LAKE VICTORIA WATER AND SANITATION INITIATIVE

SOLID WASTE MANAGEMENT SYSTEMS FOR KISII AND HOMA BAY

REPORT BY MANUS COFFEY ON VISIT TO

KISII AND HOMA BAY, DECEMBER 2005

UN-HABITAT CONTRACT NO 4798

INTRODUCTION

This report is in four sections as follows:

SECTION 1. A general overview of solid waste management in small towns in low income countries.

SECTION 2. A review of the solid waste management in Kisii Town and proposals for UN-HABITAT interventions in Kisii

SECTION 3. A review of solid waste management in Homa Bay Town and proposals for UN-HABITAT interventions in Homa Bay.

SECTION 4. A proposed strategy for UN-HABITAT interventions in Kisii and Homa Bay.

Each of the four sections can be read in isolation from the others so it will be noted that there is some repetition in this report to make this possible.

EXECUTIVE SUMMARY

The LVWATSAN (Lake Victoria Water and Sanitation Initiative) includes the provision of solid waste collection systems for the secondary towns in the Lake Victoria Catchments Areas in Kenya, Tanzania and Uganda with populations of between 8,000 and 120,000.
The intention is that UN-Habitat will provide support to these and other towns in the LVWATSAN Region for upgrading their solid waste management systems and the seven towns chosen are considered to be typical of many others in the region so that SWM systems set up in these sample towns can be replicated in other towns.

OBJECTIVE OF THIS CONSULTANCY

As part of UN-HABITAT activities in water, sanitation and waste management and in line with the objectives of LVWATSAN. The objectives of this consultancy are to:-

a) Assess the technical operation of the Vacutugs in Kenya and Tanzania and valuate the future up-scaling of the project.
b) Evaluate the proposed SWM activities in the UN-HABITAT rapid assessment
c) To design the implementation of integrated solid waste management strategy for; i) Bukoba and Muleba in Tanzania; ii) Kisii and Homa Bay in Kenya, and iii) Kyotera, Mutukula and Masaka in Uganda
d) Pre qualify manufacturers of SWM equipment and provide sketches of proposed equipment.

This report has been prepared in accordance with points b) and c) of the above objectives.

The report should be read together with the report on pre-qualification of manufacturers of SWM equipment which will be submitted as a final report to this consultancy.

Previous studies of the two towns in July 2005 were concerned mainly with the Water and Sanitation aspects and only touched very lightly on the Solid Waste Management. These studies provided estimated data on the amount of wastes generated in each of the towns which agreed closely with the present consultants estimates and proposed transfer stations (storage bunkers) in each town with a small tipping truck to collect the wastes from the bunkers. However, the present study shows that these systems would only provide for perhaps 25% of the wastes to be collected and would be a costly, inappropriate and unhygienic solid waste management system.

This report puts forward proposals for immediate and long term interventions for solid waste management in Kisii and Homa Bay in the Lake Victoria Catchment Area of Kenya. It is proposed that tractors with skip trailers and containers should be used for both these towns much more efficiently than the proposed small tipper trucks.

Improved barrows and handcarts will be introduced together with improved brushes and hand tools for the street sweepers.

All the vehicles and equipment will be sourced from within Kenya with encouragement and capacity building of local manufacturers to provide appropriate equipment to specifications which will be provided by UN-HABITAT.

Immediate Interventions are proposed for both towns and these will include emergency clean ups of both towns, the organization of community awareness campaigns and community based litter collections to remove the plastic litter scattered throughout the towns. A single tractor and skip trailer and ten containers will be provided to each town under this immediate intervention which can be used for the emergency clean ups followed by the introduction of waste collection and disposal services in a limited area in each town. During this preliminary phase reviews of the waste quantities and densities will be carried out to be followed by adjustments in the numbers of tractors and containers and other equipment proposed for the Long Term Interventions.

A review of the waste disposal sites and proposed alternative sites will be included.

Capacity building at local authority level and training of management and workers in the operation of the systems will be included and preventive maintenance systems set up for the continuing service and maintenance of the vehicles.

Financial systems will be put in place for the collection of revenues to ensure the long term sustainability of the waste management in each town.

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SECTION 1

GENERAL COMMENTS ON SOLID WASTE MANAGEMENT APPROPRIATE TO KENYA SMALL TOWNS

1.0. REVIEW OF SWM FOR LVWATSAN SMALL TOWNS.

Any SWM systems which are set up must have long term sustainability if they are not to go the way of so many donor aided projects in other countries which have set up short lived systems based on state of the art technologies from the industrialized countries without an understanding of the different waste characteristics, economic conditions and ability of the householders and commercial activities to pay for the service.

A typical example of such differences lies in the difference in the density of the wastes. In the more wealthy industrialized countries waste densities as low as 100 kg/m3 or even less are found and collection vehicles using compaction mechanisms to compact the wasters, typically to around 400 kg/m3, are commonly used to enable the collection vehicles to carry economic loads. However these trucks are costly to purchase and to operate and where there are high density wastes their heavy compactions mechanisms actually reduce the load capacity of the trucks compared with non-compaction trucks with a body size appropriate to the waste densities in each situation.

There were a number of common features of all the four towns which have been studied to date including:-:

- The relatively low income levels of the residents of the towns results in a small waste generation per capita and high density wastes. Initial studies have indicated average waste generation rates of 0.3 – 0.4 kg/capita/day and waste densities of 300 to 400 kg/m3 for all the towns. However further waste characterisation studies of selected towns should be carried out to confirm the figures.

- Financial constraints dictate the level of service which can be provided. A high level of service with house to house collection will not be affordable and so communal collection points using skips or containers to which the residents will bring their own wastes will be appropriate. The low waste generation rates and the high waste densities indicate that each collection point must be relatively small so as to minimise the distances that the residents have to bring their wastes. Typically a 4.0 m3 container will hold the wastes of around 1,600 people (300 households) with a collection every two days allowing for the containers being 80% full at the time of collection.

- The distances between the residential and commercial areas in all four of the towns and the waste disposal sites are relatively short due to the small sizes of the towns and the ready availability of dumping sites

1.0.1. July 2005 study.

Studies for UN-HABITAT in July 2005 proposed the use of concrete transfer stations (bunkers) for the storage of wastes with a single small tipping truck to transport the wastes from the bunkers to the disposal site. However such concrete bunker systems cannot be recommended for a number of reasons:

- Experience of bunker systems throughout the world has shown that these lead to vehicle inefficiencies due to the slow process of loading the wastes from the bunkers into the collection vehicles. Other problems with bunkers include.

- It is difficulty to clean out the bunkers completely at each emptying and any wastes remaining in the corners act as a refuge for the cockroaches and other insects which are inevitably attracted to the bunkers.

- Organic wastes which have remained in the corners of the bunkers decompose causing odour problems and also harbour a reserve of bacteria which then speed up the start of decomposition in subsequent wastes.

- All wastes must be removed completely at least every two days if the bunker (or skip) is not to become the source of the problem rather than the solution. Otherwise nearby residents will set fire to the bunkers when they start to smell or attract flies thus adding smoke (and toxic gases from burning plastics) to the overall pollution problems.

- The bunkers attract rodents which can bury underneath the concrete slabs and disappear down their burrows when the collection vehicles arrive.

Container or "skip" systems, where the complete skip is removed daily, or at most every two days, prevent the build up of the above nuisances. However the skips must be constructed to minimize corrosion and must be located on concrete slabs to prevent contact with the soil below. The slabs must be constructed so that rodents cannot burrow underneath them.

If skips are used they must be brushed out each time they are emptied to prevent a build up of wastes trapped in corners where they decompose and form corrosive acids.

Tipping trucks are inefficient due to the high loading heights with slow loading and consequently small daily capacity. (The small tipping trucks which were proposed for Kisii and Homa Bay in the 2005 studies had a cost of US $ 33,000 and would have a typical load capacity of 3.0 to 4.0 m3 and due to the slow hand loading process would take around 1 ½ to 2 hours per load. Thus they can collect only three to four loads per day or $9m^3$ to $16m^3$ per day or a total of around 3,000 to 4,000 kg. This compares with the estimated waste volumes of 85 m^3 / day for Kisii and $48m^3$ / day for Homa Bay). (2015 projections). A tipping tractor trailer illustrated in the appendixes has a capacity of between 2.5 m^3 and

3.0 m³ and again is unsuitable for solid wastes with typical loads of around 1,000 kg. No back up vehicles were proposed so that the vehicoles cannot be properly serviced and a simple breakdown (such as a puncture) can bring the collection service to a standstill. Thus the July 2005 proposals are not consider practical.

1.1. COLLECTION AND TRANSPORTATION SYSTEMS.

All the seven towns studied to date were estimated to have waste densities of between 300 kg/m3 and 500 kg/m3 in different parts of each town. This is equivalent to the waste densities to which compaction trucks are designed to compact the wastes. Thus there is no reason to consider the use of compaction trucks for any of the towns studied. Also all of the towns studied had short haul distances between the collection areas and the disposal sites which means that in all the towns tractor trailed systems will be more cost effective than trucks. A 40 – 50 hp tractor can pull trailers with loads of up to 5 tons at speeds of 30 kph and costs around US$ 13,000 to $15,000. A truck with the same load capacity will cost around three times this amount and although it can travel at 60 kph the faster road speed of the truck will have very little effect on the overall collection times where there are short distances. If the trucks shave to be loaded by hand their daily capacities will be greatly reduced.

The per capita waste generation rates and the density of the wastes effects the optimum size of the waste collection points or containers. Typically in all the towns studied a 4.0 m3 container (5 m3 heaped load) will hold around 1,500 kg of wastes or including the weight of the tractor trailer system and a container this will give a trailed weight of around 3.5 tons. This is well within the capacity of a 40 – 50 hp tractor even allowing for some steep hills and the high altitudes around Lake Victoria.

The following systems were therefore considered, the choice in each town depending upon the amount of wastes to be collected (population X waste generation / capita), the haul distance to the disposal site and current waste storage practices within that particular town.

1.1.1. SYSTEM 1. Tractor trailed skip (container) systems.

Containers to which the householders and businesses will bring their own wastes and a tractor trailed skip pick up system to pick up, transport and discharge the containers. A 40 – 50 hp (30 kw) tractor will transport a 4 m3 capacity (5 m3 heaped capacity) container.

1.1.2. SYSTEM 2. Tractor trailed collection systems.

A tractor trailed low loading height trailer with a maximum loading height of 1.5 metres. This will be combined with 100 litre capacity bins each servicing around 10 houses and 60 – 80 litre capacity plastic bins for the businesses and shops.

1.1.3 SYSTEM 3. Mini truck and "Bell" system.

A 1.5 m3 capacity mini truck based on a modified Chinese 2 wheeled tractor.

This system will travel slowly throughout the town stopping for short periods at designated points. The householders hear the truck coming and bring their own wastes directly to the truck as it passes their house or to the stopping point. The truck can also collect commercial wastes from bins at the same time.

The optimum system for any town will depend upon the population to be serviced, distance to the disposal site, street widths and surfaces and any systems to which the householders have become accustomed.

1.2. OPERATING COSTS AND COST RECOVERY

Although UN-Habitat will assist with the initial setting up of the collection and disposal system, if it is to be sustainable in the long term it is essential that each local authority can meet the full costs of operating the system, future costs for replacing the equipment as it becomes obsolete, the costs of expanding the system in line with any population growth and possible increases in the amounts of waste generated per capita as living standards increase. This will require the provision of operating finance for the daily running costs of the system and the creation of a long term capital budget to cover the annual depreciation costs of the equipment. This may require the payment of refuse collection charges by the householders and businesses on a weekly or monthly basis but these may also be included as an additional charge on an existing service such as water or electricity.

The costs can be broken down into operating costs (labour fuel and maintenance) and financial costs (depreciation and interest on the capital employed). When however equipment is provided under a donor grant it is common to ignore the interest on the capital but depreciation must always be taken into account if any system is to be sustainable in the long term.

1.2.1. Labour.

Labour costs can be minimized by keeping vehicle loading times as low as possible. This means fast and efficient loading of the vehicles. Labour costs for a system where the householders bring their own wastes to a container or directly to the collection vehicle (bell system) will be lower than for a bin based or house to house collection.

1.2.2. Fuel.

Fuel consumption per hour for any vehicle is roughly proportional to the engine power of the vehicle. A 40 – 50 hp tractor will have a much lower fuel consumption than a typical truck of the same capacity with a 100 – 120 hp engine.

And the Chinese 12 hp tractor based system will have lower fuel consumption still.

1.2.3. Maintenance

Maintenance costs include tyre wear and monthly servicing costs as well as repairs which will increase as the vehicle ages. Very roughly vehicle maintenance costs are proportional to the capital cost of the vehicle and an annual maintenance cost of 7% of the capital cost is typical. At the beginning of any vehicles life the maintenance costs will be small but will increase as the vehicle ages with a typical large increase when the first set of tyres wears out. It is essential that funds are put aside at the start or accumulated out of SWM revenues as the vehicle ages. Systems for the procurement of routine service materials (oils, filters, etc) must be put in place and fast systems for the procurement of parts and labour for emergency repairs are essential to any sustainable system. The SWM manager must have the authority to purchase items up to an agreed monthly amount without the need to refer back to the financial controllers for each item.

Preventive Maintenance is an essential part of the operation of any SWM system and will pay for itself many times over. A full preventive maintenance system including daily checks by the driver, weekly checks by a mechanic and monthly servicing is the minimum that is required for any new SWM system either using the local authorities own workshop resources or by sub-contracting out to a local service depot or mechanic.

1.2.4. Back up vehicles.

Back up vehicles are essential to allow for proper servicing and vehicle breakdowns but add to capital and depreciation costs. However they do not add to labour and fuel costs when they are on standby.

1.3. FINANCIAL COSTS

Financial costs include “depreciation” where the vehicles and equipment used is “amortised” or “written off” during the economic life of the equipment and “interest” on the capital cost of the equipment on the assumption that the local authority must either borrow the money for the initial purchase or use capital which would otherwise be used for other purposes or kept in reserve for future needs. Thus depreciation and interest are both cost elements of any sustainable system.

Where however equipment is provided by a donor under a non-repayable grant interest may be ignored. However depreciation must always be taken into account in any sustainable system and a “sinking fund” should be set up for future vehicle or equipment replacement when it reaches the end of its economic life or for expanding the collection fleet in line with any increase in population .

Annual depreciation costs are calculated as a percentage of the equipment's capital or replacement cost and must include the costs of replacing containers or bins as they wear out. It is possible to keep tractors and trucks going for long periods, however the "economic life" of the vehicles is the life after which it is more cost effective to replace the vehicle (making an allowance for any residual value of the original vehicle

Different types of vehicles and equipment will have different economic life and the generally recognized life expectancies are as follows:

TABLE 1. ECONOMIC LIFE OF DIFFERENT WASTE MANAGEMENT VEHICLES AND EQUIPMENT.

Truck	7 years
Tractor	10 years
Trailers, etc.	10 years
Containers and bins	4 years
Buildings and fixed equipment	20 years
Landfill development (depending upon life expectancy of site).	10 – 20 years

1.4. CAPITAL COSTS FOR EQUIPMENT.

It has been assumed for this study that the capital costs for the vehicles and equipment for all three countries will be similar but tenders must be sought for each item in each country. The following costs are used throughout this Kenyan study. Vehicle costs include for an initial stock of spare parts and for the delivery of the different vehicles and equipment to the different towns. Tenders must however be sought for the different items and these costs up-rated in line with any tendered costs.

TABLE 2. COSTS FOR DIFFERENT TYPES OF EQUIPMENT.

ITEM	COST US $	DEPRECIATION YEARS
45 hp tractor (Eg: Massey Ferguson model 240)	16,000	10
Tractor trailed container pick up system.	9,000	10
Low loading height tractor trailer	7,500	10

4 m3 container	1,000	4
12 hp Chinese tractor conversion with 1.5m3 body	6,000	7 *
100 litre bins	30	4

(* Note: It is common practice to allow 7 years life for trucks and 10 years life for tractors, the longer tractor life being due to the more simple construction and slower engine and road speeds. As we have no experience of the life expectancy of the Chinese two wheeled tractors we are assuming an economic life of only 7 years, however it may be found that this can be increased to 10 years after experience has been gained).

1.5 TRACTOR CAPACITIES.

Tractors are available in a wide range of sizes and in general the cost of the tractor is roughly proportional to its power.

The performance of any tractor and its ability to pull heavy trailers is determined by the gross weight of the tractor, trailer and load and the power of the tractor. The power to weight ratio (P/W) is the power of the tractor (hp) divided by the gross weight (tons). Tractors can operate with a P/W as low as 5 hp/Ton but the speed performance on hills will be poor. A P/W ratio of around 8.0 bhp/ton is proposed for the solid waste management for the LVWASTAN project.

The power of any engine is effected by the altitude at which it is working with a drop in power of around 3% for every 300 metres (1,000 ft) above mean sea level (AMSL). This must be taken into account in the Lake Victoria Region where there are altitudes of between 800 and 1,600 metres AMSL. Typically a power reduction of around 10% of the manufacturers ratings for the tractors can be assumed for the altitudes around Lake Victoria.

The ability of any tractor and trailer to operate on bad road surfaces and soft disposal sites is determined by the proportion of the total weight of the combined which tractor, trailer and load which is on the tractor driving wheels. For this reason the trailers used should transfer a proportion of the weight of the trailer and load (typically around 1.0 ton for a 40 –50 hp tractor) onto the tractor drawbar. With good weight transfer a two-wheel drive tractor will have very nearly the same traction (pulling power) as a four-wheel drive tractor of a similar weight.

A medium powered tractor of around 40 hp – 50 hp combines a relatively low cost with good manoeuverability and is considered appropriate for the towns in the LVWATSAN region.

1.6. PROPOSED TRACTOR TRAILER AND CONTAINER SPECIFICATION.

40 – 50 hp tractors are readily available in all three countries of the LVWATSAN region at a cost of around US $ 14,000 to $ 16,000. However it is most important that the make and model of tractor chosen should have a good spare parts and service back up in each country. (This is much more important than any small savings which can be made by choosing the lowest cost tractor).

1.6.1. Tractor Trailed Skip (Container) Trailer.

Typically a 40 - 50 hp tractor and trailed skip system will have approximate weights as follows:

Container capacity. 4.0 m3 x 350 kg/m3 =	1,400 kg wastes
Container weight. (estimated)	500 kg
Chassis weight. (estimated)	1,200 kg

Total Trailed Weight. .	3,100 kg
Tractor weight (typical 45 hp tractor)	1,800 kg

Combined weight of tractor & trailer	4,900 kg
Power / weight ratio with 45hp tractor (40 hp allowing for altitide)	8.2 bhp/ton

A 45 hp tractor with a gross weight of 4,900 and a load of 1,400 kg will have a good road performance. The same tractor will be able to pull heavier loads but the performance will be reduced, particularly where there are steep hills.

1.7 CONTAINER LIFE.

The life of the containers will be determined by their resistance to corrosion and there are a number of factors which will affect this life expectancy including:

- The quality and the thickness of the steel used. Where possible containers should be made from CorTen steel but this may not be available in the LVWATSAN Region.

- The design of the containers. Containers should be made with chamfered corners which will allow the wastes to slide freely during tipping and reduce the tendency to hold wastes in the corners where they will decompose causing anaerobic crevice corrosion. Wherever steel sheets overlap they must be fully welded to prevent liquids getting between the sheets where they decompose forming corrosive acids again causing anaerobic crevice corrosion.

- The paint finish used. Containers should be shot blasted or wire brushed before painting with a zinc chromate primer and two finish coats.

- The frequency of emptying. Containers must be emptied at least every second day to prevent decomposition of organic wastes and the formation of corrosive acids in the wastes. This is particularly important in any country with a hot climate and high humidity.

With good attention to the above details containers made from CorTen steel should last 10 years but this can be reduced to no more than two or three years with poor design, ordinary or "mild" steel, bad manufacture and bad management. The economic life of the containers is therefore assumed to be 4 years and the estimated cost is based on ordinary mild steel construction. However alternative tenders should be obtained for containers made from CorTen steel and the costs compared before a decision is made as to which version to use.

1.8. LOW LOADING HEIGHT TRAILER

A low loading height trailer suitable for a 40-50 hp tractor will have a capacity of around 4.0 m^3 (5.m^3 heaped) and a loading height of around 1.5 m. It will carry typical loads of around 1.75 tons but must be capable of carrying and tipping loads of up to 4.0 tons or more.

1.9. PREVENTIVE MAINTENANCE.

The introduction of any new equipment must include the setting up of a formal preventive maintenance programme which will include.

1.9.1 Daily checks

Each truck or tractor driver will have a list of simple checks which he must carry out every day before he starts work including checks on the engine oil, water, tyre pressures, hydraulic fluids and checks for any oil leaks. This should take no more than five minutes. He must then sign the daily check sheet to confirm that he has carried out these checks.

1.9.2. Weekly checks.

A qualified mechanic (either a municipal employee or an outside mechanic) will carry out a weekly list of checks which will include confirming that the driver has carried out his checks and a simple list of further checks for items such as loose bolts, clutch and brake wear, etc.. He will then sign the weekly check list. This should take no more than 30 minutes.

1.9.3. Monthly service.

The monthly service will include oil and filter changes where required, clutch, brake and steering adjustments and a further check on the items in the weekly check list. With the above system each person, including the driver, is held responsible for his own maintenance checks and the weekly and monthly service checks will confirm that the daily checks have been properly carried out and vehicle failures or reduced efficiencies due to a lack of maintenance should be eliminated.

During the monthly checks any imminent spare parts requirements can be identified so that they will be obtained in time for the next service and the Municipality can budget properly for the vehicle maintenance. Thus the vehicles should never be out of service awaiting spare parts. It is most important that a budget is allocated and procedures are in place for the prompt ordering of any spare parts without having to wait for approvals by the financial controller. In this way vehicle down times can be minimized. Stocks of regular service parts, such as filters and oils, must be maintained at all times.

1.10. LOCAL MANUFACTURE.

Local manufacture should be encouraged as much as possible so as to ensure spare parts and service availability and also to encourage local job creation.
The tractor trailers and containers can all be manufactured in Kenya thus avoiding any dependence on imported spare parts.

Suitable manufacturers for the container trailers and containers will be engineering companies who already have experience of manufacturing agricultural or road trailers or similar steel fabricated equipment. A key factor for the sustainability of this system must be the local availability of spare parts for the axles and hydraulic cylinders and the use of readily available tyre sizes. It would be possible to make use of used truck front hubs for this purpose but this is not recommended due to the problems of obtaining sufficient hubs and brake components which are all identical and in adequate condition..

1.11. PREVIOUS STUDY.

A previous study, which was carried out in both towns in July 2005 concentrated mainly on the water and sanitation aspects and only briefly looked at solid wastes management. This present study goes into more detail on the solid waste aspects and has reservations about the systems proposed in the previous study which included the following:

1.11.1. Waste Bunker System.

Proposals for the use of concrete bunker systems are not considered appropriate or cost effective for a number of reasons:

- Experience of bunker systems throughout the world has shown that these lead to vehicle inefficiencies due to the slow and unhygienic process of loading the wastes from the bunkers into the collection vehicles. Other problems with bunkers include. Only one loader can work effectively inside a bunker at any time due to the space restrictions.

- It is difficulty to clean out the bunkers completely at each emptying and any wastes remaining in the corners act as a refuge for the cockroaches and other insects which are inevitably attracted to the bunkers.

- Organic wastes which have remained in the corners of the bunkers decompose causing odour problems and also harbour a reserve of bacteria which then speed up the start of decomposition in subsequent wastes.

- All wastes must be removed completely at least every two days if the bunker (or skip) is not to become the source of the problem rather than the solution. Otherwise nearby residents will set fire to the bunkers when they start to smell or attract flies thus adding smoke (and toxic gases from burning plastics) to the overall pollution problems.

- The bunkers attract rodents which can bury underneath the concrete slabs and disappear down their burrows when the collection vehicles arrive.

- Container or "skip" systems, where the complete skip is removed daily, or at most every two days, prevent the build up of the above nuisances. However the skips must be emptied at least every two days, must be constructed to minimize corrosion and must be located on concrete slabs to prevent contact with the soil below. The slabs must be constructed so that rodents cannot burrow underneath them.

- If skips are used they must be brushed out each time they are emptied to prevent a build up of wastes trapped in corners where they decompose and form corrosive acids.

1.11.2. Truck Systems

Proposals for the use of truck mounted skip systems and tipping trucks for any of the four towns studied in Kenya and Tanzania are not considered cost effective for the following reasons:

- Where the distances between the waste collection points and the disposal site are short tractors can be much more cost effective than trucks. Invariably tractors pulling trailed skip systems or special refuse trailers will be more cost effective than trucks where the haul distances are less than 20 or even 30 km.

- A 40 - 50 hp tractor costs around US $ 14,000 - $ 16,000 and can pull a trailer with a load of up to 5,000 kg at speeds of up to 30 km/hr. A truck with the same load capacity will typically cost around $ 40,000 to $ 50,000 but the body will be too small to achieve its full weight capacity. A larger truck with a skip system will cost around $ 70,000. The slower speed of the tractor is more than offset by its lower costs, and the better manoeuvrability of the tractor.

- A tipping truck, such as would be used for collecting wastes from heaps or bunkers, if it is to have an adequate capacity will have a very high loading height, adding to the loading times and further reducing the vehicle efficiency. High loading heights are also unhygienic for the loaders who should not be asked to load wastes above their shoulder heights (1.5 m).

- The "economic" life or depreciation of a truck is normally taken as seven years whereas a tractor and trailers will be depreciated over ten years due to the reduced engine speeds and more simple construction of the tractor.

- The manoeuvrabilty of the tractor and trailer can be further improved by the use of a "Swan Neck Drawbar" which will enable the tractor wheel to pass underneath the drawbar for sharp turns.

Taking all the above factors into account the labour, fuel and maintenance costs of operating tractor trailed skip systems or trailed collection systems will be less than one third that of collecting wastes from bunkers or heaps of wastes and the capital costs will be greatly reduced. Thus tractor based systems can be fully sustainable in situations where trucks are too costly to provide a sustainable system.

1.12. LABOUR COSTS.

The labour rates and the hours worked by the drivers, loaders and sweepers in Kisii and Homa Bay varied somewhat but were typically in the order of:

Driver.	US $ 1,400 / annum
Loader / labourer	US $ 1,250 / annum.

These figures can be adjusted for the two towns in line with the hours worked and the local labour rates paid.

1.13. BURNING OF PLASTICS.

Burning of plastics should never be allowed and any awareness campaign should include educating the people about the very serious hazards from the dioxin and furan gases given off by burning plastics.

Note: In one city in Egypt where there was a village about 300 metres down wind from a burning landfill site a health survey found that 87% of the villagers suffered from some form of respiratory problem ranging from lung cancer, to bronchitis, and asthma due to the dangerous gases released by the burning plastics.

1.14. SUSTAINABILITY.

The objectives of any donor funded solid waste management project is to provide a capital input for the purchase of vehicles and equipment and capacity building of the local authority for the efficient operation of a sustainable system which will remain in operation after the donor interventions have ended.

The long term sustainability of any system must depend upon the towns ability to carry the operating costs (labour, fuel and maintenance) in the short and long term and the long term costs for the replacement of any equipment as it wears out. There is a tendency for capital costs to be ignored in donor funded projects where the equipment is provided by the donor but this can lead to short term solutions which collapse after a few years when the equipment reaches the end of its economic life. Any system must be affordable by the local authority and by the householders and businesses to be serviced, otherwise it will cease to operate when the donor intervention ends.

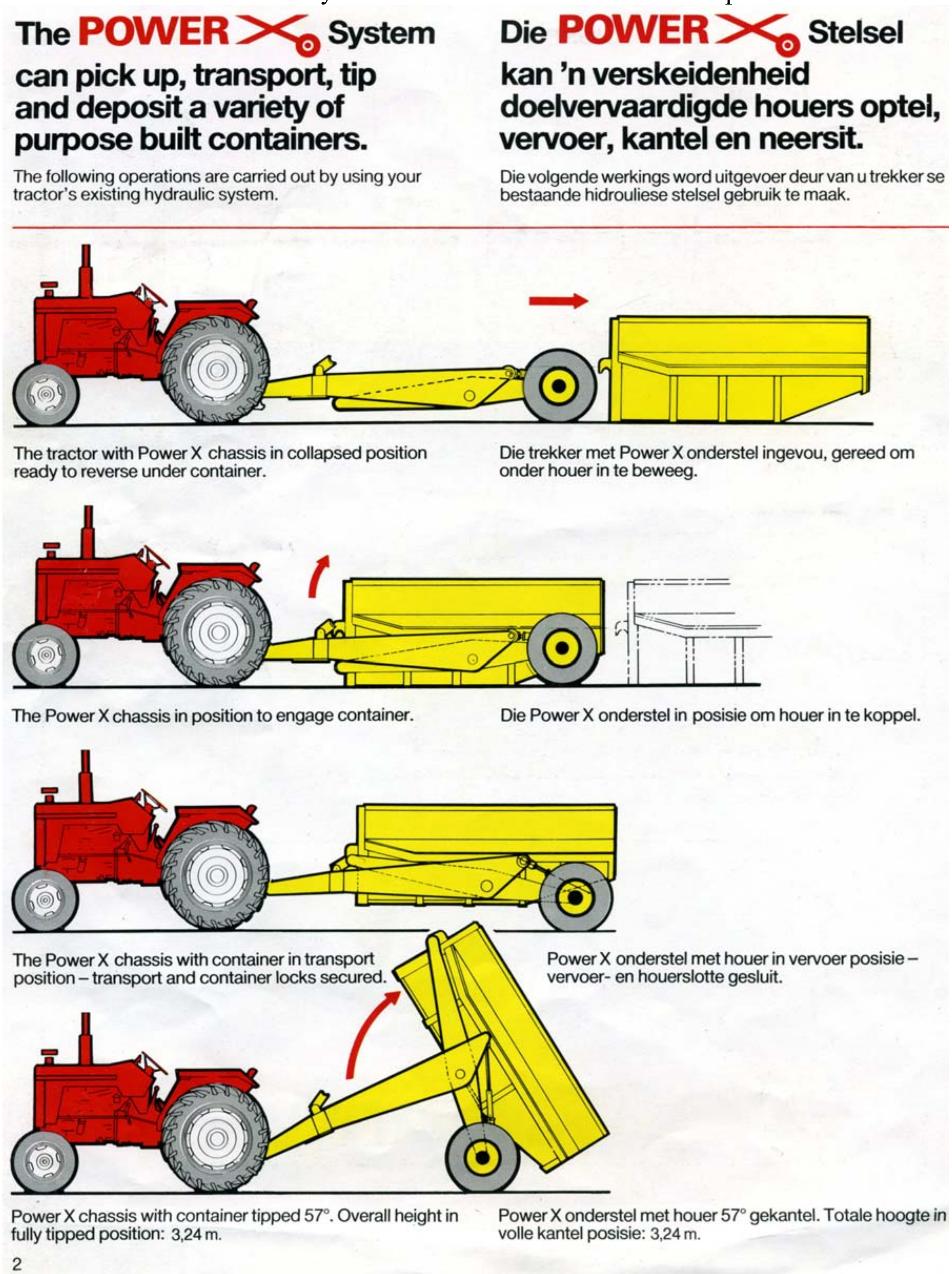
The operating and capital costs of any system will depend upon the level of service to be provided which must be within the affordability or "willingness to pay" of the people being served. It is therefore essential to take the full operating and financial costs into account when planning any system.

There is a tendency to look at waste management as a provider of low cost employment without taking into account the need to minimize the loading times for the vehicles so as to get the maximum productivity out of each vehicle and hence to reduce the number of vehicles required and consequent capital and operating costs. For any sustainable systems costs must be minimized by using low cost vehicles which have a long economic life in an efficient manner which minimizes the labour and fuel requirements.

1.15. PROPOSED COLLECTION SYSTEMS FOR KISII AND HOMA BAY.

Following the studies outlined below it is proposed that both Kisii and Homa Bay should use containers to which the householders will bring their wastes and tractor drawn skip trailers which will pick up the full containers, transport them to the disposal sites and discharge them. A typical skip trailer, manufactured in South Africa is illustrated below, however, this trailer is 2.5 metres wide, is designed to carry loads of up to 6 tons and requires a 65 – 70 hp tractor to pull it.

It is proposed that a lighter 4 ton skip trailer with a maximum width of 2.0 metres should be manufactured locally for use behind a lower cost 40 - 50 hp tractor.



The POWER X System can pick up, transport, tip and deposit a variety of purpose built containers.

The following operations are carried out by using your tractor's existing hydraulic system.

Die POWER X Stelsel kan 'n verskeidenheid doelvervaardigde houers optel, vervoer, kantel en neersit.

Die volgende werkings word uitgevoer deur van u trekker se bestaande hidrouliese stelsel gebruik te maak.

The tractor with Power X chassis in collapsed position ready to reverse under container.

Die trekker met Power X onderstel ingevou, gereed om onder houer in te beweeg.

The Power X chassis in position to engage container.

Die Power X onderstel in posisie om houer in te koppel.

The Power X chassis with container in transport position – transport and container locks secured.

Power X onderstel met houer in vervoer posisie – vervoer- en houerslotte gesluit.

Power X chassis with container tipped 57°. Overall height in fully tipped position: 3,24 m.

Power X onderstel met houer 57° gekantel. Totale hoogte in volle kantel posisie: 3,24 m.

2

PRINCIPAL OF SKIP TRAILER.

SECTION 2.

SOLID WASTE MANAGEMENT PROPOSALS FOR KISII.

2.0. BACKGROUND.

As part of the Lake Victoria Region Water and Sanitation Initiative, LVWATSAN, Iole Issaias of UN-Habitat and Manus Coffey, Waste Management Consultant visited Kisii AND Homa Bay to undertake a preliminary study of the solid waste collection and disposal systems of the two towns. It was only possible, within the short time frame to spend 1 ½ days studying each town so Iole Issaias concentrated on the organizational, financial and community aspects of the two towns and Manus Coffey concentrated on the technical aspects of collection and disposal. A list of the town and other officials met is included as an appendix at the end of this report together with notes on the discussions held and other institutional aspects.

The following brief report and recommendations on solid waste collection and disposal are based on meetings with the various town officials, a visit to the town centers, markets and bus stations, visits to the high and low income residential areas, visits to the abattoirs and meetings with health officials. Previous reports were studied but the main sources of data were the town officials and observations made during the visits. The data and assumptions on which the recommendations are made are set out and calculations shown, however it must be recognized that it was not possible to carry our full studies and so these reports should be seen as pointing the way to cost effective waste management systems without being able to precisely confirm the quantities of equipment required and the disposal site remedial works to be undertaken. This can only be done following a more detailed analysis of the waste quantities and characteristics or by a progressive introduction of the systems proposed and alternative disposal sites have been identified. In the meantime the estimates which have been made of the waste quantities and characteristics have been used to identify the optimum collection systems.

2.1. OVERVIEW OF SOLID WASTE MANAGEMENT.

The optimum waste collection system for any city or town will depend upon the quantities and characteristics of the wastes to be collected, the haul distances between the collection areas and the disposal sites, road and traffic conditions and local cost factors, including labour cost and availability, fuel costs, the availability and cost of capital and the willingness of the inhabitants to pay for a sustainable service. The overall costs must be considered under the following headings:-

Labour,

Fuel,

Maintenance,

Depreciation.

Of these depreciation is often the highest cost factor and unless it is taken fully into account from the start unsustainable systems may be introduced which will give a short term solution to the problems but which will collapse when the equipment reaches the end of its economic life.

Solid waste management vehicles and equipment are short lived compared with fixed installations such as, for example, water supply and sewerage services and this must be taken into account when planning any system. Typical depreciation rates or "economic life expectancies" for different types of equipment are as follows:

Trucks	7 years
Tractors & trailers	10 years
Containers	4 years (this can be greatly extended if CorTen steel is used)
Fixed assets	20 years (buildings, water services, roads, etc)

Although the life of the equipment may exceed these figures, maintenance costs, breakdown times and operating costs will increase and efficiencies will reduce as the equipment ages. It is therefore generally most cost effective to sell off the old equipment and purchase new equipment at the end of the economic life and as a very rough guide the "residual value" of the original equipment will compensate for price increases in the meantime.

If any interventions are to be long term and sustainable the depreciation rates must be taken into account in setting up a financial system for the collection of revenues for the operation of the waste management system and the planned replacement of the equipment as it reaches the end of its economic life. In addition population growth, changes in the waste generation per capita and reductions in the waste densities as living standards improve will add to the waste volumes to be collected. Future trends towards composting and the removal of recyclable materials from the waste stream will reduce the amount of wastes to be collected. The two studies allow for waste quantities up to year 2015 allowing for a 25% population increase and a 20% reduction due to composting and recycling.

Any solid waste management system must include back-up vehicles to allow for breakdowns and service times, otherwise even a simple breakdown such as a puncture can stop the whole system. This is particularly important for container systems where, unless the containers are collected on a regular schedule, the containers will become the focus for insects, rodents, and odours and vehicle breakdowns can upset the regular schedules. Thus a well run container system can be the most cost effective refuse collection system but if this system breaks down it can become a serious problem rather than a solution to the problem. For systems using up to five vehicles one extra vehicle is therefore included for back-up.

2.2 EFFECT OF DISTANCE ON VEHICLE SELECTION.

The most cost effective system for any situation is determined by the haul distance which the collection vehicles must travel to the disposal site. Where haul distances are short a tractor will be more cost effective than a truck and the shorter the distance the more cost effective the tractor becomes. As a rough guide in low income countries, where labour costs are low and capital is scarce, tractors will almost always be more cost effective than trucks where haul distances are less than 20 km to 30 km. In general the smaller the town or city the shorter the haul distance and hence the strong preference for tractor based systems for small towns.

A 47 hp tractor (Massey Ferguson MF240 for example) costs $ 14,000 in Kenya or $20,000 including a trailer and can pull a trailer with a typical load of up to 4.m3 at speeds of up to 30 km/hr. A small tipping truck (Isuzu NQR, for example) costs $40,000, has an engine power of 120 hp and the same load capacity as the tractor and trailer. However it will require a special high sided body to enable its full load capacity to be achieved resulting in slow and unhygienic loading and requiring more loaders. The fuel consumption of the truck with its larger engine will be two to three times that of the tractor. The slower speed of the tractor will be more than offset by the faster loading times so that the number of loads collected each day will be similar for each system. Normal economic life for the tractor, with its low engine speed and lack of sheet metal parts susceptible to corrosion, is ten years but for the truck it is only seven years. Thus the annual depreciation cost for the truck is more than three times that of the tractor and fuel costs are around twice.

2.3. LEVEL OF SERVICE.

When assessing the most appropriate waste collection system for any situation consideration must be given to the level of service required and the householders willingness to pay for such a service.

- A high level of service can include the provision of individual bins to each household or business and a daily service by a collection vehicle calling to each premise.

- A low level of service can include community containers to which the people bring their own wastes and a container pick up service to remove each full container and replace it with an empty one every one to three days.

- In high income and commercial areas a primary collection service, bringing the wastes to secondary containers, may be appropriate but this can be organized as a community based service or a separate private contractor can be encouraged to provide it with direct payment by the customers. Thus any primary collection system can be optional as far as the householders are concerned depending on their willingness to pay for the service. For this reason primary collection has not been allowed for in the equipment and labour recommendations.

- In general fixed collection points (heaps or concrete compounds) are not cost effective due to the low vehicle utilization inherent with the slow loading times for hand loading from these compounds. Other factors also militate against the fixed points as set out in Section 1.

There are many different types of collection system which can be used with different levels of service but no system should be set up which does not meet the criteria for sustainability or which is not within the householders willingness to pay. In general the higher the level of service the higher the operating costs and the higher the capital and depreciation costs resulting in higher refuse collection costs and charges to ensure sustainability.

2.4. REFUSE COLLECTION CHARGES.

Refuse collection charges (RCC) to ensure full sustainability, may be collected as a monthly charge from each household and business premise or they may be added to another service charge such as water or electricity. For business premises it may be part of a business licence fee.

In many cities the RCC from the business and commercial areas are used to subsidise the service to low income areas which cannot afford to pay the collection charges. This is a fair practice on the basis that the low income areas purchase their food and clothing from local traders who in turn purchase from the larger traders in the business areas, Thus any RCC paid by the commercial areas “trickles down” to the lower income areas as a cost increase on their purchases.

2.5. KISII SOLID WASTE MANAGEMENT.

Kisii Municipality has a resident population of 82,500 but this increases with day visitors to the town and a day time figure of between 250,000 and 350,000 was estimated by Kisii Municipal Council. However this may be on the high side.

The visit to Kisii started with a review of the Kisii Consolidated Final Field Report (KCFFR) followed by a meeting at the Kisii Municipality with the Mayor, the Town Clerk and various Kisii Municipal Council (KMC) officials where a memo was provided by the Municipal Engineer, Eng. Albert Keno, setting out their proposals for Immediate Interventions on Solid Waste Management to be Undertaken by the Council. This was followed by a tour of the town including visits to a number of transfer points in both low and high income residential areas and to the main transfer point at the Central Market in the commercial center of the town. Visits were also made to the existing disposal site at Nyambera. During these visits estimates were made of the waste densities. Meetings were also held with the Medical Officer and a visit was made to the abattoir.

2..5.1. Industrial and other wastes

It was not possible within the restricted time available for this visit to study all the other wastes streams including schools, prison, industries, etc, which are responsible for their own wastes so the visit concentrated on the waste management problems of Kisii Municipal Council.

2.5.2. Waste Disposal

A visit to the existing dumpsite at Nyambera gave a very crude estimate of a void capacity of 25,000 m^3 with a typical life expectancy of around 5 years at the present collection rate (see below) or only 2 years at the proposed increased collection rate. It is therefore essential that a new disposal site should be found as quickly as possible.

The existing site must be assessed to ensure that there are no problems with pollution of existing ground water supplies and a stream alongside the dumpsite must be culverted where it passes the dumpsite. The slaughter house is down stream from the dumpsite and the stream should also be checked for any pollution from this source.

There is ample cover material at the site for an improved operation with regular covering without reducing the capacity as any cover material excavated will increase the void space accordingly.

An existing tracked loader could be refurbished for use at the dumpsite (see below).

It is not possible at this stage to determine what landfill equipment will be required in the future when the present dump site is filled as this will depend upon the topography of the site chosen. However a minimum requirement would consist of a four wheel drive tractor of around 75 hp fitted with a front loader and a rear “push off” buckrake (See appendix 1 study on low cost landfill management). Such a system is not presently available in Kenya but has been developed by the consultant for Egypt although comprehensive trials have not yet been completed. It is hoped that this system will be developed by UN-Habitat as part of an overall sub-contract for use at small dumpsites throughout the LVWATSAN region. It is estimated that a total budget of around US $ 30,000 will be required for the tractor, front loader and push off buckrake.

2.5.3. Existing Solid Waste Management Equipment.

Kisii Municipal Council have the following collection and landfill management equipment:

- A Ford Model 5030 tractor with a non tipping trailer.
  Trailer body dimensions 3.2m x 1.9 m x 0.6m heaped = 3.6 m3.
- An Isuzu tipping truck.
  Truck body dimensions 3.2m x 2.3m x 0.9m heaped = 6.6 m3.
- A 1979 TJ Bedford tipping truck, presently unservicable.
  Truck body dimensions 3.4m x 2.2m x 0.9m heaped = 6.7 m3.
- A Caterpillar Model 951C tracked loader. This loader is 24 years old and is presently unserviceable needing engine and other repairs and track replacement estimated at K.sh 1. million. (Compared to a new replacement cost of around K.sh 20.million). Although the track grousers were almost worn away this was considered an advantage as they have no low loading trailer and the loader can travel on the roads without doing too much damage. After refurbishment this loader could be used at the existing dumpsite for, spreading and compacting the wastes and excavating, spreading and compacting cover material. It could also be used for the preparation of any new landfill site.

- There is a loader attachment for their existing tractor which could be rehabilitated to enable them to clear up existing heaps of wastes by loading them mechanically into their existing tipper truck. The loader examined was missing a mounting frame, hydraulic cylinders (4), a hydraulic valve and hydraulic hoses and it is not known if these are available. However a front loader is a relatively low cost item, typically costing around US $ 6,000, so it may be more cost effective to purchase a new one. However as the existing tractor is around 30 years old it may not be cost effective to fit it with a loader.

2.6. KCFFR REPORT.

The KCFFR report contained a number of references to solid waste collection but did not contain any overall SWM proposal.

It was found that there were considerable differences between the estimates of population, solid wastes generated and present collection rates as shown in the

KCFFR and the figures given during the briefing and in the memo by KMC; however, following discussions with the Mayor, the Town Clerk and the Municipal Engineer the following base line data was agreed:

2.6.1. Urban residential population.

The census gives a figure of 82,500, however Kisii is the main commercial center for a large rural catchment and a figure of 250,000 was quoted for the day time population.

2.6.2. Existing waste collection.

It was decided that this population could not be used as the basis for estimating waste generation rates and it was therefore decided to concentrate on the data available for the existing volume of wastes collected, an estimate of the waste density from different sources and estimates of percentage collection and to base any recommendations on this data rather than on population and estimated waste generation per capita.

The existing tractor and trailer typically collects three loads per day from the Market transfer point or10.8 m3 / day and the Isuzu truck collects 1 load per day or 6.8 m^3 from this location also working five days per week. Thus there is a total daily collection of around 18 m^3 / day from this location (90 m^3 per week). It is estimated that this waste has a density of around 500 kg/m3. Thus this area transfers around 9 tons/day or 45 tons per week.

The tractor and trailer typically collect one load per day and the truck two loads per day (17.6 m3) from other transfer points. This waste has an estimated density of 400 kg/m^3, (7. tons/day or 35 tons/week). Thus there is a total daily collection rate of around 36 m^3 or 16 tons/day, (180 m^3 or 80 tons per week).

2..6..3. Waste Generation.

It was very roughly estimated that ⅓ of the wastes generated is collected, ⅓ is buried or burnt on site and ⅓ remains uncollected where it decomposes or desiccates on site. A small amount is composted or salvaged for recycling. Thus the total generation rate is 108 m^3 / day with an average density of around 450 kg/m3. (48 tons/day). Howevere this density includes for a considerable amount of densification during storage due to the length of time between waste generation and collection. It is therefore probable that the waste density at the point of generation (household or business premise) will be around 350 – 400 kg/m^3.

2.6.4. Required Collection Capacity.

It is generally considered that a collection rate of 80% will provide a good service and it is estimated that 20% will be removed from the waste stream by recycling or composting. Allowing for a 25% population increase by year 2015 a total collection of around 85 m^3 / day can be assumed. Assuming an 80% vehicle efficiency, allowing for breakdown and service times, a total vehicle capacity of around 110 m^3 (approximately 50 tons) per day will be required, based on 5 days per week and single shift working. The capacity requirement could be reduced proportionally if six or seven days per week are worked or a second shift or extended single shift is introduced. If a container system is to be used it is essential that at least six days per week collection takes place (see section below on container life).

2.6.5. Distance to disposal site and round trip times.

The distance from the market transfer area in the Town Centre to the existing dump site is only 1.km so that travel times are very short, however the tractor trailer must be loaded and unloaded by hand and the tipping truck must be loaded by hand with a very high loading height. Thus the very lengthy loading times greatly restrict the efficiency of both the tractor and trailer and the truck with a typical daily average of four loads for the tractor and three loads for the tipping truck. Loading the truck is a dangerous and unpleasant job due to the excessive loading height.

Mr Keno said that when they got a contractor with a wheel loader to collect the wastes from the waste heaps around the town he was able to collect 20 loads per day with five times the efficiency of the KMC hand loaded truck. He estimated that KMC could collect 15 loads per day with their reduced efficiency if they had a wheel loader. This clearly shows the importance of the vehicle loading times on collection efficiency.

A new disposal site is being sought for the future and if this is significantly further from the collection areas than the present one the number of loads transferred per day will be reduced. Thus any long term collection system must take the haul distance into account.

2.7. KMC PROPOSAL FOR TRANSFER STATIONS AND TRACTOR SYSTEM. .

Among the items propose by KMC for immediate intervention on Solid Waste Management are the construction of 11 refuse transfer stations (concrete waste bunkers) at strategic locations and the procurement of a further tractor and tipping trailer. This shows their understanding of the better efficiency of a tractor for the short haul distances but will still result in the limited capacity of the tractor and trailer due to the slow loading times. It is however estimated that the tractor productivity could be increased by at least three times by the use of a tractor and trailed container pick up system (skip trailer) to avoid the lengthy loading times. The trailed container system would also replace the transfer stations they have proposed with simple concrete slabs.

2.8. PROPOSED TRACTOR / CONTAINER SYSTEM.

It is therefore proposed that Kisii should be provided with a tractor and skip trailer and 10 containers as an immediate intervention and, following the successful introduction of this system, the existing inefficient equipment should be phased out or used for other purposes and further tractors and container systems provided.

Each tractor will typically service between six and ten containers per day, depending on the haul distance to the new site and typically the containers will hold an average of 3.2m3 of wastes. Thus for the 90 m3 estimated waste collection by year 2015 there will be a need for 28 container loads to be transferred each day and a requirement for between three and five tractors and container trailers, depending on the disposal site location and distance from the town center, plus one spare to allow for servicing and breakdown times, (total 4 to 6 tractors and trailers) and assuming container collections on average every 1½ days, a requirement for around 45 containers including some spares.

Thus, assuming a short haul distance to the disposal site, the total collection requirement will be as follows: (Note the trailer and container costs are estimates to be confirmed following tendering).

	Cost	Economic Life	Depreciation / annum
4 Tractors @ 16,000	$ 64,000	10 yrs	6,400
4 Skip trailers @ $ 9,000	$ 36,000	10 yrs	3,600
45 Containers @ $ 800	$ 45,000	4 yrs	11,250
	$ 145,000		21,250

If the haul distance is long a further 2 tractors and 2 trailers will be required at a further capital cost of $ 50,000 and an increased annual depreciation cost of

$ 5,000.

It can be seen from this that distance is critical and it is cost effective to pay an extra amount to purchase a disposal site within a close distance from the town.

The refurbished tracked loader can be used for landfill preparation and operation.

2.8.1. Labour costs

Each tractor will require a driver and possibly an assistant as follows:

For the short haul distance:

4 drivers @ $ 1,400 / annum	$ 5,600
4 loaders @ 1,250	$ 5,000

	$ 10,600

(Additional labour cost for long haul distance) $ 5,300 / annum)

2..8.2. Fuel

It is estimated that each 45 hp tractor will use 25 litres of diesel per day at a cost of K.sh 62 / litre. (Note the 70 hp tractor in Homa Bay uses 17 litres/day but is standing idle much of the time during loading whereas the skip tractors will be working continuously).

Estimated fuel cost for 4 tractors. (3 working plus one spare):

25 x 3 x 62 K.sh x 250 days = K.sh 1,162,500	$ 15,700
(Additional cost for long haul distance	$ 10,500)

2.8.3. Maintenance

@ 7% of tractor cost (short haul distance)	$ 4,480
(Additional cost for long haul distance	$ 2,240)

2.8.4. Comparison between short haul (2 km) and long haul (8 km) disposal sites.

From the above data a comparison can be made between annual collection costs for short haul (2.km) and long haul (8 km) disposal sites as follows:

	Short haul distance	Long haul distance
Capital cost	$ 145,000	$ 195,000
Annual costs		
Depreciation	$ 21,250	$ 26,250
Labour	$ 10,600	$ 15,900
Fuel	$ 15,700	$ 26,200

Maintenance	$ 4,480	$ 6,720
	--------------	--------------
TOTAL ANNUAL COSTS	$ 52,030	$ 75,070

It can be seen that the longer haul distance adds $ 23,000 to the annual costs for a fully sustainable collection system. Other costs such as sweeping and supervision will remain the same. This clearly shows the cost benefits of the short haul distance and how an additional cost of five years savings (around $ 115,000 or K.sh 8.4 million) can be justified when looking for a suitable disposal site.

2.9. .LIFE EXPECTANCY OF CONTAINERS

It can be seen from the above costings that roughly one half of the total depreciation costs are accounted for by the containers. This high depreciation is due to their short life expectancy which has been calculated at only 4 years due to corrosion. However this life can be very greatly increased by a number of factors:

- Container corrosion is primarily caused by anaerobic crevice corrosion which takes place when the wastes decompose due to anaerobic bacteria which breed in the absence of oxygen. Careful design of the containers to eliminate the corners which hold wastes and fully seal any joints where there are overlapping sheets to prevent the ingress of leachate will greatly reduce this acid formation and reduce corrosion.

- If the containers are collected regularly every two (or a the very most three) days before the waste has had time to decompose and form acids and if the containers are brushed out each time they are emptied corrosion will again be greatly reduced.

- The containers should be located on concrete slabs and steel ribs underneath the containers will raise the bottom of the containers off the slabs to allow air to circulate thus eliminating another corrosion factor.

- Containers can be made from special corrosion resisting steels including:

2..9.1. CorTen and CR 12

CorTen steel contains a small percentage of copper which forms a protective copper oxide on the surface of the steel and protects it from further corrosion. The manufacturers claim that Corten steel has seven times the resistance of mild steel to corrosion. Typically the cost of Corten is about 30% to 40% more than mild steel but as this steel is also stronger than mild steel the sheet thickness can be reduced.

CR 12 steel contains chromium and will last almost indefinitely. This steel costs around four times the cost of mild steel and may be difficult to obtain in the LVWATSAN countries.

It is therefore proposed that quotations should be obtained for both ordinary (mild) steel containers and CorTen steel containers and a decision can thgen be made as to which to use.

2.9.2. Painting Containers

If the containers are sand or shot blasted or rigorously wire brushed before painting with a Zinc Chromate or Zinc Oxide primer paint and a bitumastic top coat the life will be extended.   Any containers which have been set on fire should be immediately wire brushed and repainted before any rust penetrates.

Typically, by combining good management with the use of CorTen steel the life expectancy of the containers can be 10 years or more with a considerable reduction in the depreciation costs.

COMPOSTING

A local NGO, KNEAD, has recently started four small composting operations on the fringes of the town using market wastes. At present the compost is used on the shambas where it is made but they expect to be able to sell it in due course. They are using innoculants and adding fertilizer to the compost and expect in this way to reduce the composting time to 30 days.. They should be encouraged as much as possible in this activity and any wastes which are removed from the waste stream for composting will reduce the amount to be collected and reduces the void space requirement at the disposal site.

These groups hire a truck to collect the waste from the market and deliver it to the composting locations. It is proposed that when KMC have been provided with sufficient collection equipment they could provide this service as part of their normal collection.

Support for this operation could be given at no additional cost to the KMC by providing separate containers at the market areas for organic and in organic wastes with KNEAD supervision of where the wastes are deposited. The KMC would then deliver the organic wastes directly to the composting sites instead of to the disposal site. A benefit for the KMC would be a reduction in the void space required at the disposal site.

A visit was made to the Abattoir with Mr Andrew Rianga, Manager of KNEAD, who expressed considerable interest in the waste from this operation (mainly partially digested grass and animal manure) for composting.

2.11. SCAVENGHING AND RECYCLING .

Scavangers are already collecting plastics and metals for sale to a local dealer who sells it on to recyclers in Nairobi. This should also be encouraged as much as possible as it reduces the amount of waste to be collected and the void space at the disposal site. However, the safety of the scavengers working at the disposal site must be protected and it is proposed that:

- Only registered scavengers should be permitted so that their numbers can be controlled and a strict code of safety introduced.
-
- No children should be permitted on the site at any time.

- Shoes must be worn by all scavengers at all times to protect them from sharps, (hypodermic needles , catheters , broken glass, timber with nails, metals, etc).

- All scavengers should be compulsorily vaccinated against tetanus, hepatitis B, cholera, and whatever other diseases the Municipal Medical Officer recommends.

- No burning should be permitted on the site to protect the scavengers, collection crews and local residents from hazardous dioxins, furans, etc from burning plastics.

The scavengers should be made to understand that these regulations are for their protection and not to restrict their activities and one of their members should be appointed to enforce the regulations.

(Note: In one city in Egypt where there was a village down wind from the burning dump a survey found that 87% of the village residents suffered from respiratory problems due to the noxious gases emitted by burning plastics).

2.12. LITTER BINS AND LITTER COLLECTION.

The central area of Kissi has been provided with fifteen 100 litre litter containers which are made from 200 litre oil drums cut in half and fitted on to pivoting stands to enable them to be tipped out for emptying into wheel barrows for transport to the transfer site at the market place. These brightly painted bins have been sponsored by The Cooperative Bank and by Cart Communications Ltd whose names are painted on them. KMC have looked without success for further sponsors for these bins. They have proposed that a total of 100 bins should be provided at a cost of K.sh 2,500 ($34) each = $3,400. These should be brightly painted with slogans painted on them (Keep Kisii Tidy, Place Your Litter Here, Don't be a Litter Bug, etc).

Some thought should be given to the better location of these bins which are presently predominantly in one area

2.13. WHEELBARROWS AND HAND TOOLS.

KMC have five (5) wheelbarrows and hand tools which are used for drain cleaning, street sweeping and emptying litter bins. They have requested a further ten (10) wheelbarrows, fifteen (15) spades, ten (10) rakes and ten (10) street sweeping brooms. Uniforms should also be provided with a total requirement of around $ 1,000 for these items.

A very simple modification to a standard wheelbarrow involves fitting extended sides made from steel mesh of sheet steel to increase the capacity up to three fold.

2.13. HANDCARTS

Two wheeled handcarts could also be used for street sweeping in areas with good roads. Each handcart will hold two plastic bins (typically 80 litres capacity) which will be light enough to be lifted by one man for loading into the containers.

2.14. EMERGENCY CLEAN UP.

KMC are looking for support to hire a shovel (wheel loader) and tipping trucks together with additional labour to clear the backlog of heaps of wastes around the town. Typically a wheel loader and three trucks will be required for two weeks.

2.15. HEALTHCARE WASTES .

The District Hospital in Kisii is being upgraded to Provincial level. All wastes are disposed of within the premises by incinerating or burying and smaller hospitals and clinics can use the District Hospital facilities.

They have a wood burning incinerator where they dispose of sharps, theatre wastes and ward wastes but the incinerator is too small for their requirements and does not always reach the required temperature. They have problems operating this existing incinerator due to a shortage of staff and fuel.

As soon as the LVWATSAN office is operational in Kisii this should be studied further.

2.16. ABATTOIR

The abattoir in Kisii kills 18 to 20 cattle per day and smaller numbers of sheep and goats.

This is an extremely well run operation with facilities for disposing of blood, wash water, stomach contents and reject meat on site. Stomach contents, consisting mainly of partially digested grass and animal dung are stored in a compound and are collected once per week by the Municipal Council for disposal at the dumpsite. Some of this material, but not all, is taken by farmers for fertilizing their land. It is recommended that the pilot composting operations which have been set up by KNEAD should be encouraged to make use of this material for composting.

The effluent from the abattoir goes to a grease trap followed by a soak pit and then a soak field between the abattoir and a stream. This stream should be investigated to ensure that it is not being polluted by the abattoir waste.

2.17. COMMUNITY AWARENESS, PUBLIC EDUCATION AND ENFORCEMENT

The start-up of any new collection service must be accompanied by community awareness raising to make people aware of the advantages of the new system and their role in bring the wastes to the containers. This can be done through a community groups, the schools and local radio and should be accompanied by the enforcement of existing regulations controlling public nuisances. Any fines imposed can go towards funding the operation of the collection service.

2.18. PROPOSED ACTION PLAN.

It is proposed that UN-HABITAT should NOW move as quickly as possible to:-

- Look for tenders for the development in Kenya of a 3.0 ton capacity container pick up trailer. (MC has provided a specification).
- Look for tenders for 4.0 m^3 (heaped capacity) containers for above made from both mild steel and Corten steel. (MC has provided a specifications)
- Look for tenders for 40 – 50 hp tractors. (MC has provided a specifications)

- Prepare publicity material for a community awareness programme. (This should be designed by UN-HABITAT or obtained from another such programme).
- Recruit staff and procure equipment for office in Kisii.

Kisii Municipal Council should:-:

- Prepare an office for UN-HABITAT including electricity outlets.
- Obtain a quotation for refurbishing the Caterpillar 951C tracked loader
- Obtain a quotation for refurbishing the front loader for the Ford tractor
- Obtain a quotation for the hire of a wheel loader and three tipping trucks for two weeks for an emergency clean up.
- Obtain quotations for wheel barrows, shovels, small tools, uniforms, etc.
- Identify local Community Based Organisations (CBOs) who can participate in any community awareness programme.
- Investigate and agree methods of collecting refuse collection charges (RCC) for a fully sustainable system.
- Identify locations for containers in low income, high income and commercial areas and any other points, such as the abattoir, where containers will be required. (A hand held GPS would be useful for locating container points and could be shared with Homa Bay. .
- Estimate the cost of providing concrete slabs 4.0m x 5.0m at these locations with tractor trailer access from the long side.
- Identify locations for litter bins.

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ATTACHMENT: Brief on Immediate Interventions on Solid Waste Management to be Undertaken by the Council. (As provided by KMC to Iole Issaias and Manus Coffey).

SECTION 3.

SOLID WASTE MANAGEMENT PROPOSALS FOR HOMA BAY.

3.0. BACKGROUND.

As part of the Lake Victoria Region Water and Sanitation Initiative, LVWATSAN, Iole Issaias of UN-HABITAT and Manus Coffey, Waste Management Consultant visited Kisii and Homa Bay to undertake a preliminary study of the solid waste collection and disposal systems of the two towns. It was only possible, within the short time frame, to spend 1 ½ days studying each town so Iole Issaias concentrated on the organizational, financial and community aspects of the two towns and Manus Coffey concentrated on the technical aspects of collection and disposal.

The following brief report and recommendations are based on meetings with the various town officials, a visit to the town centers, markets and bus stations, visits to the high and low income residential areas, visits to the abattoirs and meetings with health officials.

Previous reports were studied but the main sources of data were the town officials and observations made during the visits The data and assumptions on which the recommendations are made are set out and calculations shown, however it must be recognized that it was not possible to carry our full studies and so these reports should be seen as proposing cost effective waste management systems without being able to precisely confirm the quantities of equipment required and disposal site remedial works to be undertaken. This can only be done following a more detailed analysis of the waste quantities and characteristics or by a progressive introduction of the systems proposed after alternative disposal sites have been identified. In the meantime the estimates which have been made of the waste quantities and characteristics have been used to identify the optimum collection systems. The Immediate Interventions should include a reassessment of the tractor and equipment quantities following a review of the estimates and a review of the existing and alternative disposal sites.

3.1. OVERVIEW OF SOLID WASTE MANAGEMENT.

The optimum waste collection system for any city or town will depend upon the quantities and characteristics of the wastes to be collected, the haul distances between the collection areas and the disposal sites, road and traffic conditions and local cost factors, including labour cost and availability, fuel costs, the availability and cost of capital and the willingness of the inhabitants to pay for a sustainable service. The overall costs must be considered under the following headings:-

Labour,

Fuel,

Maintenance,

Depreciation.

Of these depreciation is often the highest cost factor and unless it is taken fully into account from the start unsustainable systems may be introduced which will give a short term solution to the problems but which will collapse when the equipment reaches the end of its economic life.

Solid waste management vehicles and equipment are short lived compared with fixed installations such as, for example, water supply and sewerage services and this must be taken into account when planning any system. Typical depreciation rates or "economic life expectancies" for different types of equipment are as follows:

Trucks	7 years
Tractors & trailers	10 years
Containers	4 years (this can be greatly extended if CorTen steel is used)
Fixed assets	20 years (buildings, water services, roads, etc)

Although the life of the equipment may exceed these figures, maintenance costs, breakdown times and operating costs will increase and efficiencies will reduce as the equipment ages. It is therefore generally most cost effective to sell off the old equipment and purchase new equipment at the end of the economic life and as a very rough guide the "residual value" of the original equipment will compensate for price increases in the meantime.

If any interventions are to be long term and sustainable the depreciation rates must be taken into account in setting up a financial system for the collection of revenues for the operation of the waste management system and the planned replacement of the equipment as it reaches the end of its economic life. In addition, population growth, changes in the waste generation per capita and reductions in the waste densities as living standards improve will add to the waste volumes to be collected. Future trends towards composting and the removal of recyclable materials from the waste stream will reduce the amount of wastes to be collected. The studies allow for waste quantities up to year 2015 allowing for a 25% population increase and a 20% reduction due to composting and recycling.

Any solid waste management system must include back-up vehicles to allow for breakdowns and service times, otherwise even a simple breakdown such as a puncture can stop the whole system. This is particularly important for container systems where, unless the containers are collected on a regular schedule, the containers will become the focus for insects, rodents, and odours and vehicle breakdowns can upset the regular schedules. Thus a well run container system can be the most cost effective refuse collection system but if this system breaks down it can become a serious problem rather than a solution to the problem. For systems using up to five vehicles one extra vehicle is therefore included for back-up.

3.1.1. Effect of Distance on Vehicle Selection.

The most cost effective system for any situation is determined by the haul distance which the collection vehicles must travel to the disposal site. Where haul distances are short a tractor will be more cost effective than a truck and the shorter the distance the more cost effective the tractor becomes. As a rough guide, in low income countries where labour costs are low and capital is scarce, tractors will almost always be more cost effective than trucks where haul distances are less than 20 km to 30 km. In general the smaller the town or city the shorter the haul distance and hence the strong preference for tractor based systems for small towns.

A 47hp tractor Massey Ferguson MF240 tractor, for example, costs $ 14,000 in Kenya or around $ 20,000 including a basic trailer and can pull a trailer with a typical load of up to 4.m3 at speeds of up to 30 km/hr. A small tipping truck (Isuzu NQR, for example) costs $40,000, has an engine power of 120 hp and the same load capacity as the tractor and trailer. However it will require a special high side body to enable it to carry its full load capacity and this will result in a high loading height with slow and unhygienic loading resulting in a reduced number of loads and reduced daily capacity. The fuel consumption of the truck with its larger engine will be two to three times that of the tractor. Normal economic life for the tractor, with its low engine speed and lack of sheet metal parts susceptible to corrosion, is ten years but for the truck it is only seven years. Thus the annual depreciation cost for the truck is more than three times that of the tractor.

Typically the total annual costs for the truck based system (labour, fuel, maintenance and depreciation) will two to three times that of the tractor based system.

3,1,2, Level of Service

When assessing the most appropriate waste collection system for any situation consideration must be given to the level of service required and the householders willingness to pay for such a service.

- A high level of service can include the provision of individual bins to each household or business and a daily service by a collection vehicle calling to each premise.

- A low level of service can include community containers to which the people bring their own wastes and a container pick up service to remove each full container and replace it with an empty one every one to three days.

- In high income and commercial areas a primary collection service, bringing the wastes to secondary containers, may be appropriate but this can be organized as a community based service or a separate private contractor can be encouraged to provide it with direct payment by the customers. Thus any primary collection service can be optional as far as the householders and businesses are concerned depending upon their willingness to pay for the service.

- In general fixed collection points (heaps or compounds) are not cost effective due to the low vehicle utilization inherent with the slow loading times for hand loading from these compounds and the difficulty of keeping them clean and free from insects and rodents.

There are many different types of collection system which can be used with different levels of service but no system should be set up which does not meet the criteria for sustainability or which is not within the householders willingness to pay. In general the higher the level of service the higher the operating costs and the higher the capital and depreciation costs resulting in higher refuse collection costs and charges to ensure sustainability.

3.1.3. Refuse Collection Charges (RCC).

Refuse collection charges, to ensure full sustainability, may be collected as a monthly charge from each household and business premise or they may be added to another service charge such as water or electricity. For business premises it may be part of a business licence fee.

In many cities the RCC from the business and commercial areas are used to subsidise the service to low income areas which cannot afford to pay the collection charges. This is a fair practice on the basis that the low income areas purchase their food and clothing from local traders who in turn purchase from the larger traders in the business areas, Thus any RCC paid by the commercial areas "trickles down" to the lower income areas as a cost increase on their purchases.

3.2. HOMA BAY SOLID WASTE MANAGEMENT.

Homa Bay Municipality has a population of 85,000 of which 38,500 live in the Urban Area where a waste collection service is required. There is no data available on the waste generation rates per capita or waste densities so the existing waste collection was used as a base line and estimates made by the Homa Bay Municipal Council (HBMC) Engineer, Mr Amos Owiro, and the Hon Mayor, Dr Agulo, as to the percentage of the wastes which are collected. These ranged from less than 20% to 40%. An estimate was made by Manus Coffey as to the density of the wastes, however the equipment selection was based on waste volumes rather than tons of wastes.

There are no industries producing waste apart from the fish processing factory which manages its own wastes and a small abattoir which is serviced by HBMC once per week

3.2.1 Existing Collection System.

Wastes are presently collected by a tractor and trailer which collects four loads per day from the heaps of wastes around the town. A 30 year old Massey Ferguson 265 tractor (around 70 Hp) pulls a non-tipping trailer with body dimensions 3.0m x 2.1m x 0.55m (heaped). This gives a capacity of 3.5 m3 per load or 14 m3 per day.

3.2.2. Estimated Waste Densities and Quantities

Waste densities were estimated as follows:

- A typical heap at the dumpsite. 500 kg/m^3
- Market wastes. 350 kg/m^3
- A heap consisting mostly of sand and ash at fish market. 700 kg/m^3

It is therefore proposed that an average figure of 500 kg/ m3 should be assumed with peaks up to 750 kg/m3 for specifying equipment. On this basis average tractor loads are 1.75 tons and the present collection is 7 tons/day. It is however likely that the waste density at the household is around 350 – 400 kg/m3 but this increases in the heaps due to decomposition and dessication during long storage periods due to the present irregular collection

If the lower of the two estimates for the present waste collection at 20% is taken this means that the total waste generation for the Homa Bay Urban Area is 70 m^3 / day. It is considered that this is probably on the high side. If however the higher estimate of 40% collection is taken for the present collection this gives a total waste generation of only 35 m^3 per day. A waste generation rate of 60 m^3 / day has therefore been assumed which will be reviewed as more information comes available It is proposed that the new collection system should be phased in over two to three years so that the equipment numbers can be adjusted as more experience is gained.

The waste quantities to be collected can be reduced by encouraging recycling and composting as is done in Kisii. A target waste collection of 80% should be set and allowing for a 25% population increase over the next ten years and 20% reduction due to composting and recycling a total collection of 48 m^3 should be allowed for for year 2015. Allowing for a collection efficiency of 85% to allow for breakdown and service times, the vehicle capacity should be 56 m^3 /day based on a six days per week collection by year 2015.

3.2.3 Vehicle Efficiencies.

The vehicle efficiencies or number of loads collected per day per vehicle is determined by the amount of time it takes to load the vehicle, travel to the disposal site, discharge the vehicle and return to the collection area. At present the dump site is only 1 to 2 km from the collection areas and so travel times are short. However the trailer must be loaded and unloaded by hand so that loading speeds are slow resulting in only four loads per day.

3.2.4. Waste Disposal.

The present dumpsite is however small and nearly full and it is proposed to move the dumpsite to a location presently used by the fish factory for drying fish and disposing of fish offal. (The fish factory may object to having a dumpsite alongside their drying station, however as this dried fish is only used for animal feed and there are already considerable problems with storks, egrets and ibis at the drying station this may be permissible).

The proposed site is however 7 km from the town center (bus station) and if the existing tractor and trailer is to be used for hauling to this dumpsite the collection efficiency will be reduced to around three loads per day. This is still within the economic haul distance for a tractor but the shorter the distance the greater the collection capacity of any system and it is therefore proposed that an alternative site closer to the town should be sought even if this requires a higher cost of land purchase.

We were advised that land outside the urban area in Homa Bay is valued at K.sh 200,000 per acre ($6,750 / Ha) so that a site of 2. Ha would cost around $13,500. As discussed later, this is a relatively small amount compared to the savings in collection costs by having a disposal site closer to the town.

The road to the proposed new site is very bad and a travel time of 11 minutes was recorded for the four wheel drive vehicle used. A tractor travel time of around 20 to 25 minutes each way can therefore be assumed. However it is planned to upgrade this road and travel times will then improve for both trucks and tractors.

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3.3 . ALTERNATIVE COLLECTION VEHICLES

Homa Bay Municipal Council have requested that a small tipping truck should be provided for extending their collection capacity. However some further thought should be given to this. Available tipping trucks are all designed to carry high density construction materials and are fitted to short wheelbase trucks with short bodies. They all have high platform heights due to the extra space required for the tipping mechanism. Thus, if they are to be fitted with bodies suitable for refuse collection the existing small bodies must have extended sides and loading heights become excessive. (It is generally considered unacceptable for workers to have to load wastes above their shoulder height (1.5 m) due to the health hazards of wastes falling on their heads).

A small tipping truck will therefore have a typical maximum load capacity of around 3.0m³ with a loading height of around 2.0 metres. This is much higher than the existing tractor trailer and this will greatly reduce loading speeds, Extra loaders will be required, typically a crew of three loaders and a driver.

Thus, although travel times to either the existing or the proposed new dumpsite will be shorter than for a tractor system, the loading times will be excessive and it is likely that only three loads per day will be achieved. A small tipping truck will therefore have a typical daily capacity of only 9m³ or 4.5 tons/day. The cost of a small tipping truck will be around $ 40,000 (Tanzania quotation for Isuzu NQR tipper)

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It would of course be possible to get a special tipping body made for a longer wheel base truck but this will require an additional sub-frame to be fitted to the trucks and the deck level will be even higher. An alternative proposal is therefore put forward based on tractors as follows:

Containers, typically around 4.0 m3 capacity will be located around the town, including the low income areas, to which the people, (or a primary collection service such as is presently provided in the Town Centre area by Environmental Watch) will bring the wastes. The containers will be located on concrete slabs, each large enough to take two containers so that an empty container can be deposited before the full one is picked up.

A tractor trailed container system, such as has been proposed for Kisii, will be used to pick up these containers, transport them to the disposal site and discharge the containers. Pick up and discharge times will be no more than 5 minutes each so that such a system should be able to collect around 10 to 12 loads per day with the existing short haul distance or only 6 loads per day with the longer haul distance. If on average the 4. m3 containers are 80% full at the time of collection (3.2 m^3 of wastes) the tractor and trailed container system will collect between 19m^3 and 38m^3 of wastes per day depending on the haul distance. This is between two and four times the daily capacity of the small tipping truck Typical costs for this system will be as follows:

-	47 hp tractor.	$ 16,000 (quotation for MF 240)
-	Trailed container pick-up system.	$ 9, 000 (estimate)
-	10 containers @ $ 1,000	$ 10, 000 (estimate)

Total		$ 35,000 (estimate)

Only a single driver and a helper will be required for this system. The street sweepers as part of their daily routine will clean up the concrete slabs around the containers putting any loose wastes into the container. As the containers will be alternately placed on each side of the slab there will no accumulation of wastes underneath the containers and nowhere for cockroaches or rodents to hide. The containers will be collected at most every two days so that flies will not have time to breed and the wastes will not have time to decompose avoiding any insect or smell nuisance and minimizing corrosion (see section on container design below).

3.4. VEHICLE AND LABOUR REQUIREMENTS

Based on the above calculations it can be seen that to achieve the required collection capacity of 56 m^3 / day by 2015, allowing for some spare capacity for breakdowns and service, some waste reduction due to recycling and composting and a disposal site within a short distance (say 2 – 3 km) of the town will require 6 small tipping trucks or three tractors with container pick up trailers, including spare vehicles for breakdowns and service delays.

Depreciated life of trucks.	7 years
Depreciated life of tractors	10 years
Depreciated life of containers	4 years

Note: It must be appreciated that for any sustainable system all depreciation costs must be taken into account. Any system which does not recover the depreciation costs will be only a short term solution to the problems leading to financial problems in the future. In the following costs the economic life of different items of equipment follows normal accounting practice. Longer equipment life can be achieved with good maintenance and servicing and container life can be increased with regular emptying every two days before the waste has time to decompose and form corrosive acids and further increased if the containers are manufactured from CorTen or other corrosion resisting steel. (However increased manufacturing costs will off set some of the gains from this increased life).

3.5. ANNUAL OPERATING COSTS FOR DIFFERENT SYSTEMS

Set out below are the annual costs of providing a solid waste collection service for Homa Bay Town based on a daily collection of 48 m3 of wastes and 5 days per week collection. This 48 m^3 is the estimated requirement for Year 2015 allowing for a population growth of 25% but assuming that 20% of the wastes by that time will be removed from the waste stream before collection by scavenging for recyclable materials and composting.

3.5.1. Costs for collection using small truck system.

Depreciation of Vehicles

6 small tipping trucks @ $ 40,000 each (5 + 1 spare)	= $ 240,000. (7 yrs)		$ 34,300
Labour			
5 Drivers @ $ 1,400 / annum	$ 7,000		
15 Loaders @ $ 1,250/annum	$ 18,700		

Total labour cost	$ 25,700		$ 25,700
Fuel			
10 l/day x 5x K.sh 62 x 250 days			$ 10,500
Maintenance			
6 trucks @ 7% of capital cost			$ 16,800

ANNUAL COSTS FOR SMALL TRUCK SYSTEM			$ 87,300

3.5.2. Costs using tractor trailed container system (Skip trailer).

(Based on short haul distance typically 2 – 3 km)

Vehicles	Cost		Depreciation
3 tractors @ $16,000 each	$ 48,000	(10 yrs)	4,800
3 pick-up container trailers $ 9,000	$ 27,000	(10 yrs)	2,700
24 containers @ $ 1000	$ 24,000	(4 yrs)	6,000
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	$99,000		$ 13,500

Labour

2 Drivers @ 1,400/annum	$ 2,800	
2 Loaders @1,250/annum	$ 2,500	

	$ 5,300	$ 5,300
Fuel		
25 l/day x 2 x 62 K.sh x 250 days		$ 10,500
Maintenance		
@ 7% of tractor cost 3 x 16,000 x 7%		$ 3,360

ANNUAL COST FOR TRACTOR CONTAINER SYSTEM		$ 32,660

It can be seen from the above calculations that the capital costs for the tractor hauled container system are only 41% and annual operating costs only 37% of that of the tipping truck system.

(Note: There will be an additional cost for the container system for the provision of concrete slabs at each container location. However these slabs will have an economic life of 20 years so that depreciation costs will be small.

3.5.2. Costs for tractor container system for longer hauls..

Without knowing the actual location of any disposal site including distances, road conditions, etc, it is not possible to estimate actual vehicle numbers required but it is fundamental that the longer the haul distance the more vehicles will be required with corresponding increases in labour, fuel, maintenance and depreciation costs. The annual operating and depreciation costs for each additional tractor required will amount to around $ 10,400 per annum.

This annual cost should be considered when assessing any possible disposal sites and the cost of procuring land for waste disposal.

3.6. CONTAINER DESIGNS AND CORROSION

The life expectancy of the containers can be greatly increased by good design and regular emptying. Containers should be emptied at least every two days to provide a clean, hygienic and insect and odour free system. After two days the wastes will start to decompose causing smells, attracting insects and producing corrosive acids which will result in a short container life. The containers should be brushed out each time they are emptied to prevent decomposing wastes remaining in the corners of the containers.

A particular problem with wastes and the leachate or liquids which they produce as they decompose is anaerobic crevice corrosion where wastes are trapped in corners of the containers and liquids seep between overlapping sheets at the joints. For this reason containers should have chamfered corners with typically 5 cm x 5 cm x 45 degree corners and any sheet overlaps should be designed with fully watertight welds on the inside upper edges of the overlaps and stitch welds on the lower external edges. Attention to the above details can double or treble the life of the containers.

3.6.1. CorTen and CR12 steel.

CorTen steel is commonly used for making shipping containers due to its high resistance to corrosion and nowadays outdoor items such sculptures and bridges made from CorTen are left unpainted and form an attractive brown colour on the surface.

The manufacturers of the containers should be asked to quote alternatively for mild steel and CorTen steel containers so that the economics of providing corrosion resting containers can be assessed. Typically CorTen will cost 30% to 40% more than mild steel but will have many times the life expectancy.

Containers can also be made from CR12 steel and will last almost indefinitely but the manufacturing cost will be much higher.

Quotations should be obtained for containers made from both mild steel and CorTen steel and a decision can then be made as to which to purchase.

3.7. HEALTHCARE WASTES.

Homa Bay has a very high HIV rate at 30% in 2004 but becoming less. Thus the safe disposal of healthcare waste is a high priority. The District Hospital in Homa Bay has 8 wards with 40 to 50 beds each (300 to 400 beds total). It has a large modern incinerator fueled by kerosene which disposes of any hazardous wastes including sharps, theatre wastes and ward waste. There are however times when the incinerator does not reach full temperatures due to a scarcity of fuel. A smaller hospital, St Pauls, has around 150 beds and also has its own incinerator. Thus there does not seem to be a problem with hospital wastes.

Clinics dispose of their own wastes and there are no formal arrangements for the disposal of sharps, swabs, dressings, etc. Some of these wastes reach the municipal dumpsite where they are a serious hazard for scavengers or other people on the site. It is probable that some arrangement could be made with the District Hospital for the disposal of these wastes through their incinerator. It will be relatively easy to control the formal or official clinics which are all registered and these should be supplied with special sharps and infectious waste containers. There will however be much greater difficulty in controlling the informal or illegal "quack" clinics which are outside the formal system. A study should be carried out to identify and register all clinics as the first step towards a controlled waste management system.

3.8. ABATTOIR.

The Homa Bay Abattoir slaughters 7 to 8 cattle and four sheep and goats each day starting around 6.30 am. By 10.30 am, when a visit took place to this abattoir, washing down was almost complete and there was no loose waste materials and almost no smells. The following wastes are generated:-

Blood goes to a holding tank which is emptied manually into a soak pit dug alongside.

Wash water goes through a grease trap before being released into a sewer pipe going to the main sewage treatment plant.

All carcasses are inspected by the veterinary inspector before being passed as fit for human consumption and any condemned meat (mostly livers) goes to a 30 ft deep pit where it decomposes. This pit is never emptied but a new pit will be dug when it is full.

Stomach contents go to a drainage area where any liquids drain off before the wastes is taken to the dumpsite. This wastes is collected once a week by HBMC. This type of waste is a valuable fertilizer and should not be dumped. Anyone can collect this waste free of charge but this is not being done. In Kisii, for example, farmers collect this waste for fertilizing their land and it is likely that some of it will be taken by local compost operations in future. If composting can be encouraged in Homa Bay this material, together with organic wastes from the market can be co-composted.

In general the abattoir was well managed under the supervision of a veterinary inspector and there were very little odours.

3.9. WASTE DISPOSAL..

The solid wastes are presently disposed of at a dumpsite alongside the cemetery about 1. km from the town center, however this site is not satisfactory. There is a big problem with blowing litter, burning is taking place at the dump within very close proximity to houses, sharps and other health care wastes can be seen, no covering is taking place and children are running around close to the dump. In any case this dump site has almost reached its capacity and if the collection service is extended to cover the whole town it will fill up very quickly.

An alternative site has been located around 7.km from the town center on land belonging to one of the councilors. This site is already used by the fish factory for disposing of its wastes and for drying fish for animal feed. Although the distance is not excessive the road conditions are very bad and traffic speeds are slow. It should be noted that the collection efficiency of the existing and any new vehicles will be greatly reduced due to the lengthy travel times to this dump (typically 20 to 25 minutes travel time each way for a tractor and trailer).

The estimated waste generation for Homa Bay town by year 2015 has been estimated at 48 x 250 x 0.5 = 6,000 tons/annum with a density of 500 kg/m3. If this reaches after consolidation this will reach around 800 kg/m3 in a landfill and the volume of void space required will be around 7,500 m^3 / annum.

Thus for, example, a site of 1.Ha with a fill depth of 5.0 metres will provide sufficient space for almost seven years and a 2.0 Ha site with 10m depth will provide space for almost 30 years. It can thus be seen that a relatively small site is required..

A figure of K.sh 200,000 ($2,700) per acre, ($6,500 per hectare) has been quoted for the cost of land outside the urban area. Any additional cost for investing in the purchase of land for a site closer to the town would be small compared with the savings in collection costs. If the proposed site at 7 km from the town center is used there will be a requirement for one extra tractor and trailer with an additional operating cost, including depreciation, of $ 10,400 per annum. A 2.0 ha site will cost around $13,500 (compared to an additional capital cost of $ 25,000 for the additional tractor and trailer required for the longer haul distance site) and will have a life expectancy of 20 years or more. It can thus clearly be seen that it is more cost effective to choose a site closer to the town than the one being considered and the cost of the land will be very small compared to the collection cost savings.

A proposal has been made that the existing dumpsite should be converted into a transfer station where the wastes from the collection vehicles can be transferred to larger vehicles for transfer to the disposal site. In general, transfer stations are only cost effective where there are very long haul distances and any additional handling operation increases costs.

3.10. SWEEPING, LITTER BINS.AND LITTER COLLECTION.

No Street sweeping was observed although a total of 22 workers were referred to as conservancy workers under water and sewage. A number of these will be engaged in drain cleaning. It is proposed that ten sets of wheel barrows, sweeping bushes, shovels, uniforms and other small items at a total cost of $1,000 should be provided. Ten sweepers at a labour cost of $ 11,250 per annum would keep the market and commercial areas clean.

A total of 50 litter bins (including spares), similar to those used in Kisii made from half oil drums should be provided at a cost of K.sh 2500 ($34) each. Total for 50 containers $1,700. These bins have fixed stands to prevent them from being stolen and tilt for emptying into barrows..

It is proposed that a litter collection should be organized to remove the loose plastic litter scattered throughout the town. A very successful litter campaign was organized in one town in Egypt (Nuweiba) where school children were paid by weight for plastic litter which they collected throughout the town. This could perhaps be organized with the assistance of a CBO or as a fund raising scheme for a local charity .

3.11. CONTAINER LOCATIONS AND VEHICLE ROUTINGS.

It was not possible within the time constraints of this visit to look at container locations and these can best be allocated by the Municipal staff who know their own town. Any initial locations should be on an experimental basis and these should be adjusted as knowledge is gained as to the waste generation in the different areas. A problem here is that the concrete slabs for the containers can only be put down after the optimum locations have been chosen and during the trial period the containers should be located on lengths of timber to keep the bases off the ground and reduce corrosion.

3.12. COMMUNITY AWARENESS

The start up of the container service should coincide with a community awareness campaign to ensure that the people are fully aware of their responsibilities to use these containers and this should coincide with enforcement of the existing public nuisance legislation to enforce their use.

3.13. SCAVANGING AND RECYCLING.

It is proposed that the recycler who is buying the salvaged materials in Kisii should be encouraged to purchase materials from Homa Bay and this will create a demand for the recyclable materials. Local scavengers will then find a ready source of income from scavenging. The provision of a small, hand operated baling machine would make this more attractive by baling the recyclable materials to reduce their volume for transport.

A problem at this time is the state of the road between Homa Bay and Kisii which will discourage this trade, however it is anticipated that this road will have been repaired within the next few years.

3.14 SERVICING OF VEHICLES AND PREVENTIVE MAINTENANCE.

Homa Bay Municipal Council do not have any servicing facilities but contract all servicing to a local mechanic. It is considered that the small amount of equipment recommended (three tractors and three trailers) cannot justify the setting up of a service department and the present arrangement should continue. However daily, weekly and monthly preventive maintenance schedules should be drawn up to ensure that any new vehicles should receive adequate servicing and minimum stocks of service parts as recommended by the tractor supplier (oil, fuel and air filters, spare clutch plate, tyres, engine and transmission oils, etc) should be purchased with the equipment and stored in a secure lock up with regular replacement as they are used up).

3.15. TRAINING..

The supplier of the tractors should provide training to the drivers on routine servicing and maintenance and daily and weekly drivers and mechanics check lists provided.

3.16. ACTION PLAN.

The following actions are proposed for immediate and longer term implementation by.UN-HABITAT and Homa Bay Municipal Council.

3.16.1. UN-HABITAT Action Plan. (See Section 4. UN-HABITAT strategy).

- Obtain tenders for 45 hp tractors (3) to specification provided in separate report on vehicle and equipment.
- Obtain tenders for tractor trailed container pick up systems (3) to specifications provided..
- Obtain tenders for 24 four m3 heaped capacity containers to fit the container system made from both mild steel and from CorTen steel to specifications provided.
- Decide whether the same project manager can be used for Kisii and for Homa Bay or appoint a separate manager for Homa Bay.
- Appoint staff for Homa Bay office.
- Procure office equipment and vehicle.
- Prepare publicity material for a community awareness programme. (This should be designed by UN-Habitat or obtained from another such programme.
- Investigate the composting initiative at Kisii and discuss whether a similar operation is appropriate for Homa Bay.
- Investigate the scavenging / recycling operation at Kisii and see whether the materials purchaser in Kisii can be encouraged to expand his operation into Homa Bay.

3.16.2. Homa Bay Municipal Council Action Plan..

- Allocate office space for UN-Habitat office
- Identify locations for containers and provide concrete slabs (MC to design slab)
- Estimate the cost of providing concrete slabs 4.0m x 5.0m at these locations with tractor access from the long side.
- Obtain quotations for litter bins (similar to Kisii).
- Obtain quotations for wheel barrows, shovels, brushes, and uniforms.
- Identify any Community Based Organisations who can participate in any community awareness programme.
- Investigate and agree methods of collecting refuse collection charges (RCC for a fully sustainable system.
- Draft and pass any By-laws necessary for the implementation of RCC.
- Identify locations for waste bins.

SECTION 4.

PROPOSED UN-HABITAT STRATEGY FOR KISII AND HOMA BAY ,

UN-HABITAT STRATEGY FOR SOLID WASTE MANAGEMENT IN KISII AND HOMA BAY.

4.0. OVERVIEW

The overall objective of the UN-HABITAT LVWATSAN initiative is to provide support to secondary urban centers in the Lake Victoria Region to enable them to achieve the Millenium Development Goals and to reduce the pollution loads entering Lake Victoria.

The UN-HABITAT initiatives are directed towards developing the water and sanitation infrastructure with an Intergrated Solid Waste Management (ISWM) component. Solid waste has a direct impact on the pollution loads reaching the lake as well as on the quality of life of the inhabitants of the region and all three sectors (water, sanitation and solid waste) must be integrated into the strategy to be developed.

The physical problems of collecting and disposing of the solid wastes must include the upgrading of the management structures of the local authorities and the creation of an awareness among the inhabitants which will lead to community participation in the overall solid waste collection process. This community awareness and participation must be integrated into the overall attitudes towards health, hygiene and clean water management.

The overall financial structures of the towns must be looked at in close detail with all the conflicting demands on the local authority's finances for the many different requirements of the infrastructures of the towns including health, roads, water, sanitation, waste management, etc. None of these can be looked at in isolation and financial resources are short in all the towns with charges for business licences, land taxes, etc, which are commonly used in many countries for financing solid waste management, already allocated for other services,. This means that solid waste management systems must have low operating and financial costs if they are to be affordable and sustainable without diverting an excessive proportion of scarce resources away from other equally important services. This must have a significant impact on the choice of sustainable systems.

The vehicles and other equipment required for any waste management system have a relatively short economic life and if the service is not inherently affordable but relies on regular interventions from UN-HABITAT or another donor it will simply be a short term benefit which will collapse when the equipment provided reaches the end of its economic life.

The level of service of any sustainable SWM system must depend upon the willingness and the ability of the householders and businesses to pay for the service. Any interventions which are beyond the people's ability to pay will simply create an aid dependency leading to serious problems in the future. It is therefore essential that if any systems introduced are to be sustainable they must be affordable and must not rely on costly imported spare parts with long delivery times. The level of service provided must be in line with these objectives.

A high level of service would include the daily collection of the wastes from all households and business premises throughout the town but this will not be affordable by the low income communities in the LVWATSAN Region. A lower level and much lower cost service will include the provision of community containers to which the householders and businesses will bring their own wastes. This may be supplemented by an optional primary collection service for those people who are willing to pay for it to bring the wastes from the houses and businesses to the containers on a daily basis, however any such primary collection should not be the responsibility of the local authority but should be undertaken by the private sector so as to avoid putting any further management or financial burden onto the local authority.

There are around 30 secondary towns in the Lake Victoria Region, all of which will require UN-HABITAT interventions. Seven of these towns, two each in Tanzania and Kenya and three in Uganda, have been chosen for the first stage interventions. A study of these seven towns, although they are in three different countries, has shown that there are many similarities in the requirements of the different towns relating to the characteristics of the wastes, the close proximity of the disposal sites, the high cost of fuel and the availability and low cost of labour. Thus, subject of course to more detailed studies in each of the 30 towns, it is anticipated that similar waste management systems will be appropriate for most, if not all, of the secondary towns in the LVWATSAN Region.

The most salient feature of all the towns is the relatively short distances between the towns and the local disposal sites making tractor based systems much more cost effective than truck systems. None of the towns studied are close enough to adjoining towns to make joint disposal sites appropriate. The characteristics of the wastes, however, together with the local tropical climate means that in general there are relatively small hazards from the small existing dumpsites and the management systems required for the up-grading of these sites are simple and low cost.

A major objective of the initial SWM initiative must therefore be the setting up of waste management systems using low cost, long life, easily serviced and locally manufactured vehicles and equipment which are replicable in other towns in the LVWATSAN Region. Thus any expenditure and efforts to this end for the first seven towns will benefit all the towns in the region so that considerable efforts can be justified to make appropriate vehicles and equipment available within the three LVWATSAN countries. An added benefit will include capacity building of local suppliers and manufacturers to provide affordable SWM systems for other towns throughout the three countries concerned.

4.1. STRATEGY

Immediate actions are required if the proposals put forward for the seven towns are to be implemented without long delays. A Critical Path Analysis or PERT analysis (Programme Evaluation and Review Technique) would clearly show the following items (in order of priority) to be critical to the project implementation.

4.2. PROCUREMENT OF VEHICLES AND EQUIPMENT FOR SOLID WASTE

The following three items should be sourced by UN-HABITAT in Nairobi. A separate report includes specifications for the various items.

4.2.1. Tractors, trailers and containers.

The systems proposed for six of the seven towns in the initial interventions are based on 40 – 50 hp tractors. This size of tractor is readily available in all three LVWATSAN countries at quite low cost and has been chosen to suit the waste generation rates per capita and the haul distances of the towns studied. Tractor trailers are manufactured in all three countries but these are general purpose trailers which are not appropriate for urban waste collection. Skip trailers which will pick up, transport and discharge containers of wastes were proposed for four of the towns and low loading height trailers for two. (Note: a review of one of these towns (Muleba) has since proposed a small tractor based pickup systems in stead of the low loading height trailer)..

The life expectancy of solid waste containers can vary from only 2 years for a poorly designed and poorly constructed container with poor management to 10 years or more for a well designed container made from corrosion resisting steel with good management.

The existing trailer and container manufacturers must therefore be provided with appropriate trailer and container designs including:

- "Skip" trailers for picking up, transporting and emptying containers of wastes.
- Containers to suit the "skip" trailers.
- Special "low loading height" trailers for hand loading with wastes from small bins. .

A first priority must be the commissioning of sample trailers and containers to match the size of tractor chosen, the testing of these trailers under UN-HABITAT supervision and the approval of the designs for use throughout the LVWATSAN

Region. It is essential that this should start immediately if there are not to be lengthy supply delays in the future.

One particular manufacturer (Farm Engineering Industries Ltd) of Kisumu has experience of making skip trailers (although of a larger and heavier type than is required) and has expressed interest in developing a skip trailer to suit the LVWATSAN requirements. No other manufacturer has been identified in the LVWATSAN countries making this type of trailer. A visit to the FEIL factory confirmed that they have all the facilities and the skills necessary for the manufacture of the equipment required and are ideally located within the Lake Victoria catchment area with factories in both Kenya and Uganda and easy access by ferry across Lake Victoria to the LVWATSAN region in Tanzania. Thus they are ideally located to service the whole LVWATSAN region. It is strongly recommended that this manufacturer should be immediately commissioned to provide a samples of an appropriate “Skip Trailer and Container” to the specifications to be provided by UN-HABITAT. It is also recommended that the same manufacturer should provide the first sample “Low Loading Height Trailer” as far as possible based on the same axles, tyres, brakes, hydraulics and lights).

These trailers and container will be tested under UN-HABITAT supervision, modified if necessary if they are not found to be satisfactory, and then provided to the two towns (Kisii and Homa Bay) in Kenya as part of the immediate interventions. At a later date other manufacturers within the LVWATSAN countries can be invited to study this first equipment and give alternative tenders.

4.2.2. Equipment for Sweepers.

The following equipment will be required for street sweeping in the different towns:

- Wheel Barrows (single wheel).
  Barrows with extended sides will be used for street sweeping and primary collection in areas with unsurfaced roads and narrow tracks.

  A standard low cost pressed steel wheel barrow will have the sides extended to increase the load capacity to around 100 litres. A photograph of a typical barrow as used in Yemen will be provided and manufacturers (possibly from the informal sector) should be asked to come up with their own proposals.

- Handcarts
  Two wheeled handcarts will be used by the street sweepers where there are good road surfaces. A handcart will carry two 80 litre plastic bins which can be emptied by one man into a waste container. The handcarts used in Masaka in Uganda were considered to be quite good and can be used as a sample design.

- Sweeping brushes.
  It was noted that standard household sweeping brushes are being used by street sweepers in a number of towns. These are very inefficient resulting in unnecessarily high labour costs. Samples of more appropriate sweepers brushes and local materials for sweeping brooms should be obtained for evaluation. Photographs of appropriate brooms from Pakistan will be provided. These are much more efficient to use than standard brushes.

- Handtools.
  Samples of hand tools including forks, shovels and hoes should be obtained and a sample road sweepers "scoop" (A photograph of this system in use in The Philippines will be provided) should be made up. This would also be a good informal sector product.

Samples of all of the above sweepers equipment should firstly be obtained or made locally in Nairobi and then when the best items have been chosen they can be offered for manufacture in each country .

4.2.3. Design of Promotional Material for Community Awareness.

Any Community Awareness and Community Participation programmes must include publicity handouts which will promote the need for a clean and healthy environment and create an awareness by the householders of their responsibilities.

As many of the householders (in particular the older ones) may be illiterate these handouts must include cartoon type illustrations which will be understandable by the adults and which will appeal to the children so that they can be used as part of an educational programme. In general the same promotional material can be used in all three countries with some local language and perhaps cultural adaptations.

UN-HABITAT should identify a good commercial artist with an understanding of low income communities to undertake this work.

The above three items will be relevant to the initial seven towns and also to other secondary towns in all three of the LVWATSAN countries. They design and specification aspects can be managed from Nairobi.

4.3. LOCAL ACTIVITIES IN EACH TOWN.

The following items will be specific to each town. It is understood that UN-HABITAT will appoint a project manager / facilitator for each town to be responsible for the implementation of immediate and long term interventions. His duties will include:

4.3.1. Confirm Waste Estimates.

To confirm the data concerning the quantities and characteristics of the solid wastes in each town and revise the equipment requirements in line with any variations from the estimates.

It must be understood that the proposals set out for each of the towns were based on estimates of the waste characteristics and quantities provided by the local authorities and the previous studied for UN-Habitat and by a visual assessment by the consultant during a very brief visit to each town.

4.3.2. Community Awareness.

To set up a community awareness programme to make people aware of the need for a clean and healthy environment.

4.3.3. Willingness to Pay

To confirm the householders and the business owners "Willingness to Pay" for an improved environment.

4.3.4. Waste Disposal.

A review should be carried out of all disposal sites including confirming any environmental approvals and where necessary commissioning a hydrological survey to confirm that there are no threats to local water supplies.

4.3.5. Capacity Building for Local Authorities

A key part of any UN-HABITAT initiative must be capacity building at local authority level for the management and maintenance of the solid waste collection and disposal. However this should not be taken in isolation from the provision of other services including water and sanitation. The Local Authority budgets for each town should be reviewed in line with the requirements of each of the services.

4.3.6. Maintenance of Vehicles and Equipment.

The setting up and monitoring of preventive maintenance procedures for the servicing and maintenance of the collection vehicles. This will include systems for the procurement and safe storage of service parts and materials. The vehicle manufacturers and suppliers to provide daily, weekly and monthly service check lists.

4.3.7. Training Operators and Service Personnel.

Setting up training programmes for the operation and maintenance of the collection vehicles in association with the vehicle suppliers and manufacturers.,

4.3.8. Financial Budgeting

The drawing up of annual and long term budgets for the operation, maintenance and future replacement of the waste management vehicles and equipment in association with the Local Authority financial controllers.

4.3.9. Cost Recovery

The setting up of systems for "Refuse Collection Charges" (RCC) or other methods of recovering the costs of the waste collection and disposal. These systems to include for replacement of the vehicles at the end of their economic life (depreciation) and expansion of the collection fleet in line with population and waste growth.

4.3.10. Container locations and vehicle routings

The planning of the location of containers and the collection schedules and vehicle routings.

4.3.11. NGOs and CBOs

Identify any NGOs and CBOs which are operating in each town and determine what inputs they can provide towards:

a) Assisting or acting as the focus for any anti-litter campaign including organizing an initial and subsequent plastic litter collections throughout the town. This could include encouraging school children to collect plastic litter on a "paid by weight or volume basis". It should include an awareness campaign to inform people of the health dangers of burning plastics.

b) Assisting with an "emergency clean up" of the heaps of wastes throughout the town, working with the local authority who will provide the vehicles to transport the wastes to the disposal site, perhaps using hired trucks and loaders for this purpose.

c) Providing a "Primary Collection Service" to those people who are prepared to pay to have their wastes collected from the house of business premises and brought to the community containers.

d) Encouraging formalized scavenging activities to remove any recyclable materials from the waste stream.

e) Encouraging composting initiatives which will remove organic materials from the waste stream.

4.3.12. Performance Indicators

The setting up of a system for recording the success of the UN-HABITAT interventions including health improvements and householder and business satisfaction indicators.

4.4. PROPOSED BUDGETS FOR LVWATSAN SOLID WASTE MANAGEMENT.

The following three budgets show the proposed budgets for:

4.4.1. UN-HABITAT expenditure which is relevant to all towns in the LVWATSAN project.

4.4.2. Immediate interventions for Kisii and Homa Bay.

4.4.3. Long term interventions for Kisii and Homa Bay.

It is proposed that UN-HABITAT will recruit a Resident Project Manager / Facilitator who will be based in Kisii for a minimum of one year and who will also cover Homa Bay. Offices in each of the towns will include a local staff member who will report directly to the Project Manager The Project Manager will be provided with a pick up truck or a four wheel drive vehicle.

No budget has been included for the Project Manager and offices to be set up in each town with local staff as it is considered that UN-HABITAT will have experience of the costs of setting up such operations and cost data which is not available to the consultant.

The Immediate Intervention Budget includes US $ 4,000 each for equipping small offices to be provided by Kisii and Homa Bay Municipal Councils. It does not include for any office or other running costs.

The following additional items should be included:

- Salary and expenses of UN-HABITAT local Project Manager.
- Motor vehicle and fuel / service costs for the Resident Representative.
- Local staff members salary and expenses in each town..
- Local office running costs.

4.4.1. UN-HABITAT PROPOSED INTERVENTIONS FOR THE SEVEN TOWNS IN KENYA TANZANIA AND UGANDA.

ITEM	COST US $
Manufacture and testing of sample skip trailer and container. (For Bukoba, Kisii, Homa Bay and Masaka)	15,000
Manufacture and testing of Low Loading Height Trailer (For Kyotera and possibly Mulebwa)	10,000
Purchase of sample extended wheelbarrows for evaluation (For all towns) 5 barrows @ US $ 50.	250
Purchase of sample handcarts for evaluation (For all towns) 5 handcarts @: US $ 150	750
Purchase of sample hand tools and uniforms for evaluation (Shovels, brushes, scoops, uniforms for all towns)	500
Design and printing of promotional literature for public awareness campaigns (For all towns)	5,000
Purchase and testing of sample Ndume Little Pickup (For Mutukula & Mulebwa)	6,000
	37,500
10% contingency	3,750
	US $ 41,250

NOTE 1. All the above sample equipment can be used in different towns following their evaluation. The consultancy costs of liaising with the manufacturer and supervising the tests of the skip trailer, low loading height trailer and Ndume Little Pickup are include in the consultancy sub–contract to be issued.

NOTE 2. The above interventions are relevant to all the seven towns in the initial interventions and also to all other towns in the LVWATSAN region. These interventions include capacity building for the manufacturers of the various items and the promotional handouts for the community participation. Thus the costs have not been allocated against Kisii or Homa Bay. This work must be carried out as quickly as possible so as to enable the equipment purchases for both immediate intervention and long term interventions to be made.

4.4.2. <u>UN-HABITAT IMMEDIATE INTERVENTIONS FOR KISII AND HOMA BAY</u>. (All cost US $).

Note: The sample skip trailer and container included in the previous budget item 4.5. and handcarts, barrows and hand tool can be used for these towns with a budget saving of US $ 11,250.

ITEM	UNIT COST	KISII	KISII COST	HOMA BAY	HOMA BAY COST	NOTES
Refurbish existing equipment		Tractor Ford 5030	3,000	Tractor MF265	3,000	
		Tracked loader	14,000			
		Loader for tractor	6,000			
Litter bins	40	25	1,000	25	1,000	
Wheel barrow	50	5	250	5	250	
Handcart	150	5	750	5	750	
Hand tools			1,000		1,000	
Community Awareness			1,000		1,000	
Emergency Clean up			3,000		3,000	Note 1
Plastic litter collection (1)			2,000		2,000	Note 2
Disposal site			3,000		3,000	Note 3
Training			3,000		3,000	
Equipment for office			4,000		4,000	Note 4.
Tractor 45 hp	16,000	1	16,000	1	16,000	
Skip trailer	9,000	1	9,000	1	9,000	
Containers 4 m3	1,000	10	10,000	10	10,000	
TOTAL			77,000		57,000	
10% Contingency			7,700		5,700	
TOTAL BUDGET			84,700		62,700	

Note 1. Includes labour, fuel and hired equipment
Note 2. Support for local CBO
Note 3. Temporary improvements to existing disposal site pending further evaluation of existing and new site locations.
Note 4. This does not include staff costs for UN-HABITAT office. Salary and expenses for Project Manager, transport vehicle cost and fuel or local employee salary and expenses.

4.4.3. UN-HABITAT LONG TERM INTERVENTIONS FOR KISII AND HOMA BAY. (All costs US $).

ITEM	UNIT COST	KISII	KISII COST	HOMA BAY	HOMA BAY COST	
TRACTOR (40-50 HP)	16,000	3	48,000	2	32,000	
TRACTOR (40-50 HP)	16,000	3	48,000	2	32,000	
SKIP TRAILER	9,000	3	27,000	2	18,000	
CONTAINERS	1,000	35	35,000	14	14,000	
WHEEL BARROWS	75	10	750	10	750	
HAND CARTS	150	5	750	5	750	
LITTER BINS	40	25	1000	25	1000	
HAND TOOLS / UNIFORMS			1000		1000	
TRAINING			3,000		3,000	
COMMUNITY AWARENESS (2)			2,000		2,000	
WORKSHOP TOOLS & SPARES			5,000		5,000	
PLASTIC LITTER COLLECTION (2)			2,000		2,000	
TOTAL			125,500		79,500	
CONTINGENCY 10%			12,550		7,950	
BUDGET TOTAL			138,050		87,450	

NOTES: LANDFILL SITES.

The above budget does not include any expenditure on landfill sites. The Immediate Intervention budget includes for a small input of $3,000 each to the disposal sites at each town but this is only intended as an interim measure to upgrade the operation of these sites pending a full study of the existing sites and any future sites which may be proposed. The consultants were advised that NEMA had approved the use of the existing site at Ssenyange in Masaka but further studies are needed to confirm this and to see if any conditions were imposed.

It is impossible to estimate what interventions are required until sites have been identified and full hydrological studies and EIAs have been carried out.

SIGNED:

MANUS COFFEY, CONSULTANT.

DATE:

APPENDIX 1.

Data and report from Iole Issaias of UN-HABITAT who accompanied Manus Coffey on his visits to Kisii and Homa Bay.

Lake Victoria Region Water and Sanitation initiative (LVWATSAN)
Mission report

Purpose: Appraisal of Solid Waste Management proposals for Kisii and Homa Bay. The mission reviewed the SWM proposal for immediate and long-term interventions and also carried out a more detailed assessment of the SWM system in both towns.
Date of mission: 5th – 8th December 2005
Staff on mission: Iole Issaias, WSIB and Manus Coffey, consultant

Kisii 6th-7th December

Persons met:
Stephen Obae - Mayor
Mr Wa-Sese – Town Clerk (E
Eng Albert Keno – Municipal Engineer
Irene Nyamoita Mainye – Graduate of environmental science seconded by Kenya University
Pius Nkate Mambileo – Chariman Town Planning
Wilfred Monyenye Yoka – Chairman, Finance and General Purposes
P.M.O Nyakango – Municipal Surveyor
Mr Misit- Project coordinator, Water and Health
Evans Oyenga, Public Health Officer, (seconded to KMC by Min. Health)
Manager, Abattoir
Principle Registrar, Egerton University
Andrew Rianga – member of KNEAD CBO involved in composting market waste.

A) Cooperation Agreement for mobilising LVWATSAN

- The draft cooperation agreement was approved.
- A bank account would be opened by 9th December and the details will be faxed to UN-Habitat by the Town Clerk.
- The town council already holds an annual stakeholder workshop for planning on activities funded by Local Authority Service Delivery Action Plan (LASDAP). The

stakeholder workshop for 2006 was held on 2nd November the list of participants will be sent to UN-Habitat. This is an existing structure that the project can build upon to institutionalized the stakeholder forums. We were informed that any additional yearly meeting will require passing a resolution under the Local Government Act.

- Council requested that the CA include provisions for telecommunication in the project office (telephone and internet), this could be on a pre-paid system (TC has the same system).
- Two offices have been allocated for the project.

B) Solid Waste Management

i) Sites visited:-

- Inspection of machinery at town council (Bedford truck (KSN 170)
- Transfer stations, main market and equipment (Trailer KAH 023Y and tipper KWE 348)
- Front Excavator Tractor
- Current dumpsite by the new by-pass
- Transfer point near farmhouse (cleared one month ago)
- Open market, Daraja Mbili
- Nubian Village
- Mwembe Tayaria
- Jogoo
- Town council
- Egerton University

ii) Observations (The SWM technical report will be submitted by Manus Coffey)

- Central market area
    - The KMC focuses its efforts on removing the waste at the market first and due to a lack of equipment and man-power other areas of the town are neglected.
    - The transfer point in the middle of the market, this is a health hazard and the project should consider moving the transfer point to the bottom end of the market or creating two separate sites either side of the market
    - The KMC has a fee list for various stalls, on average each person pays 30/- shillings per day per stall.
- Street sweeping and bins
    - There are only 5 wheelbarrows which serve the entire town. It was noted that the town centre was a lot cleaner than the last visit (nov 04): drains and CBD was refuse free only some transfer points (such as the one near Farmhouse and the informal areas on the outskirts of the town) had piles of refuse.
    - Street bins (swinging bins made from oil drums) have been donated to the TC, some public awareness is needed to encourage residents to use the bins. Each bin costs Kshs 2,500, the KMC requests an additional 100 bins to serve the town.

- There were five of these bins within a 10m² vicinity of the police stations, it was suggested that these be moved and spread out more evenly.
- The KMC recently hired equipment to clean the town. It was suggested that this be repeated when the project starts and until the new equipment is procured this would help in the public awareness campaign.

- Informal areas
  - The project document for the EU projest in the Nubian village will be sent to UN-HABITAT by Mr Misiti
  - The Jogoo and Mwembe Tyare have transfer points on the main road, but refuse is not collected daily. The project could look at formulating dual systems of waste collection and income generation to ensure these areas are adequately served.
  - KNEAD is working with 7 poor groups to collect the market waste for compost. Currently the compost is not being sold. The town engineer was very supportive of this type of initiative.
- Dumpsite
  - An old quarry. It was estimated that the site had a 3 year life.
  - The road contracts (Jewa Shamjee) have been requested by KMC to build access to dumpsite from the top end. The contractors are building the Daramoja to Nyamataro Road. It was suggested that the KMC avoid disposing of rubbish at large heights and instead dispose of the refuse from the bottom of the site.
  - The dumpsite is on the banks of the river, it would be advisable that the river be culverted, the above contractors could be the cheapest option as they are already working in the area.
  - For the future the MCK have identified land near the Sewage Treatment Works to construct a new dumpsite but as water and sewerage services will no longer be operated by the Council these assets have been handed over to the new company and KMC might be required to purchase this land or find an alternative.
  -
- Urban planning
  - The council has been given one of UN-Habitat's GIS packages. Therefore the spatial mapping exercise with RCMRD should start soon.
  - The satellite image for Kisii has been captured.
  - Physical planner is preparing the Kisii urban development plan.
- Financial management
  - Currently the cost associated with SWM (O&M, fuel, labour) are allocated annually from the budgeted revenue collection from land rates, business permits and fees collected from market places.
  - Improvement in collection of waste fees suggested either through KPLC or Kenya Revenue Authority. Alternatively improve on the capacity in-house to collect by using a system using GIS and law enforcement.
  - KMC has proposed a new mandate to be passed which will allow KMC to open a dedicated bank account for basic service delivery,v (see minutes of

the town council meeting 24-11-05), of which 4,400/- will be allocated each day to general service delivery, such as maintenance of waste collection vehicles, breakdowns, maintain roads etc… Although this will improve O&M of SWM equipment, a more accountable and transparent system should be examined together with KMC.

- Egerton University has a campus in Kisii and offers MBA and Commerce degrees. Its department in the town also offers computer and

- Public awareness
  - The KMC also proposes that a "civic awareness campaign" be initiated after the transfer points have been constructed and the system is in operation. This would encourage dumping at designated points and in the litter bins. KMC is reluctant to undertake any campaign until an adequate collection system is in place otherwise the public will take no notice.
  - There are two local radio stations (Sayari and Radio Star) in Kisii which could be used for this.
  - An enforcement system can also only be put in place once there is a SWM system

- Local authority/community partnerships
  - NGO involvement in SWM is easy and the municipal councils appreciate that these groups are providing an alternaitve service which they are cannot.
  - To register community groups would involve preparing and presenting a project proposal to the District Environment Office and upon approval a license would be issued for free.

- Hospital and abattoir waste
  - No waste from the abattoir enters the municipal waste stream, all waste is treated on site except the stomach content (digested grass). Farmers are not aware of the value of this substance. The KNEAD representative joined us at this meeting was considering using it for composting.
  - It is recommended that water qualitay analysis is done of the river down stream of the abattoir and also upstream of the present dumpsite. The two are within 100m of each other.
  - In the District hospital, theatre, ward and sharp waste is incinerated. The incinerator uses wood (operated for 6 hours) and it is unlikely the temperature is high enough. The Town Clerk mentioned that 2 years ago it was reported that medical waste had been disposed of in the dumpsite. Food waste and litter is disposed of at the dumpsite.
  - Maternity waste is dumped in a placenta pit.
  - Some private clinics use the incinerator at the district hospital others bury their waste but there is no capacity in the KMC to monitor the disposal of hospital waste.
  - HIV Aids prevalence is down to 7% from 13% the previous year.

iii) Documents to be given to UN-Habitat by TC and Town eng

- Kisii Solid Waste byelaws
- Municipal budgets and actual revenue for 2002-05
- Municipal rates for market produce
- Land rates
- National rates for small business permit (kisii is a category 12)
- Number and capacity of hospitals, schools, hotels, industry and prison(?)
- EU project document to be sent Mr Msati

C) Way forward

- Plan for stakeholder workshops
- Look into town budgets for areas of improvement in revenue generation. Examine daily receipts from markets, land rates and small business permits collected, number of employees, salaries etc …
- Monitor daily service areas - currently the CBD is serviced from Monday-Friday, starting at the Municipal Market, hotels, business, stadium and Nyakononko. There is also a daily sweeping routine.
- Ministry of Local Government is undergoing reforms: the LA will need to be self-sustainable, UN-Habitat should liasie with Min of Local Gvt to brief them on the project.
- Assess the effectiveness of the new service delivery charge.
- Start spatially mapping the town. The workstations will need to be in place. Send quickbird image of Kisii.

<u>Homa Bay 7th-8th December 2005</u>

Persons met

Peter Agulo – Mayor
James Otieno-Okech – Town Clerk
Jonas Omwoyo Kebu- Town treasurer
Amos Awiro- Works Officer
James Onyango Oloo – Chairman Environment (Councillor)
Paul Anyango Akeyo – Chairman Town Planning (Councillor)
Mr Nyauke – MD, Environment Watch
Manager, Abattoir

A) Cooperation Agreement for mobilising LVWATSAN

- The Mayor and Town Clerk were present in this meeting.
- The draft cooperation agreement was approved. However clarification on disbursement of equipment after the project has finished will be sought from PSD and UNON (contracts and procurement)

- Bank accounts – a town meeting was scheduled for 9th December to approve a new account. Details of the account would be communicated separately to UN-Habitat.
- The Town Treasurer would also calculate HBMC's contribution and fax the information in the next week.
- Council requested that the CA include provisions for telecommunication in the project office (telephone and internet). According to the Mayor the council has an outstanding telephone bill of Kshs 150,000. The HBMC is therefore not eligbale to request for a new line until this is cleared.
- An office, second floor last office on left has been allocated for this project. The office needs to have wall sockets for computers, the board-ceiling needs to be replaced and bars put on the window as well as the corridor windows.
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B) Solid Waste Management

i) Sites visited:-

- Equipment at town council (tractor-trailer)
- Present dumpsite
- Shauri Yako
- Market and fish drying area near pier
- Proposed plot for new dumpsite
- Abattoir

ii) Observations (The SWM technical report will be submitted by Manus Coffey)

- Market areas
    - Market near Railways pier – the day of our visit was also a market day, we spoke to a HBMC staff who collects the fees and she told us that she had collected Kshs 10,000 that day which is normal for a market day, on non-market days HBMC collects Kshs. 1,500 from this market. Monthly this is Kshs 80,000.
    - The open markets (down by lake and alond roads) are environmental point sources of pollution. There is no waste collection, at the Raliways market there was a bin but waste had been dumped next to it, moreover there is no vegetation and during rains it is likely that the soil is swept into the lake.
    - The fish cleaning area has no water supply or waste collection.

- Street sweeping and bins
    - Few bins were visible. The drains were clogged with waste especially behind the CBD.
    - Few sweepers were working during the visit. The HBMC has 22 sweepers on its payroll.
    - An NGO, Environment Watch are working with the council to provide a primary collection to the CBD, they charge Kshs5 per bin. The HBMC takes 65% of the profits and the rest goes to the NGO. The NGO uses petty crime offenders as part of their community service to collect the bins, therefore there is no labour charge.

- Informal areas
    - Shauri Yako has very little provision of basic services. One of the main drains leading to the river runs through the settlement and is a hotspot of pollution entering the lake.
    - There is currently no recycling or composting.

- Dumpsite (1km from the town council)
    - The dumpsite should be fenced and guarded. It is in the middle of a peri-urban residential area.
    - It was suggested by the Works Officer that the dumpsite be used as a transfer station when the new one is constructed.
    - Medical waste was present at the dumpsite
    - A lot of burning takes place at the dumpsite, a lethal health hazard for the residents living within 10m of the dumpsite as plastic is being burnt. A lot of litter on the road leading to the dumpsite was noted.
    - The new dumpsite is 8km from the CBD, we were told that the land is owned by a councilor. The fish factory is using the site to dry fish which it exports for animal consumption.

- Urban planning
    - An urban development plan is being finalized and will be shared with UN-HABITAT.
    - The quickbird image will be sent to the HBMC.
    - Spatial mapping will be a useful tool for the council not only in urban planning but also revenue collection, however the level of education and capacity at the town council is very low.
    - The District Planner (min. of planning) was not in Homa Bay at the time of the visit however UN-HABITAT contact details were given to him. At the earliest opportunity he should be properly briefed of the project.

- Financial management
    - The potential revenue from the markets could be as much as Kshs150,000 per month. The expenses recovered from this source of revenue should be examined.
    - The town budgets for 2003-05 were handed over.
    - Copies of the land rates and small business permits will also be made available to UN-HABITAT.
    - Capacity building is needed for improving revenue generation. The council is also understaffed. With the separation of water and sewerage the staffing should be reassessed.

- Public awareness
    - Campaigns on the health implications of burning plastics, littering etc… should be considered, again the same applies to Kisii unless the waste collection system is in place.
    - SIDA is funding a Environmental Protection Centre (EPC) in HB at a cost of Kshs 1.2 million. the aim is to showcase environmentally sustainable

projects and promote conservation. The EPC will be handed over to the municipality in April 06. It was suggested by the HBMC that public awareness campaigns
  - Jinja and Mwanza are part of this project, and forms part of a larger north-south project with towns on the Baltic Sea.
- Hospital and abattoir waste
  - The District hospital has a kerosene fueled incinerator, no medical waste enters the municipal waste stream. Food and litter waste is composted.
  - The private clinics do not have access to the district incinerator waste is either buried or dumped at the dumpsite
  - Only waste leaving the abattoir is the stomach content (digested grass). Farmers are not aware of the value of this substance.

iii) Documents to be given to UN-Habitat by TC and Town eng

- Bylaws in i) environmental management ii) General nuisance iii) draft of Solid waste management
- SWM report by Ministry of Health
- Land and single business permit rates.
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B) Way forward

- The budgets for 2003-05 will be examined.
- Water quality analysis to determine hotspots and point sources of pollutions. Urban catchment management should be looked at more carefully for HB as its right on the shores of the Lake and if access roads are improved the town could grow very quickly.
- Look at recycling and composting systems for the low income areas.
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General Observations of mission

1) CA needs to be rewritten, to include communication between UN-HABITAT and LA (including telecommunication). If a project officer is recruited then all financial management and disbursement can be made through him/her. This will ensure transparency and accountability.

2) Output 4 on institutional and legal framework is requesting too much of the LAs who are currently understaffed to dedicate time to writing reports. Therefore it is suggested that instead they avail all necessary information. The budget can then be used for the immediate interventions

3) The main capacity building needs for the LA is i) revenue generation through identification and monitoring of businesses, landowners, etc… iii) and to increase revenue collection and iii) improving the level of skills and manpower within the LAs

APPENDIX 2.

Low cost landfill system based on tractor with push off buckrake.

APPENDIX 3.

Photograph of wheelbarrow conversion (Yemen)

Photograph of steet sweepers “scoop” (The Philippines)