Final Report

Heath Care Waste (HCW) Generation and Characterisation Study for Health and Treatment Facilities

Prepared

by

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Executive Summary

A comprehensive health care waste generation and composition study has been undertaken as part of the Project "Sustainable Health Care Waste Management in Gauteng". The project is implemented by the Gauteng Department of Agriculture, Conservation, Environment and Land Affairs (DACEL) with financial support of the Danish International Development Assistance (DANIDA) under the management support of RAMBØLL A/S (Denmark).

The physical sample taking and sorting was contracted to Millennium Waste (Johannesburg) and the statistical assessment and reporting was conducted by Data Management and Statistical Analysis cc (DMSA).

Sampling of both Health Care Risk Waste and Health Care General Waste took place at Leratong Hospital (Krugersdorp) from 22 July 2002 to 02 August 2002 and the sampling of HCRW took place at Sanumed's Incinerator located in Roodepoort (Johannesburg) from 19 August 2002 to 30 August 2002. A third series of sampling will take place at Leratong Hospital in 2003 to assess sorting efficiency and waste generation after the implementation of training and system interventions.

The main findings of the study include:

i) The sorting at Leratong hospital was more efficient than at Sanumed. Sample HCW was recorded for all the containers in their various types and sizes in all the predetermined categories. In addition the total weight of all the available containers was recorded. The incinerator sampling and sorting of the waste was much more involved. This was due to the large amount of waste received from private and public hospitals and clinics at the treatment plant. What further complicated the sorting process at the incinerator was the fact that the two health facilities used (in some cases) waste containers of different types and sizes.

ii) Table 2.1.4 gives the daily HCW generation rates for Leratong hospital and Tables 2.2.4a to 2.2.4f provide the same information for the HCW received an the incinerator. As expected more waste is received at the incinerator than the amount generated at Leratong hospital in the various containers.

iii) Generally more HCGW was misplaced in 140-litre and 50-litre general infectious waste boxes than any HCW component (irrespective of the facility from which the waste was generated). Sharps, pathological and other types of waste were rarely found in these boxes. General infectious and chemical waste was found in relatively high percentages of sharps containers. These substances were also found in specicans generated from private hospitals and clinics.

iv) As explained in section 1 the sample sizes suggested for the various container types and sizes were designed to attain a specific precision level. Samples were selected according to the prescribed sampling methods. In contrast to Leratong hospital, where predetermined container categories were used, sampling at the incinerator was done on the regrouped containers. This was necessary as a means of maintaining consistency between the private and public HCW sources.

Heath Care Waste (HCW) Generation and Characterisation Study for Health and Treatment Facilities

1.1 Preamble

This document presents the results of the Health Care Waste (HCW) generation and characterization undertaken at Leratong Hospital in Krugersdorp and Sanumed Incinerator in Roodepoort, Johannesburg. The objective of the study (which is conducted in two phases at Leratong Hospital: pre- and post-intervention) is to determine the amount of HCW generated at Leratong Hospital as well as arriving at the Incinerator in Roodepoort as well as the composition thereof. The information obtained from this study will be used for the development of a sustainable HCW management system for Gauteng, which is currently being developed by the Gauteng Department of Agriculture, Conservation, Environmental and Land Affairs.

The document is divided into three sections:

1. **Section 1** describes the sampling procedure and corresponding sample sizes for conducting a study of the compositions of the different components of the Health Care Waste (HCW) generated at the two pilot institutions: **Itireleng Clinic** and **Leratong Hospital** and **Sanumed treatment facility**. It was subsequently decided to omit Itireleng Clinic from the Study

2. **Section 2** performs the statistical analysis and presents the results of the HCW generation and characterisation study undertaken **at Leratong hospital** (July 2002) and the **Sanumed treatment facility** (August 2002). The analysis for both sampling periods is performed in terms of proportions and average mass composition of the various components of HCW over a period of two weeks.

3. **Section 3** performs the post-intervention analysis of the study done at Leratong Hospital. In this section an emphasis is placed on comparative analysis, which is aimed at determining the effect of the waste management intervention that is being planned to improve the processing of waste at hospitals and clinics, as well as the important areas that are to be targeted for further improvement.

The HCW consists of the following two major components:

- **Health Care General Waste (HCGW)** – the non-hazardous component of HCW generated at health care institutions with characteristics similar to domestic waste. HCGW includes substances such as: packaging material, kitchen waste, patient care waste unrelated to health care, etc. This component of the HCW is usually generated during the administrative and housekeeping functions of the health care facility and it includes some food waste and recyclable materials.

- **Health Care Risk Waste (HCRW)** which is the hazardous component of the HCW. This component has the potential for environmental, health and safety risks. It includes sub-components such as general infectious waste, sharps, pathological waste, chemical/pharmaceutical waste and radioactive waste.

The main objective of the study is to estimate the amount (as a proportion and as an average mass) of waste material that is misclassified in the waste containers of these institutions; namely, HCRW that ends up in HCGW containers and HCGW that ends up in HCRW containers, as well as the relative composition of the HCRW broken down into the main subcomponents. Disposal of HCRW as HCGW constitutes an environmental, health and safety risk, whereas disposal of HCGW as HCRW results in unnecessary expenditure because of the very much higher cost of processing HCRW.

The ultimate purpose of the study is, inter alia, to estimate the effect of an intervention programme designed for waste management at hospitals and clinics. The sampling study will therefore be conducted both before and after the intervention programme. Comparison of the results of these two studies should provide a concrete estimate of the improvement in the management of HCW that is expected to result from the intervention programme. Another important outcome of the study would be sound information on the composition from what would be considered to be representative of the HCRW generation for the whole of Gauteng, that is vitally important for the development of an integrated HCW management strategy for Gauteng.

Section 1

Statistical Sample Design for Health Care Waste (HCW) Study

1.2 Sampling for the Medical waste study

In the planning of sample surveys a decision has to be made about the size of the sample to be included in the study. This is a very important decision as too large a sample could result in poor utilization of resources and too small a sample will tend to give results of insufficient precision and hence diminish the usefulness of the results. Sampling theory provides a framework within which sample sizes can be determined scientifically.

1.2.1 Sample Size Determination

The sample size of each type of container is calculated on the basis of statistical criteria and assumptions made by the investigator. In what follows it is assumed that:

- the unit cost of sampling is the same for all types of containers;
- the i-th waste component of the waste mixture is reported in terms of the proportion of containers in which this component is present.

Generally speaking, the precision of the sample is related to the absolute sample size and not to the ratio of the sample size to the population size.

The sample size, n, for any type of container is, therefore, as follows:

$$n = \frac{(z_{\alpha/2}\sigma)^2}{d^2} \qquad (1.0)$$

where:

- $\mathbf{z_{\alpha/2}}$ is the standard normal variate corresponding to the desired confidence probability (usually $z_{\alpha/2}$=2 for approximately 95% confidence);
- σ is the (unknown) population standard deviation of the component. For the proportion of containers containing this component, $\sigma = \sqrt{p(1-p)}$ where **p** is the (unknown) true fraction/ proportion of the medical waste component in the population. In each case we will estimate the unknown parameter from its sample equivalent;
- **d** is the desired precision. This is the range of uncertainty in the estimated fraction of the waste component one is prepared to accept at the specified level of confidence.

For simplicity we use the following parameters for calculation of the sample sizes:

$z_{\alpha/2}=2$, **p** =0.5 (2.0)

This value of **p** gives a conservative estimate of the sample size.

The following table illustrates the calculation of sample sizes for various precision levels, d.

Precision, d	**Sample Size: n=4*0.025/d^2**
0.14	51
0.100	100
0.071	199
0.058	298
0.05	400

Table 1.1: *Calculation of a Sample Size for a given Precision Level*

1.2.2 Sampling for various health facilities

In what follows we outline the sample design for the HCW pilot study to be conducted at the three facilities over a 2-week period**: Itireleng Clinic, Leratong Hospital and a Treatment Facility**. The sample designs and the procedure described in this document should be applied to both pre- and post intervention studies.

1.2.2.1 **Itireleng Clinic:** Due to the relatively small amount of waste generated by the clinic, all the waste generated by this institution should be taken on a daily basis for the 2 weeks (10 days). All waste containers should be removed every day and analysed both in terms of what they contain and their corresponding masses. The waste in containers of various types and sizes should be manually sorted into their individual components (Infectious waste, sharps, general waste etc.) and each of the masses recorded.

1.2.2.2 **Leratong Hospital:** Leratong hospital is a fairly large hospital that generates a large amount of HCW daily. It is therefore not practical to examine all the waste containers every day. Instead, samples of all the different types of HCRW containers, as well as of the HCGW containers (black bags) should be taken according to the sampling procedure described in section 1.2.1.

We propose that a sample of 10 containers of each type should be taken every weekday for 2 weeks (10 working days for the clinic and 12 days, including the weekends, for the hospital). This gives a total sample of 100 containers of each type for the clinic and 120 of each type for the hospital in 10 and 12 days respectively. According to Table 1.1 the sample size, n=100 for each type of container will give a 10% level of precision, or better, when estimating the waste component fraction.

If less than 10 containers of any type is available a day, then all the containers of that type should be taken.

1.2.2.3 **Treatment Facility:** The HCRW delivered to the treatment facility for incineration comes from both private and public health care facilities. Since a large amount of waste is delivered daily to the treatment facility (over the 12-day period) we propose that a sample size of 120 containers (10 a day) of each type should be taken for 2 weeks (12 days) from each facility (private and public). That is, a total sample of 240 containers of each type delivered to the treatment facility should be taken. This will provide a 6.5% level of precision or better when estimating the given medical waste component fraction.

1.2.3 Selecting Samples

An important aspect of sampling is to ensure that it is valid to extrapolate the conclusions drawn from the results to the population. The selected samples should, therefore, be representative of the population. To ensure a representative selection, samples should be taken randomly from all the containers of the same type/size category in the storage facility. If necessary, the containers could all be numbered and a random sample selected (A small program will be provided to generate random numbers).

1.2.3.1 All containers of HCW generated at **Itireleng clinic** should be sampled.

1.2.3.2 As proposed, 10 containers of each type generated at Leratong hospital should be sampled and analysed each day for a period of 12 days (see Table 2.0). In each case containers of a given type, for example 5 L sharps, should be numbered and a sample of 10 of them chosen at random.

1.2.3.3 Similarly, 10 HCRW containers of a given type from the public health facilities and 10 from the private health facilities delivered to the treatment facility should be sampled at random each day and analysed for a period of 12 days.

Container type	Daily Sample			
	Itireleng Clinic	Leratong Hospital	Treatment Facility	
			Public Health Facility	Private Health Facility
5 L Sharps	All	10	10	10
10 L Sharps:	All	10	10	10
25 L Sharps	All	10	10	10
10 L Specican	All	10	10	10
50 L Cardboard box	All	10	10	10
140 L Cardboard box	All	10	10	10
General waste bags	All	10	not applicable	not applicable

Table1.2: *Proposed Daily Sorting Samples sizes*

1.2.3.4 For analysis purposes a comprehensive list of waste components that broadly defines the component categories is given in Table 1.3. It is advisable that a separate recording sheet be prepared for each type/size of container. Proposed formats for such sheets are attached to this document.

1.2.3.5 Sampling for **Itireleng Clinic** and **Leratong hospital** should be done at the premises of the facilities and then taken to the site designated for sorting. For the **Treatment facility** sorting should preferably be done at the designated site.

1.2.3.6 HCW containers of different types should be numbered. Where applicable, random numbers should be generated and samples selected according to these numbers.

1.2.3.7 Sorting and weighing of HCW should take place at a designated site. This site should be chosen bearing in mind the associated potential public health risk.

1.2.3.8 Sampling must be performed each day at the clinic and the hospital shortly before the waste removal truck arrives, when all the waste containers generated on that day is available.

1.2.3.9 Suitable arrangements are to be made with waste contractors for HCRW and HCGW to ensure that all waste is weighed and recorded before removal each day.

1.3 Sorting and weighing procedures

1.3.1 Empty containers of each type (referred to as storage containers) should be provided by the contractor. The sorting personnel should:

- Weigh and record the tare mass of the various storage containers;
- Sort the HCW into appropriate storage containers (according to various categories) and record the gross mass of each category;
- Record the net mass of the contents of the storage container by subtracting its tare mass from its gross mass.

1.3.2 With the storage containers weighed and placed in the sorting area, empty the contents of the sorting sample. Segregate each waste component into the appropriate storage container and weigh it. The sorting process should be as follows:

1.3.2.1 For waste sorted from receptacles for general infectious waste (50 litre and 142 litre boxes or 240 litre wheelie bins):

- All waste should be sorted and each category should be weighed;
- Super mix and fines should be recorded in its appropriate category;
- Liquids should be recorded with the mass of the container included and then the tare mass estimated and subtracted to determine the net mass;
- PVC contents to be separated and recorded by mass (if possible) after various categories are all weighed;
- Sealed sharps containers and “specicans”/containers for pathological/ anatomical waste are to be removed from the larger containers for separate analysis in the particular categories.

1.3.2.2 For waste sorted from sharps containers (e.g. 5 litre, 10 litre and 20 litre):

- Non-sharps are to be removed from stream and weighed and counted (to provide a measure of how many incorrect objects there are per sharps container);
- Super mix and fines should be recorded in its appropriate category;
- The balance of the HCW stream is then recorded as sharps and weighed. The net mass should be determined accordingly.

1.3.2.3 For waste sorted from specican containers (buckets: 5 litre, 10 litre and 20 litre)

- Containers are to be investigated against strong light (without opening) to assess if the contents are: i) mostly liquid, ii) mostly solids, and iii) appears to contain correctly sorted anatomical/pathological waste;
- The total mass of the Specican and its contents is to be recorded;
- The number of Specicans containing incorrect waste components is to be recorded.

1.3.2.4 For Health Care General Waste (e.g. from plastic bags or 240 litres wheelie bins, but excluding separately sorted foodstuff)

- All waste should be sorted and each category (HCGW and HCRW) should be weighed;
- Super mix and fines should be recorded in its appropriate category;
- Liquids should be recorded with the mass of the container included and then the tare mass subtracted to determine the net mass
- PVC contents do not need to be separated and recorded as the HCGW and should not be incinerated.

1.3.2.5 For Food Waste only (if applicable):

No sorting at all. Only weighing of daily generation.

1.3.3 It may not be advisable (for safety purposes) to open and segregate the contents of some containers such as those containing pathological waste. In this case only the mass and the contents should be recorded.

1.3.4 On completion of daily studies, clean the sorting area and all equipment used. The area should be disinfected for public health reasons.

Separate samples of the same size as described above, if possible, should be taken from waste containers generated by the **Blood Bank** and the **Pathology Laboratory.** It should be noted that at Leratong hospital the Lab is a separate entity being serviced by Sanumed and not by Buhle. The blood bank in turn is a separate entity managed by the SA Blood Transfusion services, who transfer all HCRW to their main office from where it is disposed of by Sanumed. It is, therefore, suggested that HCW from these sources should be clearly identified. The weighing of all HCRW generated shall also include the amounts generated at the Blood bank and the Laboratory at Leratong Hospital.

1.4 Trial Study

1.4.1 In order to assess the feasibility of the study as well as testing the survey equipment a trial studies of the two health facilities and the treatment facility should be undertaken. Trial studies at Itireleng clinic and Leratong hospital should be done one week prior to the main study. One day of sorting and recording should be spent at each facility.

1.4.2 The trial study for the treatment facility should be done on the third day after the completion of the trial studies at the two health facilities.

1.4.3 It is strongly advised that the statisticians from DMSA cc who will be responsible for the final analysis of the data should be involved throughout the trial study and periodically during the main studies.

1.5 Training of sorting personnel

For efficient and safe conduct of the study a comprehensive training programme should be prepared for the sorting personnel. Trainers qualified in sampling and surveys and in HCW should be engaged in the training of the sorting personnel. From a statistical perspective the whole process of sampling, sorting and recording of the data should be covered. The importance of selecting representative samples and accuracy in recording the masses should be stressed.

1.6 Waste Composition Data Recording Sheets

1.6.1 Pre-Sampling Waste Recording Sheets

The total daily number of HCRW and HCGW containers in their various types and sizes should be recorded for **Leratong Hospital** and the **Treatment facility**. It may not be necessary to record the total number for **Itireleng Clinic,** as all the daily medical waste generated will be analysed. Suggested forms for recording the total daily numbers of containers at the two facilities are given in section A1 in Appendix A.

1.6.2 Waste Component Recording Sheets

It is understood that the various components of the Health Care Waste (HCW) composition will eventually be broadly classified into **Health Care General Waste (HCGW**) and **Health Care Risk Waste (HCRW).** Suggested layouts for recording the HCW in its various components/ categories are given in Forms A3 to A7 in section A2 in Appendix A. Separate, pre-printed sheets should be available for each type/size of container.

A broad description of waste component/categories in Forms A3 to A7 (provided in Appendix A) is given in *Table 1.3* below.

Waste Category	Description
Infectious waste	Bandages, gloves, drip bags, urine bags, containers with blood products, used vacutainers, non-glass test tubes, petri dishes etc.
Pathological waste	Body Tissue including its packaging
Sharps	Needles + Syringes, Scalpels, Broken or unbroken glass (test tubes, petri dishes, vials, ampoules) etc.
Chemical waste	Pharmaceutical Waste, Chemical waste, e.g. from Labs. Thermometers, batteries and other heavy metal containing waste
HCGW	Packaging materials, flowers, and magazines, including packaging material from disposable syringes, drips etc.
Food waste	Any putrecible materials of food origin
Pathological waste	Body Tissue
Radioactive Waste	Detected with “dose rate meter”.
Stool specimens	Stools
Liquids	Blood, urine
Food waste.	Anything in pigswill containers (no sorting)

Table 1.3: *Description of Waste Component Categories*

Section 2

Pre-Intervention Results and Analysis for Leratong Hospital and Treatment Facility

2.1 Results and Analysis for Leratong Hospital

This sub-section presents the results of the HCW generation and characterisation study undertaken at Leratong hospital in Krugersdorp. The analysis of the results obtained from the treatment facility is presented in Section 2.2. The results of the post-intervention study are analysed in Section 3. It has to be noted that while Itireleng clinic was originally part of the pilot study it was decided to leave it out of the study for cost reasons.

2.1.1 Sample Design for Leratong Hospital

Due to the amount of HCW generated per day at this hospital the study was conducted on a sample basis. The following containers in their various types and sizes were originally considered when designing samples for the hospital (see Section 1 for sample design details):

2.1.1.1 General infectious waste containers consisting of 50-litre and 142-litre boxes (pre-intervention study) or 240-litre wheelie bins (post-intervention study);
2.1.1.2 Sharps in 5-litre, 10-litre and 20-litre containers (Though included in the anticipated types of containers, 5-litre sharps containers were not found in the study);
2.1.1.3 Specicans in 10-litre and 20-litre containers;
2.1.1.4 HCRW from the laboratory (mass recording only);
2.1.1.5 HCRW from the blood transfusion services (mass recording only);
2.1.1.6 Pathological waste stored in the mortuary;
2.1.1.7 HCGW in plastic bags (pre-intervention study) or 240-litre wheelie bins (post-intervention study), excluding foodstuff.

For all the HCW containers the following pre-determined breakdown of waste was used to characterise a typical HCW composition:

- General infectious waste
- Pathological waste
- Sharps
- Chemical/pharmaceutical waste
- Radioactive Waste
- HCGW (composed of the categories: Food, Clothing, Recyclables and Other)
- Liquids

To be able to finally present the results from the study for each of the waste categories in terms of the overall HCW stream generated over the study period, all HCRW and HCGW generated at the hospital during the study period was weighed. Mass recordings were not only done on the container categories from which the samples were drawn, but also the categories like pigswill and recyclable materials that were not included in the sampling process.

2.1.2 Sorting and Weighing of Health Care Waste

While the sampling took place at Leratong Hospital, the sorting, weighing and recording of HCW was done by Millennium Waste Management at the Sanumed incinerators in Roodepoort, Johannesburg. All the necessary sorting and weighing equipment etc. was provided by Millennium Waste Management whilst the necessary recording sheet forms were made available by DMSA. The recorded data was entered into Excel spreadsheets and sent to the statistician for analysis.

2.1.3 Analysis of the Survey Results

In this section we perform descriptive statistical analyses based on means, 95% confidence intervals, minima and maxima (where appropriate) and proportions and mass of the samples in which waste components were observed during the study period. The total HCW generated over the study period is also related to the number of patients in bed per day. Finally the analysis determined the amount of HCW correctly and incorrectly disposed of (per day and per patient in bed per day) in a particular container. Because of the stratified random design used in the study, it is statistically valid to extrapolate the results to the population using 95% confidence intervals.

2.1.4 Waste Composition

Tables 2.1.1 to *2.1.3* give the proportions and weights of the various types of HCW generated in the different containers defined above. It should be noted that, of the various types and sizes of HCW containers originally anticipated to be used at this hospital (see section 1.1.2), only the following were used over the two-week study period.

- 140-litre General Infectious Waste (disposable cardboard boxes).
- 10-litre Sharps Containers (disposable plastic buckets).
- 10-litre Specican Containers (disposable plastic buckets).
- 20-litre Specican Containers (disposable plastic buckets).
- General waste in black bags.

Table 2.1.1 displays the proportions (and their 95% confidence limits) and the number of times a given health care component was found in the 120 samples of the indicated container type and size. Notable findings are:

i) in the 140-litre general infectious waste containers;
   - 104 (86.7%) samples contained misplaced recyclables;
   - 6 (5.0%) samples contained misplaced sharps.

ii) in the 10-litre sharps containers the non-sharps components: infectious waste and HCGW were found in 19 (26.8%) and 1 (1.4%) of the samples respectively. 7 (9.9%) contained chemical waste. While 120 samples were planned for 10 litre sharps containers, only 71 samples were available over the 12-day study period. This means that on some days less than ten 10-litre sharps containers were generated at the hospital;

iii) Specicans were only (opened for inspection) and then weighed without sorting. Of the 120 samples originally planned for specican containers only ten samples of the 10-litre containers and four samples of the 25-litre containers were available.

iv) for general waste in black bags: chemical waste was found in one (0.8%) of the bags, while 30 (25.0%) of black bags were found to contain general infectious waste. This would seem to represent a potential health hazard.

Table 2.1.2 gives the average mass (and 95% confidence limits) of each component in the waste containers. The average mass is based only on those samples in which the component was found over the study period. We observe in this table that:

i) Amongst the 120, 140-litre general infectious waste containers: 7 contained chemical waste with an average mass of 0.63 kg, 17 contained clothing with an average mass of 0.60 kg, 3 contained food waste with an average mass of 1.11 kg and so on;

ii) Besides sharps 19 (26.76%) of the 71 10-litre sharps containers contained general infectious waste with an average mass of 1.17 kg;

iii) Averages of 6.24 kg and 5.08 kg of pathological waste were found in the 10- and 25-litre specicans respectively over the 12 days;

iv) General waste in black bags was composed largely of recyclables, 2.24 kg on average, and food waste averaging 1.77 kg was found in 75 out of 120 bags. Infectious waste averaging 0.64 kg was found in 25% of the general waste containers. This could pose some level of risk to the public.

Table 2.1.3 displays for each component, the mean mass of HCW as a proportion of the total mass of the waste generated over the study period. The table shows that:

i) Besides the infectious waste, recyclables form the largest proportion, (24%) of the total mass of HCW in the 140-litre general infections waste containers. This may be a reflection of the extent to which the staff does not understand the importance of segregating the HCGW from the HCRW.

ii) Other than sharps, the 10-litre sharps containers contained a fairly large proportion, 12%, of general infectious waste.

iii) Recyclables and food waste formed the largest proportion by weight (95%) of the total HCGW in the black bags. General infectious and chemical/pharmaceutical waste comprised 4.4% and 0.1% respectively.

This study shows that general infectious waste is frequently found in HCGW containers. Some sharps and food waste were in turn found in general infectious waste containers. A substantial amount of recyclables was found in 140-litre general infectious waste containers.

Figures 2.1.1a-2.1.1c, Figures 2.1.2a-2.1.2c and Figures 2.1.3a-2.1.3c present the proportions and averages discussed above in graphical form.

2.1.5 Waste Generation

In addition to the sampling and sorting of HCW, the total generation of HCRW and HCGW was recorded over the sample period.

The following table provides some information on the number of beds and patients treated during the month of July 2002 (when the study took place).

Number of Beds and patients treated at Leratong Hospital in July 2002					
Number of Beds	Patient days	Number of inpatients	Number of Outpatients		Total Outpatients
			In Casualty	Other	
709	15732	3340	10057	11967	22024

From the number of patient days the following information is obtained:

- the occupancy rate: $OccupancyRate = \frac{Patientdays}{31xNumber\ of\ beds} = 100\frac{15732}{31x709} \cong 71.68\%$
- the average bed-stay: $\frac{Patientdays}{Inpatients} = \frac{15732}{3340} = 4.71\ days$
- the average number of patients in bed per day: $\frac{Patientdays}{31} = \frac{15732}{31} = 508$

In what follows the amount of waste generated during the study period was related to the average number of patients, 508, in bed a day. HCW was not related to any other category of patients due to uncertainty in the quoted figures.

Table 2.1.4 displays the total mass generated in each category/component during the study period. The proportions of mass in the various categories calculated in *Table 2.1.3* were used to estimate the total composition of HCW generated over the study period. The following observations are made from *Table 2.1.3*:

- Besides general infectious waste, HCGW in the form of recyclables, food and clothing is found in relatively large quantities (76 kg/day; 0.15 kg/patient/day) in 140-litre general infectious containers.

- Besides sharps there is more general infectious waste disposed of in sharps containers than any other waste component.

- On average about 8 kg of general infectious waste finds its way into the general waste plastic bags per day.

Tables 2.1.5 and *2.1.6* give the amount of HCW correctly and incorrectly disposed of per day and per patient in bed per day in all the containers which were available during the study period. Note that *Table 2.1.6* is merely *Table 2.1.5* with the masses generated a day divided by the average number of patients in bed, 508. *Table 2.1.5* shows that:

- The daily average masses: 225 kg of general infectious waste and 17 kg of sharps were correctly disposed of in HCRW containers;

- The daily average mass of 173 kg of HCGW was correctly disposed of in plastic bags.

- The daily average masses: 76 kg and 0.01 kg of HCGW were incorrectly disposed of in 140-litre general infectious waste and sharps containers respectively.

- The daily average massed: 1.85 kg of infectious waste, 2.79 kg of sharps were incorrectly disposed of in inappropriate HRW containers.

Table 2.1.7 gives the total mass, mass/day and mass/patient/day of HCW that was simply weighed and not sampled from at Leratong Hospital. The largest part of this waste consisted of foodstuff used as pigswill and recyclables (loose cardboard papers, empty tins etc). 166 kg and 82 kg of the total waste came from the laboratory and the blood bank.

In general, the following waste generation was observed (see *Tables 2.1.5* and *2.1.6*):

- A total average of 779.25 kg (1,53 kg/p/d) of Health care waste (HCGW and HCRW combined) is generated per day at Leratong Hospital during the sample period of which 64.7% (504.20 kg or 0.99 kg/p/d) is HCGW and 35.3% (275.05 kg or 0.54 kg/p/d) is HCRW.

- An average daily mass of 76 kg (0.15 kg/patient/day) of HCGW generated over the period was misplaced in 140-litre general infectious waste containers. An average of 226 kg (0.44 kg/patient/day) per day of HCRW was disposed of correctly in 140-litre general waste containers.

- An average of 0.01 kg of HCGW was misplaced in sharps containers. 20 kg (0.04 kg/patient/day) of HCRW was disposed of in sharps containers.

- A daily average of 173 kg (0.34 kg/patient/day) of HCGW was disposed of in plastic bags. 8 kg (0.02 kg/patient/day) of HCRW was incorrectly placed in plastic bags for HCGW.

Leratong Pre-Intervention Study								
Container Type	**Container Size**	**Samples**	**Waste Component**	**N**	**Proportion**	**STDEV**	**Lower 95% CL**	**Upper 95% CL**
General Infectious Waste	140L	120	Infectious	120	1.00000	0.00000	1.00000	1.00000
			Sharps	6	0.05000	0.01990	0.01100	0.08900
			Chemical	7	0.05833	0.02140	0.01640	0.10027
			Radioactive	0	-	-	-	-
			HCGW: Food	3	0.02500	0.01425	0.00000	0.05293
			HCGW: Recyclables	104	0.86667	0.03103	0.80584	0.92749
			HCGW: Clothing	17	0.14167	0.03183	0.07927	0.20406
Sharps Containers	10L	71	Infectious	19	0.26761	0.05254	0.16463	0.37058
			Sharps	70	0.98592	0.01398	0.95850	1.00000
			Chemical	7	0.09859	0.03538	0.02925	0.16794
			Radioactive	0	-	-	-	-

Leratong Pre-Intervention Study								
Container Type	**Container Size**	**Samples**	**Waste Component**	**N**	**Proportion**	**STDEV**	**Lower 95% CL**	**Upper 95% CL**
			HCGW: Food	0	-	-	-	-
			HCGW: Recyclables	0	-	-	-	-
			HCGW: Clothing	0	-	-	-	-
			HCGW: Other	1	0.01408	0.01398	0.00000	0.04150
Specican Containers	10L	10	Pathological	10	1.00000	0.00000	1.00000	1.00000
	25L	4	Liquid	1	0.25000	0.21651	0.00000	0.67435
			Pathological	3	0.75000	0.21651	0.32565	1.00000
General Waste Containers	BLACK BAGS	120	Infectious	30	0.25000	0.03953	0.17252	0.32748
			Sharps	0	-	-	-	-
			Chemical	1	0.00833	0.00830	0.00000	0.02460
			Radioactive	0	-	-	-	-
			HCGW: Food	75	0.62500	0.04419	0.53838	0.71162
			HCGW: Clothing	4	0.03333	0.01639	0.00122	0.06545
			HCGW: Recyclables	120	1.00000	0.00000	1.00000	1.00000

Table 2.1.1: *Proportions of Components in Samples*

Leratong Pre-Intervention Study								
Container Type	**Container Size**	**Waste Component**	**N**	**Mean**	**Lower 95% CL for Mean**	**Upper 95% CL for Mean**	**Minimum**	**Maximum**
General Infectious Waste	140L	Infectious	120	6.07842	5.55576	6.6011	1.20	13.90
		Sharps	6	0.20333	0.00000	0.4133	0.02	0.51
		Chemical	7	0.63143	0.00000	1.3300	0.04	2.25
		Radioactive	0	-	-	-	-	-
		HCGW Clothing	17	0.59882	0.29913	0.8985	0.09	1.85
		HCGW: Food	3	1.11000	0.00000	3.3782	0.44	2.15
		HCGW Recyclables	104	2.02625	1.76134	2.2912	0.04	6.55
Sharps Containers	10L	Infectious	19	1.16789	0.77934	1.5564	0.03	2.50
		Sharps	70	2.28271	2.08828	2.4771	0.60	3.78
		Chemical	7	0.56143	0.00000	1.1754	0.14	1.99
		Radioactive	0	-	-	-	-	
		HCGW: Food	0	-	-	-	-	
		HCGW: Recyclables	0	-	-	-	-	
		HCGW: Clothing	0	-	-	-	-	
		HCGW	1	0.14000	-	-	0.14	0.14
Specican Containers	10L	Pathological	10	6.24200	3.45793	9.0261	0.95	11.15
	25L	Liquid	1	5.55000	.	.	5.55	5.55
		Pathological	3	5.08333	0.00000	13.0067	2.95	8.75
General Waste Containers	BLACK BAGS	Infectious	30	0.63917	0.47560	0.8027	0.03	1.53
		Sharps	0	-	-	-	-	-
		Chemical	1	0.29000	-	-	0.29	0.29
		Radioactive	0	-	-	-	-	-
		HCGW Clothing	4	0.90000	0.64146	1.1585	0.74	1.10
		HCGW: Food	75	1.76640	1.57149	1.9613	0.14	3.87
		HCGW: Recyclables	120	2.23758	2.02039	2.4548	0.57	6.65

Table 2.1.2: *Mean of Health Care Waste in Containers (Analysis Variable: Mass (Kg)*

Leratong Pre-Intervention Study							
Container Type	**Container Size**	**Waste Component**	**N**	**Proportion**	**Minimum**	**Maximum**	**Total Weight (Kg)**
General Infectious Waste	140L	Infectious	120	0.74156	0.18750	1.00000	959.290
		Sharps		0.00120	0.00000	0.05263	
		Chemical		0.00490	0.00000	0.27273	
		Radioactive		-	-	-	
		HCGW: Clothing		0.01214	0.00000	0.37500	
		HCGW: Food		0.00498	0.00000	0.35246	
		HCGW: Recyclables		0.23521	0.00000	0.81250	
Sharps Containers	10L	Infectious	71	0.12055	0.00000	1.00000	186.050
		Sharps		0.85891	0.00000	1.00000	
		Chemical		0.01992	0.00000	0.60486	
		Radioactive		-	-	-	
		HCGW: Clothing		-		-	
		HCGW: Food		-			
		HCGW: Recyclables		-			
		HCGW: Other		0.00061	0.00000	0.04334	
Specican Containers	10L	Pathological	10	1.00000	1.00000	1.00000	62.420
	25L	Liquid	4	0.25000	0.00000	1.00000	20.800
		Pathological	4	0.75000	0.00000	1.00000	
General Waste Containers	BLACK BAGS	Infectious	120	0.04352	0.00000	0.72857	424.055
		Sharps		-	-	-	
		Chemical		0.00108	0.00000	0.13004	
		Radioactive		-	-	-	
		HCGW: Clothing		0.00666	0.00000	0.23656	
		HCGW: Food		0.27585	0.00000	0.73090	
		HCGW: Recyclables		0.67289	0.21151	1.00000	

Table 2.1.3: *Mean Mass of Health care Waste as Proportion of Total Mass of Waste (Including Zeros) (Kg)*

Waste Type	HCW	N	Proportion	Total Mass	Mass Day
General Infectious Waste	Chemical	120	0.0049	3634.00	1.49
	HCGW		0.2522		76.36
	Infectious		0.7417		224.62
	Other		0.0000		0.00
	Pathological		0.0000		0.00
	Radioactive		0.0000		0.00
	Sharps		0.0012		0.36
	Total Correct (Infectious)		**0.7417**	**3634.00**	**224.62**
	Total Incorrect		**0.2583**	**3634.00**	**78.21**
Sharps	Chemical	71	0.0199	238.55	0.40
	HCGW		0.0006		0.01
	Infectious		0.1206		2.40
	Other		0.0000		0.00
	Pathological		0.0000		0.00
	Radioactive		0.0000		0.00
	Sharps		0.8589		17.07
	Total Correct (Sharps)	**71**	**0.8589**	**238.55**	**17.07**
	Total Incorrect	**71**	**0.1411**	**238.55**	**2.80**
Specican & Amputations	Other	1	1.0000	67.45	5.62
Specican & Amputations	Pathological	13	1.0000		5.62
General Waste (HCGW)	Chemical	120	0.0011	21526.50	1.94
	HCGW		0.9554		1713.86
	Infectious		0.0435		78.07
	Other		0.0000		0.00
	Pathological		0.0000		0.00
	Radioactive		0.0000		0.00
	Sharps		0.0000		0.00
	Total Correct (HCGW)		**0.9554**	**21526.50**	**1713.87**
	Total Incorrect		**0.0446**	**21526.50**	**80.01**
Lab, Morque & Blood Waste	Other	.	.	364.75	.
Pigswill	Other	.	.	2072.70	.

Table 2.1.4: *Mean of Medical Waste as Proportion of Total Waste (Kg)*

Leratong Pre-Intervention Study							
Container Type	Container Size	Waste Disposal					
		Correctly Disposed		Incorrectly Disposed		Total	
		HCGW	HCRW	HCGW	HCRW	HCGW	HCRW
		Mass/Day	Mass/Day	Mass/Day	Mass/Day	Mass/Day	Mass/Day
HCRW							
General Infectious Waste	140L	0	224.62	76.36	1.85	76.36	226.47
Sharps Containers	10L	0	17.04	0.01	2.79	0.01	19.83
Laboratory		0	13.80	0	0	0	13.80
Blood bank		0	6.87	0	0	0	6.87
Sub-total		0	262.33	76.37	4.64	76.37	266.97
Percentage		0%	76.4%	22.2%	1.4%	22.2%	77.8%
General Waste (HCGW)		1713.86	0	0	80.01	1713.86	80.01
Percentage		95.5%	0%	0%	4.5%	95.5%	4.5%
GRAND TOTAL		1713.86	262.33	76.37	84.65	1790.23	346.98
Percentage		80.2%	12.3%	3.6%	4.0%	83.8%	16.2%
Grand total per patient per day (kg/p/d)		3.374	0.516	0.150	0.167	3.524	0.683

Table 2.1.5: *Total Mass (kg) Estimated over the Sample Period*

Leratong Pre-Intervention Study							
		Waste Disposal					
Container Type Size		Correctly Disposed		Incorrectly Disposed		Total	
		HCGW	HCRW	HCGW	HCRW	HCGW	HCRW
		Mass/Patient /Day	Mass/Patient /Day	Mass/Patient /Day	Mass/Patient /Day	Mass/Patient /Day	Mass/Patient /Day
General Infectious Waste	140L	0	0.44	0.15	0	0.15	0.45
Sharps Containers	10L	0	0.03	0.01	0.01	0	0.04
Laboratory		0	0.03	0	0	0	0.03
Blood bank		0	0.01	0	0	0	0.01
Sub-total		0	0.51	0.16	0.01	0.15	0.53
General Waste Containers	BLACK BAGS	3.37	0	0	0.16	3.37	0.16
GRAND TOTAL		3.37	0.51	0.16	0.17	3.52	0.68

Table 2.1.6: *Total Mass (kg) Estimated over the Sample Period (Patients in bed a day=508)*

Leratong Pre-Intervention Study					
HCW	**Variable**	**Sum**	**Std Dev**	**Minimum**	**Maximum**
Blood	Total Mass Mass/Day Mass/Patient/Day	82.45 6.87 0.01	24.06 2.01 0.00	5.20 0.43 0.00	53.00 4.42 0.01
Laboratory	Total Mass Mass/Day Mass/Patient/Day	165.65 13.80 0.03	26.94 2.24 0.00	14.20 1.18 0.00	77.75 6.48 0.01
Pig swill (food waste)	Total Mass Mass/Day Mass/Patient/Day	2189.35 182.45 0.36	57.00 4.75 0.01	116.65 9.72 0.02	278.10 23.18 0.05
Recyclables	Total Mass Mass/Day Mass/Patient/Day	866.50 72.21 0.14	86.47 7.21 0.01	27.00 2.25 0.00	343.70 28.64 0.06

Table 2.1.7: *Total Mass of HCW Not sampled*

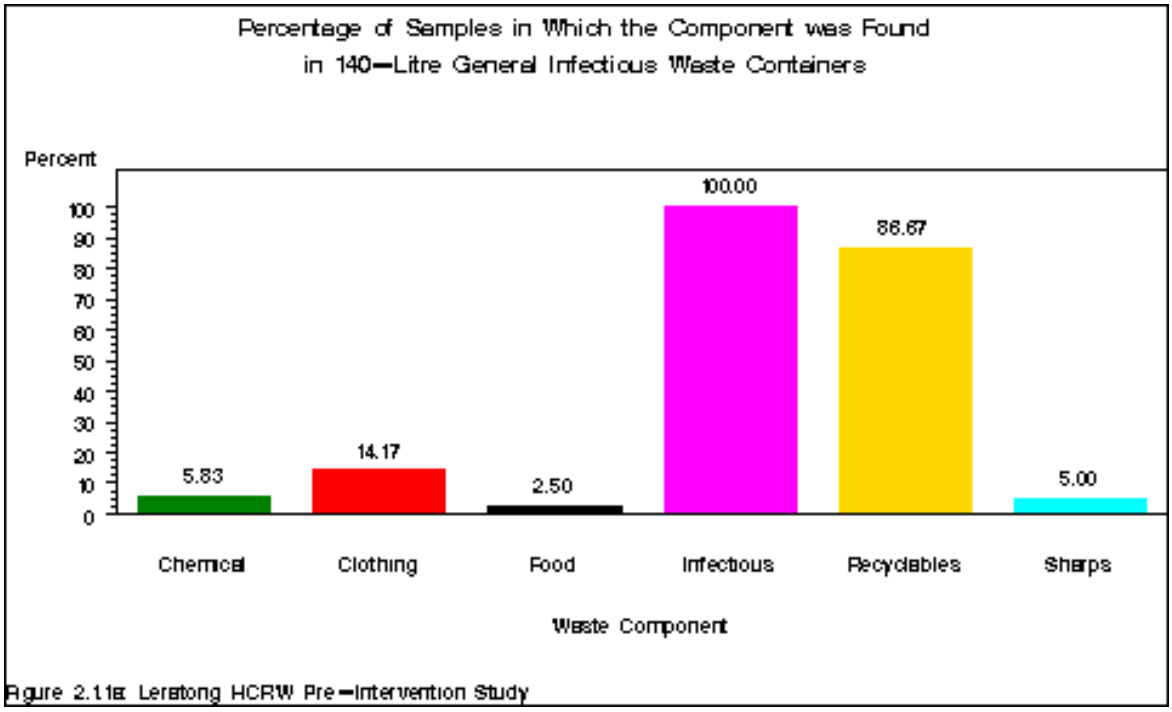


Figure 2.11a: Leratong HCRW Pre-Intervention Study

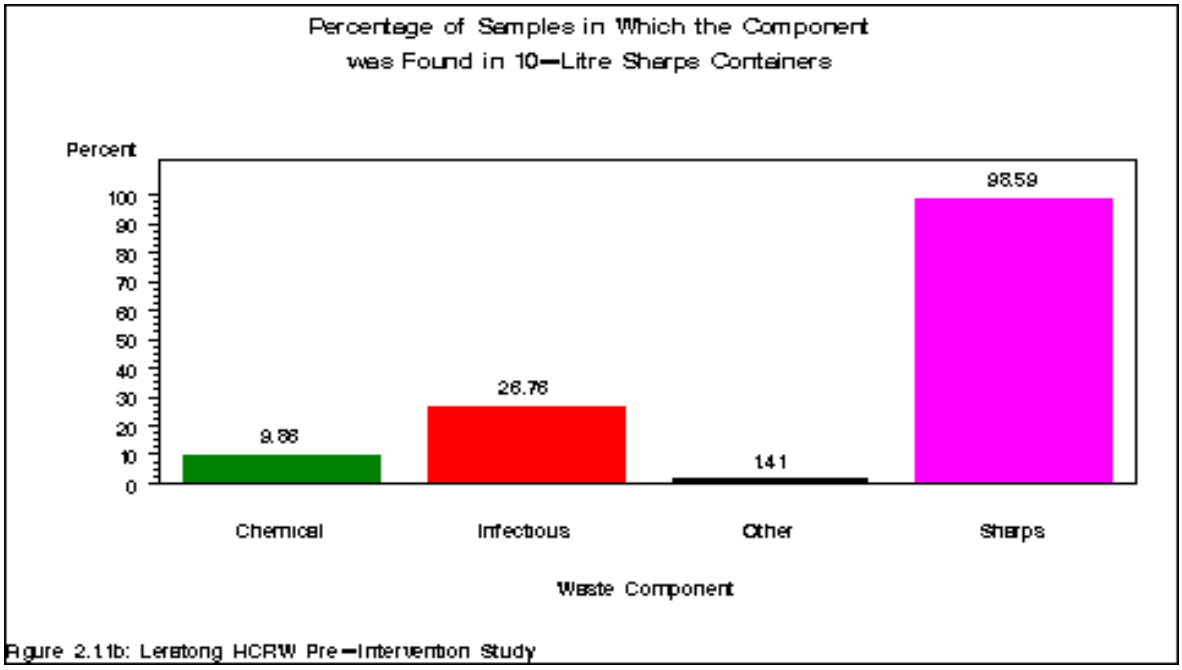


Figure 2.11b: Lesotong HCRW Pre-Intervention Study

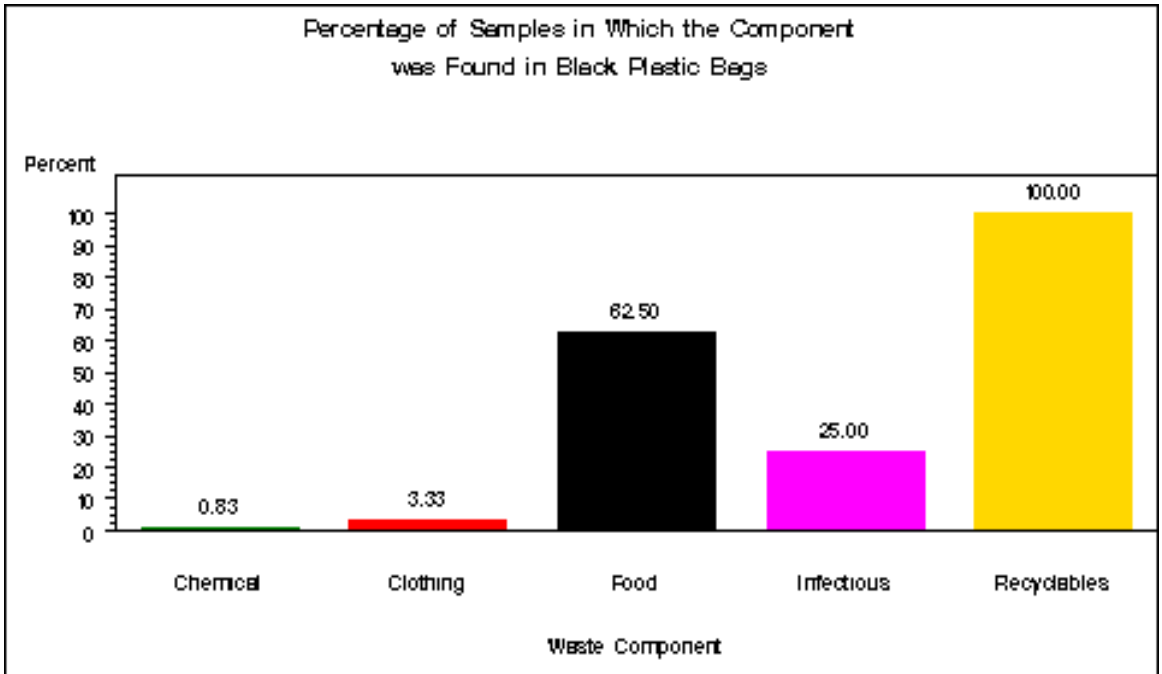


Figure 2.11c: Lesotong HCRW Pre-Intervention Study

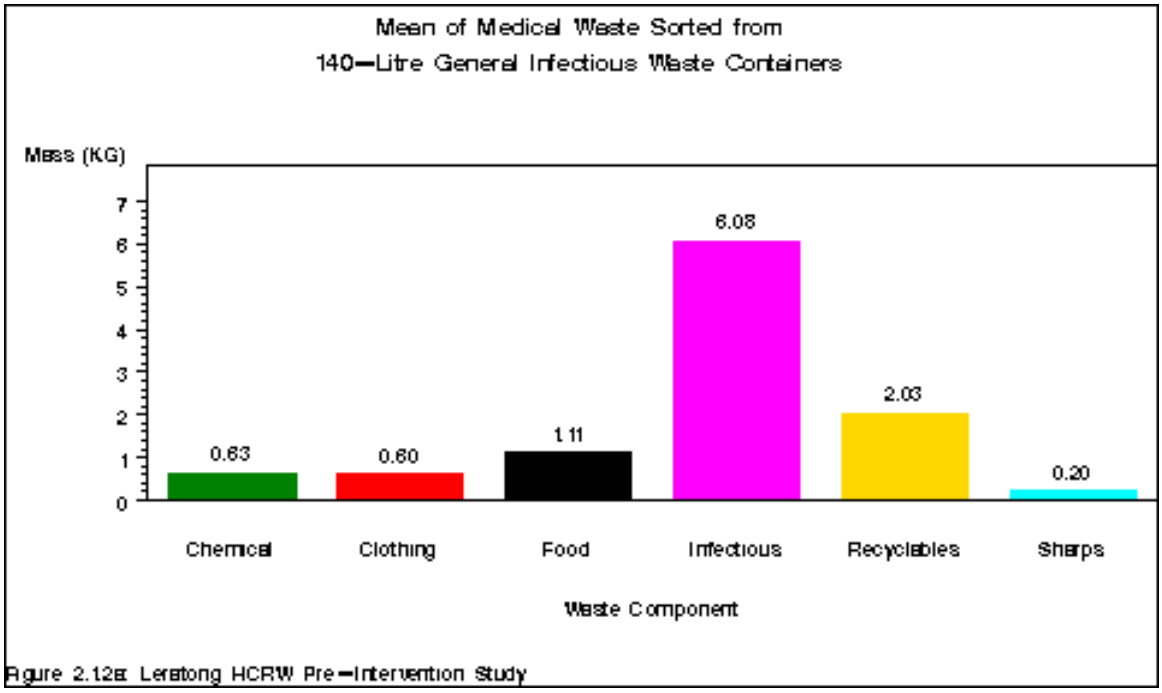


Figure 2.12a: Leratong HCRW Pre-Intervention Study

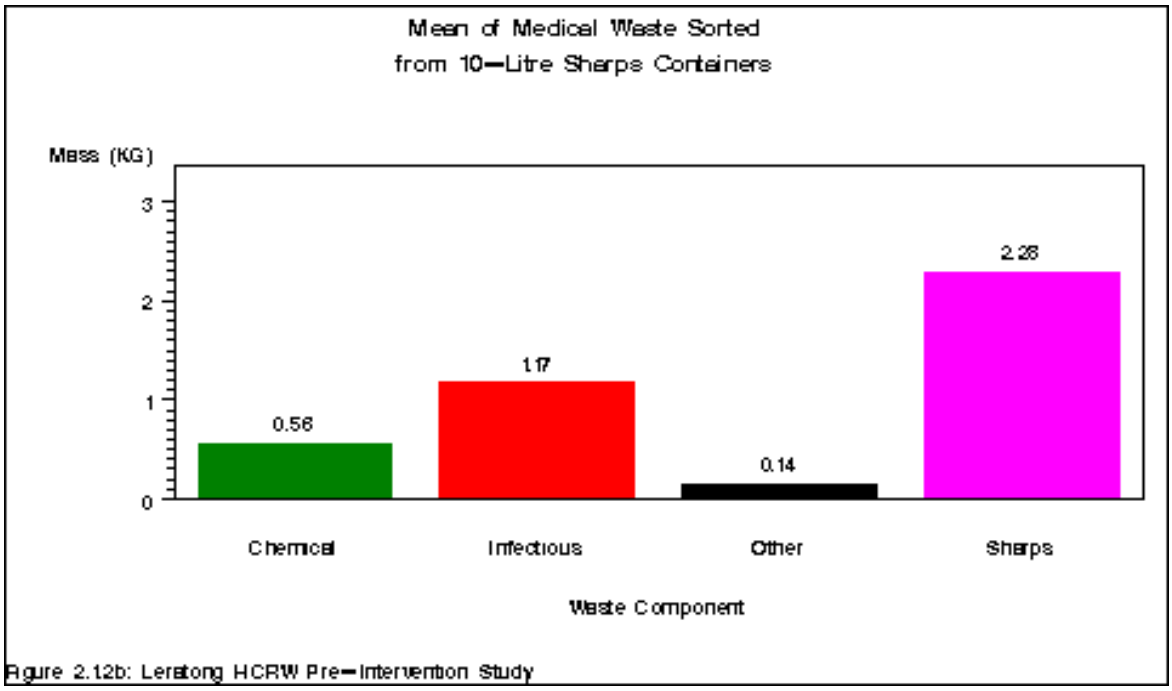


Figure 2.12b: Leratong HCRW Pre-Intervention Study

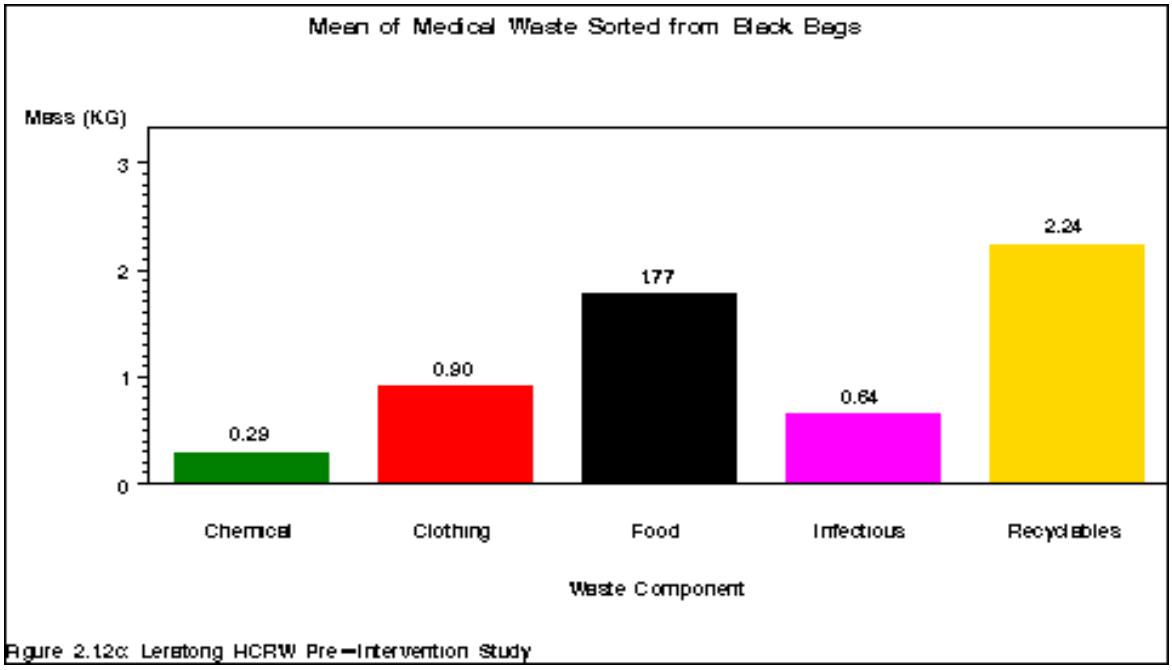


Figure 2.12c: Lesotho HCRW Pre-Intervention Study

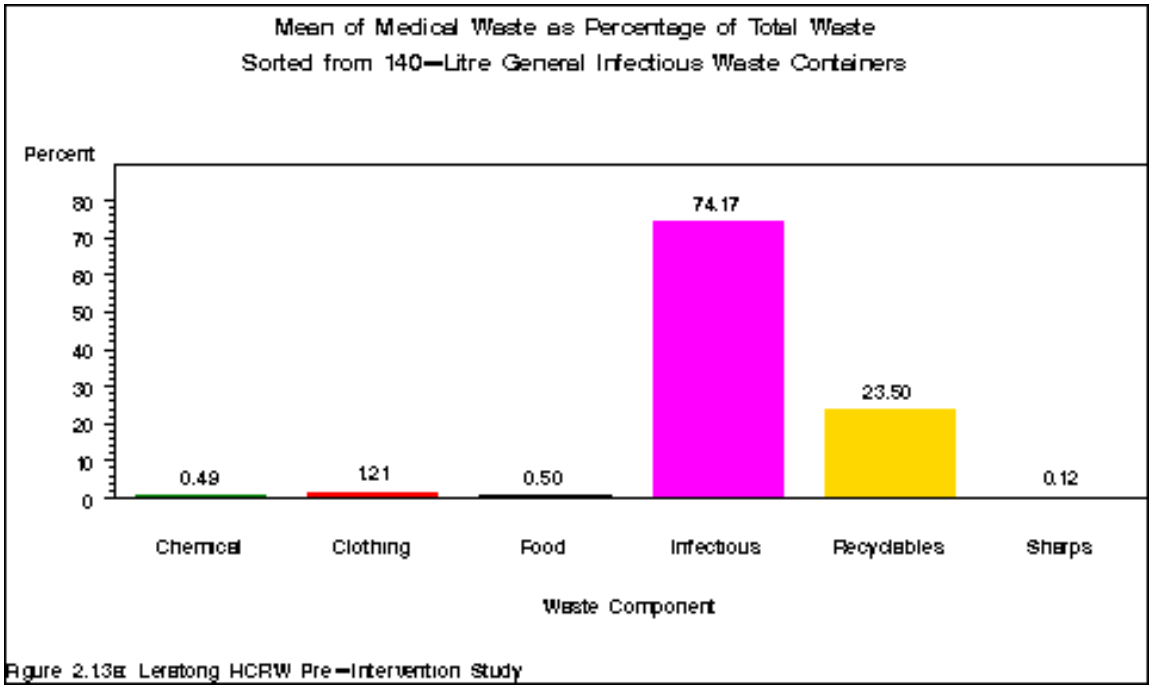


Figure 2.13a: Lesotho HCRW Pre-Intervention Study

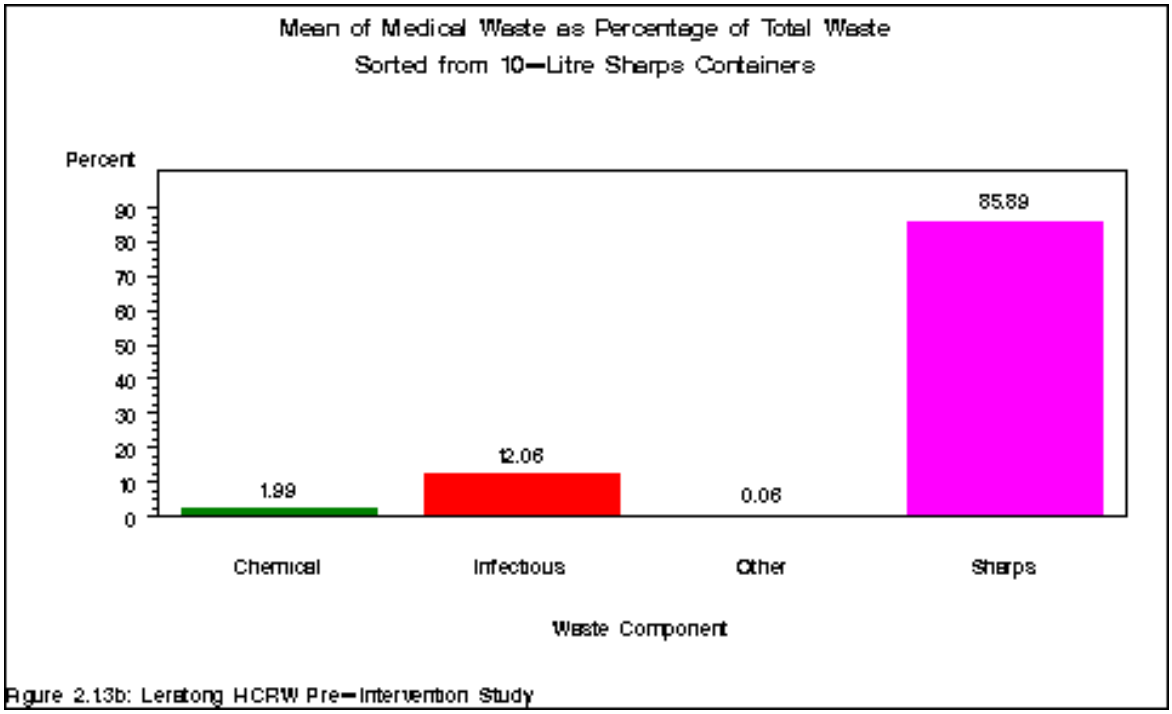


Figure 2.13b: Lesotho HCRW Pre-Intervention Study

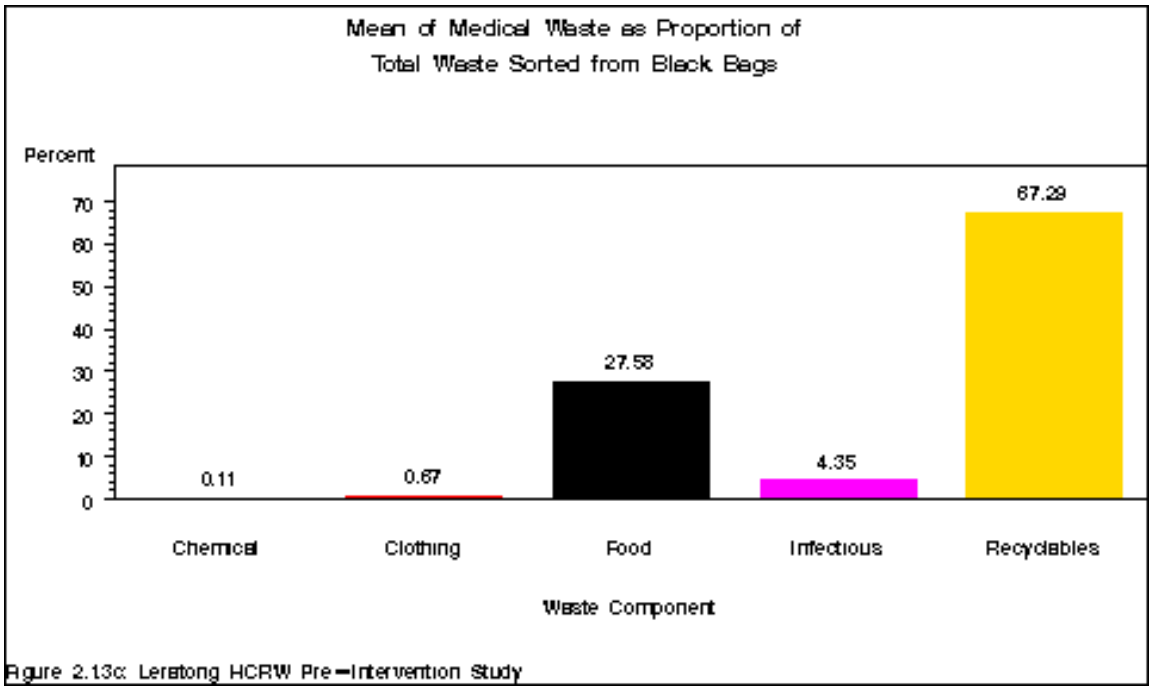


Figure 2.13c: Lesotho HCRW Pre-Intervention Study

2.2 Results and Analysis for Treatment Facility

This sub-section presents the results of the HCRW generation and characterisation study conducted by Millennium Waste Management at Sanumed's HCRW treatment facility situated in Roodepoort, Johannesburg. The purpose of the analysis in this section is to determine the amount and representative composition of HCRW generated by private and public health care facilities that are treated at Sanumed's incinerator before the residues are disposed of at the Holfontein H:H hazardous waste disposal site. Since HCGW is disposed of without any further treatment, no HCGW samples were available for analysis at the HCRW treatment facility.

2.2.1 Sample Design for Treatment Facility

Random Samples of 10 containers of each size and type were designed and selected separately for each of the two sources (private and public health care facilities) of HCRW at the incinerator. It was observed during the study that some container sizes that were not originally allowed for were delivered from private health care facilities as numerous types and sizes are being used by the industry. For reporting purposes these container sizes were re-grouped into the existing pre-determined sizes.

The following table indicates how the container sizes were re-grouped.

Container Size	Reclassified into
1L – 7.5L	5L
7.6L – 12.5L	10L
12.6L +	20L

Table 2.2.1a: *Reclassification of Container sizes*

Most of the re-grouped sizes were found in specicans and sharps containers from private health care facilities. The same sampling procedure and waste recording described in Section 1 was, however, applied to the original container sizes. While the study was originally designed to be carried out over a 12-day period, it was eventually done in 11 days, as the first day was utilised for the sampling of containers, whilst the incinerators were not operational on the Sunday that fell within the Study period.

Table 2.2.1b gives the categories of containers in their various sizes were analysed in this section of the report. Though all containers were of the disposable type only the net mass (excluding the mass of the containers) was used in the analysis in this section.

As with the First Leratong Hospital study the HCW composition of each HCRW container was characterised by the following pre-determined breakdown of waste components:

- General infectious waste
- Pathological waste
- Sharps
- Chemical/pharmaceutical waste
- Radioactive Waste
- HCGW (composed of the categories: Food, Clothing, Recyclables and Other)
- Blood Bank

Sampling, sorting and recording of the total HCRW mass as well as of the various waste components was done at the Sanumed treatment facility.

Container	Source of Waste						Total Sample
	Private Hospitals and Clinics			Public Hospitals and Clinics			
	Number of containers sampled	Percentage Distribution of Containers (public/private)	Percentage Distribution of sampled containers	Number of containers sampled	Percentage Distribution of Containers (public/private)	Percentage Distribution of sampled containers	
5L - plastic	999	52.35%	16.29%	909	47.64%	19.53%	1908
10L - plastic	1863	54.90%	30.39%	1530	45.09%	32.88%	3393
20L - plastic	1287	75.66%	20.99%	414	24.33%	8.89%	1701
50L – cardboard box.	900	50.00%	14.68%	900	50.00%	19.34%	1800
140L – cardboard box	900	50.00%	14.68%	900	50.00%	19.36%	1800
Blood Bank (240-liter)	180	100.00%	2.94%	.	.	.	180
TOTALS	-	-	100%	-	-	100%	10782

Table 2.2.1b: *Samples Selected at Sanumed's Incinerator*

2.2.2 Analysis of the Survey Results

In this Section, a comparative study of HCRW received at the Sanumed incinerator during the 11-day study period was performed. The analysis comprises descriptive statistics in terms of means, standard deviations, proportions, 95% confidence intervals, minima and maxima of the waste received from private and public health care facilities. Further, the sample proportions of the various waste components are extrapolated to the population using the total mass recorded over the study period. The amount of HCRW correctly and incorrectly disposed of in containers is also determined.

2.2.3 Waste Composition

2.2.3.1 Analysis of Proportions and HCW mass

Since the analysis tables in this Section are considered to be self-explanatory, only a few important points are highlighted. Regarding the methodology of reading and interpreting the tables, Table 2.2.2a for private health facilities is used as an example for providing results for the general infectious waste from the private hospitals and clinics received by the treatment facility over the sample period.

i) For the 140-litre general infectious waste containers, 23 (23%) and 4 (4%) samples contained misplaced HCGW and chemical waste respectively;

ii) In the 50-litre general infectious waste containers, HCGW was found in 19 number (19%) and chemical waste in 3 number (3%) of the samples from the private hospitals and clinics.

iii) No sharps, radioactive waste or pathological waste were found to be disposed of in general infectious waste containers (cardboard boxes) received from the private health care facilities.

2.2.3.2 Findings from the sample study

Tables 2.2.2a through *2.2.2f* presents the proportions (and their 95% confidence limits) and the number of times a given HCW component was found in the 100 samples of the indicated container type and size. It is to be noted from these tables that sample sizes ranging between 9 and 110 were used for the various container sizes and type. One possible reason for this variation in sample sizes is that there could have been less than the designated sample sizes of the given container type from the respective two HCRW sources. The analysis was performed separately for the waste received from the private and public hospitals and clinics.

In general the tables show that (except for specicans from the private hospitals and clinics) the proportions of misclassified HCW components in a given container type are roughly the same for the private and public health care facilities.

Table 2.2.3a to *2.2.3f* presents the average sample mass (and the 95% confidence limits of the mean) and the percentage mass, %(kg/kg) of each of the specified components in the HCRW containers. The minimum and the maximum reported against the total for each container reflect the respective total minimum and maximum received in that container over the study period. The following observations were generally made from the estimated masses of the waste components sorted at the incinerator:

- A relatively high proportion, (about 30% in each case) of HCGW was misplaced in 140-litre general infectious waste containers received from both private and public hospitals and clinics (see Tables 2.2.4a).

- Sharps containers from the private health care facilities tend to contain fairly large amounts of general infectious waste (see *Table 2.2.3c*). 20-litre sharps containers from the public hospitals contain large amounts (see *Table 2.2.3d*) of chemical waste. Some amount of pathological waste is disposed of in sharps containers (see *Tables 2.2.3c* and *2.2.3d*).

- Specicans received from the private hospitals and clinics are in general not only used for pathological waste, but also for other types of HCRW (*Table 2.2.3e*).

- *Table 2.2.3g* provide the amount of waste received daily in 140-liter boxes, 50-litre boxes, all sharps and specican containers from private and public hospitals and clinics. The table shows that generally most of the waste delivered to Sanumed's incinerator comes from public hospitals and clinics. 140-litre (and then 50-liter) containers account for the highest amount of the waste.

2.2.4 Total HCRW Stream Delivered to the Treatment Facility and its Composition

In addition to the HCRW sampled and sorted at the incinerator, the total HCRW stream delivered to the Sanumed treatment facility from both the private and public hospitals and clinics was recorded over the sample period.

Tables 2.2.4a to *2.2.4f* provide for each component, the average mass of HCW as a proportion of the total mass of the HCRW received at the incinerator, individually for each type of container. These tables also give the total mass of HCRW received in each container type over the 10-day sampling period. The following observations were made from these tables:

- HCGW forms the largest proportion of misclassified components of the total HCRW mass in all the general infectious waste containers received from the private (61.90%) and public health care facilities (see *Tables 2.2.4a* and *2.2.4b*).

- Although sharps comprised the major component in the various sized sharps containers, it was observed that of the components misplaced in sharps containers, general infectious waste formed the largest proportion in the private hospitals and clinics. On the other hand, chemical waste comprised the highest misplaced proportion in the public health care facilities (see *Tables 2.2.4c* and *2.2.4d*).

- Table *2.2.4e* shows that, other than pathological waste, a relatively high proportion of general infectious, chemical and blood bank waste was disposed of in specicans received from the private health care facilities. In contrast, specicans received from public health care facilities only contained pathological waste. This may be because public hospitals have private branches of the SA Blood Transfusion Services on their premises and the blood bank arranges for its own disposal of discarded blood bags etc.

Tables 2.2.5a and *2.2.5b* give the estimated amount of HCRW correctly and incorrectly disposed of per day by container type and size respectively. "Other HCW" in these tables refers to HCRW other than the one for which the container was designed. The tables clearly show that HCGW forms the largest proportion of misplaced HCW (per day), in particular in 140- and 50-liter general infectious waste containers received from both the private and public health care facilities.

With regard to the differences in daily waste disposal between the two types of health care facilities, it was observed that the public health care facilities tend to dispose of more HCGW in infectious waste containers than the private health care facilities. On the other hand, more non-sharp HCGW is misplaced in sharps containers received from the private health care facilities than in those received from the public health care facilities.

Facility=HCRW Treatment, Source=Private, Container type=General Infectious Waste							
Container Size	**Waste Component**	**Samples**	**N**	**Proportion**	**Std**	**Lower 95% CL**	**Upper 95% CL**
140L	**General Infectious**	100	95	0.9500	0.021794	0.90728	0.99272
	Sharps		0	-	-	-	-
	Chemical		4	0.0400	0.019596	0.00159	0.07841
	Radioactive		0	-	-	-	-
	HCGW		23	0.2300	0.020961	0.18642	0.26858
	Pathological		0	-	-	-	-
50L	**General Infectious**	100	82	0.8200	0.038419	0.74470	0.89530
	Sharps		0	-	-	-	-
	Chemical		3	0.0300	0.017059	0.00000	0.06344
	Radioactive		0	-	-	-	-
	HCGW		19	0.1900	0.019615	0.15155	0.22845
	Pathological		0	-	-	-	-

Table 2.2.2a: *Proportion of Component in Samples based on number of samples*

Facility=HCRW Treatment, Source=Public, Container type=General Infectious Waste							
Container Size	**Waste Component**	**Samples**	**N**	**Proportion**	**Std**	**Lower 95% CL**	**Upper 95% CL**
140L	**General Infectious**	100	86	0.8600	0.034699	0.79199	0.92801
	Sharps		1	0.0100	0.009950	0.00000	0.02950
	Chemical		2	0.0200	0.014000	0.00000	0.04744
	Radioactive		0	-	-	-	-
	HCGW		23	0.2300	0.020961	0.18642	0.26858
	Pathological		0	-	-	-	-
50L	**General Infectious**	100	83	0.8300	0.037563	0.75638	0.90362
	Sharps		0	-	-	-	-
	Chemical		4	0.0400	0.019596	0.00159	0.07841
	Radioactive		0	-	-	-	-
	HCGW		17	0.1700	0.018891	0.13547	0.20953
	Pathological		0	-	-	-	-

Table 2.2.2b: *Proportion of Component in Samples based on number of samples*

Facility=HCRW Treatment, Source=Private, Container type=Sharps							
Container Size	**Waste Component**	**Samples**	**N**	**Proportion**	**Std**	**Lower 95% CL**	**Upper 95% CL**
10L	**General Infectious**	110	10	0.09091	0.027410	0.03719	0.14463
	Sharps		100	0.90909	0.027410	0.85537	0.96281
	Chemical		6	0.05455	0.021652	0.01211	0.09698
	Radioactive		0	-	-	-	-
	HCGW		2	0.01818	0.012739	0.00000	0.04315
	Pathological		1	0.00909	0.009049	0.00000	0.02683
20L	**General Infectious**	71	20	0.28169	0.053384	0.17706	0.38632
	Sharps		61	0.85915	0.041284	0.77824	0.94007
	Chemical		14	0.19718	0.047219	0.10463	0.28973
	Radioactive		0	-	-	-	-
	HCGW		5	0.07042	0.030365	0.01091	0.12994
	Pathological		0	-	-	-	-
5L	**General Infectious**	86	17	0.19767	0.042944	0.11350	0.28184
	Sharps		70	0.81395	0.041962	0.73171	0.89620
	Chemical		1	0.01163	0.011560	0.00000	0.03429
	Radioactive		0	-	-	-	-
	HCGW		0	-	-	-	-
	Pathological		0	-	-	-	-

Table 2.2.2c: *Proportion of Component in Samples based on number of samples*

Facility=HCRW Treatment, Source=Public, Container type=Sharps							
Container Size	**Waste Component**	**Samples**	**N**	**Proportion**	**Std**	**Lower 95% CL**	**Upper 95% CL**
10L	**General Infectious**	100	8	0.08000	0.027129	0.02683	0.13317
	Sharps		91	0.91000	0.028618	0.85391	0.96609
	Chemical		11	0.11000	0.031289	0.04867	0.17133
	Radioactive		0	-	-	-	-
	HCGW		3	0.03000	0.017059	0.00000	0.06344
	Pathological		0	-	-	-	-
20L	**General Infectious**	37	6	0.16216	0.060597	0.04339	0.28093
	Sharps		33	0.89189	0.051049	0.79184	0.99195
	Chemical		6	0.16216	0.060597	0.04339	0.28093
	Radioactive		0	-	-	-	-
	HCGW		1	0.02703	0.026659	0.00000	0.07928
	Pathological		1	0.02703	0.026659	0.00000	0.07928
5L	**General Infectious**	101	7	0.06931	0.025271	0.01977	0.11884
	Sharps		90	0.89109	0.030998	0.83033	0.95185
	Chemical		8	0.07921	0.026872	0.02654	0.13188
	Radioactive		0	-	-	-	-
	HCGW		0	-	-	-	-
	Pathological		0	-	-	-	-

Table 2.2.2d: *Proportion of Component in Samples based on number of samples*

Facility=HCRW Treatment, Source=Private, Container type=Specican							
Container Size	**Waste Component**	**Samples**	**N**	**Proportion**	**Std**	**Lower 95% CL**	**Upper 95% CL**
10L	**General Infectious**	97	13	0.13402	0.034590	0.06622	0.20182
	Sharps		0	-	-	-	-
	Chemical		7	0.07216	0.026273	0.02067	0.12366
	Radioactive		0	-	-	-	-
	HCGW		3	0.03093	0.017578	0.00000	0.06538
	Pathological		81	0.83505	0.037683	0.76119	0.90891
20L	**General Infectious**	72	20	0.27778	0.052786	0.17432	0.38124
	Chemical		8	0.11111	0.037037	0.03852	0.18370
	Sharps		0	-	-	-	-
	Radioactive		0	-	-	-	-
	HCGW		1	0.01389	0.013792	0.00000	0.04092
	Pathological		49	0.68056	0.054949	0.57285	0.78826
5L	**Pathological**	25	25	1.00000	0.000000	1.00000	1.00000
Blood Bank	**Blood Bank**	120	41	0.34167	0.043295	0.25681	0.42652

Table 2.2.2e: *Proportion of Component in Samples based on number of samples*

Facility=HCRW Treatment, Source=Public, Container type=Specican							
Container Size	**Waste Component**	**Samples**	**N**	**Proportion**	**Std**	**Lower 95% CL**	**Upper 95% CL**
10L	**Pathological**	70	69	0.98571	0.014183	0.95792	1
20L	**Pathological**	9	9	1.00000	0.000000	1.00000	1

Table 2.2.2f: *Proportion of Component in Samples based on number of samples*

Facility=HCRW Treatment, Source=Private, Container type=General Infectious Waste								
Container Size	**Waste Component**	**N**	**Mean**	**%(kg/kg)**	**Lower 95% CL**	**Upper 95% CL**	**Minimum**	**Maximum**
140L	**General Infectious**	95	5.68653	70.05%	5.04970	6.3234	0.95	16.32
	Sharps	0	-	0.00%	-	-	-	-
	Chemical	4	0.14500	1.79%	0.02843	0.2616	0.04	0.20
	Radioactive	0	-	0.00%	-	-	-	-
	HCGW	23	2.28571	28.16%	1.95956	2.6119	0.09	8.25
	Pathological	0	-	0.00%	-	-	-	-
	Totals		**8.11724**	**100.00%**			**1.08**	**24.77**
50L	**General Infectious**	82	3.54305	23.67%	3.13511	3.9510	0.90	9.98
	Sharps	0	-		-	-	-	-
	Chemical	3	9.86333	65.91%	0.00000	30.4621	0.29	14.80
	Radioactive	0	-		-	-	-	-
	HCGW	19	1.55947	10.42%	1.23906	1.8799	0.10	6.50
	Pathological	0	-		-	-	-	-
	Totals		**14.96585**	**100.00%**			**1.29**	**31.28**

Table 2.2.3a: *Mean of Health Care Waste in Containers - Analysis Variable: Mass (Kg)*

Facility=HCRW Treatment, Source=Public, Container type=General Infectious Waste								
Container Size	**Waste Component**	**N**	**Mean**	**%(kg/kg)**	**Lower 95% CL**	**Upper 95% CL**	**Minimum**	**Maximum**
140L	**General Infectious**	86	5.16360	43.86%	4.64354	5.6837	0.49	12.60
	Sharps	1	1.95000	16.56%	.	.	1.95	1.95
	Chemical	2	1.04500	8.88%	0.00000	11.9088	0.19	1.90
	Radioactive	0	-		-	-	-	-
	HCGW	91	3.61560	30.71%	3.09935	4.1319	0.25	13.25
	Pathological	0	-		-	-	-	-
	Totals		**11.7742**	**100.00%**			**2.88**	**29.70**
50L	**General Infectious**	83	2.46434	56.30%	2.18654	2.7421	0.55	6.15
	Sharps	0	-		-	-	-	-
	Chemical	4	0.40250	9.20%	0.12831	0.6767	0.20	0.59
	Radioactive	0	-		-	-	-	-
	HCGW	69	1.51029	34.50%	1.26797	1.7526	0.07	5.35
	Pathological	0	-		-	-	-	-
	Totals		**4.37713**	**100.00%**			**8.82**	**12.09**

Table 2.2.3b: *Mean of Health Care Waste in Containers - Analysis Variable: Mass (Kg)*

Facility=HCRW Treatment, Source=Private, Container type=Sharps								
Container Size	**Waste Component**	**N**	**Mean**	**%(kg/kg)**	**Lower 95% CL**	**Upper 95% CL**	**Minimum**	**Maximum**
10L	**General Infectious**	10	2.52000	38.89%	0.03348	5.00652	0.14	9.19
	Sharps	100	1.23810	19.11%	1.14408	1.33212	0.04	2.65
	Chemical	6	1.94167	29.97%	0.00000	5.65709	0.04	9.14
	Radioactive	0	-		-	-	-	-
	HCGW	2	0.08000	1.23%	0.00000	0.20706	0.07	0.09
	Pathological	1	0.70000	10.80%	.	.	0.70	0.70
	Total		**6.47977**	**100.00%**			**0.99**	**21.77**
20L	**General Infectious**	20	2.58800	26.65%	1.43776	3.73824	0.06	7.35
	Sharps	61	5.91852	60.94%	5.17142	6.66563	2.00	14.65
	Chemical	14	0.99786	10.27%	0.25003	1.74568	0.04	4.90
	Radioactive	0	-		-	-	-	-
	HCGW	5	0.20800	2.14%	0.00000	0.43243	0.05	0.49
	Pathological	0	-		-	-	-	-
	Totals		**9.71238**	**100.00%**			**0.04**	**14.65**
5L	**General Infectious**	17	0.54294	43.55%	0.37095	0.71493	0.06	1.14
	Sharps	70	0.55386	44.42%	0.47863	0.62909	0.05	1.55
	Chemical	1	0.15000	12.03%	.	.	0.15	0.15
	Radioactive	0	-		-	-	-	-
	HCGW	0	-		-	-	-	-
	Pathological	0	-		-	-	-	-
	Totals		**1.2468**	**100.00%**			**0.26**	**2.84**

Table 2.2.3c: *Mean of Health Care Waste in Containers - Analysis Variable: Mass (Kg)*

Facility=HCRW Treatment, Source=Public, Container type=Sharps								
Container Size	**Waste Component**	**N**	**Mean**	**%(kg/kg)**	**Lower 95% CL**	**Upper 95% CL**	**Minimum**	**Maximum**
10L	**General Infectious**	8	0.95875	25.71%	0.39824	1.51926	0.14	1.79
	Sharps	91	1.67330	44.87%	1.54703	1.79957	0.20	3.52
	Chemical	11	0.94364	25.31%	0.38703	1.50024	0.19	2.20
	Radioactive	0	-		-	-	-	-
	HCGW	3	0.15333	4.11%	0.00000	0.34629	0.09	0.24
	Pathological	0	-		-	-	-	-
	Total		**3.72902**	**100.00%**			**0.62**	**7.75**
20L	**General Infectious**	6	2.90167	19.74%	0.00000	7.94524	0.06	12.23
	Sharps	33	5.03970	34.28%	4.30633	5.77307	1.31	11.07
	Chemical	6	3.78833	25.77%	0.00000	9.45268	0.15	14.05
	Radioactive	0	-		-	-	-	-
	HCGW	1	0.09000	0.61%	.	.	0.09	0.09
	Pathological	1	2.88000	19.59%	.	.	2.88	2.88
	Total		**14.6997**	**100.00%**			**4.49**	**40.32**
5L	**General Infectious**	7	1.22000	44.71%	0.69642	1.74358	0.30	1.86
	Sharps	90	0.90489	33.16%	0.84277	0.96700	0.29	1.69
	Chemical	8	0.60375	22.13%	0.31439	0.89311	0.14	1.25
	Radioactive	0	-		-	-	-	-
	HCGW	0	-		-	-	-	-
	Pathological	0	-		-	-	-	-
	Total		**2.72864**	**100.00%**			**0.73**	**4,80**

Table 2.2.3d: *Mean of Health Care Waste in Containers - Analysis Variable: Mass (Kg)*

Facility=HCRW Treatment, Source=Private, Container type=Specican								
Container Size	**Waste Component**	**N**	**Mean**	**%(kg/kg)**	**Lower 95% CL**	**Upper 95% CL**	**Minimum**	**Maximum**
10L	**General Infectious**	13	3.03231	19.51%	1.58497	4.4796	0.35	7.17
	Sharps	0	-		-	-	-	-
	Chemical	7	3.89429	25.05%	2.37047	5.4181	0.75	5.90
	Radioactive	0	-		-	-	-	-
	HCGW	3	4.35000	27.98%	1.24731	7.4527	3.35	5.75
	Pathological	81	4.26877	27.46%	3.68907	4.8485	0.10	10.15
	Total		**15.54537**	**100.00%**			**4.55**	**28.97**
20L	**General Infectious**	20	7.84800	32.03%	5.21198	10.4840	2.31	22.70
	Sharps	0	-		-	-	-	-
	Chemical	8	5.49875	22.44%	3.29179	7.7057	2.25	9.70
	Radioactive	0	-		-	-	-	-
	HCGW	1	4.55000	18.57%	.	.	4.55	4.55
	Pathological	49	6.60429	26.96%	5.33512	7.8734	1.95	22.70
	Total		**24.50104**	**100.00%**			**11.06**	**59.65**
5L	**Pathological**	25	0.52960	100.00%	0.42358	0.6356	0.06	1.00
Blood Bank	**Blood Bank**	41	8.89805	100.00%	7.54440	10.2517	3.45	17.00

Table 2.2.3e: *Mean of Health Care Waste in Containers - Analysis Variable: Mass (Kg)*

Facility=HCRW Treatment, Source=Public, Container type=Specican								
Container Size	**Waste Component**	**N**	**Mean**	**%(kg/kg)**	**Lower 95% CL**	**Upper 95% CL**	**Minimum**	**Maximum**
10L	**Pathological**	69	6.47609	100.00%	5.75612	7.19605	0.65	11.06
20L	**Pathological**	9	6.68333	100.00%	3.51363	9.85304	0.40	11.70

Table 2.2.3f: *Mean of Health Care Waste in Containers - Analysis Variable: Mass (Kg)*

		Facility									
		Private					Public				
		Container					Container				
Date		140L Boxes	50L Boxes	Sharps	Specican	Total	140L Boxes	50L Boxes	Sharps	Specican	Total
19-Aug-02	Mass	5618.5	922	515	317.5	7373	14638	937.5	485	239.5	16300
	Percent	76.21	12.51	6.98	4.3	100	89.8	5.75	2.97	1.47	99.99
	Samples	590	171	333	50	1144	1417	264	353	38	2072
20-Aug-02	Mass	6830.5	790	679.5	661	8961	13168.5	598.5	557.5	165	14489.5
	Percent	76.22	8.81	7.6	7.38	100.01	90.89	4.13	3.84	1.14	100
	Samples	608	144	379	100	1231	1342	160	312	21	1835
21-Aug-02	Mass	4276.5	624.5	455	323	5679	11072	620.5	766.5	238	12697
	Percent	75.31	10.99	8.01	5.69	100	87.2	4.89	6.02	1.87	99.98
	Samples	384	131	210	54	779	1205	168	419	36	1828
22-Aug-02	Mass	5202	271.5	376	695	6544.5	10294	500.5	450	95.5	11340
	Percent	79.48	4.15	5.75	10.63	100.01	90.78	4.4	3.96	0.85	99.99
	Samples	520	57	213	90	880	1036	138	236	15	1425
23-Aug-02	Mass	6058.5	849.5	228	196	7332	3320	393	51.5	17.5	3782
	Percent	82.63	11.58	3.1	2.67	99.98	87.79	10.39	1.37	0.46	100.01
	Samples	546	143	137	37	863	374	87	45	2	508
24-Aug-02	Mass (kg)	2387.5	178	329	65.5	2960	863.5	130	6.5	.	1000
	Percent	80.66	6.01	11.11	2.22	100	86.35	13	0.65	.	100

		Facility									
		Private					Public				
		Container					Container				
Date		140L Boxes	50L Boxes	Sharps	Specican	Total	140L Boxes	50L Boxes	Sharps	Specican	Total
	Samples	230	34	191	14	469	87	37	5	.	129
26-Aug-02	Mass (kg)	5751.5	716.5	603	1110	8181	15958.5	791	465	261	17475.5
	Percent	70.31	8.76	7.38	13.58	100.03	91.3	4.53	2.65	1.48	99.96
	Samples	583	146	309	39	1077	1638	198	317	37	2190
27-Aug-02	Mass	11172.5	1602	733.5	824	14332	3467.5	634	78.5	.	4180
	Percent	77.96	11.18	5.12	5.73	99.99	82.95	15.16	1.87	.	99.98
	Samples	1037	320	445	140	1942	369	161	37	.	567
28-Aug-02	Mass	7690	1268	769	373.5	10100.5	9012.5	782.5	224	161	10180
	Percent	76.14	12.57	7.6	3.68	99.99	88.54	7.68	2.2	1.58	100
	Samples	802	231	339	55	1427	930	210	149	22	1311
29-Aug-02	Mass	8689.5	1174.5	602.5	293	10759.5	9862.5	552	438.5	147	11000
	Percent	80.76	10.91	5.59	2.73	99.99	89.65	5.02	3.98	1.34	99.99
	Samples	828	250	336	47	1461	1030	152	263	18	1463
30-Aug-02	Mass	6032.5	658.5	411	460.5	7562.5	2878	327.5	93	21.5	3320
	Percent	79.78	8.7	5.46	6.1	100.04	86.68	9.87	2.81	0.65	100.01
	Samples	556	155	195	62	968	332	74	52	3	461
Total for the period	Mass (kg)	69709.5	9055	5701.5	5319	89785	94535	6267	3616	1346	105764
	Percent	77.64	10.09	6.35	5.92	100.00	89.38	5.93	3.42	1.27	100.00
	Samples	6684	1782	3087	688	12241	9760	1649	2188	192	13789
Average per day	Mass (kg)	6337.23	823.18	518.32	483.55	8162.27	8594.09	569.73	328.73	122.36	9614.91
	Percent	77.64	10.09	6.35	5.92	100.00	89.38	5.93	3.42	1.27	100.00
	Samples	607.64	162.00	280.64	62.55	1112.82	887.27	149.91	198.91	17.45	1253.55

Table 2.2.3g: *Total amount (kg) of waste received during the sample period*

Facility=HCRW Treatment, Source=Private, Container type=General Infectious Waste						
Container size	**Waste Component**	**N**	**Proportion**	**Maximum**	**Sample mass (Kg)**	**Total Waste Mass (kg/Day)**
140L	**General Infectious**	99	0.70041	1.00000	742.16	4461.16
	Sharps		-	-		0.00
	Chemical		0.00066	0.02618		4.19
	Radioactive		-	-		0.00
	HCGW		0.29893	0.25263		489.28
	Pathological		-	-		0.00
	Total		100.00%			4954.63
50L	**General Infectious**	100	0.65935	1.00000	438.64	520.67
	Sharps		-	-		0.00
	Chemical		0.02058	1.00000		16.25
	Radioactive		-	-		0.00
	HCGW		0.32008	0.25000		63.19
	Pathological		-	-		0.00
	Totals		100.00%			600.11

Table 2.2.4a: *Mean Mass of Health care Waste as Proportion of Total Mass of Waste (Including Zeros) (Kg)*

Facility=HCRW Treatment, Source=Public, Container type=General Infectious Waste						
Container size	**Waste Component**	**N**	**Proportion**	**Maximum**	**Sample mass (Kg)**	**Total Waste Mass (kg)/Day**
140L	Infectious	99	0.58172	1.00000	765.62	4988.29
	Sharps		0.00405	0.40123		34.75
	Chemical		0.00420	0.39095		36.02
	Radioactive		-	-		0.00
	HCGW		0.41010	0.25000		927.43
	Pathological		-	-		0.00
	Totals		100.00%			5986.49
50L	Infectious	99	0.64159	1.00000	308.80	333.22
	Sharps		-	-		0.00
	Chemical		0.00307	0.09768		1.59
	Radioactive		-	-		0.00
	HCGW		0.35534	1.00000		47.30
	Pathological		-	-		0.00
	Totals		100.00%			382.11

Table 2.2.4b: *Mean Mass of Health care Waste as Proportion of Total Mass of Waste (Including Zeros) (Kg)*

Facility=HCRW Treatment, Source=Private, Container =Sharps						
Container Size	**Waste Component**	**N**	**Proportion**	**Maximum**	**Sample mass (Kg)**	**Total Waste Mass (kg)/Day**
10L	Infectious	110	0.08308	1.00000	161.52	26.544
	Sharps		0.87830	1.00000		280.624
	Chemical		0.02609	1.00000		8.336
	Radioactive		-	-		0.000
	HCGW		0.00919	0.69231		2.935
	Pathological		0.00335	0.36842		1.070
	Total		100.00%			
20L	Infectious	71	0.14910	1.08000	427.40	72.773
	Sharps		0.80890	1.00000		394.804
	Chemical		0.03555	1.00000		17.353
	Radioactive		-	-		0.000
	HCGW		0.00647	0.41525		3.694
	Pathological		-	-		0.000
	Total		100.00%			
5L	Infectious	86	0.18221	1.00000	48.15	-
	Sharps		0.80616	1.00000		-
	Chemical		0.01163	1.00000		-
	Radioactive		-	-		-
	HCGW		-	-		-
	Pathological		-	-		-
	Total		100.00%			

Table 2.2.4c: *Mean Mass of Health care Waste as Proportion of Total Mass of Waste (Including Zeros) (Kg)*

Facility=HCRW Treatment, Source=Public, Container type=Sharps						
Container Size	**Waste Component**	**N**	**Proportion**	**Maximum**	**Sample mass (Kg)**	**Total Waste Mass (kg)/Day**
10L	Infectious	100	0.04930	1.00000	170.05	4.9900
	Sharps		0.89368	1.00000		90.4584
	Chemical		0.05781	1.00000		5.8518
	Radioactive		-	-		0.0000
	HCGW		0.00010	0.18750		0.3918
	Pathological		-	-		0.0000
	Total		100.00%			101.692
20L	Infectious	37	0.04882	1.00000	209.42	2.0949
	Sharps		0.85512	1.00000		36.6933
	Chemical		0.06836	1.00000		2.9333
	Radioactive		-	-		0.0000
	HCGW		0.00067	0.02479		0.0288
	Pathological		0.02703	1.00000		1.1597
	Total					42.91
5L	Infectious	101	0.06931	1.00000	94.81	-
	Sharps		0.88199	1.00000		-
	Chemical		0.04871	1.00000		-
	Radioactive		-	-		-
	HCGW		-	-		-
	Pathological		-	-		-

Table 2.2.4d: *Mean Mass of Health care Waste as Proportion of Total Mass of Waste (Including Zeros) (Kg)*

Facility=HCRW Treatment, Source=Private, Container type=Specican						
Container Size	**Waste Component**	**N**	**Proportion**	**Maximum**	**Sample mass (Kg)**	**Total Waste Mass (kg)/Day**
10L	Infectious	95	0.09825	1.00000	425.50	5.3657
	Sharps		-	-		-
	Chemical		0.04035	1.00000		2.2038
	Radioactive		-	-		-
	HCGW		0.01404	0.50000		0.7665
	Pathological		0.84737	1.00000		46.2790
	Totals		100.00%			54.615
20L	Infectious	69	0.22947	1.00000	529.11	-
	Sharps		-	-		-
	Chemical		0.11594	1.00000		-
	Radioactive		-	-		-
	HCGW		0.00483	0.33333		-
	Pathological	69	0.64976	1.00000		-
	Totals					
5L	Pathological	25	1.00000	1.00000	13.24	0.3350
Blood Bank	Blood Bank	120	0.16667	1.00000	3283.38	-

Table 2.2.4e: *Mean Mass of Health care Waste as Proportion of Total Mass of Waste (Including Zeros) (Kg)*

Facility=HCRW Treatment, Source=Public, Container type=Specican						
Container size	**Waste Component**	**N**	**Proportion**	**Maximum**	**Sample mass (Kg)**	**Total Waste Mass (kg)/Day**
10L	Pathological	69	1	1	446.85	106.905
20L	Pathological	9	1	1	60.15	

Table 2.2.4f: *Mean Mass of Health care Waste as Proportion of Total Mass of Waste (Including Zeros) (Kg)*

Source=Private, health facility

	Incorrectly Disposed		Correctly Disposed			
	HCRW		HCRW			
	HCGW	Other HCW	Infectious	Pathological	Sharps	Total
Container Type	**Mass/Day**	**Mass/Day**	**Mass/Day**	**Mass/Day**	**Mass/Day**	**Mass/Day**
General Infectious Waste	1705.37	576.8	4226.07	.	.	6508.24
Sharps Containers	13.07	395.2	.	.	325.9	734.17
Specican Containers	13.89	22.12	.	13.94	.	784.12
Total	1732.33	994.12	4226.07	13.94	325.9	8026.53
Percent	21.58%	12.39%	52.65%	0.17%	4.06%	100.00%

Table 2.2.5a: *Total Mass (kg) by container type disposed of per day at the incinerator*

Source=Public, health facility

	Incorrectly Disposed		Correctly Disposed			
	HCRW		HCRW			
	HCGW	Other HCW	Infectious	Pathological	Sharps	Total
Container Type	**Mass/Day**	**Mass/Day**	**Mass/Day**	**Mass/Day**	**Mass/Day**	**Mass/Day**
General Infectious Waste	2556.9	2026.62	3684.94	.	.	8268.46
Sharps Containers	3.98	72.34	.	.	54.66	130.98
Specican Containers	.	.	.	97.19	.	228.17
Total	2560.88	2098.96	3684.94	97.19	54.66	8627.61
Percent	29.68%	24.33%	42.71%	1.13%	0.63%	100.00%

Table 2.2.5b: *Total Mass (kg) by container type disposed of per day at the incinerator*

Source=Private health facility

	Incorrectly Disposed		Correctly Disposed			
	HCRW		HCRW			
	HCGW	Other HCW	Infectious	Pathological	Sharps	Total
Container	**Mass/Day**	**Mass/Day**	**Mass/Day**	**Mass/Day**	**Mass/Day**	**Mass/Day**
10L	17.46	253.51	.	13.63	55.51	340.11
140L	1630.56	103.65	4056.14	.	.	5790.35
20L	9.5	163.82	.	.	270.39	6234.06
50L	74.8	473.16	169.92	.	.	1161.59
5L	.	.	.	0.3	.	718.18
Total	1732.32	994.14	4226.06	13.93	325.9	14244.29
Percent	12.16%	6.98%	29.67%	0.10%	2.29%	100.00%

Table 2.2.5c: *Total Mass (kg) by container type disposed of per day at the incinerator*

Source=Public Health Facility

	Incorrectly Disposed		Correctly Disposed			
	HCRW		HCRW			
	HCGW	Other HCW	Infectious	Pathological	Sharps	Total
Container	**Mass/Day**	**Mass/Day**	**Mass/Day**	**Mass/Day**	**Mass/Day**	**Mass/Day**
10L	3.78	46.95	.	97.19	41.29	189.21
140L	2394.01	1983.19	3419.13	.	.	7796.33
20L	0.2	25.39	.	.	13.37	7835.29
50L	162.89	43.44	265.82	.	.	511.11
Total	2560.88	2098.97	3684.95	97.19	54.66	16331.94
Percent	15.68%	12.85%	22.56%	0.60%	0.33%	100.00%

Table 2.2.5d: *Total Mass (kg) by container type disposed of per day at the incinerator*

Section 3

Post-Intervention Results and Analysis for Leratong Hospital

3.1 The Intervention phase and Post-Intervention Study Analysis

This section presents the post-intervention results of the HCW generation and characterisation study undertaken at Leratong hospital between May 26th and June 8th 2003. The study was the follow up of the one that took place in this hospital for a period of two weeks (22 July to 02 August 2002) whose results are presented in section 2.1.

The HCW intervention phase introduced waste segregation and disposal systems that were expected to have significant impact on waste management costs, segregation efficiency and health related issues at Leratong hospital. Unlike the old system of waste disposal (which involved a number of disposable containers of different sizes) two parallel systems were introduced mainly for sharps in disposable containers and general infectious waste disposal in reusable containers. The two systems involve:

- **System A:** which is based on reusable 770 litre wheelie bins. Each bin contains approximately 15 large red plastic bags each of which containing general infectious waste and a maximum of 3- 12L sharps.

- **System B:** which is based on 100 litre and 50 litre reusable boxes collected separately in large cage trolleys. Each box contains general infectious waste and sharps containers.

Waste collected in these two systems consists of sharps and general infectious waste. Other types of HCW are being containerised and collected using the same equipment and systems for both of the two systems:

- **Pathological waste** which is disposed of in 30-litre disposable containers;

- **Large amputations etc.** which are disposed of in plastic bags and stored in the freezer in the morgue;

- **Empty vials** which are separated at the source and kept in ordinary boxes for recycling; and

- **HCGW** disposed of in black plastic bags. No change has been introduced for the disposal of the HCGW but there has been a provision of wall-brackets for HCGW throughout the hospital as well as HCGW containers on most nursing trolleys compared to earlier. The HCGW still consists of general domestic waste, food waste, clothing recyclables etc. and it is stored in black plastic bags as before.

It should be noted that compared to the first study at Leratong Hospital significant changes had been introduced. Among others sealed sharps containers are now placed inside the 50, 100, and 770 litre reusable containers for general infectious waste (HCRW).

3.2 Selection of the Sample for the Post-Intervention study

As before the daily total waste generated in the various types and containers was recorded on a special form. The study was conducted on a sample basis. 10 samples of each type of container were selected and sorted daily. Due to the new system of waste disposal a slightly different sample selection approach was applied. The process of sampling was as follows:

- Since the 770-litre wheelie bin and the cage trolley systems included both sharps containers and general infectious waste (in red plastic bags), it was suggested to select a combined daily sample of 10 containers from both systems. These consisted of 5 samples of red bags from the 770-litre wheelie bins and 5 from both the 50-litre and 100-litre box cage trolleys.

- A daily sample of 10 30L specican containers (visual inspection only. Mass recording only).

- Amputations in large plastic bags (mass recording only).

- HCRW from the laboratory and the mortuary (mass recording only).

- HCRW from the blood transfusion services (mass recording only).

- 10 samples of HCGW in plastic bags excluding foodstuff (pigswill) in big drums.

The typical pre-determined HCW components into which the waste in each container could be characterised included the following categories:

- General infectious waste
- Pathological waste and amputations
- Sharps and vials
- Chemical waste
- HCGW comprising Food waste, domestic waste, Clothing, Recyclables and Other types of general waste

Masses of HCRW from the lab, morgue and blood transfusion services and that of HCGW categories such as pigswill and recyclable materials that were not included in the sampling process were recorded as part of the total daily waste.

Recording of total daily mass, sampling, sorting and weighing of HCW samples was done by Millennium Waste Management at the Sanumed incinerators in Roodepoort, Johannesburg. A database was recorded in Excel spreadsheets and sent to the statistical consultant, DMSA cc, for analysis.

3.3 Analysis of the Post-Intervention Survey Results

The analysis of the post-intervention study results described in this section was done in two stages:

Stage 1: **Within survey results analysis**

This stage concentrates exclusively on the results of the post-intervention study. The analysis performed in this stage is to a large extent similar to that performed for the pre-intervention study. It is based on descriptive statistics such as means and proportions of containers and corresponding confidence intervals and the total weight of waste components observed during the study period. Waste generated over the study period is further related to the number of patients in bed per day. We also determine in this stage the amount of HCW correctly and incorrectly disposed of in the various containers.

Stage 2: **Comparison of Pre- and Post-intervention studies.**

In this stage we determine the effect of the intervention through a comparison analysis of the pre- and post-intervention studies. Due to the new system (which abolished the use of disposable cardboard boxes traditionally used at Leratong hospital and replaced them with one of two types of reusable containers) the comparison is performed on the waste generated in each category over all container sizes. The analysis is done in terms of proportions and means of mass of the waste composition.

3.4 Waste Characterisation

In this section HCW containers are classified into the following six broad categories:

- **Infectious Waste Containers**. Infectious waste is disposed of in large red bags stored in 770-litre wheelie bins and in 100 – and 50-litre boxes stored in cage trolleys.
- ***12-litre Sharps Containers.*** *These containers are also disposed of in large red bags stored in 770-litre wheelie bins and in 100 – and 50-litre boxes stored in cage trolleys.*
- **30 litre Specican Containers and Amputations in Plastic bags** stored in the freezer in the morgue**.**
- **Waste from the Laboratory, Morgue and Blood Transfusion Services**.
- ***HCGW*** *disposed of in black plastic bags.*

The waste composition to be determined in some of these containers is given in section 3.2.

3.4.1 Stage 1: Within study results analysis

Tables 3.1.1 to *3.1.6* display the statistical results of the post-intervention study. The results include proportions of waste in containers as well as of the masses of HCW components found in designated containers.

Table 3.1.1, which displays the proportions of health care components in the various containers, shows that recyclables and other types of HCGW formed the largest part of misclassified waste incorrectly disposed of in wheelie bins and cage trolleys. In particular it was observed that:

i) 70% and 49% of the infectious containers in 100L boxes in cage trolleys contained recyclables and other types of HCGW respectively;

ii) 45% and 24% of the infectious containers in 50L boxes in cage trolleys contained recyclables and other types of HCGW respectively;

iii) 55% and 34% of the infectious containers in 770L wheelie bins contained recyclables and other types of HCGW respectively.

Other types of waste misclassified in these infectious waste containers occurred in relatively small proportions. On the other hand, it is observed in Table 3.1.1 that a high proportion (42% to 59%) of sharps containers in all the systems contained infectious waste.

Though some amount of infectious waste is still found in HCGW containers (black Bags) the proportion of bags in which it is found is relatively small. It has to be pointed out, however, that vials which did not form part of the components of HCGW in the pre-intervention study form part of the components part in this study.

Table 3.1.2 provides the mean weight of the HCW components. Sealed sharps containers found in 100- and 50- litre cage trolley boxes intended for infectious waste should not be considered as misplaced components of the infectious waste. They are simply noted in this table, as their disposal in general infectious waste containers is part of the way the system should work.

As pointed out earlier HCGW (which includes recyclables, clothing, food waste and other types of general waste) formed the largest misclassified component of the general infectious waste. Table 3.1.2 shows that between 13% and 18% by weight of the contents of general infectious waste containers is. The average mass of infectious waste found in sharps containers is large compared to the other components, and can be higher than the mass of the sharps in them. Infectious waste and vials formed the greatest proportion by weight of misplaced waste in general waste (HCGW) bags.

The average mass of the various components as a proportion of the total mass of waste recorded over the study period is displayed in *Table 3.1.3*. Between 6% and 8% by mass of the general infectious waste containers is misclassified; between 16% and 35% of sharps containers and 3% of HCGW containers is incorrectly classified.

From the information provided for May and June 2003 regarding the number of patients admitted and the number of beds allocated to patients we calculated the occupancy rate and the number of patients in bed per day as follows:

- $OccupancyRate\ for\ May = 100\dfrac{Patientdays}{31xNumber\ of\ beds} = 100\dfrac{14271}{31x708} \cong 65.02\%$
- $OccupancyRate\ for\ June = 100\dfrac{Patientdays}{30xNumber\ of\ beds} = 100\dfrac{16187}{30x708} \cong 76.21\%$

- the average number of patients in bed per day: $\dfrac{Patientdays}{Days} = \dfrac{14271+16187}{31+30} \cong 500$

The calculations given above indicate that the occupancy rate is variable. The occupancy rate for the month in which the pre-intervention study took place was 71.68% which lies between that of May and June 2003.

Tables 3.1.4, 3.1.6, 3.1.9a and *3.1.9 b* display the results of the amount of waste when related to the average number of patients, 500, in bed per day.

Extrapolated to the total waste obtained over the study period we notice that though the total mass of HCGW misplaced in infectious waste containers per day is very small it is larger than that of the other misplaced components. The same argument applies to the amount of infectious waste disposed of in sharps and HCGW containers per day (see *Table 3.1.*4).

Tables 3.1.5 and *3.1.6* display the overall results of total mass generated per day and per day per patient. These tables also give the amounts of waste correctly and incorrectly disposed of in containers. Generally a large amount of waste generated daily is correctly put into the right container. It is, however, observed from these tables that HCGW formed the largest part of the waste misplaced in general infectious containers per day. Similarly, other HCRW than sharps formed the greatest portion of the waste misplaced in sharps containers daily.

3.4.2 Stage 2: Comparison of Pre- and Post-intervention studies

The waste segregation and characterisation study at Leratong Hospital was done in two phases namely the Pre- and Post-Intervention studies. The pre-intervention study was undertaken mainly to study the manner in which HCW was disposed of by the hospital staff. The study was also undertaken to provide useful information on the approach and better methods of waste disposal that would minimise cases of waste misclassification. The post-intervention study was conducted as a means of post hoc assessment of staff training and application of methods introduced for the purpose.

The results of the comparison analysis of the two studies are given in *Tables 3.1.7* to *3.1.8b*. The following observations were made from these tables:

- **General Infectious Waste**: There was a larger amount of infectious waste generated per day in the post- than in the pre-intervention study. It is also noticed that the proportion of infectious waste correctly disposed of in the post-intervention study is considerably larger than that observed in the pre-intervention study. This is an indication of improved methods of segregating infectious waste (see *Table 3.1.7*).

- **Sharps.** With regard to sharps it is observed that the effect of the intervention was not quite effective. There was a higher proportion of correctly disposed of sharps in the pre-intervention study than in the post-intervention study. The most dramatic difference in the pre- and post-sharps is in the total amount (238.6 kg pre vs 29.0 kg post) generated As pointed out earlier most infectious waste formed a large part of the waste misplaced in sharps containers. It may be important to investigate the effect of separation of vials from the needles and to revisit the definition of infectious waste particularly with regard to its disposal in sharps containers.

- **General Waste (HCGW**). A much smaller proportion of HCRW was incorrectly classified in the in the post– intervention study compared to the pre-intervention study. This also holds for the mass of HCRW incorrectly classified. We also notice in Table

3.1.7 that some sharps were found in HCGW bags in the post-study while none occurred in these bags in the pre-study.

Tables 3.1.8a and *3.1.8b* show that the daily mass incorrectly disposed of in the various containers was appreciably more in pre-intervention study than it was in the post-intervention study. This indicates that generally the new system of waste disposal and the training offered were effective.

Leratong Post-Intervention Study								
Waste Type	**System**	**Samples**	**Waste Component**	**N**	**Proportion**	**Std**	**Lower 95% CL**	**Upper 95% CL**
General Infectious Waste	**100L Box in Cage Trolleys**	70	Chemical	1	0.01429	0.01418	0.00000	0.04208
			Clothing	24	0.34286	0.05673	0.23166	0.45405
			Food	13	0.18571	0.04648	0.09461	0.27681
			Infectious	70	1.00000	0.00000	1.00000	1.00000
			Other HCGW	34	0.48571	0.05974	0.36863	0.60280
			Recyclables	49	0.70000	0.05477	0.59265	0.80735
			Sealed Sharps	4	0.05714	0.02774	0.00277	0.11152
			Sharps	4	0.05714	0.02774	0.00277	0.11152
	50L Box in Cage Trolleys	62	Chemical	1	0.01613	0.01600	0.00000	0.04749
			Clothing	14	0.22581	0.05310	0.12173	0.32988
			Food	6	0.09677	0.03755	0.02318	0.17037
			Infectious	62	1.00000	0.00000	1.00000	1.00000
			Other HCGW	15	0.24194	0.05439	0.13533	0.34854
			Recyclables	28	0.45161	0.06320	0.32774	0.57549
			Sealed Sharps	2	0.03226	0.02244	0.00000	0.07624
			Sharps	1	0.01613	0.01600	0.00000	0.04749
	770L Wheelie bin system	58	Clothing	14	0.24138	0.05619	0.13125	0.35151
			Food	12	0.20690	0.05319	0.10264	0.31115
			Infectious	58	1.00000	0.00000	1.00000	1.00000
			Other HCGW	20	0.34483	0.06241	0.22250	0.46715
			Pathological	1	0.01724	0.01709	0.00000	0.05074
			Recyclables	32	0.55172	0.06530	0.42373	0.67971
			Sharps	3	0.05172	0.02908	0.00000	0.10872
	Other(Not specified systems)	14	Clothing	3	0.21429	0.10966	0.00000	0.42923
			Infectious	14	1.00000	0.00000	1.00000	1.00000
			Other HCGW	6	0.42857	0.13226	0.16934	0.68780
			Recyclables	6	0.42857	0.13226	0.16934	0.68780
Sharps & Vials	**100L Box in Cage Trolleys**	31*	Chemical	1	0.03226	0.03173	0.00000	0.09446
			Infectious	13	0.41935	0.08863	0.24565	0.59306
			Other HCGW	4	0.12903	0.06021	0.01102	0.24704
			Sharps	29	0.93548	0.04412	0.84900	1.00000
	50L Box in Cage Trolleys	14*	Food	1	0.07143	0.06883	0.00000	0.20634
			Infectious	7	0.50000	0.13363	0.23808	0.76192
			Other HCGW	3	0.21429	0.10966	0.00000	0.42923
			Sharps	10	0.71429	0.12074	0.47764	0.95093
	770L Wheelie bin system	49*	Chemical	1	0.02041	0.02020	0.00000	0.06000
			Infectious	29	0.59184	0.07021	0.45422	0.72945
			Other HCGW	4	0.08163	0.03911	0.00497	0.15830
			Sharps	45	0.91837	0.03911	0.84170	0.99503
Specican & Amputations		31	Amputations	1	0.03226	0.03173	0.00000	0.09446
			Specican	30	0.96774	0.03173	0.90554	1.00000
General Waste (HCGW)	**Black Bags**	130	Chemical	1	0.00769	0.00766	0.00000	0.02271
			Clothing	23	0.17692	0.03347	0.11132	0.24252
			Domestic waste	72	0.55385	0.04360	0.46839	0.63930
			Food	60	0.46154	0.04372	0.37584	0.54724
			Infectious	32	0.24615	0.03778	0.17210	0.32020
			Recyclable1es	113	0.61525	0.03347	0.11132	0.92719
			Sharps	6	0.04615	0.01840	0.01009	0.08222
			Vials	5	0.03846	0.01687	0.00540	0.07152
Lab, Morgue & Blood Waste Run		56	Blood	5	0.08929	0.03811	0.01460	0.16397
			Laboratory	23	0.41071	0.06574	0.28186	0.53957
			Morgue	28	0.50000	0.06682	0.36904	0.63096

Note: There were more sampled sharps containers than sorted. This was due to the presence components other than in the affected containers.

Table 3.1.1: Proportion of Components in Samples (Proportion=N/Samples)

Leratong Post-Intervention Study								
Waste type	**System**	**Waste Component**	**N**	**Mean**	**Lower 95% CL**	**Upper 95% CL**	**Minimum**	**Maximum**
General Infectious Waste	**100L Box in Cage Trolleys**	Chemical	1	0.0500	.	.	0.05	0.05
		Clothing	24	0.3208	0.0690	0.5727	0.05	2.40
		Food	13	0.3769	0.0365	0.7173	0.05	2.05
		Infectious	70	6.2064	5.6839	6.7290	1.95	12.10
		Other HCGW	34	0.4162	0.2437	0.5887	0.05	2.00
		Recyclables	49	0.2837	0.1929	0.3744	0.05	1.95
		Sealed Sharps	4	2.0250	0.7347	3.3153	1.35	3.05
		Sharps	4	0.3750	0.0000	1.4093	0.05	1.35
	50L Box in Cage Trolleys	Chemical	1	0.0500	.	.	0.05	0.05
		Clothing	14	0.2107	0.0404	0.3810	0.05	1.10
		Food	6	0.1583	0.1067	0.2099	0.10	0.25
		Infectious	62	4.3258	3.7483	4.9033	0.85	10.15
		Other HCGW	15	0.3167	0.1477	0.4856	0.05	1.10
		Recyclables	28	0.1946	0.1395	0.2498	0.05	0.55
		Sealed Sharps	2	1.3750	0.0000	8.6811	0.80	1.95
		Sharps	1	0.1000	.	.	0.10	0.10
	770L Wheelie bin system	Clothing	14	0.1607	0.0907	0.2307	0.05	0.40
		Food	12	0.3125	0.1026	0.5224	0.05	1.25
		Infectious	58	5.9595	5.1271	6.7919	0.15	15.80
		Other HCGW	20	0.6125	0.1911	1.0339	0.05	3.85
		Pathological	1	0.1000	.	.	0.10	0.10
		Recyclables	32	0.2844	0.1609	0.4079	0.05	1.40
		Sharps	3	0.0667	0.0000	0.1384	0.05	0.10
	Other(Not specified systems)	Clothing	3	0.0833	0.0000	0.2268	0.05	0.15
		Infectious	14	6.5250	4.2672	8.7828	0.85	12.55
		Other HCGW	6	0.5167	0.0000	1.1624	0.10	1.75
		Recyclables	6	0.2333	0.1020	0.3647	0.10	0.45
Sharps	**100L Box in Cage Trolleys**	Chemical	1	0.0500	.	.	0.05	0.05
		Infectious	13	0.4885	0.1066	0.8703	0.05	1.95
		Other HCGW	4	0.0750	0.0000	0.1546	0.05	0.15
		Sharps	29	0.8017	0.6841	0.9193	0.10	1.65
	50L Box in Cage Trolleys	Food	1	0.7000	.	.	0.70	0.70
		Infectious	7	1.8286	0.2989	3.3583	0.05	4.15
		Other HCGW	3	0.0667	0.0000	0.1384	0.05	0.10
		Sharps	10	0.7200	0.5662	0.8738	0.35	1.00
	770L Wheelie bin system	Chemical	1	0.0500	.	.	0.05	0.05
		Infectious	29	0.3793	0.2295	0.5291	0.05	1.60
		Other HCGW	4	0.1000	0.0000	0.2125	0.05	0.20
		Sharps	45	0.8222	0.7303	0.9141	0.20	1.55
Specican & Amputations		Amputations	1	4.4500	.	.	4.45	4.45
		Specican	30	7.6167	6.3508	8.8826	0.95	11.90
General Waste (HCGW)	**Black Bags**	Chemical	1	0.0500	.	.	0.05	0.05
		Clothing	23	0.6761	0.5076	0.8446	0.05	1.40
		Domestic waste	72	1.6528	1.3721	1.9334	0.05	4.80
		Food	60	0.8625	0.6790	1.0460	0.05	3.15
		Infectious	32	0.2734	0.1836	0.3633	0.05	1.05
		Recyclables	113	0.70212	0.2537	0.5506	0.05	2.50
		Sharps	6	0.0583	0.0369	0.0798	0.05	0.10
		Vials	5	0.5100	0.0000	1.2279	0.05	1.30
Lab,		Blood	5	6.2760	4.2994	8.2526	3.74	8.00

Morgue & Blood Waste		Laboratory	23	11.2878	10.4305	12.1452	7.93	14.07
		Morgue	28	7.0000	5.6159	8.3841	1.00	12.00

Table 3.1.2: *Mean of Health Care Waste in Containers – Mass (kg) (Excluding zeros)*

Leratong Post-Intervention Study (Proportion=Average Mass/Total Mass)									
Waste type	**System**	**Summary of proportions correctly and incorrectly disposed of**		**Waste Component**	**N**	**Proportion**	**Minimum**	**Maximum**	**Total Weight (Kg)**
General Infectious Waste	**100L Box in Cage Trolleys**	**Proportion Incorrect classified**	0.09689	Chemical	70	0.00011	0.00000	0.00763	484.75
				Clothing		0.01501	0.00000	0.39024	
				Food		0.00908	0.00000	0.16466	
				Infectious		0.90310	0.44715	1.00000	
				Other HCGW		0.03041	0.00000	0.30534	
				Recyclables		0.02577	0.00000	0.15415	
				Sealed Sharps		0.01383	0.00000	0.35057	
				Sharps		0.00268	0.00000	0.16364	
	50L Box in Cage Trolleys	**Proportion Incorrect classified**	0.05526	Chemical	62	0.00008	0.00000	0.00524	285.20
				Clothing		0.00789	0.00000	0.10628	
				Food		0.00337	0.00000	0.08108	
				Infectious		0.94473	0.21795	1.00000	
				Other HCGW		0.01427	0.00000	0.28205	
				Recyclables		0.01916	0.00000	0.12500	
				Sealed Sharps		0.01010	0.00000	0.50000	
				Sharps		0.00039	0.00000	0.02439	
	770L Wheelie bin system	**Proportion Incorrect classified**	0.0604	Clothing	58	0.00472	0.00000	0.05195	373.30
				Food		0.00851	0.00000	0.12690	
				Infectious		0.93961	0.60432	1.00000	
				Other HCGW		0.02531	0.00000	0.29167	
				Pathological		0.00036	0.00000	0.02083	
				Recyclables		0.02104	0.00000	0.15217	
				Sharps		0.00046	0.00000	0.01130	
	Other(Not specified systems)	**Proportion Incorrect classified**	0.08102	Clothing	14	0.00701	0.00000	0.04615	96.10
				Infectious		0.91898	0.59770	1.00000	
				Other HCGW		0.05203	0.00000	0.40230	
				Recyclables		0.02198	0.00000	0.12000	
Sharps	**100L Box in Cage Trolleys**	**Proportion Incorrect classified**	0.1608	Chemical	31	0.00134	0.00000	0.04167	29.95
				Infectious		0.15322	0.00000	1.00000	
				Other HCGW		0.00624	0.00000	0.06122	
				Sharps		0.83919	0.00000	1.00000	
	50L Box in Cage Trolleys	**Proportion Incorrect classified)**	0.35434	Food	14	0.01163	0.00000	0.16279	20.90
				Infectious		0.33857	0.00000	1.00000	
				Other HCGW		0.00414	0.00000	0.03448	
				Sharps		0.64566	0.00000	1.00000	
	770L Wheelie bin system	**Proportion Incorrect classified**	0.22849	Chemical	49	0.00057	0.00000	0.02778	48.45
				Infectious		0.21835	0.00000	1.00000	
				Other HCGW		0.00957	0.00000	0.26667	
				Sharps		0.77151	0.00000	1.00000	
Specican				Amputations		0.01910	0.00000	1.00000	232.95

& Amputations				Specican	31	0.98090	0.00000	1.00000	
General Waste (HCGW)	**Black Bags**	**Proportion Incorrect classified**	0.02929	Chemical	129	0.00011	0.00000	0.01389	363.70
				Clothing		0.03149	0.00000	0.38806	
				Domestic waste		0.24660	0.00000	1.00000	
				Food		0.10571	0.00000	0.70930	
				Infectious		0.02477	0.00000	0.42857	
				Recyclables		0.5869	0.00000	1.00000	
				Sharps		0.00065	0.00000	0.02000	
				Vials		0.00376	0.00000	0.23009	
Lab, Morgue & Blood Waste Run				Blood	56	0.08929	0.00000	1.00000	487.00
				Laboratory		0.41071	0.00000	1.00000	
				Morgue		0.50000	0.00000	1.00000	

Table 3.1.3: *Mean Mass of Health care Waste as Proportion of Total Mass of Waste(Including Zeros) (Kg)*

Leratong Post-Intervention Study							
Waste Type	**System**	**Waste Component**	**N**	**Proportion**	**Total Mass**	**Mass/Day**	**Mass/ Patient/Day**
General Infectious Waste	**100L Box in Cage Trolleys**	Chemical	70	0.00011	1424.00	0.011	0.00002
		HCGW: Clothing		0.01501		1.527	0.00305
		HCGW: Food		0.00908		0.924	0.00185
		Infectious		0.90310		91.858	0.18372
		Other HCGW		0.03041		3.093	0.00619
		Pathological		0.00000		0.000	0.00000
		HCGW: Recyclables		0.02577		2.621	0.00524
		Sealed Sharps		0.01383		1.407	0.00281
		Sharps		0.00268		0.273	0.00055
	50L Box in Cage Trolleys	Chemical	62	0.00008	555.00	0.003	0.00001
		HCGW: Clothing		0.00789		0.313	0.00063
		HCGW: Food		0.00337		0.134	0.00027
		Infectious		0.94473		37.452	0.07490
		Other HCGW		0.01427		0.566	0.00113
		Pathological		0.00000		0.000	0.00000
		HCGW: Recyclables		0.01916		0.760	0.00152
		Sealed Sharps		0.01010		0.400	0.00080
		Sharps		0.00039		0.016	0.00003
	770L Wheelie bin system	Chemical	58	0.00000	1862.00	0.000	0.00000
		HCGW: Clothing		0.00472		0.627	0.00125
		HCGW: Food		0.00851		1.132	0.00226
		Infectious		0.93961		124.968	0.24994
		Other HCGW		0.02531		3.367	0.00673
		Pathological		0.00036		0.048	0.00010
		HCGW: Recyclables		0.02104		2.798	0.00560
		Sealed Sharps		0.00000		0.000	0.00000
		Sharps		0.00046		0.061	0.00012
	Other (Not specified systems)	Chemical	14	0.00000	343.39	0.000	0.00000
		HCGW: Clothing		0.00701		0.172	0.00034
		HCGW: Food		0.00000		0.000	0.00000
		Infectious		0.91898		22.541	0.04508
		Other HCGW		0.05203		1.276	0.00255
		Pathological		0.00000		0.000	0.00000
		HCGW: Recyclables		0.02198		0.539	0.00108
		Sealed Sharps		0.00000		0.000	0.00000
		Sharps		0.00000		0.000	0.00000

Sharps	**100L Box in Cage Trolleys**	Chemical	31	0.00134	10.00	0.001	0.00000
		HCGW: Food		0.00000		0.000	0.00000
		Infectious		0.15322		0.109	0.00022
		Other HCGW		0.00624		0.004	0.00001
		Pathological		0.00000		0.000	0.00000
		Sharps		0.83919		0.599	0.00120
	50L Box in Cage Trolleys	Chemical	14	0.00000	1.00	0.000	0.00000
		HCGW: Food		0.01163		0.001	0.00000
		Infectious		0.33857		0.024	0.00005
		Other HCGW		0.00414		0.000	0.00000
		Pathological		0.00000		0.000	0.00000
		Sharps		0.64566		0.046	0.00009
	770L Wheelie bin system	Chemical	49	0.00057	29.00	0.001	0.00000
		HCGW: Food		0.00000		0.000	0.00000
		Infectious		0.21835		0.452	0.00090
		Other HCGW		0.00957		0.020	0.00004
		Pathological		0.00000		0.000	0.00000
		Sharps		0.77151		1.598	0.00320
Specican & Amputations		Amputations	1	1.00000	232.95	16.639	0.03328
		Specican	30	1.00000		16.639	0.03328
General Waste (HCGW)	**Black Bags**	Chemical	129	0.00011	26968.00	0.207	0.00041
		HCGW: Clothing		0.03149		60.660	0.12132
		Domestic waste		0.24660		475.029	0.95006
		HCGW: Food		0.10571		203.632	0.40726
		Infectious		0.02477		47.721	0.09544
		Pathological		0.00000		0.000	0.00000
		HCGW: Recyclables		0.5869		1130.54	2.26
		Sharps		0.00065		1.25	0.00250
		Vials		0.00376		7.24	0.01449
Lab, Morgue & Blood Waste		Blood	56		31.38	.	.
		Laboratory			259.62	.	.
		Morgue			198	.	.

Table 3.1.4: *Mean of Medical Waste as Proportion of Total Waste (Kg)*

Leratong Post-Intervention Study						
		Classification				
		Incorrect		Correct		
		HCW		HCW		
		HCGW	HCRW	HCGW	HCRW	
		Sum	Sum	Sum	Sum	
Waste Type	**System**					
General Infectious Waste	100L Box in Cage Trolleys	8.17	1.69	0	91.86	
	50L Box in Cage Trolleys	1.77	0.42	0	37.45	
	770L Wheelie bin system	7.92	0.11	0	124.97	
	Other	1.99	0	0	22.54	
Total Mass (kg) of Infectious waste per day		**19.85**	**2.22**	**0**	**276.82**	
Sharps	100L Box in Cage Trolleys	0	0.11	0	0.6	
	50L Box in Cage Trolleys	0	0.02	0	0.05	
	770L Wheelie bin system	0.02	0.45	0	1.6	
Total Mass (kg) of Sharps per day		**0.02**	**0.58**	0	**2.25**	
General Waste (HCGW)	.	531.45	1394.83	**1394.83**		
Total Mass (kg) of waste generated per day		**19.87**	**534.25**	**1394.83**	**279.07**	

Table 3.1.5: *Total Mass (kg) per day Estimated over the Sample Period*

Leratong Post-Intervention Study					
		Classification			
		Incorrectly Disposed		Correctly Disposed	
		HCW		HCW	
		HCGW	HCRW	HCGW	HCRW
		Sum	Sum	Sum	Sum
Container Type	**System**				
General Infectious Waste	100L Box in Cage Trolleys	0.01634	0.00338	0	0.18372
	50L Box in Cage Trolleys	0.00354	0.00084	0	0.0749
	770L Wheelie bin system	0.01584	0.00022	0	0.24994
	Other	0.00398	0	0	0.04508
Total Mass (kg) of Infectious waste per day per patient		**0.0397**	**0.00444**	**0**	**0.55364**
Sharps	100L Box in Cage Trolleys	0	0.00022	0	0.0012
	50L Box in Cage Trolleys	0	0.00004	0	0.0001
	770L Wheelie bin system	0.00004	0.0009	0	0.0032
Total Mass (kg) of Sharps per day per patient		**0.00004**	**0.00116**	**0**	**0.0045**
General Waste (HCGW)	Black Bags	0	1.0629	2.78966	0
Total Mass (kg) of waste generated per day per patient		**0.03974**	**1.0685**	2.78966	**0.55814**

Table 3.1.6: *Total Mass (kg) per Patient per day Estimated over the Sample Period (Patients in bed a day=500)*

		Pre-Intervention Study				Post-Intervention Study			
Waste Type	**Waste Compo-nent**	**N**	**Propor-tion**	**Total Mass**	**Mass/ day**	**N**	**Propor-tion**	**Total Mass**	**Mass/- day**
General Infectious Waste	**Infectious**	120	0.74173	3634.00	224.62	204	0.92722	4175.39	276.54
	Sharps		0.00120		0.36		0.00117		0.35
	Chemical		0.00490		1.49		0.00006		0.02
	HCGW		0.25216		76.36		0.06363		18.98
	Sealed Sharps		.		.		0.00782		2.33
	Other(Not specified systems		0.00000		0.00		0.00010		0.03
	Total Correct (Infectious)	**120**	**0.74173**	**3634**	**224.62**	**204**	**0.92722**	**4175.39**	**276.54**
	Total Incorrect		**0.25826**		**78.21**		**0.07278**		**21.71**
Sharps	**Infectious**	71	0.12055	238.55	2.40	94	0.21478*	29.00	0.44
	Sharps		0.85891		17.07		0.77509*		1.61
	Chemical		0.01992		0.40		0.00074		0.00
	HCGW		0.00061		0.01		0.00940		0.02
	Total Correct (Sharps)	**71**	**0.85891**	**238.55**	**17.07**	**94**	**0.77509**	**29.00**	**1.61**
	Total Incorrect		**0.14109**		**2.80**	**94**	**0.22491**		**0.47**
Specican & Amputa-tions	**Patholo-gical**	13	1.00000	67.45	5.62	31	1.00000	232.95	16.64
	Other	1	1.00000				0.00000		0.00
General Waste (HCGW)	**Infectious**	120	0.04352	21526.	78.07	129	0.02477	26968.00	47.72
	Sharps		0.00000		0.00		0.00065		1.26
	Chemical		0.00108		1.94		0.00011		0.21
	HCGW		0.95540		1713.86		0.97071		1869.86
	Other		0.00000		0.00		0.00376		7.24

		Pre-Intervention Study				Post-Intervention Study			
Waste Type	**Waste Compo-nent**	**N**	**Propor-tion**	**Total Mass**	**Mass/ day**	**N**	**Propor-tion**	**Total Mass**	**Mass/- day**
	Total Correct (HCGW)	**120**	**0.9554**	**21526.5**	**1713.87**	**129**	**0.97071**	**26968**	**1869.86**
	Total Incorrect		**0.0446**		**80.01**		**0.02929**		**56.42**
Lab, Morgue & Blood Waste	**Lab**		.	165.65	13.80	56		259.38	18.53
	Morgue		.	116.65	9.72			198.62	14.19
	Blood		.	82.45	6.87			31.38	2.24
Pigswill	**Drums**	.	.	2072.70	172.73		.	2174.00	155.29
Vials	**Vials**	.	.	.	.		.	37.00	2.64
Grand-total				**27903.45**	**2325.32**			**34105.72**	**2436.13**

*NOTE: *) Due to the change in procedure for the handling of vials an error has occurred. The new procedure included separation of whole, empty and unbroken vials for placement is special containers for subsequent recycling/land filling. However, there where some vials placed in the sharps containers. In the study these vials where erroneously classified as misplaced infectious waste, whereas, it should have been classified as correctly placed sharps. Hence, the sum of "infectious" and "sharps" needs to be considered when comparing to the Pre-interventions data. In our assessment and supported by numerous inspections in the wards, the amount of misplaced "infectious waste" had been significantly reduced. It is not unlikely that the real proportion of "infectious" in the sharps containers have been reduced from approx 12% in the pre-intervention study to perhaps 6% in the post intervention study. Hence, it can be assumed that the remaining part of the "infectious" was indeed the very heavy glass vials that should have been classified as correctly placed "sharps".*

Table 3.1.7: Mean of Medical Waste as Proportion of Total Waste (Kg)

Leratong Pre- and Post-Intervention Studies																
	Waste Disposal															
	Correctly Disposed								Incorrectly Disposed					Total		
	HCGW				HCRW				HCGW				HCRW			
Waste Type	Pre		Post		Pre		Post		Pre		Post		Pre		Post	
General Infectious Waste	0	0.000	0.00	0	0.442	0.553	0.15	0.038	0.03	0.005	0.00	0	0.157	0.033	0.45	
Sharps	0	0	0.00	0	0.034	0.003	0.00	0	0.00	0.006	0.00	0.001	0	0	0.00	0.040
Laboratory	0	0	0.00	0	0.027	0	0.00	0	0.00	0	0.00	0	0	0	0.00	0.028
Specican & Amputaions	0	0	0.00	0	0.000	0.003	0.02	0	0.00	0	0.00	0	0	0	0.00	0.000
Blood bank	0	0	0.00	0	0.014	0	0.00	0	0.00	0	0.00	0	0	0	0.00	0.014
Sub-total	0	0	0.00	0	0.516	0.559	0.15	0.038	0.03	0.006	0.00	0	0.158	0.034	0.53	
General Waste (HCGW)	4	3.370	3.74	0	0.000	0	0.00	0	0.00	0	0.16	0.113	3.37	0	3.74	0.160
GRAND TOTAL	4	3.370	3.74	0	0.516	0.559	0.15	0.038	0.03	0.006	0.16	0.113	3.528	0.034	3.77	0.694

Table 3.1.8a: *Total Mass (kg) Estimated over the Sample Period - Mass per patient per Day*

Leratong Pre- and Post-Intervention Studies												
	Waste Disposal											
Waste Type	Correctly Disposed				Incorrectly Disposed				Total			
	HCGW		HCRW		HCGW		HCRW		HCGW		HCRW	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
General Infectious Waste	0.00	0.00	224.62	276.54	76.36	18.98	1.85	2.73	76.36	18.98	226.47	279.27
Sharps	0.00	0.00	17.04	1.61	0.01	0.02	2.79	0.45	0.01	0.02	19.83	2.06
Laboratory	0.00	0.00	13.80	18.53	0.00	0.00	0.00	0.00	0.00		13.80	18.53
Morgue	0.00	0.00		14.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.19
Specican & Amputaions	0.00	0.00	5.62	16.64	0.00	0.00	0.00	0.00	0.00	0.00	5.62	16.64
Blood bank	0.00	0.00	6.87	2.24	0.00	0.00	0.00	0.00	0.00	0.00	6.87	2.24
Sub-total	0.00	0.00	267.95	329.75	76.37	19.00	4.64	3.18	76.37	19.00	272.59	332.93
Percentage	0%	0%	76.79%	93.70%	21.89%	5.40%	1.33%	0.90%	21.89%	5.40%	78.11%	94.60%
General Waste (HCGW)	1713.86	1869.86	0	0	0	0	80.01	56.43	1713.86	1869.86	80.01	56.43
Percentage	95.50%	97.07%	0%	0%	0%	0%	4.50%	2.93%	95.50%	97.07%	4.50%	2.93%
GRAND TOTAL	1713.86	1869.86	267.95	329.75	76.37	19.00	84.65	59.61	1790.23	1888.86	352.60	389.36
Percentage	79.98%	82.08%	12.50%	14.47%	3.56%	0.83%	3.95%	2.62%	83.55%	82.91%	16.45%	17.09%
Grand total per patient per day (kg/p/d)	3.374	3.740	0.527	0.660	0.150	0.038	0.167	0.119	3.524	3.778	0.694	0.779

Table 3.1.8b: *Total Mass (kg) Estimated over the Sample Period - Mass /Day excluding food waste/pig swill)*

APPENDIX A

HCW Data Recording Sheets

A1: Total Daily Waste Recording Sheets

The following are the suggested forms for recording the total daily numbers and mass of containers at Leratong Hospital and the Treatment Facility.

Form A1: Total Number of containers and Mass generated each day

Date: _____ Facility: Leratong Hospital
Recorded by:_____ Checked by:_____
Form No.:_____

Container/Product		Number of containers	Mass
Sharps	5 L		
	10 L		
	20 L		
Specican	5 L		
	10 L		
	20 L		
General Infectious Waste	50 L		
	140 L		
	240 L		
Blood Bank			
HCGW	Food Waste Recyclable Protective clothing		

Form A2: Total Number of containers and Mass collected each day

Date: _____ Facility: **Treatment Facility**
Recorded by:_____ Checked by:_____
Form No.:_____

Container/Product		Private Hospital		Public Hospital	
		Number of containers	Mass (Kg)	Number of containers	Mass(Kg)
Sharps	5 L				
	10 L				
	20 L				
Specican	5 L				
	10 L				
	20 L				
	50 L				
	140 L				
General Infectious Waste	240 L				

A2: Daily Waste Component Recording Sheets

Suggested layouts for recording waste component mass.

Form A3: Waste sorted from receptacles for general infectious waste (50 litre and 142 litre boxes or 240 litre wheelie bins)

Day: _____ Date: _____
Container type / size :_____ Container Sampling I.D.:_____
Recorded by: _____ _____ Checked by:_____
Captured by:_____ Checked by:_____
♣Facility:_____Mass of sealed container_____

Waste Component Category - Segregated as:	**Mass in Kilograms**		
	***Number**	**Gross**	**Tare**
Infectious waste			
PVC			
Pathological waste			
Sharps			
Chemical waste			
Radioactive Waste			
HCGW: Food waste			
HCGW: Recyclable			
HCGW: Clothing			
HCGW: Other			
Total mass of container contents			

Form A4: Waste sorted from sharps containers (e.g. 5 litre, 10 litre and 20 litre)

Day: _____ Date: _____
Container type / size :_____ Container Sampling I.D.:_____
Recorded by: _____ _____ Checked by:_____
Captured by:_____ Checked by:_____
Facility:_____ Mass of sealed Container:_____

Waste Component Category - Segregated as:	**Mass in Kilograms**		
	Number	**Gross**	**Tare**
Sharps			
Infectious waste			
PVC			
Chemical waste			
Pathological waste			
Radioactive Waste			
HCGW			
Total mass of container contents			

♣ If Treatment facility state whether public or private.
*** If applicable.**

Form A5: Waste sorted from Specican containers (buckets 5 litre, 10 litre and 20 litre

Day: _____ Date: _____
Container type / size :_____Container Sampling I.D.:_____
Recorded by: _____Checked by:_____
Captured by:_____ Checked by:_____
Facility:_____Mass of sealed Container:_____

Waste Component Category - Segregated as:	**Mass in Kilograms**		
	Number	**Gross**	**Tare**
Pathological waste			
Stool specimens			
Liquids			
Infectious waste			
Chemical waste			
Radioactive Waste			
HCGW			
Total mass of container contents			

Form A6: General Waste sorted (e.g. from plastic bags or 240 wheelie bins, but excluding separately sorted food stuff)

Day: _____ Date: _____
Container type / size :_____ Container Sampling I.D.:_____
Recorded by: _____ _Checked by:_____
Captured by:_____ Checked by:_____
Facility:_____ Mass of sealed Container:_____

Waste Component Category - Segregated as:	**Mass in Kilograms**		
	Number	**Gross**	**Tare**
Infectious waste			
PVC			
Pathological waste			
Sharps			
Chemical waste			
Radioactive Waste			
HCGW: Food Waste			
HCGW: Recyclabls			
HCGW: Clothing			
Total mass of container contents			

Form A7: Blood bank, Laboratory and Mortuary waste: No sorting. Only weighing of quantities generated.

Day: _____ Date: _____
Container type / size :_____ Container Sampling I.D.:_____
Recorded by: _____ _Checked by:_____
Captured by:_____ Checked by:_____
Facility:_____ Mass of sealed Container:_____

Waste Component Category - Segregated as:	**Mass in Kilograms**
Blood Bank	
Laboratory Waste	
Mortuary Waste	

A3. Data Entry Excel Spreadsheets

The following Excel Spreadsheets should be created for data entry. Please note that these sheets are according to the forms suggested above. Data recorded for health and treatment facilities in Form A1 to A5 should be entered in the same (appropriate) sheet constructed below.

i) **Sheet1**: The total number of containers generated each day at **Leratong hospital** and **Itireleng clinic;**
ii) **Sheet2**: The total number of containers received each day at the **Treatment Plant**;
iii) **Sheet3:** Waste sorted from receptacles for general infectious waste (50 litre and 142 litre boxes or 240 litre wheelie bins**)**;
iv) **Sheet4**: Waste sorted from sharps containers (e.g. 5 litre, 10 litre and 20 litre**)**;
v) **Sheet5**: Waste sorted from specican containers (buckets 5 litre, 10 litre and 20 litre;
vi) **Sheet6:** General Waste sorted (e.g. from plastic bags or 240 wheelie bins, but excluding separately sorted food stuff;
vii) **Sheet7:** Food Waste and Blood Samples: No sorting at all. Only weighing of daily quantity generated.

Sheet1 (Form A1): Total number of containers generated each day at Leratong hospital and Itireleng clinic														
Date	Capturer	Form No.	Source	Sorting Area	Hospital	5L Sharps	10L Sharps	20L Sharps	5L Specican	10L Specican	20L Sharps	50L Box	140L Box	240L Box	Blood

Source: ***Leratong hospital or Itireleng clinic***

Sheet2 (Form A2): Total number of containers received each day at the Treatment Plant														
Date	Capturer	Form No.	Source	Sorting Area	Hospital	5L Sharps	10L Sharps	20L Sharps	5L Specican	10L Specican	20L Sharps	50L Box	140L Box	240L Box	Blood

Source: ***From public or private health facility***

♥Sheet 3 (Form A3): Waste sorted from receptacles for general infectious waste (50 litre and 142 litre boxes or 240 litre wheelie bins)																					
Date	Capturer	Form No.	Sample ID	Sorting Area	Container	♦Source	Infectious waste		Pathological waste		Sharps		Chemical waste		Radioactive Waste		Food waste		HCGW	
							Gross Mass	Tare Mass	Gross Mass	Tare Mass	Gross Mass	Tare Mass	Gross Mass	Tare Mass	Gross Mass	Tare Mass	Gross Mass	Tare Mass	Gross Mass	Tare Mass

Sheet4 (Form A4) : Waste sorted from sharps containers (e.g. 5 litre, 10 litre and 20 litre)																	
Date	Capturer	Form No.	Sample ID	Sorting Area	Container	Source	Infectious waste		Pathological waste		Sharps		Chemical waste		Radioactive Waste		HCGW	
							Gross Mass	Tare Mass	Gross Mass	Tare Mass	Gross Mass	Tare Mass	Gross Mass	Tare Mass	Gross Mass	Tare Mass	Gross Mass	Tare Mass

♥ Columns for the number of items should be inserted in sheets 3 to 6 where applicable.

♦ Source refers to Leratong hospital or Itireleng clinic in the case of health facility and to public or private in the case of treatment plant.

Sheet5 (Form A5): Waste sorted from specican containers (buckets 5 litre, 10 litre and 20 litre)																			
Date	Capturer	♥Form No.	Sample ID	Sorting Area	Container	Source	Infectious waste		Pathological waste		Sharps		Chemical waste		Radioactive Waste		HCGW	
							Gross Mass	Tare Mass	Gross Mass	Tare Mass	Gross Mass	Tare Mass	Gross Mass	Tare Mass	Gross Mass	Tare Mass	Gross Mass	Tare Mass

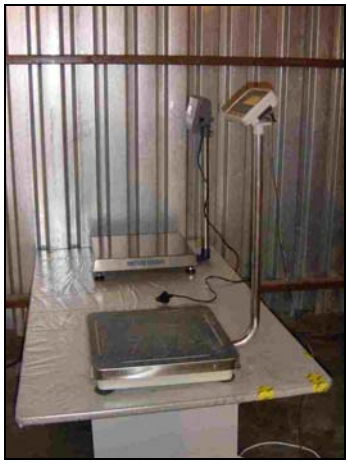
Sheet6 (Form A6) : General Waste sorted (e.g. from plastic bags or 240 wheelie bins, but excluding separately sorted food stuff)																			
Date	Capturer	Form No.	Sample ID	Sorting Area	Container	Source	Infectious waste		Pathological waste		Sharps		Chemical waste		Radioactive Waste		Food waste		HCGW	
							Gross Mass	Tare Mass	Gross Mass	Tare Mass	Gross Mass	Tare Mass	Gross Mass	Tare Mass	Gross Mass	Tare Mass	Gross Mass	Tare Mass	Gross Mass	Tare Mass

Sheet7 (Form A7): Blood Samples: No sorting at all. Only weighing of daily quantity generated							
Date	Capturer	Form No.	Sample ID	Sorting Area	Container	Source	Blood sample
							Gross Mass

♥ All the forms should be numbered and the numbers entered in this column.

APPENDIX B

Pictures of the Sample Sorting




COLD
ZONE


WARM
ZONE


METTLER TOLEDO