PROJECTION OF HOSPITAL AND CLINIC HEALTH CARE RISK WASTE GENERATION QUANTITIES AND TREATMENT CAPACITIES FOR THE SOUTH AFRICAN NATIONAL WASTE MANAGEMENT STRATEGY IMPLEMENTATION PROJECT

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ABSTRACT

This paper addresses the need for quantitative data for planning health care risk waste (HCRW) management from hospitals and clinics in South Africa. Quantitative estimates of HCRW generation and treatment capacity are determined for hospitals and clinics so that: 1) provincial tenders can be prepared and assessed, even if there is no previous recording of masses of HCRW, 2) the outcomes of regional pilot projects can be assessed in a national context, and 3) policy and strategy options can be assessed before changes in policy are made. Projections for generation and treatment come to approximately 28 000 tonnes per annum (tpa). Hospitals are the major source ie, 92%, and commercial treatment services are the major treatment destination, ie, 88%. Authorized treatment facilities capacity, ie, having at least one of, the Provincial EIA Record of Decision (RoD) approval, and the air pollution control licence to operate an incinerator, exceeded generation masses by 36% for January 2006, and this is expected to increase to 84% unless some plants reduce capacity. The treatment and collection capacity of service providers is available to all rural hospitals and clinics in 7 of the 9 provinces, including the most remote facilities in the least populated province Northern Cape. In some provincial departments, segregation, storage and administrative capacity to use these services is still being developed and as result HCRW is being burnt in pits in some rural areas. Commercial treatment services operate nationally on an open bidder tender basis and for each province HCRW is transported over provincial boundaries.

Context and background: This projection is part of the National Waste Management Strategy Implementation project (http://www.deat.gov.za/nwmsi/index.html) and provides the first national inventory of HCRW. The project is shared by the National Department of Environmental Affairs and

Tourism and the National Department of Health in collaboration with Danish International Development Assistance (DANIDA).

Approach and methodology: Generation rates for 6 classes of hospitals are measured from HCRW masses and bed occupancies for 137 of the 836 hospitals in the data set. These are verified using three provincial data sets. The national average for hospitals is 0.80 kg/patient bed day. Unverified generation rates for 5 classes of clinics based on measurements from 61 Gauteng clinics and projected for 3 501 clinics. Hospital projections are made for the 6 provinces which do not have mass based collection systems. Treatment capacities were calculated for 12 authorized commercial service plants and 1 authorized and 148 un-authorized on-site hospital facilities. The generation projections for hospitals were verified using measurements from 3 provinces. Treatment capacities were verified using equipment performance specifications, achievable operating hours and mass flow rates calculated from the reported collection and treatment quantities and operating hours.

KEYWORDS

Keywords: health care risk waste, generation rates, classification of health care facilities, provincial and national projections, treatment, policy

INTRODUCTION

This study has been carried out as part of the National Waste Implementation Strategy Project and more details can be obtained from the website http://www.deat.gov.za/nwmsi/index.html. The project approach follows that of the Gauteng HCRW project (Gauteng DACE, 2000-2004) in which quantitative data on HCRW generation rates and treatment capacities were used to develop policies and regulations that promote the safe and cost effective management of Health Care Waste. The generation rates reported in 2000 from the Gauteng project were the starting point for the national generation data set. It contained a facility name, classification, number of patients served, and HCRW masses collected for a sample of each class of hospital and clinic. None of this information was readily available for hospitals in the other 8 provinces. The approach was to prepare an initial public data set by using the National Department of Health (NDoH) Information System (IS) data set for 2004, and verify it with the data from each province. All of the main data sets were accessed with the assistance of the owners of the data. All data that was received was analysed and checked for internal consistency and cross consistency with all the other available data sets after which it was entered into the national data set from which all data in this paper is taken.

PART 1: HEALTH CARE RISK WASTE GENERATION

A review of HCRW generation rates has been provided by the World Health Organization (WHO) (Preuss 1999). This provides rates in various country and hospital situations. Generation rates can be expected to be variable as the result of differences in waste management methods, the class of facility, relative service levels in a class of facility eg, in-patient/out-patient ratios, as well as the amount of reuse of medical equipment. The reported data (Preuss 1999) (Ratala 1989) show a tendency to higher generation rates in higher income countries. The facility rates can vary over a factor of ten within a country. The objectives of the SA projections report are to:

- Provide projections of annual amounts of HCRW for each of the provinces
- Explain how projections can be made and how reliable they can be in order to enable Provinces, District Municipalities and waste management service providers to make realistic estimates of HCRW quantities for the preparation of quantitative waste management plans, eg, preparation of tender documents and numbers of HCRW containers.
- Establish benchmarks for typical generation rates so that waste managers can verify their measurements by using data from other provinces in the private and public sectors.
- Provide facility classification system that relates to HCW compositions and quantities. This includes recommendations on how to make use of the National Department of Health Information System (NDoH IS) for setting up a Waste Information System (WIS), and on how to use this area for policy development.
- Enable the impact of pilot projects to be estimated at national level, by showing how calculations can now be carried out for each type of public sector clinic and hospital.

The steps used to prepare generation data sets are:

1. Identify all the Health Care Facilities and obtain measurements of services offered, eg, patients served per annum, at each facility and aggregate the facilities into classes of facility, eg, District Hospitals.
2. Obtain measurements of the amount of HCRW for a representative sample of each class of health care facilities over a time period that represents a typical operating cycle, eg, one year of services.
3. Calculate generation rates for these samples, eg, by dividing the mass of HCRW by the number of patients served, or the number of days that the service is operated, and analyse the data so that statistical significance can be verified, eg, by inter provincial comparisons.

Composition of Health care waste in South Africa

The composition of Health Care Waste (HCW) leaving a regional hospital in SA has been analysed in terms of the SANS 10248 waste categories (DMSA cc, 2003) (Gauteng DACE, 2000-2004). The contributions by the non-hazardous Health Care General Waste (HCGW) stream and the hazardous Health Care Risk Waste (HCRW) are given in Table 1.

Table 1 Typical composition of a HCRW stream at a hospital using the SANS 10248 classification system

Categories of HCW found in HCRW containers	HCRW sub-category	SA -values (%Mass) (Note 1)		WHO indication values (Note 2)
		Before training	After training	
Infectious	Anatomic (/pathological)	1.6%	4.3%	75%
	non-anatomic	66.2%	75.9%	
	Sharps	5.6%	0.5%	5%
Chemical		3.9%	4.8%	15%
Radioactive				<5%
General		22.7%	14.5%	n.a
All HCRW as % of total waste stream		15%	17%	20%

Note 1: SA Data obtained for Leratong Regional Hospital (DMSA, 2003) for waste analysed at the SANUMED treatment facility as part of the Gauteng study on segregation in public and non-public health care facilities (Gauteng DACE, (2000-2004)).

Note 2: WHO, 1999 provides estimates for preliminary planning in developing countries that do not include a breakdown between anatomic and non-anatomic infectious waste sub categories.

Note 3: The large reduction in sharps after training is due to the placement of glass vials into reusable and puncture proof plastic containers, so as to reduce the costs due to single use sharps safety boxes.

Health care facility service levels, waste compositions, and generation rates

The National Department of Health has classified public health care facilities using a service level system. These levels are discussed below and illustrated in Figure 1 with the SANS 10248 waste categories that can be expected from the services.

- Service Level 1: primary health care up to general practitioner services. These include all immunization, accidents and emergencies and are provided by Clinics, Community Health Centres and District Hospitals.

- Service Level 2: specialist support to the Level 1 facilities provided up to medical specialist level, as well as some Level 1 activities. These include general surgery, obstetrics and gynecology, radiology and anesthetics, pediatrics, orthopedics, and general medicine and are mostly provided by Regional Hospitals.

- Service Level 3: sub specialist support is provided to the Level 2 facilities and includes for example sub-specialist surgery, urology, neurosurgery, plastic surgery, and cardiothoracic surgery and is mostly provided by Provincial Tertiary and National Central Hospitals.

Because the number of services and HCRW categories increases with the Service Level it can be expected that the HCRW generation rates will be correspondingly higher for the Level 2 and Level 3 health care facilities (see Table 2). Example of additional wastes generated by these facilities are as follows:

- Radioactive wastes, and infectious wastes from pathology test laboratories, and chemical wastes from laboratories and R&D pharmacies, eg, carcinogenic drugs oxidizing substances and organic solvents.

- Specialist wards wastes, eg, isolation, and oncology wards, and operating theatres waste, eg, anatomical waste from surgery.

Not all waste generators are identified on the NDoH health care facility classification system. For example, some support facilities to the health care facilities, eg, pathology and R&D laboratories are not located on the hospital premises. Only those support facilities that dispose of their HCRW via the hospital contract are included in the measurements reported by the provincial Departments of Health.

Sources of information on usage and service levels at health care facilities

Each month the NDoH collates the "in-patient bed days" for the public hospitals and the "head counts and deliveries" for public clinics. This is contained in the NDoH Information System (IS) and can include other information such as GIS coordinates and phone numbers. Similar data is available for the non-public hospitals in the annual Hospital and Nurses handbook which includes total beds and services for hospitals and clinics. The industry average for bed occupancies is used to calculate the equivalent to the public sector measurement for in-patient bed days. One of the problems experienced with identifying health care facilities for waste management purpose in the NDoH IS is the practice of separate reporting for each section within the clinic, such as Maternity and Obstetrics Units (MOU). This practice and the incidence of more than one name for clinics, eg, due to renaming, can result in double counting. The NDoH data set was validated by cross checking with the Hospital and Nurses Handbook, using the GIS coordinates, and verification by the provincial Departments of Health.

Determination of generation rates per class of health care facility

Quantities of HCRW per health care facility are obtainable from the service providers who weigh the HCRW as required by the service contracts with the Gauteng, Free-State and Kwa-Zulu Natal DoHs. The data was checked for consistency by statistical analysis and validated by inter provincial comparisons. In the case of Regional Hospitals this comparison resulted in the removal of the 2000 Gauteng data because it reduced the Gauteng rate by approximately a factor of 2. The results of public sector hospital comparison can be seen in Table 22. Non-public hospital generation rates were only available from the Gauteng 2000 report, and an additional statistical analysis and spot checks were carried out to check for outliers. This resulted in a reduction of the average of hospital generation rate from 1.57 to 1.09 kg/patient bed day and is discussed in the project report (Rogers, 2006).

Table 2: Summary of public hospital generation rates for Gauteng, Free State, and Kwa-Zulu Natal using 2005 survey data

	Gauteng	KZN	Free State	Avg.	median	Std dev
Category	**kg/pbd**	**kg/pbd**	**kg/pbd**	**kg/pbd**	**kg/pbd**	**kg/pbd**
National Central Hospital	1.26	1.22	-	1.24	-	-
Provincial Tertiary Hospital	-	1.36	1.70	1.53	-	-
Regional Hospital	1.11	1.12	0.92	1.05	1.11	0.11
District Hospital	0.59	0.71	0.65	0.65	0.65	0.06
Specialised Hospital	0.04	0.15	0.30	0.17	0.15	0.13

Public clinic generation rates for 2005 were obtained by an analysis of a set of Gauteng data for 3 months in 2005. DoH advised that two categories of clinic be used, ie, Community Health Centres, which operate 7 days per week and have up to 30 beds for overnight stay, and Clinics which work fewer days and do not typically have beds. This also yielded differences from the Gauteng 2000 data and is shown in Table 4. The differences are a factor of two; the 2005 data has a larger sample and for this reason is used in the projection. Private clinic generation rates were not obtained for 2005 and the Gauteng 2000 survey have been used. More information and comparisons for the clinic generation rates are provided in the project reports and support documentation (Otto, 2000) (Rogers, 2006).

Calculations of quantities of HCRW using generation rates per health facility

HCRW generation quantities were calculated annually for each hospital using the annual in-patient bed days and the average generation rate for that class of facility. For the six provinces where public hospitals' generation rates were not available, the applicable average in Table 2 was used,

Mass of HCRW = No of patient bed days/an * kg/patient bed day per class of hospital…Eq 1

For non-public hospitals the industry average occupancy of 0.62 was used as follows:

Mass of HCRW = Average occupancy * No of beds * kg/patient bed day* 365 days……..Eq 2

Clinics quantities are calculated using average generation rates per class of clinic, ie,

Mass of HCRW = Generation rate for class of clinic (kg/day) * No. days open/an……..Eq 3

The results of these projections for each province are provided in Table 5 and Table **6**. A summary of the breakdown between hospital and clinic and public and non-private quantities of waste is given in Table 1. The precision of the projection for clinics is lower than that of the hospitals due to the higher variability. The accuracy could not be established because only one province was able to provide masses on a per-clinic basis. The head count generation rate was not used here, in part due to the larger difference between the median and the average rates. A check on the effect of the daily average and head count methods was made by comparing projections for the 9 provinces, and this showed that the facility generation rate provided a higher estimate. In the absence of any other information, and in order to bias the projection to an over, rather than an under projection for the treatment capacity assessment (see further discussion in Part 2), the national projection has been based on the daily generation rate. If the head count rate would be used, the projection of quantities from clinics would be lower than the 2222 tonnes and 8% of the total projection given in Table 3.

Table 3: Relative contributions of hospitals and clinics, and public and non-public sectors to the national HCRW inventory

	Hospitals		**Clinics**		**Total**		
	Number	**tonnes/an**	**Number**	**tonnes/an**	**Number**	**tonnes/an**	**%**
Public	422	16 168	3 225	1 912	3 647	18 080	**64%**
Non-public	414	9 861	276	309	690	10 170	**36%**
Sum	**836**	**26 029**	**3 501**	**2 222**	**4 337**	**28 251**	**100%**
Total %Wt		**92%**		**8%**		**100%**	

Note: The authors would like to mention here that in addition to the **generation** masses shown in the paper, relatively small individual HCRW amounts will be generated by many GPs, home care, specialists, laboratories and similar minor sources. Based on professional opinions as to how many of these there are in SA and how much each of these could generate on an annual basis, these quantities are believed to total not more than 3-5% of the hospitals and clinics generation quantities. As the treatment masses already account for some of this waste, ie, that is already being collected from these sources, any additional quantity to the total inventory will be less than this 3-5% of the estimate of the national inventory.

SANS 10248 Waste category coming from HCF	SANS 0228 Classification codes	Typical source(s) in health care facilities	Relative Complexity of hazard management system for HCF (see Option 3 in text)	Clinics	CHC's	District	Specialised Chronic	Regional National	Specialised critical	Provincial Tertiary /National Central
NDoH Service level				Level 1	Level 1	Level 1	Level 1	Level 2	Level 2/3	Level 3
A: Human or animal Anatomical	infectious	MOU, Operating theatres, laboratories	Smaller/Larger	limited	Yes	Yes	Yes	Yes	?	Yes
B: Infectious										
- non-anatomic	infectious	general wards, clinics, consulting rooms	Smaller	Yes	Yes	Yes	Yes	Yes	Yes	Yes
		Isolation wards	Larger	No	No	Yes	Yes	Yes	Can be	Yes
		Operating theatres	Larger	No	Limited	limited	?	Yes	?	Yes
- pathological	infectious	pathology research and laboratory testing (Note1) ,	Larger	No	No	limited	limited	Yes	?	Yes
C: Sharps	infectious	general wards, immunization at clinics	Smaller	Yes	Yes	Yes	?	Yes	Yes	Yes
D: Chemical/ pharmaceutical										
-Chemical	-explosive -gaseous -flammable -oxidizing -corrosive -toxicity	Laboratories, pharmacy	Larger	No	No	limited	limited	Yes	?	Yes
-Pharmaceutical excluding cytotoxic	toxicity	Pharmaceutical stores, wards, returned drugs	Smaller	No	Yes	Yes	Yes	Yes	Yes	Yes
-Cytotoxic pharmaceutical	toxicity	Laboratories, oncology, wards	Larger	No	No	Yes	Yes	Yes	Can be	Yes
E: Radioactive	radioactive	Oncology, X-ray, laboratories	Larger	No	very limited	limited	limited	Yes	?	Yes
Note 1: NDoH Laboratory Service facilities are not classified as Health Care Facilities by NDoH										

Figure 1. Health care service levels and waste compositions at health care facilities

Table 4: HCRW Generation rates from SA and international sources

	Sample size	Generation rate				unit	Reference
		lower	upper	median	average		
Botswana Private Hospitals					1	kg/bed/day	(Prüss,1999)
Botswana Referral and Regional Hospitals					0.75	kg/bed/day	(Prüss,1999)
South American Countries					0.60	kg/bed/day	(Prüss,1999)
high income countries		0.4	5.5			kg/head of population	(Prüss,1999)
middle income countries		0.3	0.4			kg/head of population	(Prüss,1999)
USA Nation Wide Hospital Survey on infectious waste	441			1.04		kg/patient/day	(Rutala,1989)
Tanzania Referral Regional and District hospitals					0.41	kg/patient occupied bed/day	(Prüss,1999)
Health Care Centres and Dispensaries					0.03	kg/patient/day	(Prüss,1999)
SA Non-public Gauteng	10	0.50	2.53	0.97	1.09	kg/patient bed/day	(Otto, 2000), (Rogers, 2006)
SA Public hospitals-District province ann. averages	3	0.59	0.71	0.65	0.65	kg/patient bed/day	(Rogers, 2006)
SA Public hospitals- Regional province ann. averages	3	0.92	1.12	1.11	1.05	kg/patient bed/day	(Rogers, 2006)
SA Public - National Central province ann. averages	2	1.22	1.26		1.24	kg/patient bed/day	(Rogers, 2006)
SA Public - Provincial Tertiary Hospital, province ann. Averages	2	1.36	1.70		1.53	kg/patient bed/day	(Rogers, 2006)
SA Public hospitals – Specialized, province ann. Averages	3	0.04	0.30	0.15	0.17	kg/patient bed/day	(Rogers, 2006)
Gauteng Clinics (2000)	6	0.005	0.05		0.015	kg/patient	(Otto, 2000)
Gauteng Community Health Centres (2000)	6				0.05	kg/patient	(Otto, 2000)
Gauteng Clinics (2005)	39	0.0020	0.022	*0.0047*	*0.0080*	kg/patient	(Rogers, 2006)
Gauteng Community Health Centres (2005)	15	0.00070	0.068	*0.029*	*0.024*	kg/patient	(Rogers, 2006)
Gauteng Clinics (2005)	39	0.091	4.29	*0.79*	*0.77*	kg/day	(Rogers, 2006)
Gauteng Community Health Centres (2005) (Note 2)	14	0.20	27.9	*10.3*	*11.5*	kg/day	(Rogers, 2006)
SA public- all hospital classes 3 provinces (2005)	125	0.0030	2.08		0.79	kg/patient bed/day	(Rogers, 2006)

Note 1: high-lighted numbers are 2005 values. Clinic values in italics are 3 month averages have not been verified by inter-provincial comparisons
Note 2: Hillbrow CHC has 1.8 tonnes per month of waste from the pharmacy, and is therefore excluded from the kg/day calculation
Note 3: 125 of the 422 public hospitals were included in the sample from which the projections were made

Table 5: Hospital data on HCRW generation

Sector	**Public**					**Non-public**				**Total**
Province	Hospitals	Capacity	Capacity	Patient bed days	Waste	Hospitals	Capacity	Patient bed days	Waste	**Waste**
Units	No.	Total beds	Usable Beds	measured	tonnes/an	No.	Total Beds	est.	tonnes/an	**tonnes/an**
Eastern Cape	91	17 805	15 900	4 152 189	2 238	28	3 380	764 894	849	**3 087**
Free State	31	5 865	5 157	1 636 312	1 027	21	1 951	441 511	490	**1 517**
Gauteng	29	16 835	15 887	4 495 375	3 216	131	16 011	3 623 289	4 022	**7 238**
Kwa-Zulu Natal	74	28 850	25 366	6 240 641	4 218	76	3 932	889 812	988	**5 206**
Limpopo	47	11 067	9 138	2 313 813	1 631	3	340	76 942	85	**1 716**
Mpumalanga	31	4 847	4 802	1 111 399	818	13	1 251	283 101	314	**1 132**
North West	30	6 958	5 916	1 486 765	914	19	1 478	334 471	371	**1 286**
Northern Cape	30	1 884	1 907	518 755	311	16	779	176 288	254	**566**
Western Cape	59	10 569	9 642	2 939 871	1 796	62	4 670	1 056 821	1 173	**2 969**
Mining						45	4 514	164 761	1 314	**1 314**
Total	**422**	**104 680**	**93 715**	**24 895 120**	**16 168**	**414**	**38 306**	**7 811 891**	**9 861**	**26 029**

Table 6: Clinic data on HCRW generation

Sector	**Public**		**Non-public**		**Total**	
Province	Clinics	Waste	Clinics	Waste		
Units	No.	tonnes/an	No.	tonnes/an	**tonnes/an**	%
Eastern Cape	697	302	18	21	**323**	15%
Free State	229	100	4	5	**105**	5%
Gauteng	333	179	104	119	**298**	13%
Kwa-Zulu Natal	514	187	37	43	**229**	10%
Limpopo	447	215	2	2	**217**	10%
Mpumalanga	241	222	16	19	**241**	11%
North West	356	339	19	22	**361**	16%
Northern Cape	96	94	5	6	**100**	5%
Western Cape	312	276	60	70	**346**	16%
Mining			11	3	**3**	0.12%
Total	**3 225**	**1 912**	**276**	**309**	**2 222**	**100%**

PART 2: HEALTH CARE RISK WASTE TREATMENT

The treatment facility survey was carried out by questionnaire and interview of all the main service providers and Provincial Departments of Health and Environment.

The objectives of the survey were to: Identify HCRW treatment and disposal facilities, and to establish whether additional treatment capacity is required, and to make projections of treatment capacity to establish whether additional authorized capacity should be planned.

Classification of health care waste treatment facilities

Facility registration as a waste disposal site is required by the National Environmental Management Act (NEMA) and subsidiary regulations, eg, National Air Quality Management Act and the scheduled process 39 of the former Air Pollution Prevention Act for medical waste incinerators. The reporting requirements in the regulations were used as the basis for a survey questionnaire to all the operators of treatment facilities. The survey fields include: HCRW facility site name, ownership, address, facility permits and licences (eg, air pollution, treatment and storage, EIA record of decision, and radioactive waste dispersal) treatment technology, capacity, actual throughput, and operational status (eg, operational, waiting repairs or decommissioned).

Only those facilities that were reported to be in operational status, ie, treating HCRW waste over the period October 2005 to January 2006 were included in the survey. The two treatment technologies are incineration to destroy pathogens and the waste, and steam treatment to destroy pathogens and shredding to make the waste unrecognizable prior to disposal on a landfill site permitted for the waste. Treatment facilities that are not in operational condition or that have been decommissioned (eg, the two former Evertrade facilities in Cape Town and Johannesburg) were not included in the survey. If a health care facility did not have a confirmed means of either treatment or transport to an identified treatment facility, it was recorded as having its own treatment operation, eg, incinerator or open pit burning. The survey distinguishes between unauthorized and authorized facilities, ie, facilities that have been approved and inspected for safe operations under one or more of the air pollution regulations, the provincial EIA, or the storage exemption from Sect 20 of the Environmental Conservation Act amendment Act 53 of 2003. In addition there are the HCRW regulations for waste treatment and municipality regulations in some provinces.

A survey form was completed for each of the commercial service provider facilities that were operational or that are being built as part of a tender requirement. On site treatment facilities were surveyed using available data, eg, consultant reports, and interviews with the owners. Information from Hospital located facilities was typically limited to type of treatment technology, model and name of equipment, and use of any available collection and treatment services. Hospitals operate much smaller equipment with correspondingly lower average throughputs, ie, 20 to 100 kg/day, than commercial treatment suppliers, ie, with throughputs of 3 000 to 12 000 kg/day. Only one hospital (newly built and with 40 kg/day) was reported to have a Provincial RoD. All commercial treatment facilities were authorized. As HCRW mass was not measured at hospitals, the quantity treated was equated to hospital and serviced clinics combined generation quantity.

Treatment throughputs for the treatment facilities

The summary of the treatment throughputs is provided in Table **3).**

Table 8. Twelve commercial facilities treat 88% of the HCRW. This is achieved by larger treatment facilities, operating full time with scheduled maintenance plans to minimize downtown, that use standard containers and long range collection systems with transfer stations that meet cost and safety standards specified in provincial level tenders that serve both rural and urban areas. For each of the provinces some HCRW is transported over provincial boundaries.

Table 7: Quantities of HCRW treated by service providers, public hospitals and non-public hospitals at January 2006

	HCRW treatment (tpa)			
Province	**Commercial Service Provider**	**Public Hospital**	**Non-public Hospital**	**Total**
Eastern Cape	960	2 238		3 198
Free State	756			756
Gauteng	9 812			9 812
KZN	6 960			6 960
Limpopo			45	45
Mpumalanga		818	113	931
North Cape		18		18
North West	3 888			3 888
Western Cape	2 239	112		2 351
SA	**24 615**	**3 185**	**158**	**27 959**
% of total	**88%**	**11%**	**1%**	**100%**

Treatment capacities with existing treatment plants

In order to determine whether additional treatment capacity is required, the current authorized capacity was compared with the generation projection so as determine whether there was an excess or shortfall. For commercial plants, total capacity was calculated by using the authorized limits for the plant, and the achievable operating hours and measured hourly throughputs for HCRW. Industry performance, equipment ratings and model numbers were used to cross check these reported capacities and were adjusted if necessary after discussions with each facility manager. The industry norms used for weekly capacity calculation for the newer incinerators are 24 hours per day and 5.5 days per week, and for steam and shredding treatment, 24 hours per day and 6 days per week. The industry norm number of weeks per annum is calculated from 4.33 weeks per month, and 12 months per annum. This gives the following norms:

Incinerator throughput = hourly treatment rate (kg/hr) * 6859 hrs/annum

Steam treatment throughput = hourly treatment rate (kg/hr) * 7482 hrs/annum
For on-site hospital treatments where no measured data was provided, it is assumed that the facility is working close to full capacity, ie, that there was no excess capacity in the public sector. Authorized capacities were found to be 37 561 tpa for commercial service providers and 64 tpa for hospitals, this compares with the projected quantities of 28 000 tpa which gives an excess capacity of 10 000 tpa which is an exceedence by 36**%.** These capacities at January 2006 are shown in Table **3).**
Table 8.

Treatment capacities with soon to be installed treatment plants

The waste treatment service providers have reported that additional capacity can also be expected from plants commissioned after the end of the survey period in January 2006. This included the re-commissioning of the former Evertrade plant in Cape Town, expansion of the North West incinerator, and the building of new plants in Limpopo, Free State and Eastern Cape. The newly or “soon to be installed/ recommissioned” additional capacity is approximately 10 000 tonnes per annum.

Disposal of solid residues from waste treatment

Permits are required from DEAT (the function was transferred effective from 3 January 2006) for waste disposal sites to receive the residues of treated HCRW. If the treated waste is not disposed into a hazardous waste site, DEAT policy is to ensure that the treated HCRW is delisted, ie, classified as being no longer hazardous, and is destroyed so that it is not recognizable as HCRW, before it is disposed in a site approved for this purpose (Brendenhann, 2006-1). This would typically be a GMB+ or a GLB+ site, subject to demonstrated compliance with existing permit conditions for existing waste streams, and possibly additional permit conditions for the treated waste (Bredenhann, 2006). As some provinces may not yet have either a H:H, H:h, GMB+ or a GLB+ disposal site already available for receiving HCRW (le Roux, 2005), the location of a treatment plant is important to ensure cost effective disposal, particularly in the case of steam treatment where mass reduction may be of the order of 15%, (compared to incineration which can reduce waste masses by 90%). In the case of small scale steam treatment plants located adjacent to the source of the waste at a District Hospital, this can result in a significant barrier to establishing economically viable treatment facilities, as has been found in the North West pilot project.

DISCUSSION AND RECOMMENDATIONS

Accuracy of the health care facilities data base

Checks carried out on the provincial facility data sets for clinics showed that the provincial data bases either counted too high or too low by up to a factor of two, and that the service provider names did not correlate with the names on the data set extracted from the NDoH IS. The reasons for this included the use of historical names due to renaming of facilities, the opening and closure of facilities, the use of similar names for different District Municipalities, and the double reporting, ie, pharmacy reported as a separate facility. These problems were resolved after one on one cross checks using all the available data bases (Public national and provincial, and private national and service provider), using GIS coordinates, and checking the most up to date status of each facility. It is concluded after these checks that the updated NDoH data set was the most accurate of the data bases, and the most accurate is now this data base. A count of the number of facilities has been made using the Hospital and Nurses Handbook count of 851 public hospitals and this count of 836. In order to avoid these problems it has been agreed that a unique name is required for each facility and this should be maintained in the NDoH IS and be included as part of the tender documentation and WIS reporting system.

HCRW generation rates and projection accuracy

Hospitals

A comparison of the provincial public hospital generation rates in Table 2, shows that generation rates typically range within +/- 10% of the median and the average. However the ranges within each provincial data set generation rates can vary within a factor of 3 higher and lower than this average (See Table 4 for the example of non-public facilities, a complete list is available in the project report (Rogers, 2006)). The most reliable projections are, therefore, for aggregates of a hospital class at provincial level where the under and over projections of individual facilities are averaged out. This is confirmed for specialized hospitals which show a higher consistency within province data sets than between provinces, ie, a factor of 8 is shown in Table 4, and may be attributable to differences in service types and waste management between provinces. The large difference between the 2000 and the 2005 assessments may be due to changes in waste management practices, and may indicate that measurements in provinces newly embarking on provincial waste management plans will change over periods of 5 years until uniform training and collection systems are fully implemented.

Clinics

Provincial clinic projections cannot be compared because clinic facility masses were only available for one province. Individual clinic projections show variations from the averages between 6 times higher and

60 times lower. As in the case of hospitals, factors that may contribute to this are different waste management practices, and service levels in the facility that are not reflected in the patient counts. One example is the use of numbers of births in a clinic, which may have an estimated 1.5 kg per count, which is approximately 200 times greater than the estimated head count rate of 8 g. A larger data base with inter provincial comparisons will enable a better assessment of the benefits and disadvantages of the alternative projection methods.

District and regional planning

Planners, who wish to make use of the projected data for preparing, eg, District Hospital Integrated Waste Management Plans (for say 20 clinics), are faced with the decision whether to use the head count or the facility generation rate. As both methods have a very large spread for individual facilities, then uncertainties will be too high to make an accurate projection and a measurement will be required for accurate planning as well to monitor performance. In the absence of any measured data, an indication of maximum requirements can be obtained from the maximum rates found during this survey.

For projections in the future when head count rates and in-patient bed days are expected to change, the 2005 generation rates can be used for estimates. An ongoing monitoring of generation rates will enable any changes in waste management generation rates to be monitored.

Quantities of HCRW from generators not included in the survey

One question which was asked during the development of the survey was “Is there a relatively large amount of HCRW that is being generated outside of the hospitals and clinics, eg, doctors, blood banks, and laboratories, that will result in any capacity evaluation giving the wrong information to policy makers and planners?”. Unfortunately very limited records of masses of waste from treatment facilities, individuals or groups of these generators were made available. The response from the commercial service providers are that the HCRW from such generators is included in the total mass of HCRW reported. As the sum of the projections equals the sum of the treatment quantities, the quantity of treated HCRW from these sources is within the uncertainty of the projection of hospitals and clinics and is expected to account for any additional amounts less than 3-5% of mass of the projection (see note on Table 3).

Table 8: Treatment throughput of HCRW by facility ownership

	HCRW treatment service providers	Public Hospitals	Non-public hospitals	Total
Throughput per annum (tpa)	24 615	3 185	158	27 959
No of treatment facilities	12	146	4	162
Average daily throughput (kg/d)	7 178	84	203	7 465
% of total waste treated	88%	11%	1%	100%
Authorized capacity (Jan 2006) (tpa)	37 561	11	53	37 625

CONCLUSION ON PROJECTIONS OF GENERATION AND TREATMENT RATES FOR THE SURVEY

For 2005 the national inventory for HCRW is expected to be approximately 28 000 tonnes per annum of which approximately 90% comes from hospitals and approximately 90% is treated at centralized commercial service treatment plants after collection and transport over large distances from urban and rural areas. Safety standards are therefore controlled for approximately 90% of the health care facilities by way of health care waste contracts that are authorized by the Department of Health for the public sector, and Provincial Departments of Environment authorization of treatment and disposal facilities used by the public and non-public facilities. Capacity to exceed this projection is approximately 40% and will increase if new plants are commissioned as planned during the foreseeable future, ie, 2006 and 2007.

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