companies have been allocated certain portions of the site where they can dump their rubble and they are expected to maintain the area until the permit expires. One of the requirements of the permit allows companies to utilise their own machinery/loader/dozers to spread the soil to the required gradient.

Facilities, equipment and machinery

There are few household units situated about 50 metres from the site but are currently being relocated. The Council operates with one bulldozer that is used for spreading the rubble and soil to the required levels. Three council staff members are in charge of operating this bulldozer. A large compactor will soon be acquired and be used for waste compacting. A certain portion is fenced for storage of machinery and equipment and to guard against theft. There are neither sanitation facilities nor water standpipes and therefore people have to fend for themselves.

Volumes of waste disposed

About 20-30 vehicles enter the area to dump rubble every day. The size of the vehicles varies between 7 and 15 tons. Based on these, on average, 250 tons of waste is dumped in Ledumadumane and this translates into 91 250 tons per annum. This is likely to increase in the near future as construction developments are growing tremendously. It is predicted that with the current rate of rubble production, the dumping site will last another three years. The Council has started planning and sourcing for other potential areas for disposal of rubble.

Management practices

- The council engages casual labourers to pick litter around the dumping site. This waste is eventually transported to Gamodubu landfill for disposal.
- Individuals and companies are allowed to scavenge for re-usable and recyclable materials. However, this is not done in a systematic manner and they are not charged for material recovery.

Monitoring

Four people monitor activities at the dumping site. Upon entry, they direct vehicles as to where they should dump and also check if they are carrying non-designated waste. This is also done when they dispose the waste. However, this is not systematic, and some vehicles can enter using different routes as the area is not fenced. Apparently they operate day and night but they are not provided with vehicles to track the wrong doers especially at night. There are no records on the amount of waste disposed hence no information to support decision making. The GCC alluded that monitoring is ineffective as wrong doers can dump waste at night, including un-intended and hazardous waste

Figure 5: Types of waste disposed at Ledumadumane dumpsite

Waste re-use and recycling

Several companies re-use and recycle waste in Gaborone, in particular paper, glass, cans and plastics. At the Gamudubu landfill, waste is separated in different cells. Five companies collect recyclable material onsite, including paper, beverage cans, plastic, tires and metal. The recovered materials are mostly sold to traders for exports. There are no local facilities for waste recycling processing. The landfill was constructed with the assumption that recycling transfer stations would be built in Gaborone and surrounding villages. This has not happened, allegedly because of lack of funding. One transfer station will be designed and built with Swedish assistance.

4.1.2 Quantities of waste collected and disposed

Data on the amount of waste generated is poor and where available, there are inconsistencies and gaps. Councils do not keep records and instead rely on data recorded at the Gamodubu landfill, which was unable to disaggregate the waste dumped from various settlements.

Amount of waste collected

The amounts of generated and collected waste are not precisely known and existing figures are conflicting. For example, GCC data for 1999-2001 mention annual waste collection figures in the order of 150 to 250 000 T, while incomplete figures for 2009-2012 suggest that waste was collected in the order of only 25 to 35 000 T/annum. Vijayakumar (2010) states that 49 800 T of Gaborone waste was disposed at Gamodubu landfill⁸.

The differences between figures can in part be attributed to the fact that construction waste and rubble, previously disposed at the Gaborone land fill, is now dumped at Ledumadumane dump site (the amount is not recorded). Data for Gamudubu land fill show that the annual waste disposed has been on average 88 800 tons (average for 2009 - 2012). This includes waste from Gaborone and many other settlements around Gaborone and in Kweneng. No recent breakdown of the Gaborone waste could be obtained. Using the figure of 1.5 kg waste/person/day, waste generation would be 126 800 T for Gaborone and

⁸ This means 17 500 T is disposed at the land fill from other settlements, including Mogoditshane and Tlokweng.

178 400 T for Gaborone with Tlokweng and Mogoditshane. The wide range of figures can be explained by data recording errors, wrong assumptions (e.g. 1.5 kg of waste/person/day?) or significant amount of unaccounted for waste (illegally dumped and/or on-site treated waste).

As a result of the data shortcomings, most parts of the solid waste cycle (figure 1) cannot be quantified. Better data recording and analysis is vital to improve waste management in and around Gaborone.

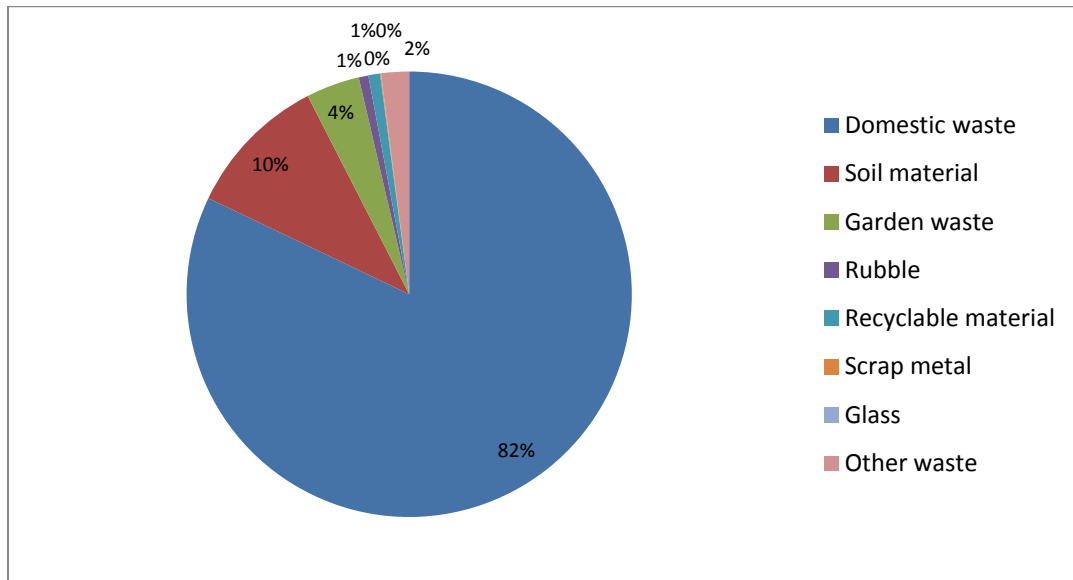
Recovery rates

The recovery rate is high in Gaborone (probably in excess of 90%) but very low in Mogoditshane (11.7% among households). However, due to fleet problems, the collection has become irregular leading to a lower amount of waste collection and increased littering and illegal dumping.

Waste composition

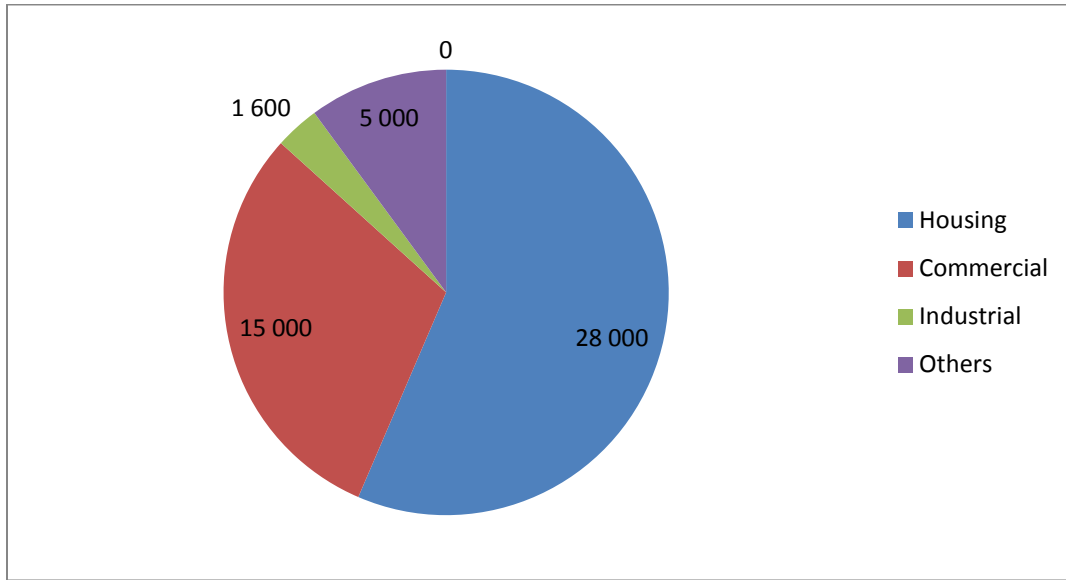
The waste composition at Gamodubu land fill is shown in figure 6 for the period 2009- 2012 (August). This refers to all waste disposed at the land fill but it is believed to be representative of the Gaborone area. Domestic waste accounts for 82% of all waste followed by 14.3% for soil and garden waste. Around 2% is recyclable material, glass and scrap metal. The amount of building rubble is small due to the fact that it may be dumped illegally and at the Ledumadumane dumpsite near Gaborone. Waste reduction and separation of domestic waste at source would be most effective to reduce the amount of disposed waste.

Figure 6: Composition of waste disposed at Gamodubu landfill (2009-2012)



Source: Data provided by Gamodubu land fill management.

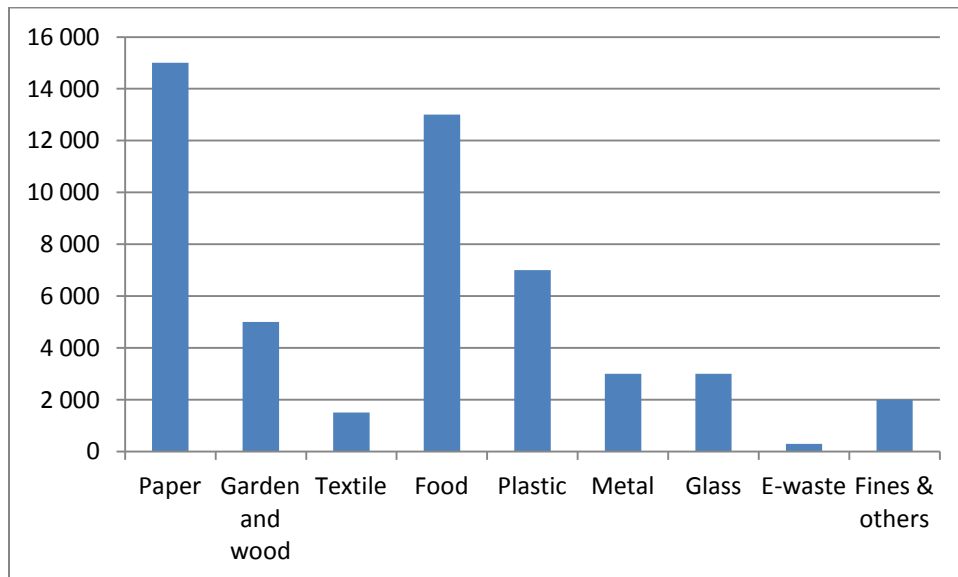
Figure 6: Sources of Gaborone waste disposed at Gamodubu in tons.



Source: adapted from Vijayakumar, 2010.

Paper and food accounts for more than half (56%) of Gaborone’s solid waste disposed at Gamodubu (Figure 8). There appears to be huge potential to re-use and recycle waste at Gamodubu (e.g. food, paper, plastics, metal etc. This is best done at source in Gaborone.

Figure 7: Types of waste from Gaborone disposed at Gamodubu in tons.



Source: adapted from Vijayakumar, 2010.

Waste disposed at Ledumadumane dumpsite is not recorded. However, the volume is significant. In 2000, 123 619 T of construction waste and rubble was dumped at the Gaborone land fill. The amount of

construction waste could have risen to 150 000 T/annum today. Without recording it is impossible to estimate how much is illegally dumped and how much is disposed at the dump site. The strategy to dump voluminous construction waste close to Gaborone and rehabilitate land saves waste disposal costs and expands the lifetime of Gamodubu land fill. Re-use and recycling opportunities of construction waste need to be investigated.

4.1.3 Solid waste management challenges

Waste management in Gaborone faces significant challenges that warrant immediate attention. Below, we discuss the major ones.

General solid waste management

Infrastructure

Challenges are faced for re-use and recycling collection points, the collection fleet and the absence of hazardous waste facilities.

Waste collection vehicles frequently breakdown, thus limiting waste collection capacity and reliability of collection. Increasing the fleet efficiency is a priority for better collection and cost savings (90% fleet efficiency would reduce the collection costs to BWP160/ T instead of the BWP909/ T⁹ at 18% fleet efficiency; GCC, 2003). At present, more vehicles are operational than in the past, but many are on their way to and from the land fill and not available for waste collection. Proper maintenance and increased fleet efficiency should be prioritized for short term action. In Mogoditshane, interviews revealed that the available vehicles cannot cope with the amount of waste generated in the village and that poor roads cause access problems, delays in collection and vehicle breakdowns.

Currently there are no local facilities for handling and disposal of hazardous waste. The landfill is not designed to receive hazardous waste, but such waste may find its way to the land fill. Some collectors hide the waste and operators only realize later during compaction that there is hazardous waste present. Waste is not scanned upon entry nor are there labs for testing the waste. Where arrangements have been made, some of the hazardous waste is transported to neighbouring countries as per the requirements of the Basel Convention for disposal of this type of waste.

There is a shortage of waste separation and re-use/ recycling facilities. Unlike in other countries, there are no separate waste collection facilities in parts of the city (e.g. near shopping centres) or in shops. Small recycling facilities exist at Somarelang Tikologo and a number of private companies. However, these opportunities are not well known and require efforts and commitment of those with waste. Therefore, such waste often ends up at the landfill.

The distant location of the landfill is costly for waste disposal institutions. This has led to widespread illegal dumping of waste around Gaborone. *It is important that planning of the next land fill incorporates waste disposal costs considerations.*

⁹ Disposal costs were estimated at P7.68/T.

Data and information management

Section 4.1.2 shows that there is no data base or a systematic recording system kept by waste collectors and recycling companies. It proved very difficult to get information on the amount of waste generated, collected and disposal at the landfills. Councils have poor record keeping systems and mostly rely on the data from Gamodubu Landfill. Gamodubu has aggregate data, but is unable to break it down by settlement and collector. Presumably, DWMPC, with its responsibility for waste management, is meant to have a comprehensive database of all waste management companies and the amount of waste collected as they issue waste permits. This is not the case. *It is recommended that waste collection and transport permits are only renewed if the required waste data for the previous year(s) have been submitted.*

Costs and funding

Local authorities face general budgetary constraints and waste management is often not prioritised in the budget allocation process. The economic recession has increased competition for public funds, and the case for waste management funding needs to be clearly made. *A revenue and (required and actual) expenditure exercise needs to be carried out to improve funding of the sector.*

Attitudes and priorities

Illegal waste dumping is common and solid waste management still focuses on getting rid of it. The economic opportunities are insufficiently appreciated. While the distant location of the landfill contributes to littering and illegal dumping, attitudes are also to blame as waste is usually just disregarded.

There is much littering and disposal of waste especially garden waste, general waste and builders' rubble along the roads and in open public spaces. There is poor participation by communities as indicated by the low number of households who register and pay for sanitation and refuse collection in Mogoditshane. In Gaborone, people only clean their yards and are inconsiderate of outside public areas. Sometimes, they even dump rubbish in near-by residential areas. Generally, people's attitude towards waste management is poor and people have adopted an "I do not care" habit towards waste and the environment. *Other types of waste are not given priority for proper waste management. These include car batteries, electronics and cartridges. However these should be collected and safely disposed off or re-used.*

Gamodubu landfill

Operation

The landfill experiences frequent breakdowns of equipment and vehicles. Maintenance takes time, and sometimes the parts have to be imported, which also takes time. The number of operational staff is adequate but the range of skills and know-how is too limited. This affects mostly compaction as it requires people with adequate skill. There is need for regular and continuous training of operational staff. Training and capacity building is however hampered by limited funding in the council as resources are not adequately distributed for waste management. There is need for knowledge and skills for engineers at the landfill especially on operation and maintenance of the landfill and need for equipment for compaction.

The land fill manager indicated that the landfill is still unlicensed because it has not adequately met some of the requirements of the licensing authority (DWMPC). For instance, the compactor has not been approved by DWMPC and staff does not meet the skills requirements.

Design

The land fill is not designed to receive hazardous waste, but this finds its way to the land fill. Hazardous should only be disposed at a designated facility, which the country does not possess. The only alternatives are to legally export it at high costs or to dump it illegally at lower costs for the waste generator.

The general view is that the land fill planning was not done adequately, was abrupt and proper research should have been undertaken. It is costly to transport waste from Gaborone to the landfill and this has led to illegal dumping in the city. This has environmental impacts and can be a health hazard to the public.

Non-payment

Collectors are required to pay for waste management services received at the landfill. However, there is no regular payment of fees and most payments are behind. This is largely due to lack of revenue officer on site and therefore payments have to be made in Molepolole or Mogoditshane Sub-district Council offices. Based on interviews with stakeholders, the actual amount of revenues collected on an annual basis is around BWP300 000 per month on average while the costs of operating the landfill can reach more than BWP 400 000 million per month.

Attitude & lack of prioritisation

The attitude of consumers and collectors towards waste management is poor. Instead of disposing at the land fill, some people dump the waste on the side of the roads, in open spaces or along the landfill fence. People still disregard waste management despite the numerous campaigns to sensitize people on proper waste management practices.

At government level, waste management is not prioritised. Some projects are delayed or even shelved because of limited funding. Within the council, waste management is embedded within Public Health division with other sub-units and shares its budget.

Ledumadumane dumpsite

- There is pressure on GCC to clean up the area and ensure proper operations. When the Council took over, the site was infested with all types of waste;
- The area is not fenced and its size is unknown;
- Inadequate control of the type of waste disposed at the dumpsite increases the risk of waste dumping of illegal material (e.g. hazardous waste); this increases the risks of pollution and restricts future land use opportunities;
- Given the huge amounts of construction waste, the dump site should be full in a couple of years. *Plans need to be initiated for a new dump site for construction waste and its re-use;*
- There are several access routes to the dumpsite, and the risk for disposal of non-designated waste is high;
- Lack of facilities on site, e.g. sanitation, a small building for the guards/people who monitor. Currently these people use a structure made of plastic bags and tree branches; and
- Dumping is free, no charges are imposed.

4.2 Liquid waste

The study was restricted to wastewater (4.2.1) and waste oil (4.2.2) due to their importance, time limitations and data availability.

4.2.1 Waste water

The process

Gaborone's sewerage system covers most of the city, and parts of Mogoditshane and Tlokweng. Currently, the sewerage system is expanded into low-income areas, which will lead to an increase in waste water. In 1997 an activated sludge treatment plant was constructed in Gaborone. The city's growth necessitated a further expansion of the treatment plant, which is currently under construction. Initially the treatment plant was designed to receive 40 000 m³/day (or 14.6 Mm³/annum). However, the plant is currently receiving 65 000 m³/day (23.7 Mm³/annum) and its capacity is being expanded to 90 000 m³/day (32.8 Mm³/annum). The wastewater treatment works (WWTW) services the Gaborone region, including Gaborone, Phakalane, Tlokweng, Mogoditshane and Metsimotlhabe.

The WWTW was designed to receive mainly domestic effluent. Several industrial premises have been identified as having the potential to discharge harmful wastewater. There is currently however no effluent discharge agreement (called trade effluent agreement or TEA) between local industries and the plant operator (i.e. Water Utilities Corporation or WUC).

The Gaborone WWTW uses an activated sludge process with polishing of the effluent done in the Broadhurst and Phakalane maturation ponds. Afterwards, most effluent is discharged into the Notwane River from these ponds. The treatment plant receives mostly domestic wastewater, with some industrial wastewater, storm water and the septage from tankers. The activated sludge process plant comprises of the following:

- a. Inlet works: mechanically raked screens, flow measurement and degritting;
- b. Primary settlement;
- c. Activated sludge reactor with surface aerators and secondary settling tanks; and
- d. Maturation ponds in Broadhurst and Phakalane for polishing and disinfection.

The treatment plant is also equipped with a modern laboratory where effluent analysis is undertaken. Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD) and Suspended Solids (SS) are monitored with NH₃-N and PO₄ measurement done occasionally. Table 2 indicates the average wastewater quality entering the WWTW in 2001 and 2002 (SMEC *et. al.*, 2003).

Table 2: Average wastewater composition at GWWTW

Parameter	Units	2001	2002
COD	(mg/l)	1 731	2 004
BOD	(mg/l)	1 153	1 277
SS	(mg/l)	1 568	N/A

Source: SMEC *et. al.*, 2003.

Table 3 shows recent data about the average quality of the outflow as compared to Botswana Bureau of Standards (BOBS) standards. It is clear that *the plant outflow does not meet most of the BOBS standards*,

particularly for temperature, SS and COD. The treatment plant was designed to treat better quality effluent than what it actually receives (1000 mg/l COD, 500 mg/l BOD and 400 mg/l SS). The concentrations in the inflow exceed the design levels, and this adversely affects the plant performance. These high loads could be caused by industrial load or malfunctioning of the thickeners.

Table 3: Waste water composition at Gaborone WWTW

Determinant	Temp (C ^o)	pH	SS (mg/l)	COD (mg/l)	BOD5 (mg/l)
Average 2011	29.04	8.688	62.2	164	45
Average 2012	26.11	10.8475	56.5	193	41.25
BOBS Standards	35	6.0-9.0	25	75	30

Source: WUC data.

The situation appears to have deteriorated over the last few years. In 2005, industrial discharges and water quality samples (inflows and outflows) were analysed by Botswana College of Agriculture (BCA) and GCC staff and the findings are summarised in Table 4. The quality of the outflow would permit unrestricted irrigation (this is no longer the case). Industrial discharges of four sectors did not meet the standards. Heavy metals did not yet pose a significant problem, but traces were picked up in the dry sludge. Clearly, they need to be closely and continually monitored. Use of the dry sludge as fertiliser is risky because of the heavy metal traces.

Table 4: Results of quality analysis of discharges and effluent (2005).

Focus	Method	Results
Effluent discharge of five industrial sectors	Industrial effluent discharges were monthly monitored for one year	Four sectors (brewery, chemical, paints, food & beverage industries) had significantly high COD, BOD and suspended solids above the maximum permissible limits. In contrast the pharmaceutical industry met the standards.
Heavy metals in industrial effluent discharge	Industrial effluent discharges were monthly monitored for one year	No industrial discharge of zinc, cadmium and lead. Small discharges of nickel. Only chemical industry discharged some iron. Dry sludge contained some nickel, zinc, lead and iron which must originate from other industries (e.g. educational institutions and laboratories).
Suitability of treated secondary sewage effluent for irrigation of horticultural crops	Secondary effluent water was sampled every month for one year	Gaborone secondary sewage effluent is suitable for unrestricted irrigation of horticultural crops based on the EC, SAR, CIG, NaCl, faecal coli forms, available plant nutrients and the low concentration of heavy metals (Pb, Cr, Cu, Co, Cd, As and Se all present in parts per billion).
Effluent quality assessment	Monitoring of water quality for 29 weeks	Significant removals of COD, BOD, TSS, NH ₃ -N & TKN. Removal percentages of 97.7, 99, 98.2, 95.5 & 93.6% resp. Significant removal of ortho phosphate but discharge remains above the guidelines; an increase in NO ₃ level but it remained below the expected level.

Sources: Emongor, 2005a & b; Nkebwe, 2005a, b & c.

Apart from the unwanted solids from raw sewage which may include plastics and rags, the WWTW produces sludge. The sludge produced during the treatment process was approximately 11 400 kg and only 2 986 kg/day was applied to the drying beds. This difference indicated unresolved operational and monitoring problems in the plant.

There are significant wastewater losses in the WWTW and re-use is low. The outflow is around 55% of the inflow and re-use is around 3.5% of inflow and 6 – 6.5% of outflow (Arntzen *et.al*, 2006). Losses are mostly due to evaporation in the maturation ponds.

The final stage of treatment of effluent from the Glen Valley is done in the Broadhurst ponds where bacteria dies off to lower levels, but there are no bacteriological and limited PO₄ analyses available (NMPWS; SMEC *et. al.*, 2003). *There is need to monitor the trend in wastewater flows and loads as the COD and SS levels are beyond the design capacity. If these two main issues are not properly addressed then the Glen Valley WWTW performance will deteriorate.*

Re-use of treated effluent is limited and solely for garden watering and crop irrigation. The GCC uses it for watering its public gardens, hotels use it for golf courses and most recently government uses it for the Glen Valley irrigation scheme. The irrigation division at the Ministry of Agriculture pumps effluent from the primary ponds in Glen Valley near the Gaborone Wastewater Treatment Plant to secondary ponds for further treatment near Phakalane. The effluent is then pumped back to Glen Valley irrigation scheme and supplied to different farm plots owned by different individuals. The Glen Valley irrigation scheme covers about 200 ha, of which some 120 ha are currently used. Most irrigation farms use drip irrigation. Effluent is supplied to each farmer at 100L/s from 7 in the morning to 4 in the afternoon with a 1 hour lunch interruption; this amount to re-use of 1 Mm³ of TWW per annum, less than 10% of the outflow and far from the NWMPSS target of 96% re-use. Further re-use is done at Sebele irrigation scheme at BCA to irrigate fodder crops. The final effluent is then discharged into the Notwane River and numerous small land owner along the river use the treated effluent for cultivation of cash crops mainly vegetables. A small amount of treated wastewater is re-used for watering private gardens through small traders. For Gaborone re-use fraction was 0.096 in 2003 split between BCA, Phakalane Golf Club and Gaborone Golf Club (CAR, 2006). Some TWW is also sold for BWP 0.60/m³ to traders, which sell it to customers for BWP 40 – 100/m³. Trade picks up during droughts when there is a prohibition on watering gardens with tap water.

The types of crops grown at Glen Valley are mainly vegetables especially leaf vegetables only. The root crops are not grown at Glen Valley since the treated effluent contains salts that may concentrate at the roots and be harmful to consumers.

Challenges

There are four main challenges with respect to wastewater treatment: a. inadequate capacity at the moment; b. poorer than planned quality of the inflow; c. very limited re-use and recycling and d. poor performance and management of the plant (partly due to the low quality of the inflow). On-going construction should solve the capacity problem. The low quality of the inflow and accelerated re-use and recycling as well as better plant management and performance need to be addressed. It is hoped that the takeover by WUC will improve plant management and performance and will be an incentive for re-use and recycling.

The plant was designed to treat domestic waste but the current inflow discharges from industries. The content of inflows into the treatment works often includes materials ranging from metals to industrial waste which is beyond what the plant can handle. This waste material chokes the pipes and results in breakdown of infrastructure. In addition, households flush undesired material into the sewer system (e.g. condoms and sanitary pads), which lead to plant breakdown.

The manpower for efficient wastewater handling and management is inadequate. Ideally, there should be infrastructure for treatment before the water is sent to the ponds; tertiary treatment would improve the quality of the treated wastewater and its re-use and recycling opportunities. Additionally, the operational staff needs further training on handling, treating and managing wastewater. As a result of these challenges the WWTW has not received the mandatory license.

4.2.2 Waste oil

Discharge of used oil into the environment may cause serious environmental problems, including (ground) water pollution and soil degradation. Recovery of waste oil is therefore important. Interestingly, current used oil recovery is run by the private sector and civil society. Government has no direct involvement.

Collection infrastructure and processes

Waste oil is collected by several companies. Tshole Trust (TT) is a Non-Governmental Organisation (NGO), which aims to facilitate waste oil management, waste oil collection, waste oil spillages and used engine oil filters. The NGO is funded through a levy from the oil lubricant companies. TT has established a country wide network of around 150 tanks for waste oil collection. Around Gaborone area tanks have been installed in Tlokweng (1), Mogoditshane (2 tanks; one broke down), Ramotswa (1) and Pilane (1). The tanks are located in public spaces near busy garages. These waste oil tanks are filled by garage owners and the general public. Tanks suffer from abuse and unwanted waste disposal. For example, the collection tank in Gaborone ceased to operate because of abuse.

Once the tanks are full, private companies collect the oil from the tanks free of charge. These companies have to be members of TT¹⁰. After collection, the companies transport the oil to South Africa for refinery; some waste oil is partly refined and re-used domestically. Used oil can be re-used or recycled for the following:

- a. Industrial burner oil. This use requires that used oil is de-watered, filtered and de-mineralised for use in industrial burners;
- b. Re-refined base oil. This can be used as a lubricant, hydraulic or transformer oil; and
- c. Bitumen-based products for road construction and maintenance.

Recovery

Figures from TT indicate approximately 10 ML of lubricating oil was sold annually in Botswana and it was estimated 50% of the total was consumed or burned during its usage and lost through leakage. According to TT data, 1 000 to 3 500 T of oil was recovered annually over the period 2005-2008 (Figure 9). This is a modest 10% of the annual imports¹¹. Unfortunately, more recent data could not be

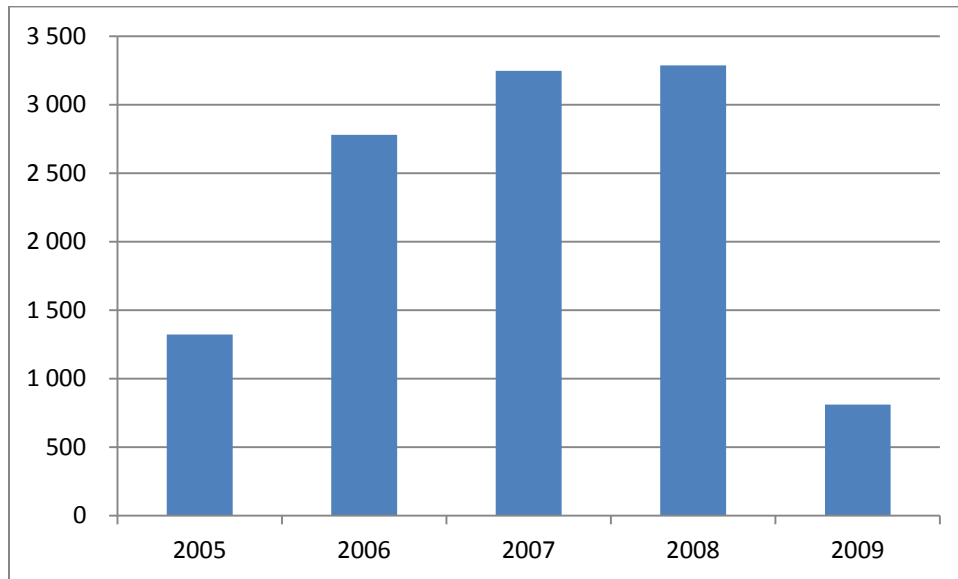
¹⁰ Currently there are six private companies registered with Tshole Trust.

¹¹ It is an underestimate as companies do not regularly report their volumes.

obtained. More oil recovery companies have started operation, so it is expected that the recovery has increased. The recovery rate could be between 10 to 20% of oil imports. If half of the imports are used during the production process, 30 to 40% of oil is recoverable but not yet recovered.

One of the oil recovery companies indicated that it collected 194 T in 2011 and 74.1 T in 2012. One of the private oil waste collecting companies has indicated that it is expensive to refine oil to a finer level for recycling purpose but did not give the figures. However it is feasible to re-use oil after removing the suspended solids and water (i.e. a simpler form of processing).

Figure 8: Oil recovered as reported to Tshole Trust (tons)



Source: Tshole Trust data.

Waste oil recovery faces several challenges, including:

- Inadequate infrastructure:
 - ✓ Lack of facilities for disposal and storage of waste oil , making it difficult to collect waste oil;
 - ✓ Inaccessibility of some areas in Mogoditshane, where many motor garages are located;
 - ✓ Inadequate resources such as vehicles that could be used to move around sensitizing the public on waste oil management. The Trust hires cars to travel around and trucks and cranes to install the waste oil tanks.
- High costs and lack of funds:
 - ✓ Small users are often left out but they also use oil that can be collected and reused;
 - ✓ Funding to the trust is inadequate. Tshole Trust cannot afford to establish waste oil collection centres.
- Poor attitudes and awareness
 - ✓ Illegal and indiscriminate oil disposal especially by bush mechanics. This results in spillages hence affecting the integrity of the environment;
 - ✓ Lack of knowledge and understanding by the public- waste oil collection, disposal, reuse and recycling.

- Data and information
 - ✓ The amount of waste oil generated is hard to get from the waste oil collector companies. The Trust has requested DWMPC to monitor the volumes as it is the licensing body but DWMPC faces the same problem. Most waste oil collector companies do not want to disclose the amount of oil they collect for fear of where their confidential data will end up.

5 Institutional set-up and policy environment

This section describes the regulatory environment of waste management in Botswana, with particular reference to Gaborone and surrounding villages.

5.1 Institutional structure

Waste management is driven by central government through the Department of Waste Management and Pollution Control (DWMPC) and through local authorities. Parastatals, private sector, non-governmental organizations and communities also play a role in waste management.

At government level, the Waste Management Act of 1998 led to the establishment of DWMPC. Initially DWMPC resorted under the Ministry of Local Government, but since 2002 it falls under the Ministry of Environment, Wildlife and Tourism (MEWT). Its primary mandate is to ensure that pollution is prevented, to develop policy and to ensure its implementation and to regulate waste management. The department is also charged with research and development, compliance and enforcement of waste management law and dissemination of waste management information to the public. It serves as an advisory body to local authorities and the public on sanitation and waste management. It is involved in the design and construction of projects e.g. landfills, which are then handed over to local authorities for management. The department plays a dual role of policy development and implementation/regulation which has been a challenge over the years. The organizational structure of the department is indicated in Figure 11.

Gaborone City Council

Waste management in Gaborone is the responsibility of the GCC. The council has more than 35 councillors representing the various wards in Gaborone. It is responsible for providing services management, public and environmental health. The council also has several committees where public health and waste management are provided for. Waste management falls under the public health unit and it has the following human resources: environmental officers, litter pickers, waste collectors and field assistants. The general view is that there is inadequate capacity in GCC to adequately address waste management issues.

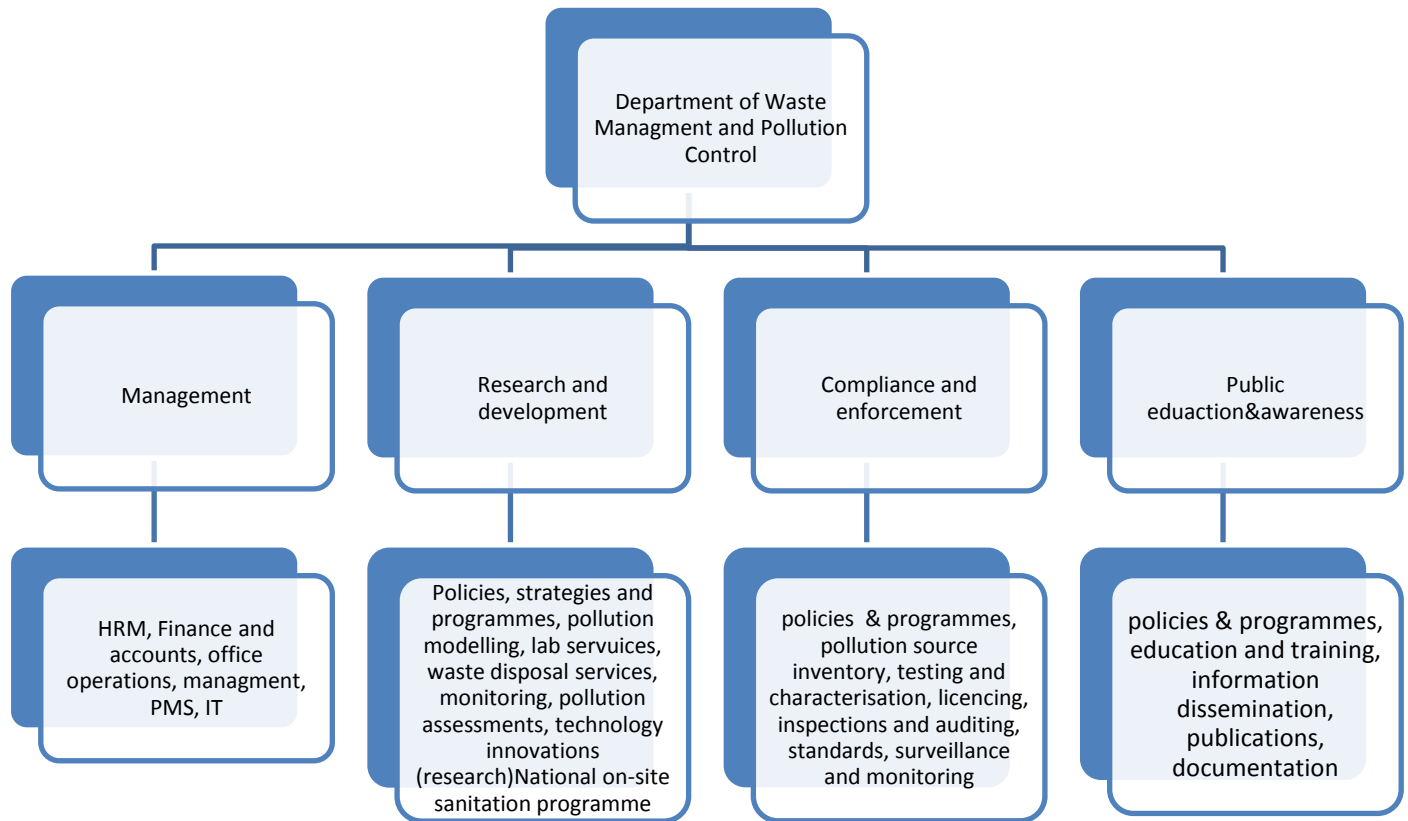
Mogoditshane sub-district council

The sub-district is one of the three sub districts of Kweneng District Council. The sub-council started as a small service centre in 1997 with provision for waste management, water and social & community development services and only became a fully-fledged sub-district council in 2010. It covers 11 villages including Mogoditshane. The waste management section falls under environmental health and operates with one officer, fifty five refuse collectors, four sewage attendants and nine drivers. The refuse collectors are responsible for collection of refuse from households and institutions and for collection of street litter using compactors and trucks. Some refuse collectors are placed at strategic areas in villages for litter picking at open spaces, passages and along the streets. The perception is that the section is understaffed and requires capacity building, particularly for waste recycling and operation and maintenance of machinery.

Tlokweng Sub-district Council falls under South-East District Council and performs waste management activities in Tlokweng. The organisational framework for the Council is similar to that of the Mogoditshane Sub-District Council. The waste management section resorts under Environmental Health

department. The latter department has two environmental officers; one of them deals with waste management issues and manages 24 refuse collectors, one enumerator and 10 drivers. The council ceased managing the sewer systems by the end of 2012. The refuse collectors collect refuse from households and other institutions. Collection of refuse in Tlokweng is carried out by the Tlokweng Sub-District and two contracted companies working for the council. The companies collect one half of the village and the council takes the other half of the village. The Sub-District is faced with challenges, including the frequent breakdown of collection vehicles and the delay of their maintenance. The delay in maintenance is perceived to be caused by the location of the workshop in Ramotswa.

Figure 9: Organisational structure of DWMP



Source: pers. Comm. Mr. E Banda, DWMP

Water Utilities Corporation

In February 2010, Water Utilities Corporation (WUC) took over wastewater treatment management from GCC as part of the on-going water sector reform process. The GWWTW was taken over without a specific budget. Currently there is no tariff for wastewater discharge Waste water recycling and re-use are limited and the treated effluent does not meet the standards (refer to Section 4.2.1).

Private sector

Private sector involvement in waste management in Gaborone is significant. For instance, companies such as Kgalagadi Breweries and Kgalagadi beverages collect and pack cans and returnable bottles for soda and beer and these bottles are reused or exported to South Africa for re-processing. Collect-a-Can, Dumatau trading company, Recycle it are among companies that collect waste and enhances recycling

of the waste products. Waste collection companies have augmented collection services of GCC particularly collection from businesses as the council has stalled providing services to businesses in 2010. Scrap metal is another resource that is recovered by some companies. The scrap is directly collected from the source while some companies collect from the landfill. Table 5 shows the amount of recovered scrap metal in Gaborone over a four year period. Recent data was not available from DWMPC.

Table 5: Total amount of scrap metal recovered from Gaborone

Year	Quantity (Tons)
2006	1 109.3
2007	384.5
2008	12 873.3
2009	2 659.6

Source: DWMPC

NGOs

A notable number of NGOs are involved in waste management activities, including Somarelang Tikologo (ST) and TT. ST promotes sustainable environmental protection through education, demonstration and encouraging best practices in environmental planning, resource conservation and waste management in Botswana. Most of their projects involve participation of local communities with the view of enhancing their livelihoods. Specific waste related activities include:

- Bulk waste recycling of glass. ST collects glass and has a glass depot in Sebele. The glass is packaged and exported to Consol in South Africa. Between 66 and 132 tons of glass is recycled per month. The company buys glass from ST at R684/ton. To transport the glass, ST spends around P6 000 per truck (30-32 ton) per month, leaving ST with a gross income of BWP 49 000 (assuming an average collection of 100 tons);
- ST also collects paper, plastic and cans for recycling. These waste products are picked up by various companies such as Collect-a-Can, Recycle it, Total and Dumatau trading. The waste is not weighed upon collection because insufficient manpower at ST. From cans, the NGO makes about BWP300 per month and this is usually used as petty cash.

Tshole trust is involved in used oil management in Botswana and provides infrastructure for oil collection and also raises awareness on oil waste management. Its members are oil producing entities as well as collectors.

Communities

Communities participate little in waste management activities. There are community programmes such as Clean-up Botswana encouraging voluntarism for anti-littering. Communities in the Mogoditshane area tender for waste collection projects from the Sub-district Council in their area. This could be further exploited and replicated in other parts of the city and surrounding areas.

5.2 Regulatory environment

Botswana's national waste policy and legislative environment is limited and weak. There is an overarching strategy and Act for waste management as well as a policy and master plan for sanitation

and wastewater. However, these are out-dated and need to be reviewed. Waste regulations do not exist and waste recycling guidelines are being developed.

5.2.1 Botswana Waste Management Strategy of 1998

The Botswana Waste Management Strategy (BWMS) was formulated in 1998 by the DWMPC in order to facilitate and coordinate waste management issues in the country as well as to consolidate the initial achievements in the waste management industry (Kgosisiele and Zhaohui, 2010). It was also a response to implement the objectives of Agenda 21, which is the Action Programme from the 1992 Rio Earth Summit. The main objectives of the strategy are to:

- a. Minimize and reduce waste in industry, commerce and private households;
- b. Maximize environmentally sound waste re-use/recycling; and
- c. Promote environmentally sound waste collection, treatment and disposal.

The strategy adopted the widely accepted Waste Management Hierarchy of 1. Reduction of waste; 2. Re-use and recycling of waste; 3. Waste treatment; and 4. Safe disposal of waste at designated landfills.

Gaborone's waste management does not appear to adhere to this hierarchy as little is done to reduce waste and to stimulate re-use and recycling. As a result, the landfill is under pressure and economic opportunities for re-use and recycling are lost.

The strategy has led to a number of studies from 1996 onwards to evaluate the current waste situation in various sectors and to develop guidelines for improving the situation. However, fifteen years down the line, guidelines are still being developed and there are no regulations. The strategy needs to be reviewed and updated to address emerging issues of green economy among others.

5.2.2 Wastewater and Sanitation Management Policy, 2001

The overall aim of this policy is to promote health and well-being of Batswana through provision of sanitation and waste water conservation programmes and to introduce mechanisms for the protection and management of water resources. The policy proposes the following measures and instruments for achieving its objectives:

- a. Institutional regulatory framework with DWMPC, local authorities and Department of Water Affairs (DWA);
- b. Private companies would be involved in areas such as consultancy, construction of sanitation and waste water works and provision of wastewater;
- c. Legislation: A new Act should deal with: enforcement institutions, cost recovery framework, licenses, environmental protection, trade effluent control, monitoring etc. This Act has not been finalised and approved even though a draft Bill was developed in 2003;
- d. Cost recovery and linking wastewater treatment levies with water bills. Cost should be recovered for sewerage services, trade effluents, sale of treated effluent/ sludge; new connections. The Polluter-Pays-Principle (PPP) should be applied to industrial sector through a charge system;
- e. Environmental protection by: guidelines for discharge effluent into environment and public sewer system, model trade effluent agreements. WUC has developed a trade effluent agreement (2012) to regulate effluent entering the public sewerage system. The agreement is

meant to provide an understanding between the Corporation and a specific industry and trade regarding the quality of effluent discharged into the public sewers;

- f. Operation and maintenance: DWMPC to develop proper guidelines for the responsibilities of local authorities. Guidelines exist for disposal of waste at landfills while recycling guidelines are under development;
- g. Development of a data base and human resources; and
- h. Public awareness raising campaigns

Re-use of return flows is recommended for commercial crop irrigation in primary and secondary settlements, watering of municipal parks and gardens; fresh water augmentation in primary centre, in particular Gaborone; commercial fish cultivation; and use by industry. However, this depends on the availability and quality of TWW and further research is recommended prior to re-use.

Greater priority should be awarded to re-use and recycling of TWW, in particular to improve Glenn Valley irrigation, support data base and data management, infrastructure and range of skills and expertise, cost recovery and TWW charge and public awareness raising campaigns. Efforts should extend to Tlokweng and Mogoditshane.

5.2.3 National Master Plan for Wastewater and Sanitation (NMPWWS), 2003

The NMPWWS is the bedrock of sanitation and wastewater management until 2030. The Master Plan argues that the 2003 emphasis of WW treatment is still on discharge and it is not considered as an economic good. This is slowly changing. A rapidly growing amount of WW is available due to improved sanitation, growing water consumption and living standards and expansion of the WW treatment facilities. The plan made several recommendations related to wastewater management, including:

- a. More legislation, regulations and instruments. Legislation for the wastewater and sanitation sector needs to be enacted, including the right to a clean and healthy environment; empowerment of regulators and stakeholders to protect the environment from pollution; an institutional framework aimed at providing the best service with the available resources; and institutional/stakeholder participation in the planning, design and implementation of strategies of wastewater and sanitation management; and finally efficient and equitable administration of the legislation by appropriate processes, practices and economic instruments;
- b. Preparation of wastewater plans and facilities. The NMPWWS identified settlements where wastewater services are required during the next twenty years and developed a set of strategic plans for these settlements to assist planners in coordinating services;
- c. Promotion of re-use of wastewater. The target for 2030 is to increase re-use from 20% to 96% of the outflow through agricultural re-use and reduction of losses in the treatment systems. Agricultural re-use is judged economically viable in ten settlements, including Gaborone. As shown earlier, Gaborone is still far from the 2030 target, re-use monitoring is poor and farmers are not charged for utilization of the resource;
- d. Promotion of on-site sanitation. This would reduce the inflow into WWTW and put less pressure on such facilities;
- e. Cost recovery and affordability. A staggering P 3.2 billion would be needed for implementation of the NMPWWS in the NDPs. Full cost recovery is considered not affordable for households, and the NMPWWS proposes recovery of the operational costs for households. A tariff of P290 per household per annum or P25 per month is considered

affordable, and some P2.08/m³ would be charged for collection and treatment costs (assuming a water consumption of 165 l/person/day and a return flow of 80%). This is yet to be implemented.

5.2.4 Waste Management Act, 1998

The Act established DWMPC and aims to minimise pollution and address issues of trans-boundary movement of waste and their disposal. Local authorities such as GCC are mandated to collect and dispose, at a prescribed fee, all household waste in their area. The waste collection and disposal system should be environmentally sound and recover valuable components from the waste. Littering in any public place is prohibited and local authorities are required to clean public places. Enforcement powers are provided for in the Act, particularly regarding the powers of DWMPC for inspection of waste sites and imposing penalties on wrong doers.

All waste needs to be disposed at designated waste disposal sites. This is however currently prohibited by financial and infrastructural constraints within councils, distance to the land fill and inadequate infrastructure for waste management.

The Act stipulates that local authorities such as GCC, Kweneng and South East District Councils should develop waste management plans for their areas with close guidance of DWMPC. The District Councils have no plans and GCC only has an old plan 2003-2009. The instruments indicated in the Act need to be revised to cater for current situations and improve efficiency of waste management systems in place.

5.2.5 Atmospheric Pollution (prevention) Act (Cap 65:03 of 1971)

This Act provides for the prevention of atmospheric pollution caused by industrial processes. It seeks to control the emission of objectionable matter which is defined as 'smoke, gases including noxious or offensive gases, vapours, fumes, grit, dust or other matter capable of being dispersed or suspended in the atmosphere which is likely to be produced by any industrial process'. The objective of the Act is therefore to minimize emissions of objectionable matter into the atmosphere that would cause environmental and human health problems.

5.2.6 Gaborone Waste Management Plan (2003-2009)

The Gaborone Waste Management Plan (GWMP) has been developed by the Gaborone City Council in 2002 through the Department of Waste Management and Pollution Control (DWMPC), which was then called the Department of Sanitation and Waste Management (DSWM). The plan covers the period 2003-2009 on waste collection activities and up to 2013 for waste disposal activities.

Some of the issues of concern identified in the Plan include:

- a. No local rules for waste handling and resource recovery;
- b. Waste management fell under the GCC and had to conform with the council rules and regulations, which sometimes hampered proper waste management implementation;
- c. The potential advantages which could be provided by the involvement of the private sector were not considered;
- d. The Gaborone landfill was nearly full, mostly construction waste and rubble which could have been disposed easily at a lower standard landfill;
- e. The performance of the collection fleet was extremely low (18 to 19%); and

- f. There was no effective implementation of waste reduction, minimisation and recycling programmes.

The Waste Management Plan categorises the waste in the following categories: i. household waste; ii. commercial waste; iii. market waste; iv. street cleaning waste; and v. construction waste and rubble. In order to estimate and plan for future waste generation three factors were considered: 1. impact of economic development; 2. impact of waste avoidance activities on the waste stream; and 3. influence of recycling on waste production.

The plan was developed at the time when the Gaborone Landfill had reached its full capacity and had to be closed as soon as possible. A new regional land fill with an incinerator for Gaborone and neighbouring districts was planned at Gamodubu. The main target of the GWMP was to implement waste avoidance so as to reduce waste by 1% in 2003 and 3% by 2006. In addition: Targets were set for different groups:

- a. Civil Society:
- Provide impetus and support for public cleaning campaigns;
 - Public awareness campaign to inform people of their rights and obligation relating to waste;
 - Support private composting activities through provision of compost bins to households.
- b. Government and Industry:
- Introduce green accounting in the GCC;
 - Raise awareness in industries about waste minimisation and incorporation of waste management in Environmental Management Systems;
 - Implement rules concerning the supply of plastic bags by retailers.
- c. Botswana Defence Force (BDF):
- Introduce waste composing within BDF compounds; and
 - Promote Green Accounting.

It has been estimated that paper metal and tyres are being recycled at low amounts of 5-10%. The Landfill operator had proposed to obtain a shredder for tyres and it is now in operation at Gamodubu landfill. The targets have included to:

- Facilitate organised waste recycling to meet targets of 10% reduction by 2006
- Establish a clearly demarcate and manage locations for rubble dumping, by informing all building construction companies of these locations and the requirements needed for dumping.

The Department of Environment and Health is in charge of waste management and a new monitoring system should be installed to support waste management. Waste management is normally funded through a Council tax.

All recycling is carried out by private companies. Rubble is mainly stored and used for land rehabilitation in an old borrow pit in Kweneng District. Some of the waste disposed at the landfill site included a certain amount of biodegradable waste. Therefore the GWMP suggests erecting a plant for compost production.

5.2.7 Revised Gaborone City Development Plan (1997 – 2021)

The main goal of the Revised Gaborone City Development plan RGCDP (1997 – 2021; Mosyienane & Plantec, 2009) is to create a well-planned city with defined image, safe to dwell in and functional as the main city of the country. The goals of the development plan are to:

- a. Create a well-planned city with a defined character and image;
- b. Optimize the use of available land to meet existing and future land need;
- c. Promote Gaborone as a tourism destination;
- d. Promote the planned CBD into a regional centre;
- e. Cater for the needs of informal business activities in a planned and regulated manner;
- f. Formulate economic growth and diversification strategies;
- g. Promote urban agriculture;
- h. Protect and conserve the city's natural resources and the environment;
- i. Improve line infrastructure services such as sewage and storm water drainage systems; electricity and water supply, to adequate and affordable standards; and
- j. Improve sanitation practices and conditions.

The Vision of the plan is that “Gaborone will be a vibrant, prosperous sustainable and globally competitive city, as well as a model city of choice” (p.17). Clearly, Gaborone has national and international ambitions as is expected from the ‘SADC capital’. The plan distinguishes three major land use zones. The first macro zone is the central core area (urban compaction zone). This is the priority area that needs to be further developed into an intense attraction of higher order activities. It has limited or no vacant sites. The second zone is the inner built up ring zone. This Zone is the existing built up areas lying between the central core areas of the city and outlying suburbs. This zone has a potential of high intensification as it has predominantly low density residential areas. The third zone is the outer ring or sub-urban zone, which includes areas such as Sebele, Glen Valley, Gaborone North and Phakalane Freehold or allocated land to the north of the City, and Kgale view Roman Catholic and remainder Forest Hill 9- KO freehold land in the south.

Solid waste generation (due to building activities and city expansion) and medical waste are mentioned as environmental concerns during the RGCDP implementation. The Plan does not cover Tlokweng and Mogoditshane and its impact on waste management.

5.2.8 Others

Township (public sewer) regulations are meant to regulate the use of public sewers for passage of wastewater. This regulation requires the provision of the rights and duties of property owners connected to public sewers. It further regulates the discharges of trade effluent into public sewer lines.

Guidelines for the disposal of waste by landfills (1997) provide a basis for the policy and a minimum requirement on which DWMPC will issue licences for landfills. The guidelines also provide practical information, which enables license applicants, license holders and their appointed advisers and managers to comply with the policy of DWMPC and with any associated legislative requirements. They were designed to protect public health, the environment and local amenities, using appropriate and cost effective methods. Gamodubu land fill is not yet licensed as it does not meet the guidelines. The guidelines are summarised in Appendix 3.

Botswana is signatory to the Basel convention that regulates trans-boundary movement of hazardous waste and their disposal. The requirements of the convention are provided for in national legislation for waste management.

Recycling guidelines for Botswana have been completed and are awaiting final approval by DWMPC. The report is in fact a recycling strategy for Botswana (rather than mere guidelines). The aim is to “shift the fundamental purpose of waste management in Botswana, from controlling disposal to maximising the use and re-use of resources in the waste stream” (Scheinberg, *et al.*, 2012). The guidelines are based on experiences from Botswana and other countries (mostly), and in fact set out a comprehensive recycling framework for Botswana. It is structured under four thematic areas, each with guidelines, activities and targets/ results. The guidelines contain specific public and private sector infrastructure projects (e.g. transformation centres, drop off and buy back centres, composting facilities) to be undertaken. The document needs to be internalised by DWMPC, which has to decide which activities should be prioritised and how they can be best implemented (only superficially covered in the report). The twenty broad ‘guidelines’ are briefly summarised in Box 4.

Box 4: Botswana recycling guidelines

The guidelines are structured under four thematic areas.

1. **Modernising the enabling environment.** The aim is to address the policy gaps and improve governance within the sector. Guidelines include:
 - ✓ Reforming the policy environment. Legislative reform is needed as well as environmental economic instruments for sustainable solid waste management, including pricing for disposal at landfill. The revenue generated needs to be channelled into ‘enterprise and recycling funds’. The former would be used for operational costs of the landfills as well as inspection and benchmarking by DWMPC. The recycling fund would be used solely for recycling activities.
 - ✓ Benchmarking, reporting and monitoring of waste flows and recycling;
 - ✓ Development of a communication plan for recycling activities and solid waste management
 - ✓ Capacity building and strengthening, including development of recycling guidelines for local authorities;
 - ✓ Development of public private partnerships for recycling.
2. **Planning and organising valorisation.** This involves the use and commercialisation of waste.
 - ✓ Assessment of land fill costs and establishment of proper levies for waste disposed at the landfill upon entry into the landfill. Monitoring of waste disposed at the landfill
 - ✓ Training manual for recycling at landfills. Waste picking and scavenging should be carried out in a systematic manner; training of registered waste scavengers/recycling companies.
 - ✓ Planning for valorisation based on reliable data on the waste cycle and flows and subsequent establishment of targets for recycling.
 - ✓ Market study for recyclables and organic waste. New legislation should capture recyclables as they relate to their marketability status. They should not be captured as ‘waste’. Participation of local communities in waste picking and sorting is encouraged with a role for the private sector is invaluable.
 - ✓ Design, implement and monitor recycling demonstration projects as well as rolling them out for normal operations. A Botswana National Recycling Platform should be established with the view of devising innovative and sustainable interventions;
3. **Technical and operational issues.** This set of guidelines largely deal with recycling facilities for different types of waste.
 - ✓ Establishment of drop-off centres and buy back centres are advocated for. The former is simply a depot where community members can deliver their recyclables while a buyback centre is a site where people drop off their recyclables and are in-turn remunerated for collecting and delivering these recyclables. Payment can be in the form of cash, vouchers, coupons, etc and in Southern Africa this is mostly practiced

in South Africa. The buy-back and drop-off centres must be easily accessible by community members and should be strategically and conveniently located. However, these centres need to be well managed and monitored and there would be need for market studies so as to establish their viability and associated costs.

- ✓ Education and capacity building for source separation and separate collection (the aim would be 80% participation) should be undertaken at all levels (waste generators, collectors, planners, operators, etc).
- ✓ Establishment of material recovery facilities¹² (e.g. for paper, plastics, glass and cans) should be established.
- ✓ Increased recovery and recycling of metals and high grade paper (type 1 or high value) waste to create economic value and employment;
- ✓ Increased recovery and recycling of plastics, glass, cans and other type 2 (i.e. moderate value) waste materials to create economic value and employment;
- ✓ Increased recovery and recycling of composting material (type 3 or low value but high volume) through establishment of composting facilities.

4. **Finances and fees.** Guidelines deal with sourcing financial resources for waste management.

- ✓ Conduct a willingness to pay analysis undertaken among stakeholders and this would guide the design of fees and tariffs for waste.
- ✓ Carry out a cost and tariff structure analysis
- ✓ Provision of financial incentives for waste recycling and re-use.

The activities are expected to be implemented within a time frame of four years (2012-2015). The guidelines could be an entry point for support by the Japanese government. Support is necessary for the implementation of activities associated with these guidelines. These could be in the form of technical support for development of physical structures for recycling.

¹² These are the same as waste transfer stations.

6 Towards better local waste management

6.1 Past and current responses to waste management challenges

6.1.1 Solid waste management

The emphasis of solid waste management still lies on collection and disposal. This situation has prevailed despite the Waste Management Hierarchy's emphasis on reducing waste and re-use and recycling. As a result, waste management infrastructure and mechanisms are under severe pressure and economic opportunities are lost. Current waste disposal suggests that the Gamodubu land fill will be full 5 years before its design lifetime of 20 years. The land fill is unlicensed as it does not meet the DWMP requirements. Ledumadumane dumpsite may also soon be full, making the search for alternative dump sites for construction rubble a priority. Waste dumping is hardly controlled and risks of soil pollution and inadequate land rehabilitation are high.

Little is undertaken to ensure efficient waste management in Gaborone. Emphasis has been (as in other environmental management areas) on disposal infrastructure; much less is done on maintenance, efficient operations, re-use and recycling. However, the following are noted:

Infrastructure:

- Provision of waste bins and containers by consumers, local authorities and private companies. However, there is no sorting at source therefore waste discharged is often comingled;
- Up-to date landfill facilities. The weighbridge is fully functional and equipments are operational;
- Provision for waste scavenging at the landfill. Five recycling companies are currently engaged in the collection of recyclables on-site at the landfill.
- Dump facility for construction and garden waste at Ledumadumane.

Collection and disposal:

- Construction waste and rubble is now disposed at a nearby dumpsite instead of filling up the Gamodubu land fill (with high transport costs);
- Improved but still inadequate fleet performance.

Participation and stakeholder involvement:

- Active participation of private companies and environmental NGOs to enhance waste collection and management. The NGOs specifically raise awareness on efficient use of waste material for improved livelihoods and sustainable waste management practices;
- Community engagement in waste management, for instance, in Mogoditshane;
- Mixed experiences with outsourcing waste collection to the private sector;
- Restriction of local authorities waste collection responsibilities to household waste. Industrial and most commercial waste is collected by private enterprises.

Enabling environment:

- Development of recycling guidelines/ strategy for Botswana;
- Levy on plastic bags to encourage re-use and recycling;
- Implementation of EIAs.

6.1.2 Liquid waste management

Wastewater Infrastructure and reuse

Infrastructure:

- Renovation and expansion of Gaborone WWTW;
- Expansion of Gaborone's sewer system.

WWTW plant management and re-use:

- Takeover by WUC to improve performance, meet license requirements and encourage re-use and recycling.

Water quality monitoring and treatment of wastewater – the monitoring of waste water quality is not consistent, the data available is fragmented and wastewater treatment goes up to a secondary level.

Waste Oil infrastructure Reuse and recycling

Infrastructure:

- Installation of public waste oil tanks.
- Limited used oil processing facilities by private companies.

Market development:

- Collection of used oil, processing and re-sale. Although the sector consists of mainly foreign companies, local companies are slowly emerging and gaining interest.

Environmental rehabilitation:

- Rehabilitation of oil/fuel contaminated areas.

6.2 Priority issues for improved waste management

The key issues for waste management in and around Gaborone have been identified based on the analysis of literature and consultations with key resource persons. The analysis followed the waste cycle and frameworks of sustainable development and green economy.

The population and economy of Gaborone and surrounding areas is growing, creating increasing amounts of waste and demand for waste management facilities and services. The economic value of waste is as yet hardly captured. Higher waste volumes require efficient and sustainable solutions scarcity of public funds.

Below, detailed priority issues for waste management in general, solid waste and liquid waste are presented.

6.2.1 General waste management priorities

G1. Shift in waste management emphasis towards waste reduction, re-use and recycling

An urgent shift is required in the emphasis of waste management towards waste reduction and re-use and recycling of waste instead of merely focusing on waste collection and disposal infrastructure¹³. Basically, this requires the genuine implementation of the waste management hierarchy, introduced in the 1998 Waste Management Strategy. In other words, it can happen within the current policy environment, and requires implementation and increased investments. Much of the investments will have to come from the private sector in line with the green economy development; UNEP, 2010). The benefits will include: job creation, poverty reduction, longer life time of waste disposal infrastructure and reduced waste collection costs. The recently developed recycling guidelines/ strategy offer a good framework for waste reduction and capturing a larger part of the economic value of waste. Its approval and implementation should be a policy priority.

G2. Strengthening and implementation of the enabling environment

The policy environment needs to be conducive for sustainable waste management practices and strategies. The policy environment is inadequate as indicated by out-dated legislation and a non-existent Act to support the Wastewater Strategy. There are no bye-laws or regulations to enhance efficient and sustainable waste management, re-use and recycling of both solid and liquid waste. Oil and wastewater discharge into the sewer line and the environment are hardly supported by the law. TEAs need to be concluded with selected industries to improve the quality of effluent discharges into the sewer system. Re-use and recycling need to be promoted by regulations, incentives and guidelines.

Law enforcement is poor although the Act gives DWMPC the power to enforce the law to wrong doers. The Gamodubu landfill and the GWWTW currently operate without licenses. Although local authorities police illegal dumping of waste, it is ineffective. Environmental economic instruments such as polluter pays principle need to be applied in and around Gaborone. This should also be adequately provided for in the legislation.

Local authorities do not have waste management plans nor is there a national waste management plan as required by the Waste Management Strategy. GCC developed its Plan for 2003 to 2009 under a GTZ project but it needs to be updated. Mogoditshane and Tlokweng do not have waste management plans at all. Such would give direction and resources for proper waste management and have verifiable targets for waste reduction, re-use and recycling.

G3. Inadequate public sector institutional capacity and need for greater participation of the private sector and civil society

Waste management requires skilled personnel to fully ensure effective coordination, planning and implementation of waste management strategies and programmes. Currently coordination of the sector is poor and monitoring is inadequate (presumably the role of DWMPC). Waste management is embedded within the public or environmental health departments in the councils. There is a shortage and an imbalanced distribution of human resources within the waste management sector. Formal training and professional courses are necessary to enhance skills' development and knowledge. Emerging concepts of green economy need to be understood for interventions to be successful.

¹³ Suitable new terms in line with general environmental management literature would be integrated solid waste resource management (ISWRM) and integrated liquid waste resource management (ILWRM).

Community participation in waste management is poor and attitudes towards waste and the environment are appalling, and this is associated with lack of understanding for the need for proper sanitation and a healthy environment. Continuous and strategic public awareness programmes are required. More private sector and NGO participation is also necessary. There is scope for public private partnerships or privatization of the sector.

G4. Improving the waste management data base and monitoring

Proper waste management needs to be based on up-to-date information. Therefore, baseline information and monitoring data need to be collected to measure performance and the impact of policies programmes etc. The analysis in chapter 4 has shown that such data are unavailable in Gaborone. This is also a priority area in the Recycling Guidelines/ Strategy.

Currently, data collection, analysis and storage are poor. Many private sector companies fail to submit annual figures on waste handling to DWMPC as required by law. Local authorities do not keep waste data and DWMPC has no strategy toward data collection, management and analysis (e.g. data from waste carriers and recyclers). A waste management database needs to be established and waste carriers and recyclers should provide waste data over the previous year before acquiring new permits. This would encourage more research and offer better chance to convince policy makers of the importance of waste management.

6.2.2 Solid waste management

SW1. Waste reduction

The amount of waste is growing due to economic and demographic growth and higher living standards. Increased recovery rates in satellite villages will further increase the amount of collected waste. Indications are that Gamodubu land fill will not last for 20 years. Therefore, there is an urgent need to reduce the amount of waste generated and for collection. This can be achieved by re-use and recycling, and improved re-usable packaging of consumer goods. Re-use and recycling opportunities need to be created and stimulated. The private sector and communities should become the main players in re-use and recycling.

The used car motor industry is growing and the demand for imported cars from Japan and the UK has rapidly increased, generating additional waste and scraps and their disposal will be a future challenge. Some of the cars are stripped and parts used elsewhere, while some are collected as scrap metal while some car frames end up in the bush. This has serious impacts on the environment and aesthetic beauty of the city.

SW2. Improved waste collection

Waste collection needs to become more regular and extend to all areas. This requires more and well maintained vehicles to increase the collection efficiency (higher frequency and lower costs). Moreover, it will improve on-site sanitation (no stock piles of waste), reduce littering and benefit public health (no bad odour, flies, etc) and the general environment. Additionally, this has led to frequent dumping of waste in undesignated areas. Improving and maintaining the recovery rate is critical and separation of waste at recycling depots is required.

Local authorities are underperforming in waste management due to insufficient equipment, funds and skilled personnel. The commercial sector has engaged private companies for waste collection and this could be replicated for households. Public private partnerships should thus be encouraged to enhance

waste management in Gaborone. In Tlokweng village, the Council has involved two private waste collection companies to collect waste in some parts of the village while the Council covers the rest. Opportunities for community based waste collection activities can be explored through programmes such as Ipelegeng.

SW3. Re-use and recycling

Re-use refers to extending the life or use of a single product without changing it though the product purpose may change while recycling refers to reclamation of waste, recovery of materials, reprocessing of waste into a new material as well as reuse of waste (GoB, 1998). Current re-use and recycling rates are low and most recyclable and re-usable waste ends up at the landfill, reducing its lifetime and foregoing economic benefits from re-use and recycling. The following issues are noted:

- a. There is virtually no waste separation at source and very few re-use/recycling stations are available (drop off and buy back centres as well as transfer stations). These stations would allow for waste segregation and recovery of recyclables before the waste is transported to the landfill;
- b. Participation of stakeholders in re-use and recycling is low. Waste producers do not participate in re-use and recycling and only five private companies are engaged in scavenging of waste at the landfill for the purpose of recycling. Community based recycling ventures should be provided for;
- c. Recycling and re-use of garden and construction waste is hardly practiced. The Waste Management Plan of Gaborone and the Recycling Guidelines/ Strategy call for composting of garden waste for re-use in agricultural activities. Construction waste could be crushed and re-used beyond land rehabilitation (as done at present).

SW4. Waste disposal

Illegal waste dumping and hazardous waste are major waste disposal issues. Disposal of hazardous waste is regulated under the Waste Management Act and the Basel Convention. Not all hazardous waste is transferred to neighbouring countries and some is likely to end up in Gamodubu and/or undesignated areas. There is no hazardous waste disposal facility in Botswana.

Illegal waste disposal is common in the form of indiscriminate dumping of rubble, garden and general waste in open public spaces. It is unsightly and harms Gaborone's image as a 'clean and green city' nationally and internationally.

The Ledumadumane dumpsite is used for disposal of rubble and garden waste. The area is unfenced and it is a temporary measure to rehabilitation the land. There are high risks of dumping of other types of waste. More formal waste management of the dumpsite is required.

Traditionally people are used to throwing around whatever they do no longer need and this has grown into a habit. Furthermore, there is no regard for the next person and people only clean their own compounds and leave their immediate surroundings. Waste management is still disregarded as a priority by many individuals.

6.2.2 Liquid waste

Wastewater Generation

LW1. Poor water quality of inflow & outflow

The amount of wastewater will grow due the expansion of the sewer system and population and economic growth. The main problem is the poor quality of the wastewater that enters the WWTW. People need to be taught not to dispose of solids in the toilet and agreements with industries and government are necessary to control the quality of discharges and inflows. Inspection and monitoring responsibilities for trade effluent discharges as well as analytical facilities need to be clarified and updated. The lack of adequate skilled manpower makes the operation and maintenance initiatives difficult at certain levels.

LW2. Improved wastewater treatment

Wastewater treatment has to be improved to ensure acceptable a quality of the outflow that meets the BOBS standards. This requires improved plant operation as well as monitoring of the inflow and outflows (quantity and quality).

LW3. Increase in waste water re-use and re-cycling

The choice for re-use or recycling should be informed by economic factors (costs and benefits). Currently, the quantity and quality of the outflow are unreliable and relatively poor, limiting the potential for re-use and recycling. Therefore there is need for funding the construction of the tertiary level for wastewater treatment. Irrigation projects need a reliable water supply of a guaranteed minimum quality. Re-use and recycling should increase to 96% of the outflow as soon as possible, but certainly before 2030 (target date of the NMPWWS).

Introduction of metering system – the simple solution to cost recovery is to get the existing irrigation scheme at Glen Valley working correctly to prevent unnecessary pipe burst and over supply of treated effluent to the farmer’s plots through metering at each farm plot and introduce the charges. The current system does not have charges of the amount of effluent used by the farmer therefore the government incurs the costs of pumping water to the farmers.

LW4. Measuring and monitoring. There is need to have all the data concerning, waste water inflow and outflow, wastewater quality amount re-used including annual reports under one department or institutes.

LW5. Increased recovery rate of waste oil

The recovery rate of used oil is low and should increase significantly. This requires more or larger oil recovery enterprises and a better oil storage network. This can be funded form oil levies linked to the polluter pays-principle. TT needs to have at least one more branch opened somewhere else in Botswana. This will enable the Trust to reach out to a larger community when sensitizing on waste oil management.

Private companies are reluctant to reveal the amount of re-used oil collected from clients. DWMPC should systematically collect such figures (prior to license renewal) and enter the data in a new data base. Re-use within the country and export opportunities seem to be sufficiently large to support the industry’s growth.

6.3 Possible support areas for Japanese embassy

The proposed interventions were discussed with consulted stakeholders. The main focus of Japanese support would be to assist with changing the emphasis of waste management towards reduction of waste flows and re-use and recycling as well as environmentally sound waste collection and disposal.

Japanese support could be in several forms: technical assistance; support for infrastructure projects and support for improving waste management. Recycling opportunities for Gaborone and surrounding areas are also highlighted (Box 5) as possible areas for Japanese support.

Infrastructure:

- a. Support the establishment of drop off, buy back and transfer/ waste transformation facilities in the Gaborone area. The Swedish government is supporting the establishment of one transfer station; the Japanese government could support another transfer station close to/ in Mogoditshane;
- b. Fleet expansion and improved maintenance;
- c. Support the establishment a composting facility;
- d. Establishment of additional used oil collection tanks;
- e. Establishment of a hazardous waste disposal facility;
- f. Establishment of crusher plant for construction waste for re-use and recycling.

Training:

- a. Continuous training of staff (land fill, WWTW, fleet mechanics, recycling and re-use operators, etc.);
- b. Awareness and public education to enhance sound solid and liquid waste management attitude among consumers and collectors.

Policy and institutional support:

- a. Support for improving waste management in Tlokweng and Mogoditshane (e.g. separate waste management units);
- b. Law enforcement and must be put up to date;
- c. Implementation of the recycling guidelines/ strategy;
- d. Support the development of local waste management plans (as required by law);
- e. Twinning arrangement between Gaborone and a Japanese city with environmentally sound waste management.

Research & studies:

- a. Assessment of waste management costs and tariff setting;
- b. Cost and benefits of outsourcing waste collection;
- c. CBA studies of re-use and recycling of specific forms of waste (e.g. electronic equipment);
- d. Funding requirements and sources of environmentally sound waste management.

Box 5: Recycling opportunities for Gaborone

Opportunities for recycling and re-use in Gaborone and surrounding areas should be better exploited to capture the value of waste and to extend the lifetime of landfills and dump sites. Examples are discussed herewith and the Japanese government could support these areas.

a. Composting – This involves the aerobic biological decomposition of organic materials to produce a stable humus-like product. Compost should be viewed as a usable product, *not* as waste that requires disposal. Various types of waste can be used for composting and these include: kitchen waste, yard and garden waste, animal waste, processing waste, some construction waste such as soil, tree roots, commercial waste (from restaurants -cooking waste) and some latrine and dredge spoils. The basic requirements for composting include:

- Dry place;
- A supply of organic material;
- Green materials;
- Grown materials;
- Bulking agents;
- Water and air;
- Sufficient mass to retain heat.

There are several benefits of composting. It can be used as humus to improve soil conditions for (backyard) gardening and urban agriculture as it adds nutrients and help retain soil moisture. It also reduces the amount of waste disposed at landfills and contributes to import substitution (all compost is currently imported). Composting helps aerate the soil and controls erosion due to some beneficial organisms that are added to the soil. It should also be considered as an environmentally sound recycling method that offers a natural alternative to chemical fertilisers. Compost recycling can be done at the level of individual households, communities or by private companies. However there is need for sufficient knowledge and understanding of composting among consumers and local authorities as well. Furthermore, a market for compost products needs to be developed by government and the private sector. Compost could be purchased for greening the city, for agricultural schemes, in mines for closure and reclamation processes.

b. Recycling of construction rubble

Construction rubble can be processed and used for a number of purposes. It can be crushed and screened for use in various applications such as road base, drainage fill products, bricks and temporary paving. The brick and concrete rubble crusher machine can break down the waste brick material into smaller bits, and water or alternative hardening agent would be sprayed onto the small pieces. The powdered mash is then moulded into the shape of a brick through the use of the compressor in the machine and it can be re-used.

Crushing plant operation

Construction waste is crushed into the desired size in the construction waste crushing plant. The operational process is as follows. First, construction waste goes into the jaw crusher for primary crushing, and then into the impact crusher for secondary crushing; finally, the construction waste enters into a cone crusher for fine crushing, then through the screening machine, which selects the suitable materials. Waste from construction can be re-used as building materials after crushing.

c. Drop-off centres – According to Scheinberg *et al* (2012), a drop-off centre is a site or depot where individuals can go to deliver their recyclables; there is no form of payment for this activity. These should be established in easily accessible areas close to supermarkets or shopping centres. At the drop-off centre, people throw their waste in different containers for e.g. paper, bottles, plastics and cans. The centre could alternatively have people working there to clean, sort and process recyclables before they could be transported to/ collected by a recycling facility or company. Suitable waste could be used for community-based activities such as art and crafts production. Participation of communities, private sector and NGOs is therefore critical. An example of a drop off station is shown in Appendix 4.

d. Buy back centres. These could be established in large supermarkets for returnable glass bottles.

e. Transfer centres or stations – These facilities are much bigger than the former these are for consolidating waste from multiple collection vehicles into larger and high volume vehicles for transferring waste to disposal site. They would have cells for different types of waste for segregation. Waste is sorted at this centre and resources such as crushers and shredders should also be present at the site for tyre shredding. Before dispatching into transfer vehicles, the waste is compacted. Electronic waste and used acid lead batteries should be accommodated as well. As such, companies that recycle this waste could collect from this facility. There is no provision for long-term storage of waste at this facility as with other transfer stations worldwide.

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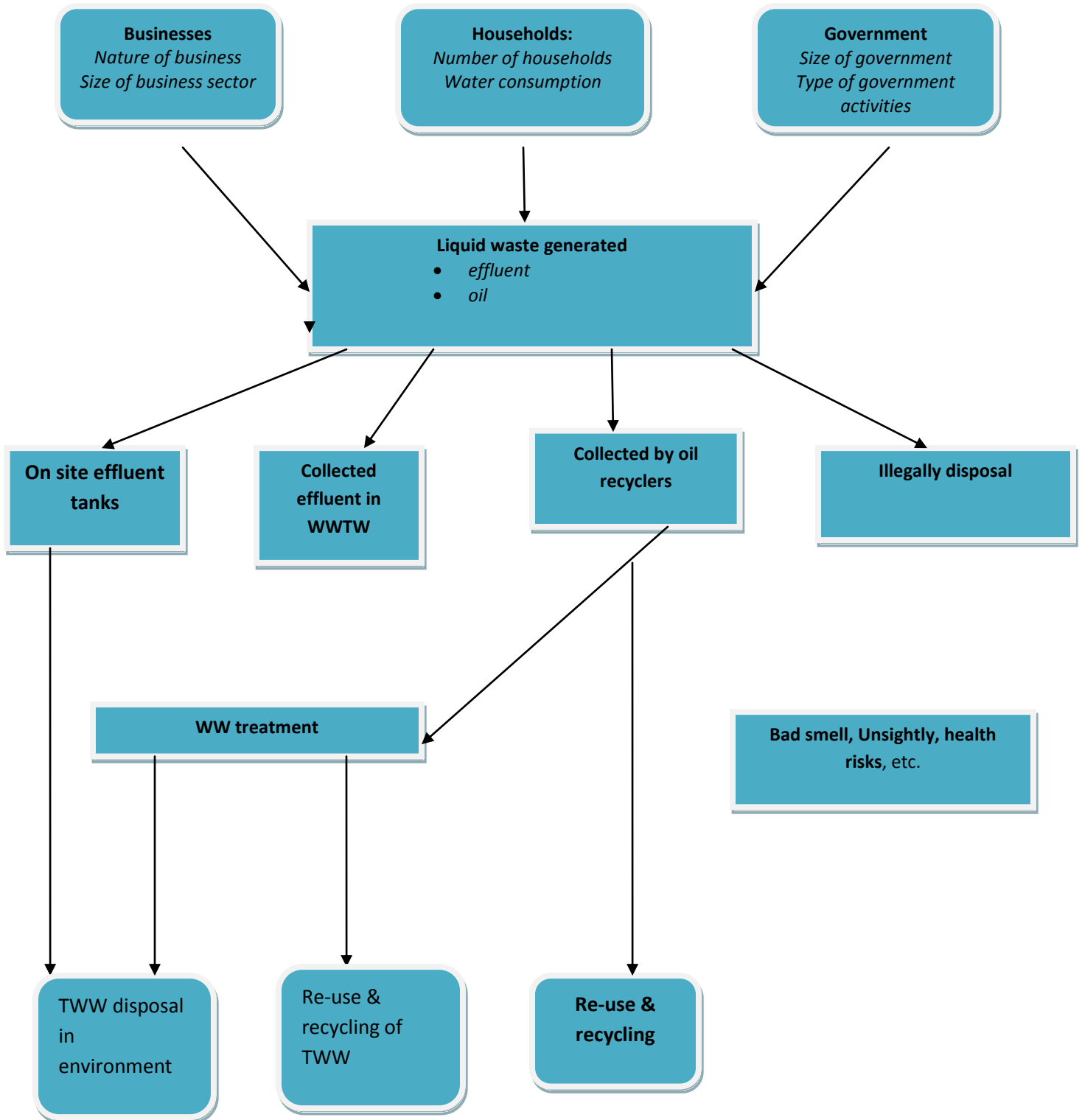
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Appendix 1: List of consulted institutions and persons

	Name	Organisation	Position Held
1	Mr. D. Aniku	Department of Environmental Affairs	Head of the Environmental management and EIA
2	Mr. Makati	Gaborone City Council (GCC)	Principal Environmental Health Officer
3	Mr. D. Tshotelo	Gaborone City Council (GCC)	Environmental health officer
4	Mr. Banda	Department of Waste Management and Pollution Control	Sanitation engineer Health Officer
5	Ms Hubona	Kweneng District Council/Gamodubu landfill	Landfill manger
6	Mr Segokotlo	Kweneng District Council/Gamodubu landfill	Landfill operational manager
7	Ms K. Moseki	Somarelang Tikologo	Executive Director
8	Mr. Mothobi	Tlokweng Sub-District Council	Environmental health officer
9	Mr Makagwa	Tlokweng Sub-District Council	Environmental health officer
10	Dr. Segosebe	University Of Botswana (Environmental Science Department)	Lecturer
11	Dr. Lenkopane	University Of Botswana (Environmental Science Department)	Lecturer
12	Mr Teddy Ditsabatho	Water Utilities Corporation	Water Quality Manager
13	Mr. K. Bedi	Ministry of Agriculture	Irrigation officer
14	Mr. Bokete	Environmental systems	Oil waste collection
15	Ms. P. Mokgalo	Tshole Trust	Oil waste collection
16	Mr. B. Buzwani	Champs Botswana	Oil waste collection
18	Mr G. Senai	Water Utilities Corporation	Infrastructure development
19	Mr. C. Gaothuse	Water Utilities Corporation	Glen Valley wastewater treatment plant operator
20	Mr. Kealotswe	Water Utilities Corporation	Water quality
21	Mrs. Senai	Mogoditshane Sub-District council	Environmental health officer
22	Mr. Ooke	Department of Town and Regional Planning	Country planning

Appendix 2: Liquid waste cycle (wastewater and oil)



Appendix 3: A summary of guidelines for the disposal of waste by landfill

The guidelines provide practical information for licence and policy compliance as well as any associated legislation requirements. The specific objectives of the guidelines are therefore to:

- Improve the standard of waste disposal in Botswana;
- Provide minimum requirements for environmentally acceptable waste disposal for a various landfill sizes and types; and
- Provide a framework of sustainable waste disposal standards within which to work and upon which to build.

It is important to sufficiently select a landfill site, carry out appropriate design and construction, provide good operation and ensure monitoring during operation and upon closure of the landfill. The above categories are briefly discussed as follows as per the guidelines:

1. *Site selection* – several selection criteria are considered and these include economic, environmental and public acceptance. Economic considerations could be site size and access, land availability and distance from waste generation areas. Environmental considerations relates to the physical aspects of the environment. Gamodubu landfill is located 35km away from the city. Although most of the waste is generated in Gaborone, there is insufficient land to accommodate a landfill hence the selection of Kweneng district. Additionally, the site services Kweneng and parts of South-East district. During consultations, there was concern that the distance to the landfill is a problem and that proper consultations were not undertaken. An EIA for the landfill was however undertaken to determine potential environmental and social impacts of the landfill. This is also in-line with the requirements of the guidelines.
2. *Landfill design and construction*- the design should not present any adverse environmental implications and should reduce the risk to public and environmental health hence appropriate engineering techniques should be utilised. The design should also provide a cost-effective and acceptable waste disposal facility. Notable guidelines for the site layout design include access to and within the landfill, infrastructure facilities such as offices, weighbridge, fencing and security, basic utility services such as power and water, laboratory for waste analysis and considerations for emergency situations. Gamodubu meets the above criteria except for the laboratory facilities which are currently unavailable. Leachate management, drainage design and monitoring systems should also be provided for.
3. *Landfill operation*- This requires appropriate facilities and resources. These include:
 - Signposting and access – Signposts should be erected in the vicinity of the landfill to show the route and distance to the landfill. Notice boards indicating the details of the landfill should be visible upon entry. Access roads to and within the landfill should be maintained and only two way traffic should be provided for and vehicles must be inspected when entering the site. Gamodubu meets these requirements.
 - Access control-there should be a single controlled entry to the landfill to prevent unauthorised entry and illegal dumping. Additionally, the site should be fenced at-least 1.8m high and security should be provided.
 - Plant equipment – a variety of equipments such as compactors, bulldozers, trucks, front end loaders and tipper trucks are required for efficient operation of the landfill. Such equipments are available at Gamodubu landfill.
 - Controlled reclamation of waste – facilities for reclamation and scavenging should be provided for. Scavenging needs to be conducted in a proper manner.
 - Storm water diversion methods and leachate management.
 - Methods of landfilling – Cell operation is required for large landfills such as Gamodubu. The cells should be 1.5 to 2m high and can be constructed from soil, rubble or sloped waste. Gamodubu has cells for various types of wastes and the walls are built from soil material.
 - Other aspects include health and safety, control of nuisances such as fires, odours, noise, dust and disease vectors. Gamodubu has a problem of flies and the situation has worsened. Appropriate measures need to be undertaken.
4. Continued monitoring during the operation of the landfill and post closure is also critical. These may include water quality and environmental impacts of the landfill.

Appendix 4: An example of drop off centre in the Netherlands.



Above: Containers for collection of plastics at a small shopping centre: the text on the container explains what types of plastics can be recycled and re-used.

Below: a drop off centre for plastics, paper, glass and textiles at a strategic location. The containers are emptied by a recycling truck and brought to a recycling facility.

