environment & tourism

Department:
Environmental Affairs and Tourism
REPUBLIC OF SOUTH AFRICA

Survey of

Generation Rates, Treatment Capacities and Minimal Costs of Health Care Waste in the 9 provinces of RSA

Prepared by: **Kobus Otto & Associates** in association with **John Clements.**
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Executive Summary

The results from a survey on Health Care Risk Waste (HCRW) generation and treatment capacity undertaken by the Department of Environmental Affairs and Tourism (DEAT) as part of a Danish International Development Aid (DANIDA) funded project in 2005, indicated that the available HCRW treatment capacity exceeded generation by 35%. The criteria used at the time for HCRW treatment capacity were that the treatment facility was as a minimum to be permitted under the old Air Pollution Prevention Act (APPA).

The present study indicates that total HCRW generation across South Africa now amounts to some 42,200 tons per year. Against this, available commercial treatment capacity (non-burn facilities plus incinerators with air-emission control) totals only 31,690 tons per year, although his figure increases to approximately 52,350 tons per year if commercial incinerators without air-emission control are included. New capacity that is expected to come on stream during 2008 (comprising non-burn facilities plus incinerators with air-emission control, but only including capacity where the necessary plant and equipment is already physically in place) is estimated to total 36,860 tons per year, which means that by the end of 2008, total available capacity (non-burn facilities plus incinerators with air-emission control) should amount to approximately 68,500 tons per year, i.e. well in excess of likely HCRW generation levels. According to service providers, a further 18,000 tons per year of treatment capacity could possibly come on stream during 2009 and 2010.

It should be noted that since the 2005 DEAT study there has been some reduction in treatment capacity, *inter-alia* due to the closure of a regional HCRW incinerator for non-compliance in terms of air emission standards, the burning-down of another incinerator and the closure of two Electro Thermal Deactivation (ETD) plants due to insolvency. On the generation side there was at the same time an increase in the amount of HCRW destined for treatment at regional / commercial HCRW treatment facilities. Increased awareness around the environmental impact of HCRW treatment and disposal resulted in various onsite HCRW incinerators being decommissioned with more HCRW generators, like provincial Departments of Health, opting to outsource HCRW management services.

Resulting from the fact that available treatment capacity is either located at great distances from the place of generation, and / or unwillingness on the part of treatment facilities to accept waste from competitors (either on the grounds of price, or for strategic reasons) various incidents of large scale illegal dumping and long-term storage of HCRW have occurred, in particular in Gauteng. Large volumes of HCRW transported from Limpopo Province to the Western Cape for treatment were for instance returned to Gauteng due to insufficient treatment capacity in the Western Cape. The lack of access to HCRW treatment capacity also resulted in requests for use of alternative HCRW disposal methods, such as land filling, being put forward to DEAT.

To enable Regulating Authorities to make informed decisions on HCRW management policies and strategies, the need for reliable information on HCRW generation and available treatment capacity was identified. Kobus Otto & Associates, in association with John Clements, was therefore appointed by DEAT to undertake a survey on the current state of HCRW management throughout South Africa (SA), with projections on the expected state of affairs over the next 2-5 years. Costs for processing HCRW were also to be determined to provide HCRW generators, and in particular Provincial Departments of Health, with a clear understanding of the financial implications associated with sustainable outsourcing of HCRW management services.

For long-term strategy development, the study was to support DEAT as well as the National Department of Health (NDoH) in preparing strategic policies on HCRW management, for example the possibility of having HCRW management services rendered as Public Private Partnerships (PPP). It was further important to

determine the impact that the current permitting process has on the available HCRW treatment capacity. Other impacts that were to be evaluated included the risk of water pollution as well as the protection of in particular poor communities from hazards and risks posed by illegal dumping as well as disposal of untreated HCRW on general waste disposal sites.

The national survey entailed visits to and consultation with the National Department of Health, 9 provincial departments of environment, 8 provincial departments of health (Limpopo Province was not available), 5 private hospital groups, 4 municipalities and 19 HCRW service providers (together with their HCRW treatment facilities where applicable). To finally acquire a better understanding of HCRW management training for health care professionals, an interview was also conducted with a representative from the medical school at the University of Stellenbosch.

In order to establish 'minimal costs' for various components of HCRW management, financial models were constructed for containerisation, transport and treatment. Within these models, capital costs (plant and equipment) were based on information obtained from equipment vendors, and land, building and infrastructure costs were based on ruling market rates. Operating costs were determined by extending consumption quantities (power, fuel and other consumables) at market rates; labour and management costs were determined by making reasonable assumptions regarding the number of personnel required at various levels of skill. Representative cash-flows were then generated, from which viable (Rand per kilogram) rates for the various components were established by setting an internal rate of return (IRR) 'hurdle-rate' (in real money terms) of 12% per annum. Finally, selected service-providers were asked to confirm the reasonableness of the viable rates as determined from the models.

Valuable information was generated during the investigations, not only on matters related to HCRW management operations, but also related to strategic planning. For ease of reference, an extensive list of needs identified were grouped into the following main categories: Environment, Occupational Health and Safety, Institutional / Organisational, Equipment and Technical, Financial, Legislative, Information and Awareness as well as Public Health. Although the needs identified are all considered to be relevant, the most prominent needs expected to have contributed towards the current "HCRW management crisis" are the following:

- Lack of communication and coordination of HCRW management activities on national, provincial and local government levels;
- Lack of uniform standards for HCRW management on national level, in particular for HCRW treatment and disposal of residues;
- Lack of effective enforcement of available legislation, with uncertainty on roles and responsibilities as provincial departments of environment only have jurisdiction over facilities for which EIA's were undertaken;
- Lack of appropriate HCRW treatment facilities located in accordance with HCRW generation patterns throughout SA;
- Lack of appropriate and readily accessible facilities for the disposal of treated HCRW residues;
- Lack of capacity in terms of human resources, available skills and institutional memory within departments of health to effectively execute tender letting and contract management where HCRW management services are outsourced, which is aggravated by a high turnover of staff;
- Lack of uniform standards set in tender specifications with poor enforcement of specifications when HCRW management services are outsourced;
- Lack of capacity in terms of human resources, available skills and institutional memory at provincial and national level to evaluate the various HCRW treatment technologies submitted for approval, which is aggravated by a high turnover of staff;

- Lack of understanding and/or cooperation by departments of Public Works that continue to install onsite HCRW incinerators at health care facilities without Environmental Impact Assessments being undertaken;
- Lack of awareness by different sized HCRW generators from both the public and private sector in terms of the risks associated with HCRW management as well as the duty of care principle. This problem is evident from large HCRW generators all the way down to patients on home based care;
- Lack of cooperation between HCRW management service providers due to fierce and even unhealthy competition. This is inter alia resulting in HCRW treatment capacity not being used optimally, whilst long-haul transport of HCRW is required since HCRW is not treated at the nearest available facility;
- Lack of income generated to render HCRW management services at the required standards due to a price war that is resulting in HCRW management service providers tendering at rates below the minimum required for sustainable service delivery;
- Lack of appropriate and financially viable HCRW management systems for rural communities where relatively small volumes of HCRW are generated and long transport distances to treatment facilities are involved;
- Lack of appropriate and financially viable HCRW management systems for minor HCRW generators in both the urban and rural environment;
- Lack of reporting on the Waste Information System (WIS), with information submitted not being reliable for use in strategic planning processes.

The components of HCRW management relating to the containerisation, transport and treatment / disposal of HCRW have been modelled, and 'viable' rates (or 'minimal costs') for these components, and for the provision of an overall HCRW service to public health-care facilities, have been determined.

Based on the financial models, it was found that viable current (January 2008) rates (excluding VAT) for **treatment** of HCRW were as follows:

- Incineration (with air-emission control): R 4.58 per kg (250kg/hr plant capacity) reducing to R 3.69 per kg (1,000 kg/hr plant capacity)
- Autoclaving: R 3.06 per kg (350 kg/hr plant capacity) reducing to R 2.70 per kg (1,400 kg/hr plant capacity)

The results indicate further that 'viable' **overall** rates excluding containerisation, (i.e. for collection, treatment, disposal and training / marketing) range between R 5.00 and R 8.50 per kilogram of HCRW for treatment by incineration, depending on the containerisation system in use and the average round-trip collection distance involved. The equivalent rates for treatment by autoclaving range from R 4.00 to R 7.50 per kilogram. (All rates are exclusive of VAT.)

Both 'disposable' and re-usable containerisation systems were modelled. Viable **containerisation** rates (excluding VAT, and accounting for all components of the various systems[1]) were found to be as follows:

- Cardboard box system: R 2.49 per kg
- Re-usable box system: R 3.05 per kg
- Liner system: 240-litre wheelie-bins: R 2.79 per kg
- Liner system: 770-litre wheelie-bins: R 3.21 per kg

The needs identified and the conclusions reached finally resulted in a series of recommendations aimed at providing long term solutions to the most prominent shortcomings identified. The recommendations vary

[1] For example, the re-usable box system makes use of consumable items in the form of sharps containers, speci-cans and plastic liners, the cost of which is included within the overall system cost.

from high-level interdepartmental consultation between the affected organs of state, to implementation of strategies for cost-effective and sustainable HCRW management service delivery throughout SA. The recommendations presented inter alia include:

- Allocating responsibilities and introducing effective lines of communication between role players from both the public and private sector;
- Training and capacity building amongst a broad spectrum of stakeholders, with improved information dissemination on matters related to appropriate HCRW management;
- Setting and effective enforcement of uniform HCRW management standards throughout SA;
- Executing a country-wide HCRW generation and treatment mass balance to determine the need for increased HCRW facilities, inter alia evaluating options for service delivery in areas not yet serviced and provinces not yet equipped with appropriate HCRW treatment or disposal facilities;
- Develop a strategy in consultation with HCRW service providers through which HCRW can be treated as close of possible to the point of generation as opposed to the current system of HCRW being long-hauled;
- Through effective implementation of the Waste Information System (WIS), information on available HCRW treatment capacity is to be provided to HCRW generators from both the public and private sector, should existing service providers not be able to render the required services.
- Implement and maintain an accreditation system for HCRW management service providers that is similar to the CIDB ratings used in the building industry for public tenders;
- An environmental Ombudsman is to be introduced to deal with legal disputes, thereby resolving disputes more cost effectively and in a shorter timeframe, whilst at the same time reducing the burden on the legal system;
- Develop and implement pilot projects on various HCRW management matters not yet effectively addressed.
- The 'viable rates' for various components of HCRW management, as determined from the financial models, provide a reference against which rates quoted / offered by service-providers can be compared. Offered rates which are significantly below the 'viable' rates may be indicative of economically un-sustainable services, or services which are based, for example, on the use of treatment facilities with inherent or operational deficiencies (e.g. inadequate temperature-control, no air-emission control [incinerators], improper disposal of residues, etc.)

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National Departments:

- National Department of Health

Provincial Departments of Health:

- Eastern Cape Department of Health
- Free State Department of Health
- Gauteng Department of Health
- Kwazulu-Natal Department of Health
- Mpumalanga Department of Health and Social Services
- Northern Cape Department of Health
- North West Province Department of Health
- Western Cape Department of Health
- Zeerust Pilot Project Staff

Provincial Departments of Environment:

- Eastern Cape Department of Economic Affairs, Environment and Tourism
- Free State Department of Tourism, Environmental and Economic Affairs
- Gauteng Department of Environmental Affairs and Tourism
- Kwazulu-Natal Department of Agriculture and Environmental Affairs
- Limpopo Department of Finance, Economic Affairs, Tourism and Environment
- Mpumalanga Department of Agriculture, Conservation and Environment
- Northern Cape Department of Agriculture, Landreform, Conservation and Environment
- North West Province Department of Agriculture, Conservation and Environment
- Western Cape Department of Environmental Affairs & Development Planning.

Local Authorities:

- Emnambithi Municipality (Ladysmith)
- Mangaung Local Municipality (Bloemfontein)
- Mbombela Municipality (Nelspruit)
- Polokwane Municipality (Pietersburg)

Hospital Groups:

- JMH City Hospital (Durban)
- Life Healthcare (Illovo)
- Medi-clinic Corporation (Stellenbosch)
- Netcare (Sandton)

HCRW Management Service Providers:

- Aesthetic Waste
- Aid Safe
- BCL Medical Waste
- Buhle Waste
- ClinX
- Compass Waste
- Industech Waste Solutions
- Millennium Waste
- Phambili-Wasteman
- Pikitup
- Sanumed
- Solid Waste Technologies
- Tshumisano
- Waste Company
- Wasteman

Training Institutions:

- Medical School of the University of Stellenbosch.

1. Background

In 2005 the Department of Environmental Affairs and Tourism (DEAT) undertook a study funded by the Danish International Development Aid (DANIDA) as part of the Health Care Waste (HCW) Policy formulation. The study inter alia entailed projections for Health Care Risk Waste (HCRW) generation as well as recording of the available HCRW treatment capacity throughout South Africa (SA). Comparing the HCRW generation rate with the treatment capacity available at the time, the study showed that the HCRW treatment capacity exceeded the HCRW generation by 35%. The criteria used in determining whether HCRW treatment capacity existed were that the treatment facility was to be permitted, even if the permit was issued under the old Air Pollution Prevention Act (APPA).

In 2007 the regulating authorities, due to non-compliance on air emissions, shut down a major HCRW incinerator located in Ekurhuleni (Gauteng) whilst another incinerator located in Johannesburg burnt down and subsequently stopped treating HCRW. In addition to that, two Electro Thermal Deactivation (ETD) plants located in Johannesburg and Cape Town respectively also discontinued operations after the owners went insolvent.

On the HCRW generation side there was at the same time an increase in the amount of HCRW destined for treatment at the regional / commercial HCRW treatment facilities. As a result of increased awareness around the environmental impact of HCRW treatment and disposal, various onsite HCRW treatment facilities were shut down and more HCRW generators, like provincial Departments of Health, opted to outsource HCRW management services by making use of regional / commercial HCRW treatment facilities, which in turn increased the demand for such treatment capacity.

At the time when the National Waste Management Strategy Implementation (NWMSI) project survey was undertaken in 2005, the following provinces outsourced HCRW management services:

- Gauteng
- Free State (hospitals only)
- Northern Cape
- Western Cape (excluding some rural hospitals and clinics)
- KwaZulu-Natal (hospitals only)
- Northwest Province

Since the time of the 2005 NWMSI survey, the following provinces also opted to outsource their HCRW management services:

- Eastern Cape
- Limpopo
- Mpumalanga (on 3-monthly quotation system)
- Clinics not previously included in the provincial service contracts.

Resulting from the situation described above, various incidents of large scale illegal dumping and long-term storage of HCRW occurred in Gauteng in particular. Impacts from such actions included the risk of water pollution whilst in particular poor communities were exposed to health and safety hazards resulting from illegally dumped HCRW. Large volumes of HCRW were transported from Limpopo Province to the Western Cape for treatment, only to have the same truckloads of HCRW returned to Gauteng due to insufficient treatment capacity in the Western Cape. Numerous requests to make use of alternative HCRW disposal methods, such as land filling, were submitted to DEAT. The most commonly motivation cited in these requests was “lack of HCRW treatment capacity”.

2. Introduction

2.1 Study Objective:

As Regulating Authorities are required to make informed decisions on policies and strategies regarding alternative solutions for HCRW management that are highly dependant on updated verifications of HCRW generation rates and treatment capacities, DEAT appointed Kobus Otto & Associates in association with John Clements to undertake a survey on the current state of HCRW management throughout South Africa. In addition, costs for processing HCRW were also to be determined to provide HCRW generators, and in particular Provincial Departments of Health, with a clear understanding of the financial implications associated with sustainable outsourcing of HCRW management services.

The immediate objective for this project was therefore for DEAT to obtain reliable data / information on the current state of HCRW management in SA together with projections on HCRW generation rates and treatment capacities for the next 2-5 years.

The long-term objective of the study was to support DEAT as well as the National Department of Health (NDoH) in preparing strategic policies on HCRW management. Amongst the anticipated options to be investigated is whether a feasibility study should be undertaken for HCRW management to be rendered as a Public Private Partnership (PPP) and how prioritising the permitting of HCRW treatment facilities could assist in addressing the current treatment capacity shortages.

2.2 Health Care Waste Categories

The Health Care Waste (HCW) stream generated at health care facilities consists of:

- Health Care General Waste (HCGW);
- Health Care Risk Waste (HCRW) (including radioactive waste);
- Health Care General and Health Care Risk Liquid Waste.

2.2.1 Health Care General Waste

HCGW is the non-hazardous component of HCW that includes many substances similar to domestic waste, but could also include certain non-infectious and non-hazardous liquids. HCGW is generated *inter alia* during the administrative and housekeeping functions of health care facilities as well as by patients and visitors. HCGW may include a number of recyclable materials.

HCGW primarily consists of:

- Packaging materials: e.g. cardboard boxes, plastic bags etc.
- Kitchen waste: e.g. organic waste and packaging materials.
- Office wastes: Mostly paper etc.
- Other solid wastes generated from patient wards: Similar to household waste.
- Non-infectious animal bedding: e.g. from veterinary facilities.
- Garden and park waste: e.g. organic waste from gardening activities.
- Building and demolition waste: e.g. from construction and renovation activities.

All HCW generated in isolation wards and TB wards is to be treated and disposed of as HCRW, irrespective of the waste characteristics.

2.2.2 Health Care Risk Waste

HCRW represents the hazardous component of HCW generated at both large and small health care facilities. HCRW has the potential for creating a number of environmental, health and safety risks, depending on the particular type of HCRW that is handled as well as the way in which exposure takes place.

The five different categories of HCRW are described below and examples of the most commonly found components are presented. Liquid waste is defined as any liquid waste that is discharged to the sewer system, e.g. via washbasins, sluices, drains, etc.

Three of the components of HCRW may be infectious (infectious waste, pathological waste and sharps), but since pathological waste and sharps have additional features, it constitutes a separate category. HCRW further includes infectious or hazardous liquids, which may under certain conditions be disposed of to sewer.

HCRW primarily consists of:

- Infectious waste: Waste that may contain pathogenic micro-organisms
- Sharps: Includes sharp and pricking objects that may cause injury as well as infection
- Pathological waste: Includes parts that are sectioned from a body.
- Chemical waste: Includes all kinds of discarded chemicals, including pharmaceuticals that pose a special risk to human health and environment
- Radioactive Waste: This includes solid, liquid and gaseous waste contaminated with radionuclides.

2.2.2.1 Radioactive Health Care Waste

The health care sector is one of the major users of radioactive substances. Due to its particular characteristics, radioactive substances and waste containing radioactive substances can affect both human health and the environment, and hence the materials have to be handled with special precaution. For the same reason special legislation on radioactive substances as well as waste containing radioactive substances has been put into force.

The safe management of radioactive waste within health care facilities is a responsibility of the Directorate of Health Technology, Department of Health in Cape Town.

A radioactive material is defined as:

"Any substance, which consists of or contains any radioactive nuclide, whether natural or artificial, and whose activity exceeds 74Bq/g of a chemical element and has a total activity of greater than 3.7kBq (3700Bq)."

Most of the radioactive waste commonly generated by nuclear medicine is defined as low-level radioactive waste. A substance is classified as low-level radioactive material when the radioactivity is within defined limits, which are based on the Annual Limits of Intake (ALI) for specific radioisotopes. ALI's are limits that are based on a recommended annual dose limit of 20mSv for radiation workers and the values differ not only for different isotopes but also for the pathway, i.e. ingestion and inhalation: in terms of the precautionary principle, the lowest value of the two, i.e. the ALI_{min} is used.

Examples of low-level radioactive waste include:

- Solid waste such as absorbent paper, swabs, glassware, syringes and vials;
- Residues or unwanted solutions used for diagnostic or therapeutic use;
- Liquids immiscible with water, such as liquid scintillation-counting residues, pump oil, etc;
- Wastes from spills and from decontamination of radioactive spills;
- Excreta from patients treated or tested with unsealed radionuclides;
- Low-level liquid radioactive waste, e.g. from washing of apparatus; and
- Gases and exhausts from stores and fume cupboards.

Radioactive materials of higher activity are normally used as sealed sources and can contain isotopes such as cobalt, ^{57}Co, caesium, ^{137}Cs; gold, ^{198}Au; radium, ^{222}Rd; and radon, ^{226}Ra. These isotopes which have longer half-lives are used in therapy, e.g. in cancer treatment. These wastes are generated in low volumes and usually only from the larger medical and research laboratories.

2.2.3 Liquid Health Care Waste

Liquid HCW generated at health care facilities includes:

- Faeces and urine samples;
- Faeces and urine collected from patients (urine bags, stoma bags);
- Termination of pregnancy residues;
- Blood and blood products;
- General effluents from toilets, kitchens, laundries, etc;
- Rinsing liquids from dialyses, etc;
- Disinfecting and cleaning solutions;
- Liquids/effluents from laboratory equipment (autoanalysers etc.);
- Laboratory chemicals;
- Solvents;
- Liquid pharmaceuticals;
- Oil; and
- Radioactive liquids.

The liquid wastes listed above fall into three major categories:

- Infectious and possibly infectious waste, i.e. bullets 1 to 5;
- Effluents that are chemically or possibly chemically hazardous, i.e. bullets 5 to 12, and
- Radioactive waste, i.e. bullet 13.

The main disposal options for liquid wastes include discharge to sewer, incineration and direct disposal to landfill.

2.3 Health Care Waste Generators

The primary sources of HCW are hospitals, clinics and laboratories, whilst general practitioners, dentists etc. are smaller primary sources. Furthermore, limited amounts of HCRW are generated by for example old age homes, residential properties, etc. However, there are considerable characteristic and qualitative differences between HCW being generated by the different health care facilities. While the smaller health care facilities (like e.g. primary health care clinics) only generate some of the above-mentioned categories of HCRW, the larger hospitals usually generate all categories of HCRW.

The sources can be divided into two distinct groups, major and minor HCW generators, based on their contribution towards the overall HCRW stream.

Although major HCRW generators like hospitals and clinics generate the bulk of the HCRW stream, HCRW generated by minor generators like general health practitioners, veterinary surgeons, tattoo artists, home-based care, etc. also creates a significant risk. HCRW that is poorly managed by the minor HCRW generators is often disposed of in domestic general waste containers where it not only puts the health and safety of municipal workers at risk, but also that of workers and informal reclaimers at waste disposal sites. From previous surveys it became evident that around 90% of the HCRW stream is generated by around 10% of the HCRW generators (major generators), whilst the remaining 10% of the HCRW stream is generated by 90% of the HCRW generators (minor generators). With such a large number of minor generators, it is therefore difficult to register and keep track of them

Major HCRW Generators

- **Hospitals:**
  Owned and operated by provincial government, the private sector, the defence force and mines.
- **Clinics:**
  Owned and operated by provincial government, local government, the private sector and industries' including day-care clinics.
- **Blood transfusion services:**
  Blood banks and their associated laboratories.

Minor HCRW Generators

- **Laboratories:**
  Private and public pathology laboratories as well as research laboratories.
- **Pharmaceutical industry:**
  Pharmaceutical manufacturers and outlets.
- **Health Care practitioners:**
  Doctors, dentists, specialists and allied practitioners like acupuncturists, chiropractors and various therapists etc.
- **Veterinary Services:**
  Veterinary hospitals and veterinary surgeons.
- **Specialised institutions:**
  Psychiatric hospitals, rehabilitation centres, prisons, old age homes, hospices, mortuaries
- **Private homes:**
  Private health care treatment, domestic health care, home nursing.

With the "duty-of-care" principle being entrenched in the National Waste Management Strategy (NWMS), health care facilities have the primary responsibility of ensuring that the HCW generated at the respective facilities is managed, treated and disposed of in an environmentally sound manner, whilst meeting the relevant occupational health and safety requirements.

2.4 Potential Impact from Health Care Risk Waste Generation

Although HCRW is classified as hazardous waste with its generators (in terms of the 'duty of care' principle) being responsible **up to and including the point of safe treatment and disposal**, various incidents of inappropriate HCRW management occur on an ongoing basis. Although the list of impacts is extensive and dealt with in the main text of this report, the most prominent impacts *inter alia* include:

- Poor HCW segregation, thus resulting in HCRW being disposed of with HCGW where it exposes various parties to the risk of needles and other infectious HCRW, creating a risk for transmitting of diseases;

- Inappropriate HCRW containerisation that could lead to HCRW spillage or needle-stick injuries, once again creating the risk of exposure and infection;
- Internal HCRW transport systems that do not protect workers against infection or injuries caused by having to manually lift heavy HCRW containers;
- HCRW storage facilities that do not protect HCRW against the elements, thus resulting in damage to HCRW containers and subsequent release of pollutants;
- HCRW treated onsite at HCF's in various inappropriate manners, ranging from open pit burning to the use of single chamber incinerators without air emission control systems, all of which has a significant impact on the environment;
- HCRW transported with inappropriate vehicles ranging from private sedan vehicles to ambulances and hired vehicles;
- Various HCRW categories not being treated within the timeframes specified by SANS Code 10248, resulting in fermenting of HCRW with subsequent generation of odours as well as breeding of vectors and rodents;
- Commercial HCRW incinerators being used for treatment of HCRW without air emission control systems, thus resulting in extensive levels of air pollution;
- Residues from ineffectively treated HCRW from both incineration as well as non-incineration treatment technologies being disposed of onsite or at inappropriately permitted, developed and operated waste disposal sites where workers as well as members of the public are put at risk;
- Although relatively small in volume, the HCRW generated by large numbers of minor HCRW generators is often disposed of as part of the general waste stream where it once again puts workers as well as members of the public at risk.

2.5 Legal Requirements

The Constitution of South Africa sets out the right of every South African to an environment, which is not harmful to their health or well-being. Every South African has the right to have the environment protected for the benefit of present and future generations through reasonable legislative and other measures that prevent pollution, promote conservation and secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.

The Environmental Impact Assessment (EIA) Regulation that was promulgated under Sections 21, 22 & 26 of the Environmental Conservation Act (Act 73 of 1989) was one of the legislative mechanisms that have been employed to ensure that government can give effect to these environmental rights and fulfil the assigned functions. Provincial Members of the Executive Council (MEC's) for Environment have been delegated authorisation powers.

The most common method of treating HCRW in South Africa in the past was by incineration. Incineration is a process which was at the time controlled under Schedule 2 of the Air Pollution Prevention Act (Act No. 45 of 1965) and as such was identified in GN R1182 as a process which required authorisation from the provincial Departments of Environment in terms of the EIA Regulation. The requirement for incineration facilities to be authorised under the EIA regulation was promulgated in September 1997.

During 1994 the Department of Environmental Affairs & Tourism (DEAT) produced emission guidelines that prescribed the allowable stack emissions for various scheduled processes, set minimum operating temperatures, set minimum residence times for flue gases as well as requiring all units to have secondary combustion chambers. To ensure compliance, a period of 8 years was granted for incinerator operators to comply with these requirements. Full compliance was therefore expected by the year 2002.

At the time it was recognised that the National Waste Management Strategy (NWMS) would continue to be the cornerstone of the national, provincial and local waste management initiatives in South Africa. The NWMS was seen

as a generally well-accepted and suitable framework for achieving improved waste management at national, provincial and local levels.

The HCW component of the NWMSI project was founded on the White Paper for Integrated Pollution and Waste Management (IP&WM), the NWMS and the Action Plan for Waste Treatment and Disposal, which included a number of strategic elements and actions. In addition to this, a Starter Document for Health Care Waste, developed during 2000, was a further source of information.

The White Paper on IP&WM has a number of requirements that were directly related to HCW, with trans-boundary movement of HCW and the duty-of-care principle being two key elements that had to be addressed. Integrated HCW management also requires the implementation of waste avoidance, resource recovery, waste treatment and finally waste disposal.

The Action Plan for Waste Treatment and Disposal in turn required that standards on HCW incineration, air emissions and the classification of treatment facilities be reviewed, revised and enforced. This was however to be done against the background of various readily available non-thermal HCRW treatment processes for which treatment standards were to be set. Public awareness and HCW management education campaigns were also to be launched. Although there was recognition in the Starter Document for a clear distinction to be made with regard to the standards for small and large HCRW treatment facilities, the general consensus by stakeholders present at the NWMSI workshop was that the environmental standards were under no circumstances to be compromised and were to be applied uniformly throughout South Africa.

Although the Air Quality Management Act, 2004 (Act No 39 of 2004) was promulgated in 2004, there is still a need for Regulations that will deal specifically with the air emissions from HCRW incinerators. At present the Gauteng Health Care Waste Management Regulations included in the Gauteng Regulations, 2004, is the only legislation on air emissions for incinerators since the Air Pollution Prevention Act (Act No. 45 of 1964). Although the Gauteng Regulations, 2004 set the air emission standards in line with the DEAT guidelines on air emission developed in 1994, such Regulations are only enforceable in Gauteng. This is creating a situation of differentiated standards, allowing incinerators in all other provinces to operate at standards far below those currently enforced in Gauteng.

It should finally be mentioned that the National Waste Management Bill allows for Health Care Waste Regulations to be promulgated on national level. There is however a problem in the sense that the National Health Act, 2003 (Act No 61 of 2003) allows for similar Regulations to be promulgated, which could result in conflicting legislation if not managed with care.

3. Terms of Reference

The Outputs that were to be delivered by the consultancy in terms of the appointment included the following:

1. A Draft Outline for the Report;
2. A time plan for the consultancy including a list of confirmed contacts and meetings in each of the 9 provinces;
3. A meeting to elaborate and confirm the outline and the time plan;
4. Drafts of (a) the Report, (b) Completion Report and (c) Press Release;
5. A meeting to elaborate and confirm the content of these three documents;
6. Final drafts of (a) the Report, (b) Completion Report and (c) Press Release.

Output 1: The Draft Outline was to:

- Show in headlines, sub-headlines and comments what the final Report was to entail;
- Include templates of questionnaire or a comprehensive list of interview questions;
- Include approval and similar list / framework from Costing Subcontractor specifying the information(s) he requires for comprehensive break even point determination.

Output 2: Time plan and list of confirmed contacts in each of the 9 provinces.
This was to accompany the Outline.

Output 3: Project update meetings.

Output 4: Draft reports
These reports were to be submitted for approval by both the Project Manager and Program Director.

Output 5: Final drafts of (a) the Report, (b) Completion Report and (c) Press Release

The Report emanating from this survey was to contain the following:

Statistical survey: Lists, tables, descriptions and conclusions of existing HCW treatment facilities, for each province and the country as a whole, including (but need not be limited to):

- The current capacity of each HCW facility and cumulated;
- The projected capacity for the next 2-5 yrs of each facility and cumulated;
- Types of treatment facilities and the types and quantities of waste treated;
- Problem identification with regards to HCW management at each facility and expert recommendations for solutions to these;
- Break-even analysis and the determination of break-even points for the various HCW treatment technologies in SA;
- Amounts of waste generated for various types of HCW.

Interpretation, conclusions and recommendations for the next 2-5 years based on these data including (but need not be limited to):

- Needs assessment for additional HCW treatment facilities;

- Recommendations & implementable actions regarding HCW treatment options taking into account costing;
- Recommendations & implementable actions regarding prevention of conducting HCW treatment capacity surveys every 2 years;
- Recommendations and solutions for DEAT to be able to update generation or capacity data in an efficient manner but without using external services;
- A brief discussion on international best practice for each HCW treatment technology, including special attention to applicability in RSA.

Separate section (mini report) which expert comments to the Technical Report "*Autoclaving of Anatomical Waste*" provided by DEAT.

The Completion report and the Press Release were to describe and put in perspective the progress made in this project with regards to Health Care Waste. The draft was to be made by the consultant, but the Project Director was sign off as responsible person for the final version to be submitted to the UEMP and the Donor.

The Urban Environment Programme may publish all outputs via web etc. Publishing will be planned with the Project Manager. Should e.g. DEAT and the involved stakeholders wish to use the documents for publication of this initiative this will be considered in timing, etc. Issues of discretion e.g. company discretion etc. would be considered.

Key Tasks

The consultancy includes (but need not be limited to) the following key tasks:

1. Prepare draft outline for the report;
2. Prepare a time plan for the consultancy;
3. Meet with project management to elaborate / confirm outline;
4. Conduct literature review, identify, prioritize, list and describe existing and planned (new and upgrades) HCW treatment facilities e.g. by way of:
   - Reviewing the literature listed and any other available reports, documents and information systems relevant to the study;
   - Interviewing and seeking information from the Institute of Waste Management and other relevant institutions.
5. Visit existing commercial HCW treatment facilities and interviewing senior members e.g. Directors, owners of HWC treatment facilities, HWC generators etc. to flesh out:
   - Quantities of waste for previous years- adequate to assist in data extrapolation and trend analysis in terms of generation for SA;
   - Types and quantities of waste and the generators;
   - Capacity of treatment in later years, current and predicted for the upcoming 2-5 years;
   - Technology capabilities and limitations;
   - General challenges pertaining to HCW management;
   - Planned developments - for the next 2-5 yrs:
     - Break even point for each technology and a summary per province per technology;
     - Data required for break-even points determination;
     - Sustainable solutions from the perspective of permit holders in relation to HCW management in SA;
   - Identify main generators and interviewing them in terms of challenges and solutions as from the perspective of these stakeholders;

6. Comment on one technical report submitted to DEAT as supporting documentation regarding for alternative treatment of anatomical waste using non-burn technology;
7. Compile how much capacity is required if any;
8. Identifying the current HCW challenges in addition to capacity, and their causes and making short, medium and long term recommendations to DEAT on how to remedy the situation;
9. Write drafts of the Report, the Completion report and the Press Release;
10. Meet with project management to elaborate / confirm drafts;

Write final draft of the Report, the Completion Report and the Press Release.

4. Methodology

4.1 Interviews and Site Visits

With DEAT being the client, the approach followed in identifying stakeholders was to start with the National Department of Health, after which interviews were conducted on provincial level. For each of the 9 provinces, it was important to interview representatives from both the departments of health and environment. Other than the Limpopo Department of Health that was not available due to the upcoming ANC Congress in the province, interviews were conducted with all of the provincial departments of health and environment.

Where more stakeholders were however identified during interviews, additional meetings or site inspections were conducted wherever possible. A typical example was Mpumalanga where it was reported during the interview with the Department of Health that the Department of Public Works is responsible for the installation of onsite incinerators at HCF's. Since no EIA's were reportedly undertaken for such facilities, it was important for this matter to be further investigated. The Mpumalanga Department of Public Works was however not available at the time of the visit to the province and further telephonic and electronic communication with the responsible person proved to be fruitless.

During the interview with representatives from the NDoH, it was also proposed that meetings be conducted with some municipalities to determine how HCRW from their clinics is dealt with, in particular where the municipal clinics were not yet transferred to the provincial departments of health. For this purpose 4 municipalities from both the urban and rural environment were added to the list of stakeholders.

To obtain information from major HCRW generators in the private sector, interviews were conducted with representatives from 4 private hospital groups. Although one of the hospital groups interviewed is still using onsite incineration, most of the private health care facilities outsourced their HCRW management services.

As far as the private HCRW service providers are concerned, the focus was primarily on the larger and well-recognised service providers and in particular those with HCRW treatment facilities, using both incineration and non-incineration technologies. Where HCRW service providers owned a number of treatment facilities throughout the country, an effort was made to visit all of the facilities to determine the actual state of the plants, resulting in a total of 19 HCRW service providers (some located at the HCRW treatment facilities) being interviewed. Although the objective of the investigation was not to conduct detailed audits for all HCRW treatment facilities throughout the country, reporting was done where shortcomings were identified during the visits. Until such time that uniform standard-setting is done for HCRW treatment facilities throughout South Africa, it will not be possible to do detailed audits. What is currently acceptable in one province is illegal in another.

Although the option existed to visit some of the HCRW treatment facility suppliers, this was deliberately not done since only incinerators are manufactured in SA. Interacting only with incinerator suppliers without giving similar attention to non-incineration treatment technologies may have provided a distorted picture.

Finally, in order to acquire a better understanding of HCRW management training for health care professionals, an interview was also conducted with a representative from the medical school at the University of Stellenbosch where valuable insight was obtained in terms of the level to which HCRW awareness is created at tertiary training institutions.

Although standard questionnaires were developed and used during interviews, the questionnaires were to a large extent used to stimulate further discussions around HCRW management. The approach followed during the survey was not restricted to factual information gathering, but to expand it towards perceptions by the stakeholders. All of this information was ultimately to form the basis for the Needs Assessment. It is however to be recognised that respondents were, as competitors in a cutthroat market, not always objective in their reporting. Although it is unlikely that full details of each incident reported upon would ever have been uncovered, it was by the end of the survey possible to draw some conclusions on which the recommendations were then based.

Although detailed operational matters at the point of generation, like containerisation, internal storage, internal transport and external storage together with training was not the main focus of the survey, shortcomings reported during the interviews were also captured as part of the Needs Assessment. It is important to recognise that the focus of the study was primarily aimed at investigating the level of HCRW generation for comparison with the treatment capacity, together with the associated problems leading to illegal dumping and storage of HCRW. HCRW management problems at health care facility level were therefore not the main objective of the study.

4.2 HCRW Generation

Estimates produced by the NWMSI project (CSIR: 2005) were used as a reference for current HCRW generation quantities. The CSIR estimates were based on average HCRW generation rates (kg per patient per day, in the case of hospitals, and kg per patient in the case of clinics) as measured at a sample of HCF's of various types and sizes. These generation rates were then applied across each province based on HCF usage statistics obtained from the DoH.

For the present study, the envisaged time-frame dictated that HCRW generation quantities would have to be determined at a higher (i.e. macro) level. In the case of Gauteng, the provincial DoH was able to supply current overall HCRW generation figures, but this was unfortunately the only province in a position to provide such data. In the case of the other provinces, HCRW collections (as quantified by the various service-providers interviewed) were used to build a picture of overall HCRW generation. There were, however, cases where no information was available (e.g. for private health-care facilities in the less-populous provinces); in these cases the CSIR figures were adjusted in line with an overall percentage adjustment factor, in turn deduced from provinces where current data was available and could be compared with the respective CSIR estimates.

In order to obtain as reliable an estimate as possible, a country-wide 'mass-balance' was performed for HCRW, in which quantities reported by service-providers (collectors) were matched with treatment figures as provided by treatment-facility operators[2]. From this comparison it was also possible to infer values for on-site treatment of HCRW (at public health-care facilities), and also values for on-site (or unspecified) disposal (by private health-care facilities).

As a check, generation figures were compared with overall current treatment figures (as provided by service-providers owning / operating treatment facilities) in the mass-balance.

4.3 HCRW Treatment Capacity

[2] This detailed mass-balance has not been presented in this report, in order to respect the undertaking of confidentiality (for competitive reasons) that was given to service-providers.

Current and projected HCRW treatment capacity, and current HCRW throughput, was obtained by means of face-to-face interviews with treatment facility owners / operators, or through subsequent correspondence.

In the case of treatment capacity and throughput at incineration facilities, a distinction was made between facilities having air-emission control equipment (currently only mandated in Gauteng) and those without such equipment.

As regards projected HCRW treatment capacity, a distinction was made between capacity due to come on stream during 2008, and capacity possibly coming on stream in 2009 and 2010. In the case of capacity recorded here as due to come on stream during 2008, only those facilities where the associated plant and equipment is already in place have been included; where service-providers have indicated that they "expect" the additional capacity to come on stream during 2008 but the associated plant and equipment has not yet been installed, the proposed new capacity has only been included in the estimates for 2009 / 2010.

4.4 Minimal Costs of Health Care Risk Waste in South Africa

Excel models have been developed for each of the major components of a HCRW management service, as provided to health-care facilities by a HCRW service-provider.

The purpose of the models is to facilitate the determination of 'minimal costs'[3] for the various components of the service, based on a quantification of the equipment, personnel, consumables, etc. required, and the application of appropriate input-cost rates.

The models have been developed as separate 'modules' (i.e. for treatment, transport, containerisation) to allow for the maximum of flexibility in the determination of 'viable rates', and also in the interests of avoiding unnecessary complexity.

[3] It has been suggested (see section 7.2 for motivation) that the term 'viable rates' be used in preference to 'minimal costs'.

5. HCRW generation

The Gauteng DoH provided actual (current) HCRW generation figures for public hospitals and clinics in Gauteng. Information made available by service-providers allowed generation figures to be determined for the Eastern Cape (private HCF's), Free State (public and private HCF's), Gauteng (private HCF's), KwaZulu-Natal (public and private HCF's), Limpopo (public HCF's), Northwest (public HCF's) and Western Cape (public and private HCF's)[4]. The total HCRW generation figure for all the above (viz. 29,430 tons/year) was found to be 34% higher that the total of the corresponding 2005 CSIR figures (21,967 tons/year).

For provinces and HCF types where current actual generation figures could not be established from service-provider figures, viz. Eastern Cape (public HCF's), Limpopo (private HCF's), Mpumalanga and Northern Cape (public and private HCF's) and North West (private HCF's), and for all mining hospitals, the 2005 CSIR generation estimates were adjusted upwards by 34%, i.e. in line with the difference in those cases where current actual figures could be compared with the 2005 CSIR estimates, as described above. This means that, of the overall current HCRW generation figure of 39,030 for public and private HCF's and mining hospitals (see Table 5.1 below), 29,430 tons/year is based on actual figures and 9,600 tons/year (or 25% of the total) is based on estimates.

Over-and-above the mass of HCRW generated by public and private hospitals and clinics and by mining hospitals, HCRW is also generated by intermediate and small generators such as pharmaceutical manufacturers, pharmacies, pathological laboratories, blood-transfusion services, doctors, dentists and medical specialists, veterinarians, etc. These generators have been assumed to add 8% to the overall HCRW mass generated around the country[5].

The estimated HCRW generation figures for SA are summarised in the table below.

The table indicates that the current (November / December 2007) overall HCRW generation in South Africa is estimated to amount to approximately 42,200 tons per year.

From the mass-balance calculations, the overall treatment figures were found to agree with overall actual and estimated generation figures (for public and private HCF's and mining hospitals, but excluding intermediate and small generators) to within approximately 4%.

[4] Note that it was assumed that 10% of overall provincial (public) HCRW is treated on site in the case of Free State, Limpopo, North West and Western Cape, on the basis of current or historical evidence to the effect that such disposal is / was taking place (viz. interviews conducted during the present study and / or the 2005 CSIR study).

[5] A study performed for the Western Cape EADP in early 2006 gave a figure of 8%. In the case of Gauteng, the DACEL 2000 study suggested that the comparable figure was somewhat higher, at approximately 11%. Although it is likely that the more populous / more developed provinces (Gauteng, KwaZulu Natal and Western Cape) have relatively more small HCRW generators than the other provinces, a figure of 8% has been used for the country as a whole, in the absence of better information.

Table 5.1 HCRW generation rates per province

HCRW GENERATION

All figures in tons per year

Province	Institution type	CSIR estimates 2005	Actuals or estimates 2007	Source(s) of information
Eastern Cape	Public Hospitals and Clinics	2,540	3,400	Assumes 34% increase over 2005/6 figures
	Private Hospitals and Clinics	870	1,100	Deduced from service-provider figures; assumes no on-site disposal
	Totals	**3,410**	**4,500**	
Free State	Public Hospitals and Clinics	1,127	1,270	Deduced from service-provider figures; assumes 10% on-site disposal
	Private Hospitals and Clinics	495	630	Deduced from service-provider figures; assumes no on-site disposal
	Totals	**1,622**	**1,900**	
Gauteng	Public Hospitals and Clinics	3,395	3,790	DoH Gauteng
	JHB Mun. clinics		360	Pikitup
	Private Hospitals and Clinics	4,141	5,750	Deduced from service-provider figures; assumes no on-site disposal
	Totals	**7,536**	**9,900**	
KwaZulu-Natal	Public Hospitals and Clinics	4,405	5,770	Deduced from service-provider figures; assumes no on-site disposal
	Private Hospitals and Clinics	1,031	2,210	Deduced from service-provider figures; assumes no on-site disposal
	Totals	**5,436**	**7,980**	
Limpopo	Public Hospitals and Clinics	1,846	2,030	Deduced from service-provider figures; assumes 10% on-site disposal
	Private Hospitals and Clinics	87	120	Assumes 34% increase over 2005/6 figures
	Other			
	Totals	**1,933**	**2,150**	
Mpumu-langa	Public Hospitals and Clinics	1,040	1,390	Assumes 34% increase over 2005/6 figures
	Private Hospitals and Clinics	333	450	
	Totals	**1,373**	**1,840**	
Northern Cape	Public Hospitals and Clinics	1,253	1,680	Assumes 34% increase over 2005/6 figures
	Private Hospitals and Clinics	393	530	
	Totals	**1,646**	**2,210**	
North West	Public Hospitals and Clinics	1,142	1,470	Deduced from service-provider figures; assumes 10% on-site disposal
	Private Hospitals and Clinics	260	350	Assumes 34% increase over 2005/6 figures
	Totals	**1,402**	**1,820**	
Western Cape	Public Hospitals and Clinics	2,072	2,080	Deduced from service-provider figures; assumes 200 tpa on-site disposal
	Private Hospitals and Clinics	1,443	2,970	Deduced from service-provider figures; assumes no illegal disposal
	Totals	**3,515**	**5,050**	
All	Mining Hospitals	1,317	1,680	Assumes 34% increase over 2005/6 figures
	Grand totals :	**29,190**	**39,030**	
	Add: estimated intermediate & small generators (8%)	**2,335**	**3,122**	
	Estimated grand total incl. intermediate & small generators	**31,500**	**42,200**	

6. HCRW treatment capacity.

HCRW treatment capacity and current throughput figures have been obtained from service-providers known to be operating in the various provinces.

Capacity (current, and also new capacity expected to come on stream within 2008, and within 2-3 years[6]) has been indicated, as follows:

- Non-burn
- Incineration (with air-emission control)
- Incineration (without air-emission control)

Note that, in the case of capacity projected to come on stream during 2008, only capacity relating to facilities **where the necessary plant and equipment has already been installed** has been included.

HCRW TREATMENT CAPACITY & THROUGHPUT:
COMMERCIAL FACILITIES - JANUARY 2008

All figures in tons per year

Province	CSIR Study 2005/6		Incineration						Non-burn technologies			
			No air emission control		With air emission control							
	Incineration & non-burn capacity		Capacity available Jan 2008	Current through-put	Capacity available Jan 2008	Current through-put	New capacity coming on stream:		Capacity available Jan 2008	Current through-put	New capacity coming on stream:	
	Actual	Planned					Within 1 year	Within 2-3 years			Within 1 year	Within 2-3 years
Eastern Cape	1,560	6,000	1,560	930				3,740			3,650	
Free State	2,400	3,000	1,680	1,680								4,830
Gauteng	14,640		6,640	5,160	5,770	3,190	6,810				26,400	2,800
KwaZulu-Natal	11,610								11,520	10,310		1,640
Limpopo		3,430										
Mpumulanga												
Northern Cape												
North West	3,640		7,480	6,000				3,740				
Western Cape	3,140	970	3,300	2,540				1,170	14,400	2,640		
Grand totals	**36,990**	**13,400**	**20,660**	**16,310**	**5,770**	**3,190**	**6,810**	**8,650**	**25,920**	**12,950**	**30,050**	**9,270**

Overall capacity available Jan 2008: 52,350

The table indicates that current installed and operational commercial capacity (non-burn facilities, plus incinerators with air-emission control) amounts to 31,690 tons per year (5,770 tons/yr incineration + 25,920 tons/yr non-burn). Over-and-above this, installed and operational commercial incineration capacity without air-emission control amounts to 20,660 tons per year.

Total current throughput is approximately 32,450 tons per year (16,310 tons/yr incineration without air-emission control + 3,190 tons/yr incineration with air-emission control + 12,950 tons/yr non-burn). With estimated current generation amounting to 42,200 tons per year (viz. 9,750 tons per year more than reported throughput at commercial facilities) our estimate is that approximately 5,130 tons per year of HCRW is being treated on-site at public health-care facilities, with the balance of approximately 4,620 tons per year either being treated on-site or disposed of in an unspecified manner.

[6] No service-providers indicated that they were planning new capacity beyond a 3-year horizon.

New capacity due to come on stream within one year (equipment already in place) amounts to 36,860 tons per year (6,810 tons/yr incineration with air-emission control + 30,050 tons/yr non-burn) although it should be noted that of this, approximately 6,640 tons per year represents replacement of existing incineration (without air-emission control) capacity. A further 17,920[7] tons per year capacity (8,650 tons/yr incineration with air-emission control + 9,270 tons/yr non-burn) will purportedly come on stream within 2-3 years.

6.1 Incineration Capacity Available for the Safe Treatment and Disposal of Pathological Waste.

From the above table it can be deduced that the total installed and operational commercial incineration capacity (with air-emission control) amounts to approximately 5,770 tons per year countrywide. (A further 6,810 tons per year capacity is due to come on stream during 2008.)

When considering the pathological HCRW generation for the country as a whole, the estimated total 2007 generation amounts to some 37,400 tons per annum. Assuming conservatively that 5% of this is pathological waste, this implies an estimated total pathological HCRW stream of approximately 1,870 tons per year requiring treatment by means of incineration. This is therefore considerably less than the available capacity of approximately 5,770 tons per year (with air-emission control).

[7] According to the service providers concerned, up to 4,560 tons of this is planned for 2008, but in our view this is unlikely as the plant / equipment is not yet physically in place.

7. Minimal costs of Health Care Risk Waste in South Africa

7.1 Introduction

The purpose of establishing 'minimal costs' associated with HCRW management[8] in South Africa is to provide an objective insight into the underlying economics of commercially sustainable services that comply with national and / or provincial standards, particularly in relation to the treatment and disposal of HCRW.

7.2 Minimal costs vs 'viable rates'

The project brief refers in some places to 'minimal costs' and in other places to 'break-even' costs.

The management of HCRW, and in particular HCRW treatment and the logistics associated with collecting HCRW from generators and transporting it to treatment facilities, are processes which require the investment of considerable amounts of capital by service-providers.

These investments are made on the basis that the processes / services will generate an acceptable return on investment over the expected life of the plant and equipment involved. Unlike a simple trading situation where a 'cost-price' is known for an item and a 'selling price' can be relatively easily set or computed, processes such as the treatment of HCRW by incineration require that the 'selling price' (or rate) per kg of waste be computed based on an evaluation of the income that will be generated over a period of time by treating waste at such price / rate.

A common technique for evaluation of investment options involves the setting of an acceptable 'internal rate of return' (IRR) for the project, where IRR is defined as "the interest rate which equates the present value of future returns to the investment outlay".

This technique has been used in the present study, as will be more fully discussed in the sections that follow.

In the light of this, the term 'viable rate' has been used in preference to 'minimal cost' or 'break-even cost'. This 'viable rate' is therefore the rate (usually expressed in rand per kg of HCRW) that will provide a (minimum) acceptable return (as measured by the IRR) to the service-provider.

It is important to mention here that the cash-flow calculations within the models that have been developed for this study make use of 'real' (December 2007) as opposed to 'nominal' money values, i.e. they are expressed in terms of purchasing value as at December 2007. Implicit in this method of calculation is the assumption that a service-provider will be able to escalate the 'nominal' rates that he charges for providing a service at a rate that will compensate for the effects of inflation.

Investors set their own unique minimum IRR (often called the 'hurdle-rate') based on their 'cost of capital', comparison with other avenues of investment open to them, the risks associated with a particular investment, etc. As the cash-flows used in the models have been expressed in 'real' terms, this in turn means that the hurdle-rate should be a 'real' rate as opposed to a 'nominal' rate.

[8] In the context of this section, 'HCRW management' refers to the collection of HCRW from health-care facilities, transport to and treatment at a compliant facility and safe disposal of resulting residues. It may also involve the provision of sacrificial or re-usable containers (including cleaning/disinfection of the latter) and the training of staff that are involved with HCRW at health-care facilities. It does not include the in-house segregation, containerisation, collection, storage and transportation of HCRW within the health care facilities themselves.

Just as a company's 'hurdle rate' depends on its own unique circumstances, so does its 'cost of capital'; this latter depends on its cost of debt (i.e. the rate at which it can borrow money), its cost of equity (the return which it needs to provide to shareholders) and the ratio between these two types of financing, as well as on other factors.

An OECD study in 2005[9] estimated that the cost of equity for an ungeared (i.e. debt-free) South African company was about 15%; the study argued that this rate comprised an international risk-free rate of 4%[10], an equity risk premium of 5% and, by implication, a currency- plus sovereign-risk[11] of approximately 6%. (The average inflation rate in South Africa during 2005, as measured by changes in CPIX, was 3.9%, implying a sovereign risk of approximately 2.1%; this figure was corroborated by a separate study commissioned by UBS Investment Bank[12]).

The above therefore implies that the 'real' cost of equity for an ungeared South African company was approximately 11% (i.e. 15% - 4%) in 2005. This figure is unlikely to have changed significantly between 2005 and the present.

As regards the cost of debt, the prime overdraft rate (i.e. the rate of interest charged by commercial banks to their best clients) was 14.5% per annum as at December 2007. This rate is, however, a 'nominal' rate, comprising a 'real' rate plus an expected inflation rate. The 'real' prime interest rate in September 2007 was approximately 6%, as may be seen from the following figure[13].

Figure 7-1 SA real interest rate 2000-2007

It has been assumed for the current purposes that as at December 2007, the real rate would still be approximately 6%. On an after-tax basis, and assuming a company tax rate of approximately 30%, this translates to an after-tax 'real' cost of debt of 6% x (1 – 0.3) = 4.2%.

[9] "Reducing the Capital Cost in South Africa"; An OECD Development Centre Study; accessed at: http://www.oecd.org/dataoecd/20/26/38484748.pdf

[10] The risk to maturity of US-Treasury bonds is widely accepted as the reference for the international risk-free rate.

[11] This is related to a country's political and economic environment.

[12] Healthcare Cost of Capital Handbook": UBS Investment Bank. Accessed at: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=463020

[13] This is a so-called 'ex-post' rate, i.e. calculated after the event, when the actual inflation rate applicable at the time has been determined.

As previously mentioned, the cost of capital of a firm depends on the relative proportions of debt and equity in its capital. However, assuming conservative financing with say 20% debt and 80% equity, the (weighted average) cost of capital will be: {0.20 x 4.2% + 0.80 x 11%} = 9.6%.

In order to ensure that new investments / projects add economic value, a firm will typically set its hurdle rate somewhat above its cost of capital. For the purposes of the evaluations which follow, a (real) hurdle rate of 12% has therefore been adopted. (The models do, however, allow the user to set the hurdle rate at any value.)

7.3 Approach followed

Three separate models have been developed (i.e. for treatment, transport, containerisation) to allow for the maximum of flexibility in the determination of 'viable rates', and also in the interests of avoiding unnecessary complexity within the models.

Model results have been shown to selected service-providers, who have in turn provided comments and input. (As was to be expected, service-providers were unwilling to provide details of their operating costs; they were, however, happy to question or confirm the model outputs. In some cases they were willing to indicate capital costs; in other cases, capital costs were provided by equipment vendors.)

The models have also been used to investigate the sensitivity of 'viable rates' to changes in (for example) the cost of fuel and power. Sensitivity analyses give an insight into the implications associated with errors in the cost of various inputs in the models. The sensitivities also provide a means for quick and easy estimation of the changes to viable rates in the light of marked changes in the cost of particular inputs, without having to revert to the models (see note in section 7.5.4.1 below).

The time allocated for this section of the study has not permitted the full 'generalization' of the models to cater for any and all situations. However, a user with a reasonable knowledge of *Excel* and of the basic principles of economics will be able to make adjustments to input costs (electricity, diesel, etc.) to account for changes in these over time. It is therefore anticipated that the models will be usable by DEAT for some years to come.

7.4 Major components of HCRW management costs

7.4.1 Treatment

Two methods of HCRW treatment (or destruction) have been modelled, viz. incineration and autoclaving.

In South Africa incineration has historically been the most common type of treatment, but the imposition of higher (air) emission standards in Gauteng (also anticipated to be applied country-wide over time) has significantly increased the costs associated with incineration (although it still remains the only satisfactory method for the destruction of pathological waste and chemical waste).

Although other technologies are available for the treatment of HCRW, e.g. chemical sterilisation and microwave treatment, none of these technologies appear to be commercially viable on a meaningfully large scale.

Incineration and autoclaving have each been modelled over a representative range of plant sizes, to provide some guidance on likely 'economies of scale'.

7.4.2 Transport

The transport of HCRW from health-care facilities to treatment facilities constitutes a significant proportion of the overall cost of HCRW management.

Vehicles used for the transport of HCRW require custom-built van bodies, which allow for the securing of the load internally to prevent HCRW containers from falling over or shifting during transport. The design must also prevent the spillage of any liquids out of the vehicle and vehicles must carry 'spill kits' which can be used in emergencies.

Where re-usable containers are used (boxes and wheelie-bins – see below) and where the same vehicles are used for the collection of full containers as well as the return of empty (clean) containers to the health-care facilities, separate load-compartments must be provided in the vehicle. Due to the bulkiness of wheelie-bins, the most effective way to provide separate compartments is to introduce an additional floor in the load-body: this then allows for the mechanical 'tail-lift' (essential where wheelie-bins are in use) to be used for the loading and unloading of both full and empty bins. All this adds to the initial cost of the vehicles.

A service-provider will generally utilize a range of different sizes of vehicle, in order to cater both for the expected quantity of HCRW to be collected on a 'round', the distance to be travelled, type of containers to be transported (see below), etc. There could also be questions of accessibility at the health-care facility, which may circumscribe the choice of vehicle. In the transportation model (see 7.5.5 below) four different truck sizes have been modelled.

7.4.3 Containerisation of HCRW

Proper containerisation is a crucial factor for safe and effective management of HCRW.

Various systems are in use at health-care facilities, and only a representative selection of such systems has been modelled here. Containerisation systems are generally categorized according to the type of container used for the general infectious waste[14]: the types modelled here are the 'cardboard box' system, a re-usable (plastic) box system and a (polyethylene) liner-based system with internal transport and transport to treatment facilities being in 'wheelie-bins'. Containerisation of pathological waste and sharps waste tends to be the same or similar across the various systems[15].

It is important to note here that, on a rand-per-kilogram basis, the cost of containerising pathological or sharps waste is much higher than that for general infectious waste. (Approx. 7 times higher for sharps as compared with general infectious waste and approx. 3 times higher for pathological waste as compared with general infectious waste.)

As the composition of HCRW generated by different types (and sizes) of health-care facilities varies widely, the overall containerisation cost can differ quite markedly from one facility to another. In this situation, caution must be exercised when applying 'averages', but without such averages it is impossible to assess the overall costs of HCRW management on the broad basis necessary here. With this in mind, and drawing on experience both from individual institutions where reliable statistics have been kept (e.g. Leratong, 2002) as well as studies undertaken more broadly (e.g. DACEL 2000) and figures gleaned from service-providers, the percentages adopted here for (public) health-care facilities are:

[14] Sometimes also referred to as 'dry infectious waste'.

[15] Re-usable sharps containers are used by some service-providers, but this practice is not widespread at this stage, in part due the need to install specialized equipment to safely open and empty the containers at the treatment plant.

- pathological waste: 4% by mass of the total HCRW stream
- sharps waste: 12%[16] by mass of the total HCRW stream

Other types of waste, e.g. pharmaceutical / chemical, radioactive and cytotoxic waste are generated by some facilities, but the quantities are relatively small[17]. These types of waste have been ignored for the purposes of this study.

It should also be noted that use of the so-called 'liner system' requires the provision of suitable 'hardware' such as wall- or trolley-mounted baskets, wall-mounted or free-standing holders for the large (85-litre) liners, etc. The cost of such equipment has not been included in the model but is not significant, particularly when considered in relation to its expected useful life[18]. Also to be noted is that all systems require hardware and fixtures to secure sharps containers, and also containers or baskets for the disposal of general waste; in the absence of adequate provision for general waste, such waste will find its way into conveniently located HCRW receptacles, leading to unnecessary and avoidable expense.

7.5 Models and model outputs

7.5.1 General

Four separate models have been developed, viz. for treatment (with separate models for incineration and autoclaving) transport and containerisation of HCRW. These models have been developed *in Microsoft Excel* version 2002. DEAT has been provided with 'soft' (i.e. electronic) versions of these models, but for reference purposes copies of representative 'worksheets' from the models have been included in Annexure 2 to Annexure 5.

The first worksheet of each model contains notes regarding the basis, use and limitations of the model. In view of this, only limited notes appear below regarding the models.

Results obtained from each of the models are given and discussed in each of the sections below, with overall results being presented and discussed in section 7.7 below.

7.5.2 Treatment models

Treatment models have been developed for incineration and autoclaving.

For the sake of brevity, salient features of the two technologies and also of the two *Excel* models are presented in the comparative table below.

[16] It is the practice in many health-care facilities in South Africa to dispose unbroken vials and other small glass items in sharps containers. This is a wasteful practice, both in terms of the cost of disposal, and because of the waste of recyclable material. Removal of these items from the HCRW waste stream would therefore reduce the percentage of sharps waste. It is also general practice to dispose syringe + needle as a unit, due to concerns about the safety of needle-removal. The removal of syringes from the sharps waste stream reduces the 'sharps' mass and volume considerably.

[17] Figures recorded by a service-provider give pharmaceutical waste in the range 0.2% to 2%, and cytotoxic waste in the range 0% to 0.2%, for various types and sizes of public health care facility in Gauteng.

[18] Probably of the order of R 200 per bed for a public hospital, with a useful life of at least 10 years.

Table 7.1 Treatment Technologies Modeled

Features & factors	Incineration	Autoclaving
Main elements of plant	▪ Primary & secondary incineration chambers (primary chambers take form of 'rotary kiln' in some designs) ▪ Particulate filter & dry or wet 'scrubber' for gases	▪ Treatment chamber where waste is subject to cycles of vacuum, steam saturation and exhausting of resulting gases ▪ Steam generator ▪ Shredder (optional)
Categories of HCRW that can be treated	All	All except pathological and chemical
Waste product	Ash, which is generally disposed at a H:h or H:H landfill, but can be de-listed for disposal at GLB+ landfill in some cases	Waste, which is recognizably similar to un-treated HCRW until shredded. Waste can be de-listed for disposal at GLB+ landfill.
Solid mass reduction	Approx. 85 to 95%	4% to -4% (i.e. decrease or increase by up to 4%)
Solid volume reduction	Approx. 95%	Depending on type of shredding / compaction equipment installed. 30% to 50% reported by one service-provider.
Main 'cost drivers'	▪ Initial capital cost higher than for autoclave of similar capacity ▪ Fuel cost (fuel oil or gas) is main element of operating cost ▪ Electrical power for forced-draft fans (filter) ▪ 'Sorbent' (lime, sodium bicarbonate or similar) to neutralize gases ▪ Ash disposal at hazardous landfill	▪ Fuel cost (electricity, gas, coal or oil) for steam generator (to provide steam for autoclave) ▪ Electricity for motors, pumps, fans etc. ▪ Electricity for shredders ▪ High mass (and volume) of waste requiring disposal ▪ Pathological and chemical waste must be transported to and / or treated by means of incineration
Salient features of *Excel* models	▪ Individual worksheets provided for each plant capacity which show: - Capital items and associated costs - Consumption and costs of fuel, power, water, etc., and waste generation quantities and costs - Personnel numbers & costs - Cash-flow schedules and IRR calculations (see notes below) ▪ Summary worksheet with relevant graphs/charts ▪ 'Greenfield' sites of appropriate sizes assumed, i.e. land, earthworks, (new) site infrastructure, building (incl. office), electrical switchgear and EIA costs included ▪ 'Cold-rooms' allowed for 4 days storage of pathological waste ▪ Maintenance, water consumption, insurance, security & telecoms, monitoring, testing & auditing costs included ▪ Personnel costs (labour, supervision and management) allowed ▪ Other minor capital and operating costs allowed (office furniture, computer equipment, protective clothing, medical screening of personnel)	

Features & factors	Incineration	Autoclaving
	▪ Plant capacities: 250, 500 and 1,000 kg HCRW per hour (achieved using multiples of 250 kg per hour unit) ▪ Diesel-fired burners ▪ Ceramic filter & 'dry' gas treatment ▪ Operating hours: 19 hours/day (plus 1 hour/day for cleaning), 300 days/year ▪ Transport and disposal of ash at H:H or H:h landfill	▪ Plant capacities: 350, 700 and 1,400 kg per hour (achieved using multiples of 350 kg per hour unit) ▪ Diesel-fired steam generators / boilers ▪ Operating hours: 24 hours/day, 300 days/year ▪ Transport and disposal of pathological waste (@ 4% of overall HCRW mass) by incineration ▪ Transport and disposal of autoclaved waste at GLB+ landfill

7.5.3 Note on computation of 'viable' treatment rates

In view of the significant proportion of fixed costs (e.g. depreciation) and semi-variable costs (e.g. personnel) associated with treatment of HCRW, the 'viable' rate (i.e. the rate required to produce an internal rate of return [IRR] equal to the hurdle rate) is significantly influenced by the amount of HCRW being treated in relation to the 'full capacity' of the plant[19].

To take account of the likelihood that actual throughput of HCRW could reasonably be expected to fall in a range (theoretically from 0 to 100% of full capacity, but practically over a narrower range), use has been made of the principle of 'probabilities'. The probabilities used in the autoclaving model are illustrated in the table below.

Table 7.2

Autoclaves		Actual throughput as a %-age of design capacity			"Most likely" throughput (as %-age of capacity)
Plant capacity - kg / hr	'Full' capacity - tons / year	50%	75%	100%	
		Probabilities			
350	2,520	0.08	0.67	0.25	79%
700	5,040	0.18	0.60	0.22	76%
1,400	10,080	0.38	0.45	0.17	70%

By way of example, for the plant with a full capacity of 2,520 tons per year, the probability of actual throughput being only 50% of full capacity is deemed to be very low (0.08, or 8%); the probability of throughput being 75% of full capacity is deemed to be relatively high, and has been set at 0.67 (or 67%). There is a lower probability that throughput will be 100% of full capacity: this probability is 0.25 (or 25%) here. (Note that total or overall probability must equal 1.00 across the range of throughputs used.)

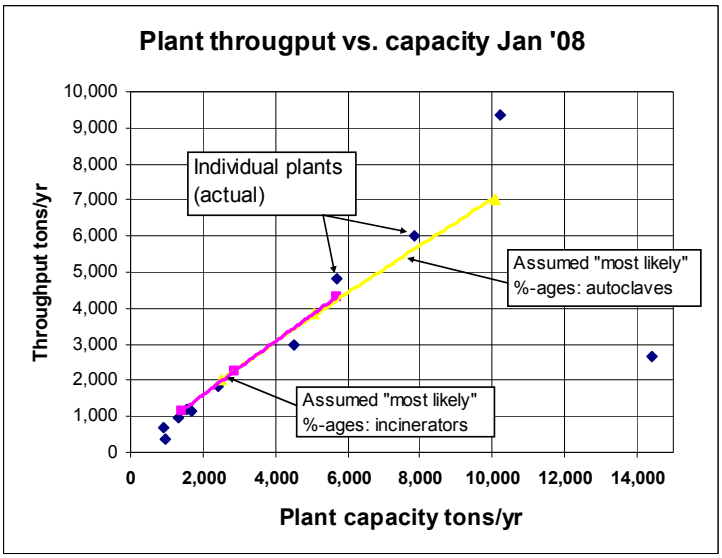
By contrast, for the (largest) plant, having a full capacity of 10,080 tons per year, the ability of the service-provider to secure enough waste to be able to operate this plant at higher percentage throughputs (75% or 100%) is likely to be lower than in the case of smaller plants (due to overall market-size constraints and competition). The likely probability of operation at a lower throughput is, however, concomitantly higher (and has been set here at 0.38 for operation at 50% of full capacity).[20]

The "most likely" column shows the sum of the products {probability x %-age of design capacity} for each plant size (e.g. 0.08 x 50% + 0.67 x 75% + 0.25 x 100% = 79%). These "most likely" percentages have been compared with actual percentages deduced from figures provided by commercial treatment facilities as at January 2008 in the figure below, to confirm that they represent a reasonable assumption.

[19] 'Full capacity' as used here denotes the amount of HCRW (by mass) that can be treated sustainably by a given plant over a long period (generally a month or year).

[20] Similar probabilities have been assigned to incinerator capacities, making allowance for the relatively smaller full capacities of these plants.

Figure 7.2



By applying the probabilities shown in Table 7.2, a weighted IRR can be determined; by setting this IRR at the hurdle rate, a viable treatment rate (rand per kg of HCRW) can be determined which takes account of the uncertainty associated with actual plant throughput.

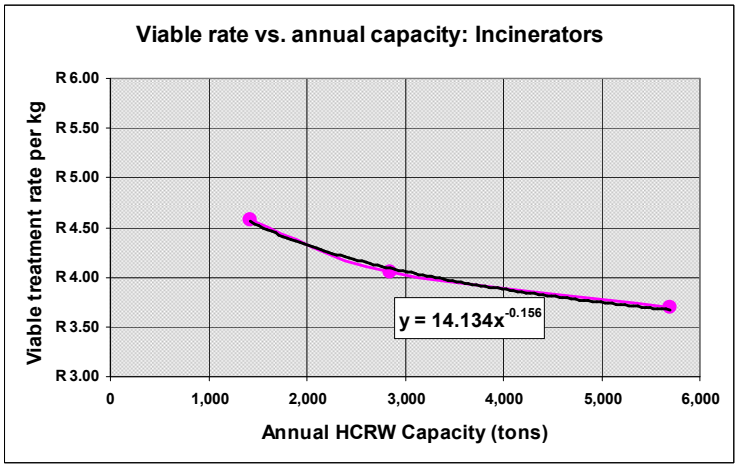
7.5.4 Model results for treatment

7.5.4.1 Incineration

Model results for incineration are presented in Figure 7.3 below.

The cerise line reflects actual model results, while the black line shows a fitted 'power' curve.

Figure 7.3



The graph indicates that the viable (current) rate for treatment by incineration varies between approximately R 4.58 per kg for the smallest plant size modelled (250 kg/hr, 1,425 tons per year) and

approximately R 3.69 per kg for the largest plant size modelled (1,000 kg/hr, 5,700 tons/yr). (All rates exclude VAT.)

Sensitivity analysis

An analysis was performed to determine the sensitivity of the viable incineration rate to increases in the cost of various inputs. Each of the respective input costs was increased by 100% (while other costs remained unchanged) and a new viable rate determined (all at an IRR of 12%). The results are given in the table below.

Table 7.3

Sensitivity of viable incineration rate to 100% increase in input costs:							
Plant full capacity tons/yr	**Capital equip-ment**	**Diesel**	**Land & Buildings**	**Labour**	**Sorbent**	**Ash disposal**	**Elec-tricity**
1,425	29%	22%	14%	13%	10%	3%	1%
2,850	31%	25%	12%	11%	11%	3%	1%
5,700	34%	28%	9%	8%	12%	4%	1%
Averages	**31%**	**25%**	**12%**	**11%**	**11%**	**3%**	**1%**

The viable incineration rate is therefore most sensitive to increases in the cost of capital equipment, followed by the cost of diesel. It is less sensitive to the cost of land and buildings, labour and sorbent, and insensitive to the cost of ash disposal and electricity.

(Application of the above sensitivities in order to estimate[21] the likely effect on the viable rate is best illustrated by way of an example, as follows:

- Assume that the average increase in costs over a given period (say a year) is 6%, as measured by the Producer Price Index (PPI);
- "All other things remaining equal", the viable incineration rate would be expected to increase by approximately the same amount, viz. by 6%;
- Assume, however, that over the given period the price of diesel increased by 20%, i.e. by 14% over and above the general 6% increase;
- Due to the sensitivity of the viable rate to the diesel price (25% in 100%, or 0.25) the additional 15% increase in diesel price over and above the general increase will on its own translate into an increase of 0.25 x 14%= 3.5%
- The overall increase in viable incineration rate is therefore likely to be approximately 6% + 3.5%=9.5% over the given period.
- If other prices increased at rates in excess of the general rate of 6%, the effect of each of these would be determined in a similar way, and the relevant percentage added to determine the overall new rate.)

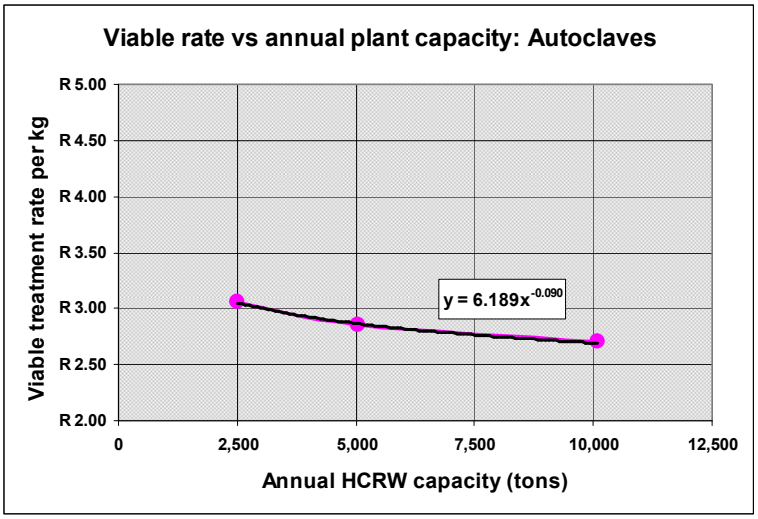
7.5.4.2 Autoclaving

Model results for autoclaving are presented in Figure 7.4 below.

As before, the cerise line reflects actual model results, while the black line shows a fitted 'power' curve

[21] This procedure can only produce an estimate; ideally, costs in the model should be updated to representative levels and the new viable rate determined accordingly.

Figure 7.4



The graph indicates that the viable (current) rate for treatment by autoclaving varies between approximately R 3.06 per kg for the smallest plant size modelled (350 kg/hr, 2,520 tons per year) and approximately R 2.70 per kg for the largest plant size modelled (1,400 kg/hr, 10,080 tons/yr).

Sensitivity analysis

As before, each of the respective input costs was increased by 100% (while other costs remained unchanged) and a new viable rate determined. The results are given in the table below.

Table 7.4

Sensitivity of viable autoclave treatment rate to 100% increase in input costs:							
Plant full capacity tons/yr	**Capital equip-ment**	**Treatment of pathological waste**	**Land & Buildings**	**Labour**	**Residue disposal**	**Diesel**	**Elec-tricity**
2,520	36%	18%	13%	12%	8%	6%	1%
5,040	38%	19%	12%	10%	8%	7%	1%
10,080	42%	20%	11%	8%	9%	7%	1%
Averages	**39%**	**19%**	**12%**	**10%**	**8%**	**7%**	**1%**

The viable autoclave treatment rate is therefore most sensitive to increases in the cost of capital equipment, followed by the cost of treatment of pathological waste (by incineration). (Similarly, the viable rate is also sensitive to the relative percentage of pathological waste in the overall HCRW stream.) It is less sensitive to the cost of land and buildings, labour, disposal of residues and diesel, and insensitive to the cost of electricity.

As may be seen by comparing the sensitivity tables for incineration and autoclaving, both treatment methods are sensitive to increases in the cost of capital equipment. By implication, the viable rate is therefore sensitive to a depreciation of the local currency relative to other currencies (where applicable to imported goods), leading to an increase in the landed cost of imported equipment. This may be of more concern in the case of autoclaving where plant is understood to be largely imported at present.

7.5.5 Transportation model

This is by far the most complex of the models, due to the range of variables that must be accommodated.

The basic features of the model are as follows:

- Four truck sizes have been included, viz.:

Table 7.5

Truck & model	Approx. maximum load mass (kg)	Body capacity (cubic metres)	Mechanical tail-lift
Toyota Dyna 4-093	1,100	10.5	No
Toyota Dyna 5-104	2,400	21.1	No
Toyota Dyna 6-105	2,500	25.6	Yes
Toyota Hino 10-176	5,000	35.3	Yes

- Mechanical tail-lifts have been allowed on the two largest trucks, allowing for the loading and unloading of wheelie-bins.
- Reasonable allowances have been made for fixed and variable (i.e. volume-related) loading and unloading times. These times differ for the various HCRW container types.
- A range of 'round-trip' distances (i.e. starting and ending at the treatment plant) have been considered, ranging between 15km and 300km. (Costs associated with the 'long-haul' of HCRW have therefore not been modelled, in part because this practice is not seen to be in the long-term interests of either generators, service-providers, the environment or the general public.)
- Multiple 'uplifts' (i.e. collections) were assumed per round-trip, with the average total HCRW collected per trip amounting to 75% of maximum potential capacity of the truck in the case of 770litre wheelie-bins, and 80% of maximum potential capacity of the truck in all other cases.
- The amount of waste that can be transported in a truck is limited by the number of containers that can be transported, rather than the overall mass of the waste. For this reason, the HCRW mass per container becomes an important factor in the model. The values used in the model have been synthesized from a number of sources (see Annexure 1) and have been taken to be as follows:

Table 7.6

Container[22]	Net HCRW Mass (kg)
142 litre cardboard box	7.7
100 litre reusable box ("RUB")	6.8
240 litre w-bin	25
770 litre w-bin	90

- The 240 litre and 770 litre wheelie-bins were only transported in the *Dyna 6* and *Hino 10* trucks. These trucks were assumed to have a lower and an upper floor (to provide separate compartments for empty [clean] and full wheelie-bins).
- Empty wheelie-bins were assumed to be exchanged for full ones at each collection point. Other containers were transported in all truck sizes, in multiple layers.

[22] See section 7.5.6 below for a note on the containerisation systems selected for modelling.

- Truck production was based on two 8-hour shifts per day, except in cases where round-trip distance necessitated a 10-hour shift, in which case only one shift per day was worked.
- Truck crews consisted of a driver and two helpers, except for the *Dyna 4* where only one helper was allowed.
- All vehicle operating and capital costs are included, and all crew costs, but no management costs have been allowed.
- Trucks were depreciated over 5 years, with a 20% recoupment assumed at the end of this period.
- The mass of HCRW collected from a health-care facility on any one occasion depends both on the generation-rate of that facility and the frequency of collection. This mass can vary widely: figures assembled in the Western Cape during 2006 range from nil to nearly 2,000 kgs per individual collection ('uplift') for public hospitals (with an average of approximately 200kg).
- Each 'uplift' involves stopping-time, which in turn reduces the distance that a vehicle can cover during a working shift. This means that the average mass of waste collected per uplift becomes an important factor in the model: the lower the mass of waste collected per uplift, the higher the relative cost. This factor was investigated in the model, using figures for average mass per uplift of 100 kg, 200 kg and 400 kg. It was found that the viable transport rate was approximately 30% higher for a given 'round-trip' distance at an average uplift of 100 kg, as compared with an average uplift of 400 kg[23]. In order to arrive at a conservative result, an average uplift of 100 kg has been adopted for the results presented in this study.

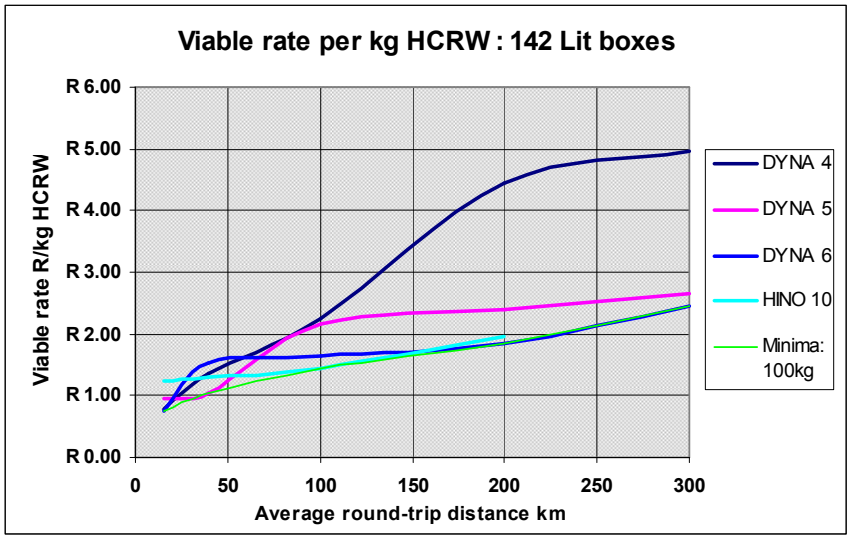
7.5.5.1 Model results for transport

Viable transport rates have been computed for each of the four containerisation systems, with each of the four truck models.

An example of the results for 142-litre cardboard boxes is shown in Figure 7.5 below.

These results are based on an average uplift mass of 100-kg and one 10-hour shift of operation per day.

Figure 7.5

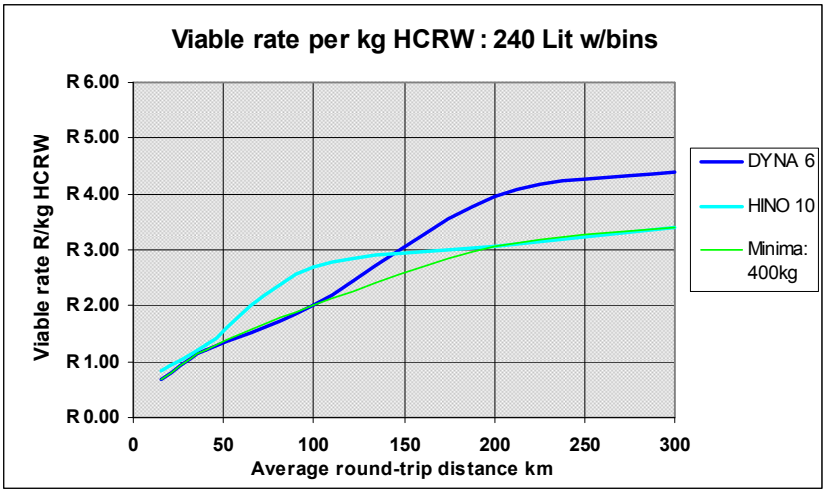


[23] This percentage relates to waste collected in cardboard or re-usable boxes, or in 240-litre wheelie-bins. The figure is higher for 770-litre wheelie-bins, but it is unlikely that such containers would be used in cases where the average uplift mass was as low as 100 kg

The results show that there is little to choose between the three smaller trucks at low round-trip distances, but the (larger) Dyna-5 and then the Dyna-6 trucks 'come into their own' as average round-trip distance increases. The largest vehicle, the Hino-10, shows the highest cost initially, but becomes the least-cost option at a round-trip distance of approximately 60-kms. At distances greater than this, however, and bearing in mind that the above graph is for an average uplift mass of 100-kg (viz. a relatively low figure), the overall length of the shift (10 hours in this case) becomes a constraining factor, i.e. time does not permit filling the truck with a full load, and consequently the overall cost per kg of HCRW rises above that for the Dyna-6 truck above a distance of approximately 140-km.

For a larger average uplift mass (400 kg), the results for 240-litre wheelie-bins are as shown below (also for one 10-hour shift per day).

Figure 7.6



The green line in each case approximates the 'minimum viable transport rate' across all the truck models (i.e. equivalent to a 'least-cost' curve).

Results similar to the above were computed for all containerisation systems, for both 1 x 10-hr shift per day and 2 x 8-hr shifts per day. Overall 'minimum viable transport rates' were then compiled from these results. These minimum viable rates are shown in Figure 7.7 to Figure 7.10 below.

Figure 7.7

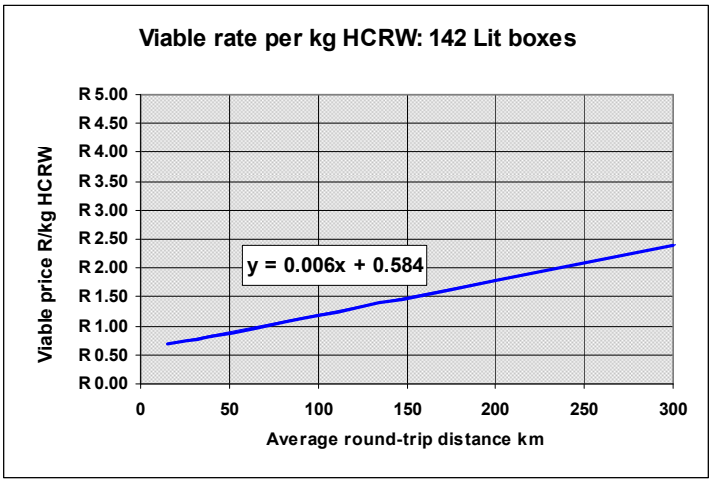


Figure 7.8

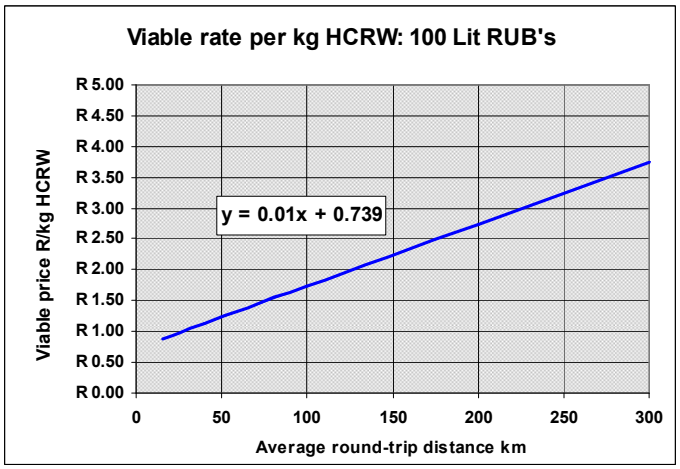


Figure 7.9

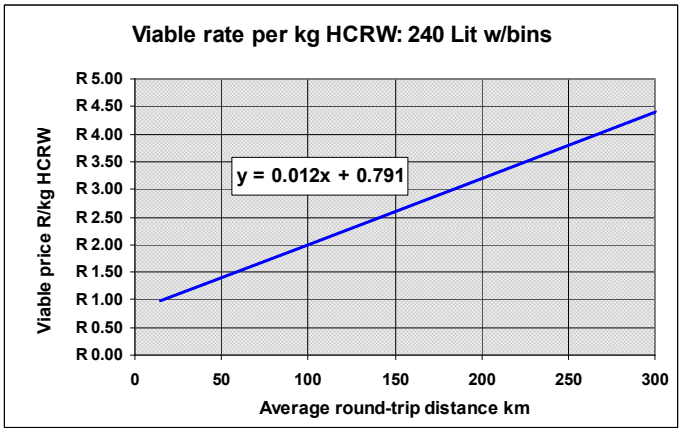
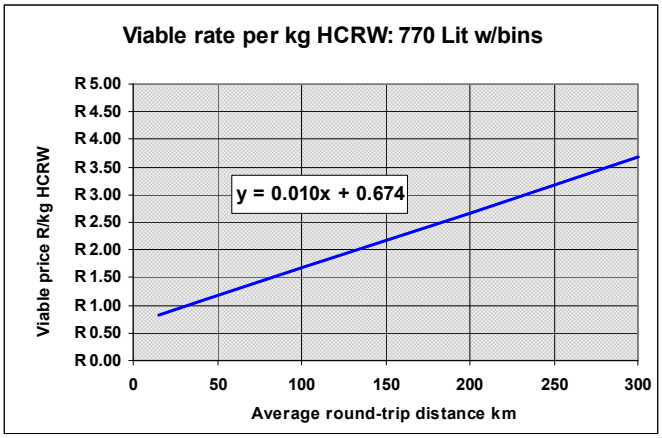


Figure 7.10



A number of observations should be made in relation to the above graphs, viz.:

- As may be seen in each of the graphs, the viable collection rate increases relatively rapidly with increase in round-trip distance. In other words, the further the treatment facility (or transfer station) is from the health-care facilities that are being serviced, the higher the transport rate to service those facilities.
- Although the graphs have similar slopes, the viable rate per kg of HCRW is lowest for the cardboard box system of containerisation.
- All re-usable container systems show viable rates higher than those for the cardboard box system; this increase can be attributed to the need to return empty (clean) re-usable containers to the health-care facilities, which impacts on loading / unloading times, and to the fact that the empty units take up space in trucks that could otherwise be utilized for full containers.
- It should be borne in mind that the graphs assume that the service-provider has a range of truck sizes available, and that he will utilize the most economical size for a given collection round.

Sensitivity analysis

An analysis was performed to assess the sensitivity of the viable transport rates to increases in capital (truck) costs, labour costs and the cost of diesel.

The results are reflected in the table below.

Table 7.7

Sensitivity of viable transport rates to 100% increases in various input costs (with other costs remaining the same):

Capital cost + 100%

Round-trip dist.:	300	200	100	40	15	Averages
142 lit boxes	30%	29%	27%	24%	23%	27%
100 lit RUBs	21%	22%	23%	25%	26%	24%
240 lit w/bins	25%	25%	24%	24%	24%	24%
770 lit w/bins	30%	30%	29%	29%	29%	29%

Labour cost + 100%

Round-trip dist.:	300	200	100	40	15	Averages
142 lit boxes	55%	56%	60%	64%	67%	60%
100 lit RUBs	46%	48%	53%	60%	65%	54%
240 lit w/bins	47%	49%	53%	59%	65%	55%
770 lit w/bins	45%	48%	52%	58%	64%	53%

Diesel cost + 100%

Round-trip dist.:	300	200	100	40	15	Averages
142 lit boxes	24%	21%	15%	7%	1%	13%
100 lit RUBs	23%	21%	16%	9%	3%	15%
240 lit w/bins	20%	18%	14%	8%	3%	13%
770 lit w/bins	23%	20%	15%	6%	-1%	13%

The greatest sensitivity of the viable transport rates is therefore to labour costs (53% to 60%); there is a lesser sensitivity to capital (truck) costs (24% to 29%), and a relatively low sensitivity to diesel costs (13% to 15%).

7.5.6 Containerisation model

The various systems that have been modelled are set out in the table below.

Table 7.8

Description:	Cardboard box system	Re-usable box system	Liner-based system (1)	Liner-based system (2)
Type of waste	**Container type(s) used**			
General infectious	142-litre cardboard box with plastic liner & lid	100-litre re-usable plastic box with liner & lid	Three sizes of plastic liner: 'small' for use on 'kick-about' trolleys 'medium' for wall and trolley-mounting 'large' (heavy gauge - 80 micron or more) for free-standing racks in sluice rooms	
Pathological waste	10-litre plastic 'speci-can' bucket with airtight lid			
Sharps & pharmaceutical waste	10-litre sharps container			
Internal transport	Boxes transported on utility trolleys		240-litre wheelie-bins	770-litre wheelie-bins

External transport	**Boxes loaded into vehicles 'as-is'**	**240-litre wheelie-bins loaded into vehicles**	**770-litre wheelie-bins loaded into vehicles**

(Of necessity, some simplification is implied in the above, but this is not expected to distort results unduly[24].)

The current unit-costs of the various containers / liners listed above are given in Annexure 1, together with average assumed net HCRW capacity (by mass).

Of necessity, the 'consumable' and re-usable elements within the various systems are treated differently in the containerisation model, viz.:

- Consumable items (cardboard boxes, sharps and speci-can containers and liners) are items which are 'bought-in' by the service-provider; it has been assumed that the service-provider will add a minimum mark-up of 33% to the cost-price of these items (although the model allows for different mark-up percentages to be used
- Re-usable containers (re-usable boxes and wheelie-bins) have been treated as capital items, which will be purchased by the service-provider, and depreciated over time. In this regard the following should be noted:
  - Multiple 'sets' of re-usable containers are required in order for the HCRW service to function; the need for this can be explained by the fact that for any full container being collected on a given day, other containers are either in wards (re-usable boxes only), in sluice, rooms, in storage at the service-provider's premises, having their contents emptied for treatment, or being washed and dried. The number of sets actually required can only be determined empirically (i.e. from actual experience): the numbers used in the model are: re-usable boxes – 6 sets[25]; 240-litre wheelie-bins – 4 sets; 770-litre wheelie-bins – 3 sets.
  - The useful life of a re-usable container is generally measured in terms of the average number of cycles through which it can be expected to pass before it becomes unusable. A range of 150 to 300 is generally quoted by service-providers: a figure of 200 has been used in the model.
  - The number of cycles per annum is a further variable: a figure of 50[26] has been used in the model (i.e. roughly one cycle per week).
  - Containers have been depreciated on a straight-line basis over 3 years in all cases.
  - Allowances have been made for loss/destruction of a percentage of containers, and also for repairs to the wheelie-bin containers (wheels, lids).
  - A separate worksheet of the model is devoted to cleaning and disinfection of the containers. Initial plant cost, operating and consumable costs and labour costs have been included in the model.

As indicated previously, the viable rate for containerisation of the HCRW, expressed here as a rate per kilogram applicable to the overall HCRW stream, is influenced by the percentages sharps waste and pathological waste in the stream. The model allows for these percentages to be varied, but the

[24] For example, two sizes of cardboard box and of re-usable box are often deployed in practice, depending on the rate of HCRW generation in a given area. Similarly, multiple sizes of sharps containers and specicans are often deployed.

[25] Re-usable boxes are used as primary receptacles for general infectious waste, and are therefore deployed in wards; by contrast, 240-litre wheelie-bins generally receive HCRW only in sluice-rooms, and 770-litre wheelie-bins are generally used as internal transport rather than internal receptacles or for static internal storage. This accounts for the different numbers of sets required for the various systems.

[26] The viable rate (for re-usable container usage) increases rapidly as the number of cycles decreases below 50; above 50 cycles/yr the decrease in viable rate is relatively slow. This effect has been graphed on the model worksheets.

percentages on which the model results below are based are 4% pathological and 12 % sharps. (See section 7.4.3 above.)

7.5.6.1 Model results for containerisation

Model results for the various containerisation systems are shown in Table 7.9 below.

Table 7.9

Containerisation system	Overall rate per kg
Cardboard box	R 2.49
Re-usable box	R 3.05
Liner system: 240 lit w-bins	R 2.79
Liner system: 770 lit w-bins	R 3.21

Sensitivity analysis

An analysis was performed to assess the sensitivity of the containerisation rates to increases in consumable costs (all sacrificial containers including cardboard boxes, sharps containers, pathological waste containers, plastic liners and also cleaning chemicals [for the re-usable systems]), capital costs (re-usable containers and also the cleaning plant itself) and finally labour costs.

The results are reflected in Table 7.10 below.

Table 7.10

Containerisation system	Consum-able cost + 100%	Capital cost + 100%	Labour cost +100%	Pathological waste + 100%	Sharps waste + 100%
Cardboard box	100%	0%	0%	5%	42%
Re-usable box	68%	28%	4%	3%	30%
Liner system: 240 lit w-bins	84%	14%	2%	4%	35%
Liner system: 770 lit w-bins	72%	27%	1%	3%	28%

As would be anticipated, the cardboard box system shows 100% sensitivity to increases in consumable costs; perhaps surprisingly, the re-usable box and wheelie-bin systems also show high sensitivities to consumable costs, due to the use of (consumable) liners and also to the chemicals required for cleaning / disinfecting the containers.

Sensitivity to increases in capital costs is moderate for re-usable boxes and the larger 770 litre wheelie-bins, but lower for the 240 litre wheelie-bins[27]. Sensitivity to increases in the labour costs are negligible.

Sensitivity to increases in the percentage of pathological waste in the overall HCRW stream are relatively low at between 3% and 5%. Sensitivity to increases in the percentage of sharps waste in the overall HCRW stream is, however, high, at between 30% and 42%. This fact, already referred to in 7.4.3 above, relates to the low mass-density of sharps waste containing syringes, vials, etc., in small and relatively costly

[27] The reason that the 240-litre wheelie-bins show a lower sensitivity to increased capital costs than the 100-litre re-usable boxes and 700-litre wheelie bins is due to the comparatively low average HCRW mass in the 100-litre re-usable boxes, and due to the very high relative price of the 770 litre wheelie-bins, respectively.

containers, and highlights the need to mitigate these factors, e.g. by disposing vials and syringe bodies separately, and / or utilizing re-usable sharps containers.

7.6 Other costs associated with HCRW management

In addition to the major cost factors analysed above, service-providers are generally obliged to provide training to waste-handling personnel at the health-care facilities which they service. This training covers some or all of the following: safe-handling of HCRW; proper segregation of waste (both HCRW vs. HCGW, and various categories of HCRW); storage and transport of waste; logging of containers onto and off the site; ordering of consumables; waste logistics.

In addition to the above, service-providers have to market their services to potential customers and then liaise with customers on a continuing basis after contracts are awarded.

The costs associated with the above are principally personnel costs, although other costs such as the preparation and production of printed material including handbooks, posters, labels, etc. are also involved.

Although these costs need to be included for the sake of overall completeness, they are small in relation to the other components of HCRW management, and do not warrant in-depth analysis. A figure of R 0.25 per kg of HCRW has been assumed here for these costs, and it is considered unlikely that actual costs will exceed this figure for the range of treatment plant capacities considered here.

7.7 Overall viable rates for HCRW management

The modelled rates have been summarised in the table below.

It should be noted that the treatment rates for incineration and autoclaving have been averaged over the various plant sizes considered, in order to simplify the summary. (For incineration, an average rate of R 4.00 per kg has been used; the range indicated by the model outputs [section 7.5.4.1 above] is from approximately R 3.69 for the largest plant to R 4.58 for the smallest. For autoclaving, and average rate of R 2.80 per kg has been used; the range indicated by the model outputs [7.5.4.2 above] is from approximately R 2.70 for the largest plant to approximately R 3.06 for the smallest.)

Overall rates have been determined for round-trip distances of 40, 100 and 300 km in each case. In all cases the overall rates have been rounded to the nearest R 0.50 per kg to avoid implying an unrealistic level of accuracy for the results.

As some contracts between health-care facilities and service-providers have separate rates for collection and treatment on the one hand and for the provision of containers on the other, separate columns of the table show overall rates with or without the inclusion of containerisation.

Table 7.11

Viable HCRW management rates: summary

As at January 2008

Treatment by incineration:

Containerisation system:	Viable rates per kg of HCRW (Excl. VAT)						
	Container-isation rate	Treat-ment rate (average)	Training & market-ing	Transportation		Overall rate excluding container-isation (to nearest 50c)	Overall rate including container-isation (to nearest 50c)
				Av. round-trip distance (km)	Transport rate		
Cardboard boxes	R 2.49	R 4.00	R 0.25	40	R 0.82	R 5.00	R 7.50
				100	R 1.18	R 5.50	R 8.00
				300	R 2.38	R 6.50	R 9.00
Re-usable boxes	R 3.05	R 4.00	R 0.25	40	R 1.14	R 5.50	R 8.50
				100	R 1.74	R 6.00	R 9.00
				300	R 3.74	R 8.00	R 11.00
240-litre wheelie-bins	R 2.79	R 4.00	R 0.25	40	R 1.27	R 5.50	R 8.50
				100	R 1.99	R 6.00	R 9.00
				300	R 4.39	R 8.50	R 11.50
770-litre wheelie-bins	R 3.21	R 4.00	R 0.25	40	R 1.07	R 5.50	R 8.50
				100	R 1.67	R 6.00	R 9.00
				300	R 3.67	R 8.00	R 11.00

Treatment by autoclaving:

Containerisation system:	Viable rates per kg of HCRW (Excl. VAT)						
	Container-isation rate	Treat-ment rate (average)	Training & market-ing	Transportation		Overall rate excluding container-isation (to nearest 50c)	Overall rate including container-isation (to nearest 50c)
				Av. round-trip distance (km)	Transport rate		
Cardboard boxes	R 2.49	R 2.80	R 0.25	40	R 0.82	R 4.00	R 6.50
				100	R 1.18	R 4.00	R 6.50
				300	R 2.38	R 5.50	R 8.00
Re-usable boxes	R 3.05	R 2.80	R 0.25	40	R 1.14	R 4.00	R 7.00
				100	R 1.74	R 5.00	R 8.00
				300	R 3.74	R 7.00	R 10.00
240-litre wheelie-bins	R 2.79	R 2.80	R 0.25	40	R 1.27	R 4.50	R 7.00
				100	R 1.99	R 5.00	R 8.00
				300	R 4.39	R 7.50	R 10.00
770-litre wheelie-bins	R 3.21	R 2.80	R 0.25	40	R 1.07	R 4.00	R 7.50
				100	R 1.67	R 4.50	R 8.00
				300	R 3.67	R 6.50	R 10.00

8. Needs Assessment.

The needs identified during the investigation are grouped according to the main facets on which it can be expected to have an impact. It is however to be recognised that some needs may have impacts in various areas, thus resulting in the same need being listed under more than one main heading.

It is further to be recognised that the investigation was not focussed on needs that may exist on micro level, i.e. HCF level where for instance liners with incorrect colour coding are used, or where sharps containers may be overfilled, but is primarily intended to deal with the overall organisational and logistical problems in terms of HCRW management service delivery throughout SA. Needs on micro level that were reported during interviews, were however listed under the relevant sub-headings.

8.1 Environmental Needs:

The following are considered to be the most prominent Environmental needs:

8.1.1 Authorities:

8.1.1.1 Standard-setting and monitoring:

- HCRW Management Policies, Strategies and Action Plans are to be developed on national level, provincial level, health district level and HCF level in consultation with the relevant stakeholders. Once adopted, Strategies and Action Plans are to be implemented, with ongoing monitoring to ensure that HCRW is managed in an environmentally sound manner. Appropriate human and financial resources are to be allocated to the relevant regulating authorities to monitor the effective implementation thereof in a sustainable manner;
- All health care facilities, whether private or public, large or small, should be required to comply with certain minimum HCRW management standards that are to be in accordance with the relevant Regulations as well as the latest revision of the SANS 10248 Code. No open pit burning of HCRW or HCGW is to be allowed and the continued use of placenta pits should be prevented. Firm action is to be taken against HCRW generators not making use of appropriate HCRW treatment facilities like unofficial abortion clinics, tattoo artists, traditional healers, etc;
- Uniform environmental standards are to be set and effectively enforced throughout SA for HCW management in general. Particular attention is however to be given to HCRW treatment and disposal, not only for the protection of the environment, but also to ensure a level playing field in the industry. Once developed, the standards are to be consulted with stakeholders throughout SA before being legislated;
- Service standards are to be set and effectively enforced to prevent HCRW management service providers from lowering service standards to meet an unrealistic drive towards lower prices by both private and public HCRW generators. Such low service prices result in the HCRW service delivery not being sustainable, as service providers have to invest large amounts of capital in the provision of legally compliant HCRW treatment facilities, which is not possible if the service tariffs are unrealistically low;
- Where SANS Codes are used in the absence of Regulations for standard-setting, it is to be recognised that the SANS Codes do not set any emissions standards or treatment efficiency standards for HCRW treatment processes; allowance must therefore be made for this;
- Air emission standard-setting should be done with cognisance being taken of other sources of air pollution resulting from waste management (e.g. illegal burning of waste on landfills, ongoing methane

generation on landfills, etc.) to ensure integrated pollution control across the board, without focussing on HCRW incineration only;

- The standards set for incineration and non-incineration HCRW treatment technologies should ensure the same treatment efficiency and environmental impact, irrespective of the technology used, thereby preventing discrimination against any of the treatment technologies;
- EIA regulations and RoD conditions should be uniform and practical for implementation throughout SA, irrespective of who the applicant is or in which province the EIA is to be undertaken;
- Roles and responsibilities of the various regulating authorities are to be clearly defined and agreed upon to prevent overlap of responsibilities, or alternatively, no party taking responsibility for particular monitoring and law enforcement activities;
- No distinction is to be made between the various sized service providers when the environmental standards are set or enforced. With HCRW being a highly hazardous waste product, only competent and environmentally responsible service providers should be allowed to render HCRW services. BEE or SMME service providers are not to be treated different from formally recognised service providers during the setting of RoD conditions or the enforcement of legislation, and HCRW service delivery should not be used for large scale empowerment initiatives;
- Crematoria nominated for HCRW treatment are to comply with the same air emission standards as incinerators, or alternatively crematoria are not to be used for HCRW treatment;
- Online emission monitoring should be required to ensure that service levels cannot be reduced once performance monitoring is completed (e.g. by lowering of treatment temperatures, disconnecting of secondary chamber burners, etc.);
- Where HCRW treatment facilities are found to be non-compliant in terms of the uniform environmental standards set for all of SA, the downstream impact of actions taken by the regulating authorities should be taken into consideration. Imposing penalties in the form of financial fines to act as a deterrent for non-compliance to environmental standards might be more appropriate under the current situation of insufficient HCRW treatment capacity in SA, than to shut down the limited number of facilities that are available;
- Onsite as well as regional / commercial HCRW incinerators that are not compliant with the proposed air emission standards are to be phased out within the shortest possible period of time. To prevent further use of such incinerators (particularly at health care facilities), incinerators are to be made unserviceable by removing burners as well as incinerator doors until such time that the incinerators can be demolished;
- Firm action is to be taken against HCRW Management service providers that are found to contravene the proposed national HCRW management regulations, with lowering in accreditation rating referred to or even removal from the accreditation list (e.g. if found to dispose of HCRW illegally or storing it for extended periods of time) being part of the penalty. This should however be in addition to fines imposed by the courts;
- Where HCRW service providers are found to act illegally by dumping or storing HCRW for extended periods of time, fines that are related to the nature of the offence should be imposed to serve as a deterrent. HCRW management service providers making an effort and incurring high costs to operate in an environmentally sound manner are put at a financial disadvantage compared to those that are allowed to harm the environment. By rendering a poor level of service that does not comply with uniform standards, the latter are able to tender at lower prices;
- As part of the Waste Information System (WIS), DEAT is to monitor availability of HCRW treatment capacity on an ongoing basis, with HCRW treatment facility owners having to submit backup plans for implementation in the event of breakdown or maintenance that will remove treatment facilities from service for extended periods of time. Where HCRW treatment capacity is significantly reduced by breakdowns exceeding what could reasonably have been anticipated, DEAT is to provide an emergency plan for disposal of such HCRW on hazardous waste disposal sites or by any other appropriate means available;

- Incidents of HCRW being turned away from any particular HCRW treatment facility due to insufficient treatment capacity are to be reported to the DEAT WIS coordinator, who is then to recommend alternative HCRW treatment facilities with spare capacity as close as possible to the source of HCRW generation.

8.1.1.2 Operations:

- Appropriate HCRW management strategies are to be developed and implemented to ensure that all HCRW generators have reasonable access to affordable HCRW management systems, irrespective of the HCRW volume generated or the transport distance;
- Regional HCRW treatment facilities (private and / or publicly owned) should be established throughout the country. A strategy is to be put in place for HCRW to be treated at the nearest available complaint HCRW treatment facility. This is intended to limit the environmental risks (possible spillage during accidents) and impacts (increased pollutants emitted to the air) brought about by the long-haul transport of HCRW in different directions throughout SA;
- Regional hazardous waste disposal facilities (landfills or cells) that are designed, constructed and operated in accordance with "Minimum Requirements" are to be provided throughout SA. Such facilities are not only intended for hazardous waste generated in all provinces, but also for residues from incineration and non-incineration HCRW treatment processes. No residues from HCRW treated by means of incineration or non-incineration technologies are to be disposed of on waste disposal facilities not appropriately designed, constructed and operated;
- The continued installation of onsite HCRW incinerators without having EIA's undertaken, in particular by the respective Departments of Public Works, should be stopped with immediate effect, even if it requires high level consultation between the 3 affected departments (Environment, Health and Public Works);
- Municipalities are to be capacitated and supported to provide and operate appropriate waste disposal facilities that are in compliance with Minimum Requirements for Waste Disposal by Landfill, thus allowing for environmentally sound disposal of Health Care General Waste (HCGW) as well as the treated HCRW residues, where applicable and appropriate;
- A system of accreditation of HCRW management service providers (similar to the CIDB - Construction Industry Development Board - ratings done for public tenders in the building / civil engineering industry) is required to prevent "opportunists" from entering the market and managing HCRW in an irresponsible manner. Criteria for accreditation should inter alia include availability of facilities and resources, availability of backup facilities, the service provider's previous experience and track record, environmental compliance and occupational health and safety compliance. In addition to the aforesaid, the need should also be expressed for a "fit and proper person" to be tasked to manage the project from the side of the service provider.

8.1.1.3 Training and Awareness:

- Effective lines of communication are to be provided between the 3 spheres of government; between the various affected departments on the same level of government, as well as between the provincial DoH and HCF's. Exchange of information and capacity building is to be undertaken on an ongoing basis;
- Provincial Departments of Environment are to be assisted by DEAT in the establishment and training of staff for implementation of environmental monitoring programmes that will ensure effective enforcement of the relevant legislation;
- DEAT and / or NDoH should provide training and render an advisory service to provincial officials on the development of tender specifications as well as the adjudication of tenders to ensure that HCRW management services are rendered in a sustainable manner once the contracts are awarded. Although input on commercial matters should be provided by staff with a procurement background, the technical

and operational specifications for tenders are to be compiled by suitably qualified and experienced HCW management specialists;

- Officials from provincial Departments of Environment are to be capacitated and trained in the evaluation of Environmental Impact Assessment (EIA) reports for various HCRW treatment technologies, compiling of Records of Decision (RoD) and executing of environmental monitoring programs subsequent to commissioning of HCRW treatment facilities. This is to assist in ensuring the setting and enforcement of uniform standards throughout SA.

8.1.2 HCRW Generators:

8.1.2.1 Standard-setting and monitoring:

- HCRW Management Policies, Strategies and Action Plans are to be developed on Provincial Health or Hospital Group level as well as HCF level in consultation with the relevant stakeholders. Once adopted, Strategies and Action Plans are to be implemented, with ongoing monitoring to ensure that HCRW is managed in an environmentally sound manner;
- All health care facilities, whether private or public, large or small, should comply with certain minimum HCRW management standards that are to be in accordance with the relevant Regulations as well as the latest revision of the SANS 10248 Code. No open-pit burning of HCRW of HCGW is to be undertaken and the continued use of placenta pits should not be allowed;
- Service standards are to be set and enforced to prevent HCRW management service providers from lowering service standards to meet an unrealistic drive towards lower prices by both private and public HCRW generators, as some HCRW generators are expecting 1st world standards at 3rd world prices. Such low service prices are resulting in the HCRW service delivery not being sustainable, as service providers have to invest large amounts of capital in the provision of legally compliant HCRW treatment facilities, which is not possible if the service tariffs are unrealistically low;
- As part of performance monitoring, all HCRW generators making use of external HCRW management services are to provide proof that services are in fact rendered by accredited service providers (and that they are in fact using such a service provider). Only accredited HCRW service providers should for instance be eligible to tender on public HCRW management service tenders;
- Onsite HCRW incinerators that are not compliant with the proposed air emission standards are to be phased out within the shortest possible period of time. To prevent further use of such incinerators (particularly at health care facilities), incinerators are to be made unserviceable by removing burners as well as incinerator doors until such time that the incinerators can be demolished;

8.1.2.2 Operations:

- Appropriate HCRW containers that are puncture-resistant and leak-resistant are to be used for containerisation of HCRW and where such containers are disposable, they should be manufactured from materials that will have limited impact on the environment, particularly when incinerated e.g. for specicans containing pathological HCRW;
- Appropriate HCRW storage facilities are to be provided at all major and minor HCRW generators, with HCRW containers secured and effectively protected against the elements, all in accordance with the relevant Regulations or SANS codes;
- All vehicles used for HCRW collection and transport should comply with the Road Transport Act, or any Bylaws that may exist at the municipality within which the vehicles are to operate. This would inter alia include all of the required signage and spill kits. HCRW collection vehicles should be sized according to the particular application, with HCRW trailers used for HCRW collection from rural clinics or minor HCRW generators where appropriate;
- Suitably qualified and appropriately licensed drivers are to drive HCRW collection and transport vehicles. In addition to the suitably qualified driver, it should also form part of the vehicle's licensing

requirements that a similarly qualified driver be made available as backup during the times when the driver is unavailable;

- Appropriate HCRW transfer facilities with HCRW containers secured, protected against the elements and refrigerated where necessary (all in accordance with the relevant Regulations or SANS codes), are to be provided at all hospitals or other facilities identified to serve as HCRW transfer points for HCRW collected from rural clinics and even private HCRW generators in the affected town or health district;
- All HCRW transfer facilities, whether private or publicly owned, are to be managed by a competent person that is suitably qualified and trained for the work. In addition to the suitably qualified transfer station manager, it should also form part of the RoD that a similarly qualified staff member must be available as backup whilst the manager is unavailable;
- Where HCRW, and in particular pathological HCRW is to be transferred for long distance transport to incinerators (which are likely to be fewer in number than the non-incineration HCRW treatment facilities), appropriate cold storage facilities are to be provided to prevent fermentation of HCRW;
- All HCRW treatment facilities, irrespective of whether they are private or publicly owned, onsite or regional, incineration or non-incineration, are to be maintained and operated by a competent person who is suitably qualified and trained for the work. The qualifications and training standards are to be set in accordance with treatment plant supplier's recommendations. In addition to the suitably qualified treatment plant operator, it should also form part of the RoD that equally qualified staff must be available as backup whilst the operator is unavailable to operate the HCRW treatment facility;
- The tender specifications for outsourcing of HCRW management services should in addition to the equipment specification also specify the manner in which HCRW is to be collected, transported, treated and disposed of, without being specific about the particular technology. Although the specifications are to comply with the SANS 10248 Code as well as any relevant legislation, the HCRW management service tender specifications are to be developed around the particular needs of health care facilities (HFC) to be serviced;
- Comprehensive stakeholder consultation is required during the development of HCRW management tender specifications to ensure that the services rendered will address the particular needs of the respective HCRW generators. Input from both the health as well as the environmental sector is required;
- Service contracts should make provision for inclusion of all public HCRW generators as required for a particular area, inter alia including hospitals, clinics, emergency services, mortuaries, mobile clinics, blood transfusion services, pathological laboratories, etc. The possibility of HCRW from the private sector being incorporated into public service tenders (with payment individually made by the respective HCRW generators) is to be investigated for remote and rural parts of SA, thereby providing the economies of scale required for cost-effective service delivery to HCRW generators throughout SA;
- Effective HCRW service contract management and enforcement of contract conditions and specifications is required to ensure compliance, thereby treating all HCRW service providers equally and ensuring that all parties are tendering on the same service level. DEAT and / or NDoH is to provide ongoing training to provincial officials whilst also acting in an advisory capacity to the provincial departments;
- The continued installation of onsite HCRW incinerators, in particular by the respective Departments of Public Works, without having EIA's undertaken should be stopped with immediate effect, even if it requires high level consultation between the 3 affected departments (Environment, Health and Public Works);
- Mercury from fused fluorescent light tubes and from thermometers generated in hospitals is to be managed in a responsible manner, with appropriate systems put in place for the collection, transport, treatment and disposal of mercury containing products from all health care facilities.

8.1.2.3 Training and Awareness:

- Senior management / decision makers at provincial Departments of Health, private hospital groups and HCF's are to be informed of the need for appropriate HCRW management systems. Such parties are to give their support to the process and ensure that sufficient funds are allocated in the annual budget for environmentally sound HCRW management systems;
- Effective lines of communication are to be provided between the 3 spheres of government; between the various affected departments on the same level of government, as well as between the provincial DoH and the HCF's. Exchange of information and capacity building is to be undertaken on an ongoing basis;
- DEAT and / or NDoH is to provide training and render an advisory service to provincial officials on the development of tender specifications as well as the adjudication of tenders to ensure that HCRW management services are rendered in a sustainable manner once the contracts are awarded. Although input on commercial matters should be provided by staff with a procurement background, the technical and operational specifications for the tenders are to be compiled by suitably qualified and experienced HCW management specialists;
- Together with the need for environmental legislation, there is also a need for awareness creation amongst members of the HCW management industry around environmentally sound HCRW treatment operations. Guidance is for instance to be provided on green procurement, appropriate treatment and disposal options, etc.

8.1.3 HCRW Service Providers:

8.1.3.1 Standard-setting and monitoring:

- Uniform environmental standards set are to be effectively adhered to throughout SA, in particular for HCRW treatment and disposal. This is not only for the protection of the environment, but also to ensure a level playing field in the industry. Given the opportunity, stakeholders throughout SA are to participate in the consultation process before the set standards are legislated;
- Commercial HCRW incinerators that are not compliant with the proposed air emission standards are to be phased out within the shortest possible period of time. To prevent further use of such incinerators, incinerators are to be made unserviceable by removing burners as well as incinerator doors until such time that the incinerators can be dismantled;
- As part of the Waste Information System (WIS), HCRW treatment facility owners should submit backup plans for implementation in the event of breakdown or maintenance that will remove treatment facilities from service for extended periods of time;
- Incidents of HCRW being turned away from any particular HCRW treatment facility due to insufficient treatment capacity are to be reported to the DEAT WIS coordinator, who is then to provide the HCRW service generator with information on the nearest alternative HCRW treatment facility with spare capacity.

8.1.3.2 Operations:

- Appropriate HCRW management strategies are to be developed and implemented to ensure that all HCRW generators have reasonable access to affordable HCRW management systems, irrespective of the HCRW volume generated or the transport distance;
- HCRW is to be treated within the specified timeframe to prevent the emission of odours as well as the breeding of vectors and rodents. Where required during excessively warm spells, time limits for HCRW storage before treatment may have to be reduced;
- Workers are to be informed about the environmental risks in handling HCRW containers inappropriately, e.g. the risk of damaging specicans or sharps containers as a result of inappropriate handling;

- All vehicles used for HCRW collection and transport should comply with the Road Transport Act, or any Bylaws that may exist at the municipality within which the vehicles are to operate. This would inter alia include all signage and spill kits that may be required. HCRW collection vehicles should be sized according to the particular application, with HCRW trailers used for HCRW collection from rural clinics or minor generators where appropriate;
- Suitably qualified and appropriately licensed drivers are to drive HCRW collection and transport vehicles. In addition to the suitably qualified driver, it should also form part of the vehicle's licensing requirements that a similarly qualified driver be made available as backup during the times when the driver is unavailable;
- Appropriate HCRW transfer facilities with HCRW containers secured, protected against the elements and refrigerated where necessary (all in accordance with the relevant Regulations or SANS codes), are to be provided at facilities identified to serve as HCRW transfer points for HCRW collected from rural clinics and even private HCRW generators in the affected town or health district;
- All HCRW transfer facilities, whether private or publicly owned, are to be managed by a competent person that is suitably qualified and trained for the work. In addition to the suitably qualified transfer station manager, it should also form part of the RoD that a similarly qualified staff member must be available as backup whilst the manager is unavailable;
- Where HCRW, and in particular pathological HCRW is to be transferred for long distance transport to incinerators (which is likely to be less in number than the non-incineration HCRW treatment facilities), appropriate cold storage facilities are to be provided to prevent the fermentation of the HCRW;
- All HCRW treatment facilities, irrespective of whether it is private or publicly owned, onsite or regional, incineration or non-incineration, are to be maintained and operated by a competent person that is suitably qualified and trained for the work. The qualifications and training standards are to be set in accordance with treatment plant supplier's recommendations. In addition to the suitably qualified treatment plant operator, it should also form part of the RoD that equally qualified staff must be available as backup whilst the operator is unavailable to operate the HCRW treatment facility;
- Regional HCRW treatment facilities (private and / or publicly owned) should be established throughout the country. A strategy should then be put in place for HCRW to be treated at the nearest available complaint HCRW treatment facility. This is intended to limit the environmental risks (possible spillage during accidents) and impacts (increased pollutants emitted to the air) brought about by the long-haul transport of HCRW in different directions throughout SA;
- A system of accreditation of HCRW management service providers (similar to the CIDB - Construction Industry Development Board - ratings done for public tenders in the building / civil engineering industry) is required to prevent irresponsible opportunists from entering the market and managing HCRW in an irresponsible manner. Criteria for accreditation should inter alia include availability of facilities and resources, availability of backup facilities, the service provider's previous experience and track record, environmental compliance and occupational health and safety compliance. In addition to the aforesaid, the need should also be expressed for a "fit and proper person" to be tasked to manage the project from the side of the service provider;
- Better cooperation and interaction between competitors in the HCRW management industry is to be facilitated, as the current price war on HCRW service delivery is resulting in a lowering of HCRW management service standards;
- To ensure the viability and long-term availability of environmentally compliant incinerators required for the treatment of pharmaceutical and pathological HCRW, the possibility should be investigated to introduce a system of differentiated treatment tariffs, thereby recovering the cost of more expensive incineration facilities through increased revenue generated from pharmaceutical and pathological HCRW treatment.

8.1.3.3 Training and Awareness:

- Together with the need for environmental legislation, there is also a need for awareness creation amongst members of the HCW management industry around environmentally sound HCRW treatment operations. Guidance is for instance to be provided on green procurement, appropriate treatment and disposal options, etc.

8.2 Occupational Health and Safety Needs:

The following are considered to be the most prominent Occupational Health and Safety needs:

8.2.1 Authorities:

8.2.1.1 Standard setting and monitoring:

- HCRW Management Policies, Strategies and Action Plans are to be developed on national level, provincial level and health district level in consultation with the relevant stakeholders. Once adopted, Strategies and Action Plans are to be implemented, with ongoing monitoring to ensure that HCRW is managed in an environmentally sound manner. Appropriate human and financial resources are to be allocated to the relevant regulating authorities to monitor the effective implementation thereof in a sustainable manner;
- Stricter control is to be exercised on HCRW generated by minor HCRW generators like doctors, dentists and home based care patients to ensure that HCRW, and in particular sharps, is not disposed of in the general waste stream through which general waste collectors and landfill operators are put at risk;
- HCRW management standards are to be legislated and effectively enforced, thereby protecting the health and safety of workers by ensuring compliance with the relevant Occupational Health and Safety Standards;
- Burning of HCRW in open pits or disposing of placentas in placenta pits should not be permitted as it is putting the health and safety of staff members as well the public at risk.

8.2.1.2 Operations:

- HCRW management activities within municipalities are to be coordinated, with municipalities having to maintain records of all HCRW generators (including minor HCRW generators) together with the amount of HCRW generated in their respective areas of jurisdiction. Such information is important for ongoing compliance monitoring;
- Financial support is to be provided to municipalities with the implementation of minor HCRW generator collection systems, as municipalities claim that insufficient funds are available to finance amongst others the distribution of sharps containers to members of the community that are unable to afford sharps containers for use during home based care;
- Provincial HCRW management strategies are to take cognisance of potentially long transport distances between the HCRW generators and the treatment facilities, thereby reducing the risk of HCRW not being treated as a result of unavailability of appropriate HCRW transfer / treatment facilities in close proximity to the HCRW generators;
- The Department of Labour should be requested to undertake ongoing audits of HCRW transfer, treatment and disposal facilities, with appropriate financial penalties imposed where occupational health and safety standards are not met. Closure of non-complying facilities for extended periods of time is however not recommended in the light of the current shortage of HCRW treatment facilities.

8.2.1.3 Training and Awareness:

- More effective communication and cooperation is required between affected departments on different levels of government; on the same levels of government, as well as between provincial departments of health and the HCF's. Information dissemination is to be prioritised to ensure that the affected provincial departments, municipalities and HCF's remain informed about the outcome of research and development in the HCRW management industry;
- All relevant matters on HCRW management is to be included in the training curriculum for health care professionals;
- Public awareness is be increased and facilities are to be provided for HCRW generated in public places by for instance diabetes patients and drug addicts, who's HCRW is often disposed of as part of the general waste stream or in municipal street litterbins where it is putting the health and safety of municipal workers at risk.

8.2.2 HCRW Generators:

8.2.2.1 Standard setting and monitoring:

- HCRW Management Policies, Strategies and Action Plans are to be developed on provincial health and hospital group level, health district level and HCF level in consultation with the relevant stakeholders. Once adopted, Strategies and Action Plans are to be implemented, with ongoing monitoring to ensure that HCRW is managed in a manner that will not put the health and safety of workers at risk;
- Decisions on the most appropriate HCRW management system should not be made by procurement officers on financial grounds, but should be taken by suitably qualified and experienced health care professionals. Opting for the cheapest HCRW management system and thereby putting workers at risk is in particular a problem in private HC facilities that are profit-driven, with HCRW generators expecting 1st world solutions at 3rd world prices;
- HCRW management systems and equipment should be designed such that workers are not put at risk by ergonomically inappropriate HCRW management systems or equipment;
- All maintenance staff and operators of HCRW treatment facilities, whether onsite or regional, incineration or non-incineration, private or publicly owned, should be suitably qualified and appropriately trained in accordance with the plant supplier's specification to ensure that such workers are not put at risk, or that other staff members are not put at risk by the inappropriate operation of HCRW treatment facilities. In addition to the suitably qualified operating and maintenance staff, it should also form part of the RoD that equally qualified staff must be available as backup whilst the fulltime staff is unavailable to operate the HCRW treatment facility;
- Special attention is to be given to health care professionals, and in particular doctors that are not cooperating in terms of effective HCW segregation, thus putting the general workers and municipal workers at risk. The possibility of using the CPD point system, as an incentive for doctors to attend HCW management training sessions should be investigated. It is often found that HC professionals are primarily concerned about the health and well being of their patients, without any concern about the health and well being of workers affected by poorly segregated HCRW;
- The relevant legislation as well as tender specifications used for outsourcing of HCRW management services are to be enforced as part of effective contract management, thus preventing service providers from rendering the HCRW management services to their own standards. Contract management is further to ensure compliance with the relevant Occupational Health and Safety Standards;
- Where the SANS 10248 Code is used as part of tender specifications or for the development of HCRW management policies, it is to be recognised that limited provision is made for Occupational Health and Safety matters and reference is still to be made to the Occupational Health and Safety Act.

8.2.2.2 Operations:

- Safe and healthy working conditions are to be provided for onsite as well as regional HCRW treatment facility operators, in particular to prevent them from being exposed to hazardous gases and liquids released from HCRW treatment facilities;
- Appropriate protective clothing is to be issued with training in the appropriate use thereof provided. The use of protective clothing is to be enforced for all workers handling HCRW;
- Spill kits, together with appropriate training in the safe removal of HCRW spills, are to be provided to workers required to deal with HCRW spills;
- Appropriate and affordable HCW segregation systems, together with the required training, should be provided to prevent disposal of sharps in the HCGW stream where it creates a risk to general workers in HCF's as well as for municipal workers undertaking the collection, transport and disposal of HCGW;
- Appropriate puncture-resistant and leak-resistant HCRW containers are to be used for the containerisation of HCRW, thus preventing the risk of workers being exposed to HCRW. Plastic liners on their own should not be permitted for HCRW containerisation due to the risk of poorly segregated HCRW sharps being disposed of with general infectious HCRW;
- Appropriate internal and external HCRW storage facilities are to be provided in compliance with the relevant Regulations and the SANS Code 10248 to prevent unauthorised entry and accidental contact with HCRW;
- Appropriate internal HCRW transport systems with proper access to all HCRW storage areas are to be provided in compliance with the relevant Regulations and the SANS Code 10248 to prevent the risk of unsafe transport equipment being used or workers having to carry HCRW in a way that could put their health and safety at risk;
- Public institutions are to set an example in terms of appropriate HCRW management, with both public and private HCF's not being allowed to treat and dispose of HCRW in any manner that could put the health and safety of their own workers or that of municipal workers at risk;
- Burning of HCRW in open pits or disposing of placentas in placenta pits should not be permitted as it is putting the health and safety of staff members at risk;
- Appropriate external transport systems are to be provided for the transport of HCRW from the clinics to the central hospitals / transfer stations from where HCRW is to be collected by the HCRW service providers. Health care facility staff are not to be put at risk by having to transport HCRW in sedan vehicles or ambulances;
- Appropriate and affordable HCRW collection systems are to be provided for HCRW generated by minor HCRW generators (general practitioners, dentists, veterinary surgeons, etc.), thereby preventing the illegal disposal of HCRW in the general waste stream where it creates a risk to the health and safety of municipal waste collectors and landfill workers;
- HCRW is to be treated within the specified time-frames to prevent workers from being exposed to fermenting HCRW, to prevent the generation of odours and to prevent the breeding of vectors and rodents;
- Realistic prices are to be paid to HCRW management service providers, as the overall drive towards improved health and safety standards for HCRW management services is undermined by an unrealistic drive towards lower prices by both public and private HCRW generators;
- Service contracts entered into with HCRW service providers are to make provision for inclusion of all public HCRW generators in any particular area, inter alia including hospitals, clinics, emergency services, mortuaries, mobile clinics, blood transfusion services, pathological laboratories, etc. The possibility of private sector generated HCRW being incorporated into public service tenders (with payment directly made by the respective HCRW generators) is to be investigated for remote parts of SA, thereby providing the economies of scale required for cost effective HCRW management service delivery throughout SA;
- Service delivery on 3-month quotation cycles, to avoid the need for a comprehensive tendering process as required by the Public Finance Management Act (PFMA), should not be permitted. Consistency in HCRW management service delivery is vitally important to ensure optimum benefits from HCW management training programs;

- With HCRW being an extremely hazardous waste product, it should not be used for empowerment projects, but services should rather be rendered by experienced HCRW management service providers with the necessary skills and resources to undertake the work in a manner that is not putting the health and safety of workers at risk;
- Regional as well as onsite HCRW treatment facilities are to make provision for mechanical bulk removal, processing and containerisation of treated HCRW residues without the need for manual handling by facility operators;
- Treated residues from private and public HCRW treatment facilities, from incineration and non-incineration facilities as well as from onsite and regional treatment facilities is to be managed in an appropriate manner and disposed of on appropriately designed and operated waste disposal sites to prevent the risk of treatment facility operators or disposal site workers being exposed to potentially poorly treated HCRW.

8.2.2.3 Training and Awareness:

- Senior management / decision makers at provincial Departments of Health, private hospital groups and HCF's are to be informed of the need for appropriate HCRW management systems. Such parties are to give their commitment to the process and ensure that sufficient funds are allocated in the annual budget for occupationally healthy and safe HCRW management systems;
- Although commercial input on tender specifications is to be provided by staff from the procurement section, input related to occupational health and safety matters is to be provided by health care experts during the development of tender specifications for outsourcing of HCRW management services;
- Where HCRW training on environmentally sound, healthy and safe HCRW management is not forming part of the HCRW management service contract, it is important that appropriate training either be provided internally by the HCF, or alternatively externally by an independent trainer;
- HCRW handlers responsible for collection, transport, transfer (where applicable), treatment and disposal are to be suitably qualified and appropriately trained in the handling of such hazardous materials. Such workers are inter alia to be informed about the health and safety risks in handling HCRW containers inappropriately, e.g. the risk of damaging specicans or sharps containers as a result of inappropriate handling;
- All maintenance staff and operators of HCRW treatment facilities, whether onsite or regional, incineration or non-incineration, private or publicly owned, should be suitably qualified and appropriately trained in accordance with the plant supplier's specification to ensure that such workers are not put at risk, or that other staff members are not put at risk by the inappropriate operation of HCRW treatment facilities. In addition to the suitably qualified operating and maintenance staff, it should also form part of the RoD that equally qualified staff must be available as backup whilst the fulltime staff is unavailable to operate the HCRW treatment facility;
- More effective communication and cooperation is required between provincial departments of health and HCF's. Information dissemination is to be prioritised to ensure that the relevant provincial departments, municipalities and HCF's remain informed around the results from research and developments in the HCRW management industry;

8.2.3 HCRW Service Providers:

8.2.3.1 Standard setting and monitoring:

- If crematoria are to be used for the treatment of HCRW, such crematoria are amongst other requirements also to make provision for the safe loading of HCRW. Alternatively crematoria are not to be used for HCRW treatment.

8.2.3.2 Operations:

- Appropriate protective clothing is to be supplied, training in the use thereof to be provided and the use thereof to be enforced for all workers dealing with HCRW;
- Spill kits, together with appropriate training in the safe management of HCRW spills, are to be provided to workers that may be required to remove HCRW spillages;
- Appropriate and affordable HCRW collection systems are to be provided for HCRW generated by minor HCRW generators (doctors, dentists, veterinary surgeons, etc.), thereby preventing the illegal disposal of HCRW in the general waste stream where it creates a risk to the health and safety of municipal waste collectors and landfill workers;
- Appropriate external transport systems are to be provided for the transport of HCRW from the clinics to the central hospitals / transfer stations from where HCRW is to be collected by the HCRW service providers. Health care staff is not to be put at risk by having to transport HCRW in sedan vehicles or ambulances;
- HCRW is to be treated within the specified time-frames to prevent workers from being exposed to fermenting HCRW, to prevent the generation of odours and to prevent the breeding of vectors and rodents;
- Safe and healthy working conditions are to be provided for onsite as well as regional HCRW treatment facility operators, in particular to prevent them from being exposed to hazardous gases and liquids released from HCRW treatment facilities;
- Regional as well as onsite HCRW treatment facilities are to make provision for mechanical bulk removal, processing and containerisation of treated HCRW residues without the need for manual handling by facility operators;
- Treated residues from private and public HCRW treatment facilities, from incineration and non-incineration facilities as well as from onsite and regional treatment facilities is to be managed in an appropriate manner and disposed of on appropriately designed and operated waste disposal sites to prevent the risk of treatment facility operators or disposal site workers being exposed to potentially poorly treated HCRW;
- Cooperation and relationships between the various HCRW service providers is to be improved as the price war that currently exists between competitors has resulted in a lowering of service standards, thus putting the health and safety of workers at risk.

8.2.3.3 Training and Awareness:

- HCRW handlers responsible for collection, transport, transfer (where applicable), treatment and disposal are to be suitably qualified and appropriately trained in the handling of such hazardous materials. Such workers are inter alia to be informed about the health and safety risks in handling HCRW containers inappropriately, e.g. the risk of damaging specicans or sharps containers as a result of inappropriate handling;
- All maintenance staff and operators of HCRW treatment facilities, whether onsite or regional, incineration or non-incineration, private or publicly owned, should be suitably qualified and appropriately trained in accordance with the plant supplier's specification to ensure that such workers are not put at risk, or that other staff members are not put at risk by the inappropriate operation of HCRW treatment facilities. In addition to the suitably qualified operating and maintenance staff, it should also form part of the RoD that equally qualified staff must be available as backup whilst the fulltime staff is unavailable to operate the HCRW treatment facility.

8.3 Institutional / Organisational Needs:

The following are considered to be the most prominent Institutional / Organisational needs:

8.3.1 Authorities:

8.3.1.1 Standard setting and monitoring:

- The Framework National HCW Management Policy developed as part of the NWMSI project is to be consulted with the affected stakeholders before submission to cabinet for approval. Since provincial departments of health are in the process of developing provincial HCW management policies without guidance from the affected national department, there is a risk of conflict between the national and provincial HCW Policies;
- HCRW Management Policies, Strategies and Action Plans are to be approved on national level, provincial level, health district level and HCF level in consultation with the relevant stakeholders. Once adopted, Strategies and Action Plans are to be implemented with ongoing monitoring to ensure that HCRW is managed in an environmentally sound, yet healthy and safe manner. Appropriate human and financial resources are to be allocated to the relevant regulating authorities to monitor the effective and sustainable implementation thereof;
- High-level negotiations are to be embarked upon between DEAT and NDoH in terms of responsibility for promulgation of HCW Management Regulations under the Waste Management Act or the Health Act. As a compromise, it may be required that the Regulations be spilt in accordance with the level of jurisdiction, i.e. Regulations by NDoH from the point of HCW generation up to onsite storage, and DEAT regulations from there onwards. It is however important that such regulations be developed simultaneously to prevent any contradictions. The Draft National HCW Management Regulations developed as part of the NWMSI project could be used as a starting point, after which the Regulations are to be consulted with the affected stakeholders before being legislated. This is vitally important in order to ensure uniform standards throughout SA;
- Uniform HCW management standards are to be set and effectively enforced throughout SA. Particular attention is however to be given to HCRW treatment and disposal standards, not only for the protection of the environment, but also to ensure a level playing field in the industry. Once developed, the standards are to be consulted with stakeholders throughout SA before being legislated;
- Before HCW management Regulations are developed on national level, it is important that consultation workshops be held with stakeholders from provinces previously subjected to HCW Management Regulations, thereby ensuring that shortcomings are identified and addressed in the proposed new national HCRW management Regulations;
- Air emissions standards are to be legislated on national level to guide provincial officials on the EIA requirements for HCRW incinerators, whilst at the same time providing investors with clear directives on the capital required for the establishment of new facilities. This is important for uniform standard setting throughout SA;
- Officials from provincial Departments of Environment are to be capacitated to be able to evaluate EIA submissions for various HCRW and hazardous waste treatment processes. DEAT is also to provide guidelines and directives for EIA evaluation and Records of Decision requirements;
- There is a need for better communication and interaction between the various levels of government affected by HCW management, between the various affected departments on the same level of government as well as between the provincial DoH's and the HC facilities;
- Roles and responsibilities for the various stakeholders on various levels of government are to be clearly defined and described in a Memorandum of Understanding that is to be entered into between the national departments of Health, Environment, Public Works and Transport;
- Roles and responsibilities in terms of environmental performance monitoring are to be clearly defined to ensure effective law enforcement throughout SA. Once the appropriate departments have been mandated to undertake the various monitoring functions, such departments are also to be provided with the required human and financial resources to fulfil their mandate;
- The next higher level of authority than that for which HCW management plans are developed are to ensure effective implementation and maintenance of such plans;

- Effective lines of communication are to be established between the various levels of the Regulating Authorities and the HCRW management industry, thereby ensuring ongoing interaction regarding potential problem areas to ensure that corrective actions are taken immediately after a problem was identified, and not left until the problem gets out of control;
- Law enforcement agencies are to be trained in terms of their roles and responsibilities as well as in terms of compliance monitoring processes to be followed;
- Where HCRW treatment facilities are found to be non-compliant in terms of nationally legislated air emission or occupational health and safety standards, the downstream impact of the actions taken by the regulating authorities should be taken into consideration. Imposing penalties in the form of appropriate financial fines for non-compliance might be more appropriate under the current situation of insufficient HCRW treatment capacity in SA, than to shut down the limited facilities that are available;
- The Department of Transport should be responsible for compliance monitoring when HCRW is transported by road. Inspectors are to be trained in the identification of HCRW, as well as on aspects to be considered when vehicles transporting HCRW are inspected for legal compliance;
- There is on municipal level a need for a comprehensive database of all HCRW generators within any municipality's area of jurisdiction, thereby allowing for effective compliance monitoring by the relevant authorities.

8.3.1.2 Operations:

- DEAT and / or NDoH is to take on the role of HCRW management coordinators for SA, making use of the WIS to keep track of HCRW generation versus available HCRW treatment capacity in the various provinces. Such information should be readily available for use by decision makers on all levels of government. Should the need exist, the WIS is to be expanded to allow for reporting on HCF level, HC district level, provincial level and national level;
- In instances where HCRW is delivered to HCRW treatment facilities without sufficient capacity, such problems are to be referred to the HCRW management and WIS coordinators who are then to provide information on alternative HCRW treatment facilities in the area where spare treatment capacity may be available;
- Although HCRW service providers should be required in provincial HCRW tenders to make provision and indicate what their backup HCRW treatment arrangements are in the event of breakdowns on their main HCRW treatment facilities, DEAT is also to provide an emergency plan for implementation in the event of unforeseen HCRW treatment capacity shortages;
- Additional capacity (human resources and skills) is to be provided within the affected national, provincial and local government departments to effectively deal with HCRW management. One dedicated person dealing with HCW is to be nominated in each of the affected national, provincial and local government departments to be responsible for the coordination of all HCRW management activities within its area of jurisdiction, to identify particular needs for the area and to coordinate training and awareness programs in the area;
- Each province should have access to its own HCRW treatment as well as hazardous waste disposal facilities, with a system introduced of HCRW being treated at the nearest compliant treatment facility irrespective of ownership, thereby limiting long distance haulage of HCRW across provincial borders;
- For appropriate HCRW treatment and residue disposal facilities to be provided in all provinces, a HCRW mass-management balance study is to be undertaken on national level to determine provinces / areas where there is a need for *additional* HCRW treatment facilities to be provided. Where such investment opportunities are not taken up by the private sector due to marginal profitability, DEAT may have to enter into PPP's that could require for DEAT to provide the capital required for supply of plant, and for the HCRW management facilities to be operated by the private sector partners in accordance with DEAT's standards;

- More streamlined decision making processes are to be introduced at the regulating authorities on provincial and national level, thereby limiting delays experienced with the EIA and permitting processes;
- The problems currently experienced in making the non-operational Electro Thermal Deactivation (ETD) plant located in Gauteng available for operations should be addressed by the affected parties in order to have this facility brought into operation in the shortest possible time;
- Municipalities are not to accept residues from either incineration or non-incineration treatment processes on their waste disposal facilities unless such waste disposal facilities (or dedicated parts thereof) are appropriately designed, constructed and operated in accordance with the waste classification as required by Minimum Requirements for Waste Disposal by Landfill;
- Some provincial Departments of Environment are at a lower grading than others (Gauteng, KZN and Western Cape are for instance under the leadership of a director) thus creating a situation where skilled staff is drawn away from the lower graded provinces by higher salary offers from higher graded provinces. This results in a large turnover of staff, with the associated loss of skills at lower graded provinces.

8.3.1.3 Training and Awareness:

- The national as well as provincial Departments of Public Works are to be capacitated around (i) the general strategy towards the closure and removal of non-compliant onsite HCRW incinerators; (ii) discontinuation of installation without EIA's of further onsite HCRW incinerators that are likely to be non-compliant, and (iii) the design requirements for new HCF's in terms of internal HCRW storage, internal HCRW transport, external storage and accessibility of all HCRW storage facilities;
- Where required in terms of provincial HCRW management plans, national and provincial Departments of Public Works are also to be capacitated around the need for HCRW transfer facilities at district hospitals for the collection and temporary storage of HCRW generated at rural clinics as well as minor HCRW generators in the area.

8.3.2 HCRW Generators:

8.3.2.1 Standard setting and monitoring:

- HCRW Management Policies, Strategies and Action Plans are to be developed on provincial health level, hospital group level and HCF level in consultation with the relevant stakeholders. Once adopted, Strategies and Action Plans are to be implemented, with ongoing monitoring to ensure that HCRW is managed in an environmentally sound, yet healthy and safe manner. Appropriate human and financial resources are to be allocated to the relevant regulating authorities to monitor the effective implementation thereof in a sustainable manner.

8.3.2.2 Operations:

- Information on HCRW generation rates as well as available treatment capacity in the various provinces is to be captured through the Waste Information System (WIS). Such information should be readily available for use by decision makers on all levels of government. Should the need exist, the WIS is to be expanded to allow for reporting on HCF level, HC district level, provincial level and national level;
- HCGW excessively contaminated with HCRW due to poor segregation should be returned to the generator to have it treated and disposed of as HCRW. The financial implications of such actions should be sufficient motivation for the HCF's to ensure improved HCW segregation in future, thus not putting the health and safety of workers and informal reclaimers at risk;
- Development of tender specifications for outsourcing of HCRW management services, tender letting and contract management on provincial HCRW management tenders is to be improved, with roles and

responsibilities between health staff and commercial staff within the respective departments of health clearly defined to ensure effective interface that will allow for appropriate input made by the respective groups when required;

- HCRW collection systems from remote rural clinics and minor HCRW generators like emergency services, mortuaries etc. are to be introduced on district level, with appropriately constructed and equipped transfer stations at for instance district hospitals, from which HCRW is to be collected by the service providers for treatment and disposal at regional facilities. This will ensure cost effective HCRW collection systems for all public HCF's in the urban as well as the rural areas of SA. The possibility of allowing HCRW generated by private minor generators from the area to be delivered to the transfer station for treatment and disposal at a reasonable fee to the generators, as part of the public HCRW stream, should be investigated to allow for the economies of scale required for such services to be rendered at affordable costs;
- Where HCRW management contracts are due to expire, initiation of the tender letting processes are to start at least 6 months before expiry of the existing contracts to avoid the crisis management that is often experienced with outsourcing of HCRW management services. In instances where HC professionals are still to be consulted throughout a province to obtain their input on the needs to be addressed in the tender specification, a lead period of at least 1 year is recommended;
- Should existing HCRW management service contracts have to be extended to allow additional time for tender letting processes to be completed, a limit of 6 months should be set on such extensions and allowance should be made for escalation of the service price during such extensions;
- Tender letting processes are to be streamlined to allow for the award of tenders within the initially specified 60 or 90-day validity periods. Should an extension to the validity period for tenders be unavoidable, description of the base date for escalation should be changed from the "date of contract award" to the "date on which the initial tender validity period expired". Service providers are in practice often required to keep their tender prices fixed for periods of up to one year due to delayed tender adjudication processes, by which time inflation results in an underpayment to the contactor over the full contract period without appropriate compensation through escalation. Underpayment of service providers is likely to impact on the standard of service delivery throughout the contract period.
- HCRW management services should not be rendered to provincial Departments of Health based on 3-month quotation cycles in order to bypass the PFMA, but should be rendered on long term (3-5 year contracts) to ensure continuity in the HCRW management systems implemented in the affected HCF's, as well as to allow service providers the opportunity to recover capital investments over longer periods, thus allowing them to reduce unit costs for the service;
- Provincial procurement procedures should be streamlined to allow for procurement of equipment with limited competition in the market that cannot be procured through public tenders, e.g. HCRW collection trailer suppliers;
- BEE is already given preference through the Preferential Procurement Act (PPA). Additional preference, in particular in a manner that could put the environment or the health and safety of communities at risk, could be illegal;
- Due to the inherent risks, HCRW management service contracts should not be used as a mechanism for BEE or SMME development, as the consequences of inappropriate HCRW management resulting from a lack of skills or resources, could have far reaching implications for the communities affected by illegal disposal, illegal burning or illegal long term storage of HCRW. Enforcing the duty of care principle could in reality make the National Minister, Director Generals (DG's), Provincial Members of Executive Committees (MEC's), Heads of Departments (HoD's) or Chief Executive Officers (CEO's) of private companies liable where HCRW generated in HCF's is disposed of illegally;
- Systems are to be introduced to speed up payments from HCRW generators to service providers, thus preventing service providers from encountering cash flow problems. It is suggested that contractors at least be remunerated at prime interest rates for interest lost on payments exceeding 30 days. It is reported that the Gauteng is in particular very slow and contractors often wait for up to 120 days for payment;

- District Hospitals are to be consulted on the need to take on the role as HCRW collection and transfer facilities for the surrounding rural clinics and minor HCRW generators, with the understanding that all HCRW generators are to remain responsible for payment of their own HCRW treatment and disposal services;
- The second phase of the Zeerust Pilot Project is still to be executed, not only as a result of contractual obligations between the North West Province and the autoclave treatment plant donors, but also due to possible need in remote rural parts of SA where small amounts of HCRW generated is to be transported over long distances. The use of district HCRW treatment facilities that would allow for the treatment of HCRW generated in any particular health district should be investigated;
- Host cities for the 2010 Soccer World Cup tournament are to comply with FIFA Regulations by ensuring that internationally acceptable HCRW management systems are put in place.

8.3.2.3 Training and Awareness:

- Senior management / decision makers at provincial Departments of Health, private hospital groups and HCF's are to be informed on the need for appropriate HCRW management systems. Such parties are to give their commitment to the process and ensure that sufficient funds are allocated in the annual budget for environmentally sound, as well as occupationally healthy and safe HCRW management systems;
- Incentives are to be provided to retain permanent nursing staff, and where cleaning services are outsourced, it is to become a contract condition that cleansing staff is not to be rotated without approval from the HCF's, thereby limiting the impact that the high staff turnover has on the effectiveness of training programs;
- There is a need for a database to be developed and regularly updated to provide HCRW generators with information on available treatment capacities from accredited service providers, for use in instances where appointed HCRW service providers fail to render the required services;
- The HCW management-training course developed as part of the Gauteng HCW management project is to be revised to ensure that it meets the needs of all provinces in SA, after which it is to be accredited. The course material should then be made available to the relevant training institutions for implementation;
- Dissemination of information and transfer of skills are to be prioritised to ensure that persons on operational level are made aware of new technologies and systems being developed on national level for implementation on provincial or local levels;
- All HCRW treatment facilities, irrespective of whether they are privately or publicly owned, onsite or regional, incineration or non-incineration, are to be maintained and operated by a competent person that is suitably qualified and trained for the work. The qualifications and training standards are to be set in accordance with treatment plant supplier's recommendations. In addition to the suitably qualified treatment plant operator, it should also form part of the RoD that equally qualified staff must be available as backup whilst the operator is unavailable to operate the HCRW treatment facility;
- The Public sector (provincial Departments of Health and municipalities) is to be capacitated to enable officials to set an example through effective, environmentally sound, healthy and safe operation and maintenance of HCRW management and disposal facilities respectively. HCRW management at rural clinics and landfills owned by smaller municipalities is reportedly the main problem area in terms of legal compliance.

8.3.3 HCRW Service Providers:

8.3.3.1 Standard setting and monitoring:

- Information on HCRW generation rates as well as available treatment capacity in the various provinces is to be captured through the Waste Information System (WIS). Such information should be readily

available for use by decision makers on all levels of government. Should the need exist, the WIS is to be expanded to allow for reporting on HCF level, HC district level, provincial level and national level.

8.3.3.2 Operations:

- Each province should have access to its own HCRW treatment as well as hazardous waste disposal facilities, with a system introduced of HCRW being treated at the nearest compliant treatment facility irrespective of ownership, thereby limiting long distance haulage of HCRW across provincial borders;
- Host cities for the 2010 Soccer World Cup tournament are to comply with FIFA Regulations by ensuring that internationally acceptable HCRW management systems are put in place.

8.3.3.3 Training and Awareness:

- All HCRW treatment facilities, irrespective of whether they are privately or publicly owned, onsite or regional, incineration or non-incineration, are to be maintained and operated by a competent person that is suitably qualified and trained for the work. The qualifications and training standards are to be set in accordance with treatment plant supplier's recommendations. In addition to the suitably qualified treatment plant operator, it should also form part of the RoD that equally qualified staff must be available as backup whilst the operator is unavailable to operate the HCRW treatment facility.

8.4 Equipment and Technical Needs:

The following are considered to be the most prominent Equipment and Technical needs:

8.4.1 Authorities:

8.4.1.1 Standard setting and monitoring:

- To ensure uniformity on the treatment and emission standards for both incineration and non-incineration HCRW treatment facilities throughout SA, DEAT is to set uniform standards, whilst capacitating provincial Department of Environment officials on the evaluation of alternative treatment technology applications as well as for performance monitoring once the facilities are operational;
- The standards set for incineration and non-incineration HCRW treatment technologies should ensure the same treatment efficiency, irrespective of the technology used, thereby preventing discrimination against any of the treatment technologies;
- Air emissions standards are to be legislated on national level to guide provincial officials on the EIA requirements for HCRW incinerators, whilst at the same time providing investors with clear directives on the capital required for the establishment of new facilities, without on the other hand overcapitalising their facilities and thereby pricing themselves out of the market. This is important for uniform standard-setting throughout SA;
- Emission standard setting should be done with cognisance being taken of other sources of air pollution resulting from waste management (e.g. illegal burning of waste on landfills, ongoing methane generation on landfills, etc.) to ensure integrated pollution control across the board, without focussing on HCRW incineration only;
- Online emission level monitoring is to be required to ensure that service levels cannot be reduced once performance monitoring is completed (e.g. lowering of treatment temperatures, disconnecting of secondary chamber burners, etc.);
- Crematoria to be used for treatment of HCRW should either comply with the same air emission and operational standards set for HCRW incinerators, or alternatively not be used to treat HCRW;

- Cement kilns should not be used for the treatment of HCRW unless this was thoroughly investigated and approved by the regulatory authorities, with EIA's and permits obtained as would be required for any other HCRW treatment process;
- EIA and permit requirements should be practical for implementation throughout SA;
- There should be uniformity in terms of the conditions stated in Records of Decision with enforcement of standards also being uniform, irrespective of the nature of the company submitting the application or rendering the HCRW management services. The consequences of inappropriate HCRW management by a contractor lacking the required skills or resources could have far-reaching implications for the communities affected by illegal disposal, illegal burning or illegal long term storage of HCRW. Enforcing the duty of care principle could in reality make the national Minister, Director General (DG), Provincial Members of Executive Committees (MEC's), Heads of Departments (HoD's) or Chief Executive Officers (CEO's) of private companies liable where HCRW generated in HCF's is disposed of illegally;
- Ongoing maintenance of HCRW treatment facilities in accordance with the supplier's specifications should become a condition in any HCRW treatment facility's Record of Decision;
- More streamlined decision making processes are to be introduced at the regulating authorities on provincial and national level, thereby limiting delays experienced with the EIA and permitting processes;
- Information on HCRW generation rates as well as available treatment capacity in the various provinces is to be captured through the Waste Information System (WIS). Such information should be readily available for use by decision makers on all levels of government. Should the need exist, the WIS is to be expanded to allow for reporting on HCF level, HC district level, provincial level and national level;
- Appropriate systems are to be provided to deal with cultural / traditional processes, e.g. for effective control to be exercised over and information on risks to be provided to mothers wishing to bury placentas at home, or when human organs are removed to embalm bodies. No organs should become available for use as "muti" and strict control measures are to be introduced to ensure compliance with the Human Tissue Act;
- Illegal abortion clinics are to be shut down to prevent the generation and illegal disposal of HCRW generated at such facilities. Legal abortion clinics should not be considered to be minor HCRW generators (irrespective of the HCRW mass generated), since the generation of pathological HCRW would require a system similar to that of clinics.

8.4.1.2 Operations:

- Systems are to be devised for each province to be equipped with its own HCRW treatment facilities (to the extent practically possible) that will allow for HCRW to be treated as close as possible to the point where the HCRW is generated, irrespective of whether the HCRW treatment facility is owned by the same contractor rendering the HCRW collection service in that area. It is believed by some stakeholders that if measured against the Gauteng HCRW management standards, only around 10% of all HCRW generated in SA is treated by means of compliant treatment facilities and disposed of on appropriate waste disposal sites;
- Provincial Departments of Environment are to facilitate the development and operation of at least one hazardous waste disposal site (or cell) per province for the disposal of treated HCRW residues that is designed, constructed and operated in accordance with Minimum Requirements for Waste Disposal by Landfill, thus preventing the illegal disposal of residues from HCRW treatment processes on HCF sites or on general waste disposal sites, where it is often accessible to workers as well as members of the public;
- Although service providers should be required in provincial HCRW tenders to make provision and indicate what their backup HCRW treatment arrangements are in the event of a breakdown of their main HCRW treatment facilities, or when facilities are to be taken out of operation for extended periods of time due to maintenance, DEAT is to provide an emergency plan for implementation in the event of unforeseen HCRW treatment capacity shortages. Should another contractor provide backup HCRW

treatment capacity to any HCRW service provider, written confirmation that such backup capacity is available is to be provided at the time of tender;
- The problems encountered in getting the old *Evertrade* ETD plant in Gauteng back in operation should be speeded-up to facilitate the availability of additional HCRW treatment capacity;
- Appropriate HCRW management systems with supporting monitoring is to be introduced to ensure the safe disposal of HCRW generated by minor HCRW generators, including sharps HCRW that is sold / issued to patients for use during home-based care;
- Appropriate systems and facilities are to be provided for the treatment and disposal of animal carcasses.

8.4.1.3 Training and Awareness:

- Municipalities are to be capacitated by DEAT to provide disposal facilities for HCGW disposal that comply with Minimum Requirements for Waste Disposal by Landfill;
- Public awareness is to be increased around the associated risks and facilities are to be provided for disposal of sharps HCRW generated in public places (by for instance diabetes patients and drug addicts), which is often disposed of as part of the general waste stream or in municipal street litterbins;
- The second phase of the Zeerust Pilot Project is still to be executed, not only as a result of contractual obligations between the Northwest Province and the autoclave treatment plant donors, but also due to possible need in remote rural parts of SA where small amounts of HCRW generated are to be transported over long distances. The use of district HCRW treatment facilities that would allow for the treatment of HCRW generated in any particular health district should be investigated;

8.4.2 HCRW Generators:

8.4.2.1 Standard setting and monitoring:

- Scales and data capturing equipment required for the WIS as well as financial management of the HCRW management service contracts are to be provided at hospitals.

8.4.2.2 Operations:

- Appropriate Personal Protective Equipment (PPE) is to be issued to staff coming in contact with HCRW. Staff are also to be trained in the appropriate use of PPE, with the effective use thereof being monitored on an ongoing basis;
- Appropriate HCGW management systems are to be provided for all HCF's, without any pit burning or remaining onsite incinerators being used for the destruction of HCGW, in particular in remote rural areas;
- Compliance with SANS 10248 code of practice is to be ensured in terms of all equipment and facilities provided, until such time that the codes can be replaced by regulations that will be legally enforceable;
- Better HCW segregation is to be undertaken to prevent damage to shredders as a result of heavy metal objects being disposed of as part of the HCRW stream;
- Appropriate HCRW containers that are leak-resistant and puncture-resistant and in accordance with the required colour coding are to be used throughout SA;
- The design of reusable containers should be such that it minimises the space occupied when empty containers are to be stored onsite. Reusable containers in circulation should be in good serviceable condition and should be delivered to HCF's in a disinfected state;
- All HCF's are to be provided with appropriate internal and external HCW storage facilities that are accessible for both internal as well as external HCW transport systems.
- Appropriate internal HCW collection systems that are occupationally healthy and safe are to be provided to all HCF's;

- Facilities for refrigeration of HCRW, and in particular pathological HCRW, are to be provided in all areas where HCRW is to be stored for periods in excess of the prescribed allowable storage periods;
- HCRW should at all times be protected against the elements, irrespective of whether it is at source, in transit, at the transfer facilities or at treatment facilities. Until such time that it is disposed of on appropriate waste disposal sites, the treated HCRW residues should also be protected against the elements;
- HCRW collection from hospitals in rural health districts should not be undertaken at a frequency of less than twice a week, even if pathological HCRW is refrigerated;
- HCRW collection systems from remote rural clinics and minor generators like emergency services, mortuaries etc. are to be introduced on district level, with appropriately constructed and equipped transfer stations at for instance district hospitals from which HCRW is to be collected by the service providers for treatment and disposal at regional facilities. This will ensure cost-effective HCRW collection systems for all public HCF's in the urban as well as the rural areas of SA. The possibility of allowing HCRW generated by private minor generators from the area to be delivered to the transfer station for treatment and disposal at a reasonable fee to the generators, as part of the public HCRW stream, should be investigated to allow for the economies of scale required for such services to be rendered at affordable costs;
- HCRW transport systems that are appropriate for HCRW generated by all private and public HC facilities throughout SA should be implemented, with vehicles that are legally compliant and drivers that are suitably qualified and trained to undertake such HCRW transport duties;
- Regional as well as onsite HCRW treatment facilities that are not able to meet the proposed air emission standards or the proposed HCRW treatment efficiency standards are to be demolished to prevent illegal use of such facilities. Until such time that the facilities are demolished, it should be made unserviceable by removing the burners as well as the primary chamber doors;
- It is to be ensured that no further HCRW treatment facilities that are unlikely to comply with the proposed treatment efficiency standards and air emission standards, are erected by the Department of Public Works without undertaking the required EIA's;
- Removal and further processing / disposal of treated HCRW residues should be done mechanically, without the use of manual labour;
- No untreated HCRW is to be disposed of on general waste disposal sites;
- Systems and facilities are to be provided for the safe disposal of old fluorescent tubes and damaged mercury thermometers that are to be disposed of by HCF's;
- The provision of appropriate HCRW management equipment and facilities by service providers is to be facilitated through the development of relevant tender specifications, effective contract management and strict enforcement of tender specifications;
- Decisions on the most appropriate HCRW management system should not be made by procurement officers on financial grounds, but should be taken by suitably qualified and experienced health care professionals. Opting for the cheapest HCRW management system and thereby putting workers at risk is in particular a problem in private HC facilities that are profit driven, with HCRW generators expecting 1st world solutions at 3rd world prices;
- HCRW management tender specifications are to be developed in consultation with stakeholders from the HCF's to whom the service is ultimately to be rendered, thereby ensuring that all equipment needed for the effective cradle to grave management of HCRW is allowed for in the tender specification;
- Service contracts entered into with HCRW service providers are to make provision for inclusion of all public HCRW generators in any particular area, inter alia including hospitals, clinics, emergency services, mortuaries, mobile clinics, blood transfusion services, pathological laboratories, etc. The possibility of private sector HCRW being incorporated into public service tenders (with payment directly made by the respective HCRW generators) is to be investigated for remote parts of SA, thereby providing the economies of scale required for cost effective HCRW management services throughout SA;

- Although service providers should be required in provincial HCRW tenders to make provision and indicate what their backup HCRW treatment arrangements are in the event of a breakdown on their main HCRW treatment facilities or when facilities are to be taken out of operation for extended periods of time due to maintenance, DEAT is also to provide an emergency plan for implementation in the event of unforeseen HCRW treatment capacity shortages. Should another contractor provide backup HCRW treatment capacity to any HCRW service provider, written confirmation that such backup capacity is available is to be provided at the time of tender;
- It is important for HCRW generators to be informed exactly where their HCRW is treated and disposed of to enable them to ensure compliance by the service provider in accordance with the HCRW generator's duty of care;
- Sufficient funding is to be provided by both the private and public sector (where applicable) for the supply and maintenance of HCW management equipment and infrastructure required for the effective operation of integrated HCRW management systems that are occupationally healthy and safe, whilst meeting the required environmental standards;
- Tender processes for rendering of HCRW management services are to be based on the same uniform standards, with such standards enforced across the board. This will allow for a level playing field in the HCRW management industry, as companies that do comply with the required standards and therefore operate in a safe and environmentally sound manner are currently being disadvantaged, as their prices are undercut by those that do not comply;
- Service standards and types of equipment required are to be set and enforced to prevent HCRW management service providers from lowering service standards to meet an unrealistic drive towards lower prices by both private and public HCRW generators, as some HCRW generators are expecting 1st world standards at 3rd world prices. Such low service prices are resulting in the HCRW service delivery not being sustainable, as service providers are required to invest large amounts of capital in the provision of legally compliant HCRW treatment facilities, which is not economically viable if the service tariffs are unrealistically low;
- HCRW management service tender prices that are outside the margins (below and above) of what is considered to be fair and reasonable prices for service delivery should not be considered during the tender adjudication process, as HCRW management services offered at unreasonable low prices are unlikely to be sustainable in terms of compliance with tender specifications;
- Even though incineration is more expensive than some non-incineration technologies, there is a need for pathological and chemical HCRW to be incinerated. Such increased treatment facility costs could result in differentiated HCRW treatment tariffs (pathological and chemical HCRW being more expensive) to compensate for the use of more expensive, but legally compliant incineration technologies;
- Where HCRW management contracts are due to expire, initiation of the tender letting processes are to start at least 6 months before expiry of the existing contracts to avoid the crisis management that is often experienced with outsourcing of HCRW management services. In instances where HC professionals are still to be consulted throughout a province to obtain input on the needs to be addressed in the tender specification, a lead period of at least 1 year is recommended;
- Service delivery on 3-month quotation cycles, to avoid the need for a comprehensive tendering process as required by the Public Finance Management Act (PFMA), should not be permitted. Long-term contracts of at least 3 - 5 years will allow the service provider to make the capital investments required to provide appropriate and compliant equipment and facilities. Long-term contracts will also allow for more competitive pricing as capital invested can be recouped over longer periods of time;
- Provincial procurement procedures should be streamlined by not mandating open tenders, thereby allowing for procurement of equipment with limited competition in the market, e.g. HCRW collection trailer suppliers;
- Appropriate systems are to be provided to deal with cultures and traditions, e.g. for effective control to be exercised and information on risks to be provided to mothers wishing to bury placentas at home, or when body organs are removed to embalm bodies. No body organs should become available for use

as “muti” and strict control measures are to be introduced to ensure compliance with the Human Tissue Act;
- Host cities for the 2010 Soccer World Cup tournament should comply with FIFA Regulations by ensuring that internationally acceptable HCRW management systems are put in place.

8.4.2.3 Training and Awareness:

- Senior management / decision makers at provincial Departments of Health, private hospital groups and HCF’s are to be informed on the need for appropriate HCRW management systems. Such parties are to give their commitment for the process and ensure that sufficient funds are allocated in the annual budget for occupationally healthy and safe HCRW management systems;
- Public HCF’s are to be capacitated and assisted to set an example in terms of compliance with the occupational health and safety standards as well as environmentally sound management of HCRW.

8.4.3 HCRW Service Providers:

8.4.3.1 Standard setting and monitoring:

- Standards are to be set for the appropriate handling of HCRW containers (like disallowing the throwing of sharp and pathological HCRW containers) during collection, transfer and transport, to prevent the risk of damage to containers and subsequent spillage of HCRW;
- Information on HCRW generation rates as well as available treatment capacity in the various provinces is to be captured through the Waste Information System (WIS). Such information should be readily available for use by decision makers on all levels of government. Should the need exist, the WIS is to be expanded to allow for reporting on HCF level, HC district level, provincial level and national level;
- Scales and data-capturing equipment required for the WIS as well as financial management of the HCRW management service contracts are to be provided at hospitals.

8.4.3.2 Operations:

- Appropriate Personal Protective Equipment is to be issued to staff coming in contact with HCRW. Staff are also to be trained in the appropriate use of PPE, with the effective use thereof being monitored on an ongoing basis;
- HCRW should at all times be protected against the elements, irrespective of whether it is in transit, at the transfer facilities or at treatment facilities. Until such time that it is disposed of on appropriate waste disposal sites, the treated HCRW residues should also be protected against the elements;
- Appropriate HCRW collection systems are to be provided for HCRW collection from all minor generators, including home based care patients. Criteria like limitations on long distance travelling with HCRW (for low-income patients) and alternatively no need for visits to public drop-off facilities situated in unsafe areas (for high-income patients) are to be taken into consideration during development of the systems. Where required, such systems should also allow for distribution of appropriate HCRW containers;
- HCRW collection systems from remote rural clinics and minor generators like emergency services, mortuaries etc. are to be introduced on district level, with appropriately constructed and equipped transfer stations at for instance district hospitals from which HCRW is to be collected by the service providers for treatment and disposal at regional facilities. This will ensure cost effective HCRW collection systems for all public HCF’s in the urban as well as the rural areas of SA. The possibility of allowing HCRW generated by private minor generators from the area to be delivered to the transfer station for treatment and disposal at a reasonable fee to the generators, as part of the with the public HCRW stream, should be investigated to allow for the economies of scale required for such services to be rendered at affordable costs;

- HCRW transport systems that are appropriate for HCRW generated by all private and public HC facilities throughout SA should be implemented, with legally compliant vehicles and suitably qualified and trained drivers to undertake such HCRW transport duties;
- A uniform and effective HCRW tracking system is to be provided by all HCRW service providers to allow for effective identification of HCRW that was inappropriately managed;
- Facilities for refrigeration of HCRW, and in particular pathological HCRW, are to be provided in all areas where HCRW is to be stored for periods in excess of the prescribed allowable storage periods;
- Systems are to be devised for each province to be equipped with their own HCRW treatment facilities wherever practical, which will allow for HCRW to be treated as close as possible to the point where the HCRW is generated, irrespective of whether the HCRW treatment facility is owned by the same contractor rendering the HCRW collection service in that area. It is believed by some stakeholders that if measured against the Gauteng HCRW management standards, only around 10% of all HCRW generated in SA is treated by means of compliant treatment facilities and disposed of on appropriate waste disposal sites;
- General infectious HCRW that is problematic for any particular treatment processes (like disposable nappies for autoclaving), is to be treated by means of appropriate HCRW treatment facilities;
- Appropriate HCRW treatment technologies should be used for the treatment of some unique HCRW categories like pathological HCRW and pharmaceutical HCRW;
- To ensure the viability and long term sustainability of environmentally compliant incinerators required for the treatment of pharmaceutical and pathological HCRW, the possibility should be considered to introduce a system of differentiated treatment tariffs, thereby recovering the cost of more expensive incineration facilities through increased revenue from chemical and pathological HCRW treatment;
- Although service providers should be required in provincial HCRW tenders to make provision and indicate what their backup HCRW treatment arrangements are in the event of a breakdown on their main HCRW treatment facilities or when facilities are to be taken out of operation for extended periods of time due to maintenance, DEAT should also provide an emergency plan for implementation in the event of unforeseen HCRW treatment capacity shortages. Should another contractor provide backup HCRW treatment capacity to any HCRW service provider, written confirmation that such backup capacity is available is to be provided at the time of tender;
- Where appropriate, electricity generators are to be provided to assist up to the point where the health and safety of staff as well as the environment is not put at risk during interruptions in power supply;
- Regional as well as onsite HCRW treatment facilities that are not able to meet the proposed air emission standards or the proposed HCRW treatment efficiency standards are to be demolished to prevent illegal use of such facilities. Until such time that the facilities are demolished, they should be made unserviceable by removing the burners as well as the primary chamber doors;
- Removal and further processing / disposal of treated HCRW residues should be done mechanically, without the use of manual labour;
- No untreated HCRW is to be disposed of on general waste disposal sites.

8.4.3.3 Training and Awareness:

- More effective communication is required between the various stakeholders in the HCRW industry, thereby ensuring that appropriate HCRW management equipment and facilities are optimally used.

8.5 Financial Needs:

The following are considered to be the most prominent Financial needs:

8.5.1 Authorities:

8.5.1.1 Standard setting and monitoring:

- Distortions in the market due to inequality in environmental and operational standard setting by various provinces, as well as within a particular province, should be corrected. Such unevenness in the playing field leads to environmentally conscious HCRW service providers being forced out of the market by irresponsible HCRW service providers that do not comply with the required standards;
- For affordability of HCRW management services to be taken into consideration when standard-setting is done, it is important that more innovative and cost effective HCRW management systems be developed, rather than to lower the operational as well as the treatment standards to make it affordable in the SA context;
- EIA and permitting requirements should be uniform throughout the country, irrespective of the profile of the company applying for this. BEE is already given preference through the Preferential Procurement Act (PPA). Additional financial preference, in particular in a manner that could put the environment or the health and safety of communities at risk, could be illegal;
- EIA and permitting processes are to be speeded up, as capital investors are not prepared to invest in HCRW treatment facilities when such facilities remain non-operational for extended periods of time due to delays in the EIA and permitting processes. This applies to both HCRW treatment facilities as well as the required residue disposal facilities;
- The standards set for incineration and non-incineration HCRW treatment technologies should ensure the same treatment efficiency, irrespective of the technology being used, thereby preventing discrimination against any of the treatment technologies.

8.5.1.2 Operations:

- Each province should have access to its own HCRW treatment facilities, with a system introduced of HCRW being treated at the nearest compliant treatment facility irrespective of ownership, thereby limiting long distance haulage of HCRW across provincial borders;
- Provincial Departments of Environment are to facilitate the development and operation of at least one hazardous waste disposal site (or cell) per province for the disposal of treated HCRW residues that is designed, constructed and operated in accordance with Minimum Requirements for Waste Disposal by Landfill, thus preventing illegal disposal of residues from HCRW treatment processes on HCF sites or on general waste disposal sites, where it is often accessible to workers as well as members of the public;
- For HCRW treatment and appropriate disposal facilities to be provided in all provinces, a HCRW management mass-balance study is to be undertaken on national level to determine provinces / areas where there is a need for *additional* HCRW treatment facilities to be provided. Where such investment opportunities are not taken up by the private sector due to marginal profitability, DEAT may have to enter into PPP's with DEAT providing the capital required for supply of the plant, with HCRW management facilities being operated by the private sector partners in accordance with DEAT's standards;
- Financial assistance is to be provided to the NW DoH for implementation and execution of the second phase of the Zeerust rural HCRW management pilot project, which could provide valuable information for implementation in areas where long travelling distances makes it difficult to transport HCRW to regional HCRW treatment facilities.

8.5.1.3 Training and Awareness:

- Municipalities are to be capacitated and provided with the necessary financial means to set an example in terms of waste disposal site operations;
- Although the dividends of investment in training may not be recognised in the short term, it can have various social, financial as well as occupational health and safety benefits in the long term.

8.5.2 HCRW Generators:

8.5.2.1 Standard setting and monitoring:

- Service standards and types of equipment required are to be set and enforced to prevent HCRW management service providers from lowering service standards to meet an unrealistic drive towards lower prices by both private and public HCRW generators, as some HCRW generators are expecting 1st world standards at 3rd world prices. Such low service prices result in the HCRW service delivery not being sustainable, as service providers are required to invest large amounts of capital in the provision of legally compliant HCRW treatment facilities, which is not possible if the service tariffs are unrealistically low;
- New service providers entering the HCRW management market, including BEE and SMME companies, should not be awarded any contracts without being able to prove that they have the required expertise and resources available for environmentally sound, yet healthy and safe HCRW management service delivery.

8.5.2.2 Operations:

- HCRW Management Policies, Strategies and Action Plans are to be developed on national level, provincial level, health district level and HCF level in consultation with the relevant stakeholders. Once adopted, Strategies and Action Plans are to be implemented, with ongoing monitoring to ensure that HCRW is managed in an environmentally sound, yet healthy and safe manner. Appropriate human and financial resources are to be allocated to the relevant regulating authorities to monitor the effective implementation thereof in a sustainable manner;
- The development and implementation of HCRW management plans on provincial, municipal and HCF level should be required and enforced throughout South Africa. Financial assistance should however be provided to the parties responsible for implementation of such HCRW management plans;
- There should be an official dedicated to coordinate HCRW management activities on national level as well as in each of the provinces, with the required resources made available for such people to be appointed at salary scales that would ensure they remain in such positions for at least the next 2 years. Effective communication and close co-operation between the various coordinators on provincial and national level is vitally important for the effective management of HCRW throughout SA;
- Significant savings can be achieved by limiting the transport of HCRW over long distances, in particular across provincial borders. In addition to the financial benefits, there are also environmental and socio-economic benefits when transport distances are reduced;
- Grouping of HCRW generators to ensure economies of scale required for cost effective HCRW management service delivery in remote rural areas is to be facilitated, even including private minor and major HCRW generators. By making use of district transfer stations, private HCRW generators should be allowed to participate in the provincial HCRW service contract, with payments from individual HCRW generators made directly to the appointed service provider;
- Financial management systems are to be introduced that will allow for cost recovery for service delivery on HCRW generated by both public and private minor HCRW generators, collected and delivered to the proposed district transfer stations;
- The current price-war on HCRW service delivery should be prevented by not awarding contracts to the lowest Tenderers, as such under-recovery by service providers in an attempt to get the work is likely to result in a lowering in service delivery standards;
- Lump sum tenders for HCRW service delivery should be avoided. Appropriate mass recording systems are to be implemented for services to be paid for on the basis of actual mass of HCRW removed, thereby not only ensuring effective mass recordings for the WIS, but also ensuring financial benefits to

HCRW generators for reducing the hazardous HCRW stream. HCF staff verification for the HCRW removed from HCF's for treatment is to be undertaken to avoid disputes during billing;

- Software should be developed and distributed, together with hardware and training required for implementation of WIS systems at various levels of government, as well as at HCF's. Reporting on the WIS should be enforced;
- Provincial Department of Health officials are to be capacitated to develop appropriate tender documentation, to undertake tender letting processes (inter alia including tender adjudication and contract award) and to effectively manage HCRW management services contracts;
- Decisions on the most appropriate HCRW management system should not be made by procurement officers on financial grounds, but should be taken by suitably qualified and experienced health care professionals. Opting for the cheapest HCRW management system and thereby putting workers at risk is in particular a problem in private HC facilities that are profit-driven, with HCRW generators expecting 1st world solutions at 3rd world prices;
- Technical and operational input should be made during the tender development and tender letting processes to ensure that tender documents developed are not only commercially sound, but are also technically practical and appropriate for the particular needs of the HCF's that are to be serviced;
- The advantages and disadvantages of splitting contracts in any particular province are to be thoroughly investigated during the tender document development phase;
- Service providers should be required in provincial HCRW tenders to make provision and indicate what their backup HCRW treatment arrangements are in the event of a breakdown on their main HCRW treatment facilities, or when facilities are to be taken out of operation for extended periods of time due to maintenance. Should another contractor provide backup HCRW treatment capacity to any HCRW service provider, written confirmation that such backup capacity is available is to be provided at the time of tender;
- Tender specifications should not be specific in terms of the treatment technology to be used, but should be specific in terms of the HCRW categories to be treated as well as the treatment efficiencies to be achieved;
- Where appropriate, electricity generators should be required as part of HCRW treatment facilities up to the point where the health and safety of staff as well as the environment is not put at risk due to a discontinuation in power supply;
- In the event of existing HCRW management service contracts having to be extended to allow additional time for tender letting processes to be completed, a limit of 6 months should be set on such extensions and allowance should be made for escalation of the service price during such extensions;
- Where HCRW management contracts are due to expire, initiation of the tender letting processes are to start at least 6 months before expiry of the existing contracts to avoid the crisis management that is often experienced with outsourcing of HCRW management services. In instances where HC professionals are still to be consulted throughout a province to obtain their input on the needs to be addressed in the tender specification, a lead period of at least 1 year is recommended;
- Tender letting processes are to be streamlined to allow for the award of tenders within the initially specified 60 or 90-day validity periods. Should an extension to the validity period of tenders be unavoidable, description of the base date for escalation should be changed from the "date of contract award" to the "date on which the initial tender validity period expired". Service providers are in practice often required to keep their tender prices fixed for periods of up to one year due to delayed tender adjudication processes, by which time inflation results in an underpayment to the contactor over the full contract period without appropriate compensation through escalation. Underpayment of service providers is likely to impact on the standard of service being rendered throughout the contract period;
- Escalation calculations should compensate service providers for above-average increases in energy costs. Escalation in both electricity and diesel prices increases HCRW treatment costs, with diesel price increases also affecting transport costs;

- Short term (3-monthly) appointments based on quotations for HCRW management service delivery to public hospitals and clinics, aimed at bypassing a comprehensive tender process required by the PFMA, should not be allowed;
- Tender specifications are to be enforced to ensure that HCRW management services rendered meet the required standards. Service providers that were awarded provincial HCRW management contracts, without rendering the service to the required standards, are benefiting from the tender process by being awarded the contracts without being held accountable to render the service at the specified levels;
- Provincial procurement procedures should be streamlined to allow for procurement of equipment with limited competition in the market, e.g. HCRW collection trailer suppliers;
- Systems are to be introduced to speed up payments made by the HCRW generators for services rendered by contractors, thereby preventing service providers from encountering cash flow problems. It is suggested that contractors at least be remunerated at prime interest rates for interest lost on payments exceeding 30 days. It is reported that the Gauteng is in particular very slow and contractors often wait for up to 120 days for payment;
- Firm action is to be taken against officials as well as HCRW service providers found guilty of corruption during HCRW management service contract awards, or alternatively with contract management during the service delivery period;
- HCW segregation is to be undertaken more effectively, as poor levels of HCW segregation is resulting in costly damage to shredders when heavy metal objects are disposed of in the HCRW stream;
- HCGW contaminated with poorly segregated HCRW should be returned to the generator to have it treated and disposed of as HCRW. The financial implications of such actions should be sufficient motivation for the HCF's to ensure improved HCW segregation in future, thereby not putting the health and safety of workers and informal reclaimers at risk;
- HCF's are to be provided with appropriate HCRW management facilities and equipment, thereby allowing for environmentally sound, yet safe and healthy HCRW management service delivery within such facilities. Such facilities should inter alia include appropriate HCRW containers, internal transport systems, appropriate and accessible internal as well as external HCRW storage facilities, district transfer stations where required as well as appropriate HCRW collection vehicles where HCRW generated by the surrounding district clinics is to be collected;
- HCF's are to be provided with the human and other resources required for the effective management of HCW;
- Facilities for refrigeration of HCRW, and in particular pathological HCRW, are to be provided in all areas where HCRW is to be stored for periods in excess of the prescribed allowable storage periods. Funding of such facilities is to be included in the tender price;
- Although the treatable HCRW stream will be increased through this, food that came into contact with patients should be treated and disposed of as HCRW. Food waste from the kitchen that was not in contact with patients can however be used as pigswill, as that does not create a risk of diseases being transferred to animals;
- Regional as well as onsite HCRW treatment facilities that are not able to meet the proposed air emission standards or the proposed HCRW treatment efficiency standards are to be demolished to prevent illegal use of such facilities as a cost saving measure. Until such time that the facilities are demolished, it should be made unserviceable by removing the burners as well as the primary chamber doors;
- It is to be ensured that no further HCRW treatment facilities that are unlikely to comply with the proposed treatment efficiency standards and air emission standards are erected without EIA,s being undertaken by the Department of Public Works;
- Proof of service delivery to minor HCRW generators should go beyond a service agreement with a service provider and should also include registration on a municipal database where service providers can report the registration numbers of service providers to whom a service was rendered during each month.

8.5.2.3 Training and Awareness:

- Senior management / decision makers at provincial Departments of Health, private hospital groups and HCF's are to be informed on the need for appropriate HCRW management systems. Such parties are to give their commitment to the process and ensure that sufficient funds are allocated in the annual budget for occupationally healthy and safe HCRW management systems;
- Public health care facilities are to be capacitated and provided with the financial means to set an example in terms of environmentally sound yet occupationally healthy and safe HCRW management services;
- Funds are to be made available for the new SANS 10248 Code to be implemented by both public and private HCF's throughout the country;
- Funds are to be provided to Soccer World Cup 2010 host cities, enabling them to comply with FIFA standards set for HCRW management.

8.5.3 HCRW Service Providers:

8.5.3.1 Standard setting and monitoring:

- Service standards are to be set and enforced to prevent HCRW management service providers from lowering service standards to meet an unrealistic drive towards lower prices by both private and public HCRW generators, as some HCRW generators are expecting 1st world standards at 3rd world prices. Such low service prices result in the HCRW service delivery not being sustainable, as service providers are required to invest large amounts of capital in the provision of legally compliant HCRW treatment facilities, which is not possible if the service tariffs are unrealistically low.

8.5.3.2 Operations:

- Sufficient environmentally compliant HCRW incinerators are to be provided to ensure sufficient capacity for the incineration of all pathological and pharmaceutical waste generated throughout SA;
- Each province should have access to its own HCRW treatment facilities wherever practical, with a system introduced of HCRW being treated at the nearest compliant treatment facility irrespective of ownership, thereby limiting long-distance haulage of HCRW across provincial borders;
- To ensure the viability and long term availability of environmentally compliant incinerators required for the treatment of pharmaceutical and pathological HCRW, the possibility should be considered to introduce a system of differentiated treatment tariffs, thereby recovering the cost of more expensive incineration facilities through increased revenue from chemical and pathological HCRW treatment.

8.5.3.3 Training and Awareness:

- Funds are to be allowed for appropriate training of all parties involved in the generation and management of HCRW.

8.6 Legislative Needs:

The following are considered to be the most prominent Legislative needs:

8.6.1 Authorities:

8.6.1.1 Standard setting and monitoring:

- Provincial HCW management policies and regulations are subject to national policies and regulations. The provincial policies and regulations are to be evaluated once the national HCW policies and regulations have been promulgated to ensure that there are no contradictions;
- Promulgation of the Waste Management Act, with its supporting Regulations, should be prioritised to ensure a uniform standard of enforcement throughout SA. Matters that are not yet legislated cannot be legally enforced, thus resulting in an urgent need for the required legislation;
- Uniform environmental standards are to be set and effectively enforced throughout SA for HCW management in general. Particular attention is however to be given to HCRW treatment and disposal, not only for the protection of the environment, but also to ensure a level playing field in the HCW management industry. Once developed, the standards are to be consulted with stakeholders throughout SA before being legislated;
- A final decision is to be taken on the air emission standards to be promulgated, as prospective investors need to know where the goal posts are when they commit their capital for erection of new incinerators;
- Standards set for HCRW treatment plant compliance should not only address air emissions and HCRW treatment efficiencies, but should also consider the overall operations of facilities, e.g. condition of HCRW storage areas, health and safety conditions at the plant, etc.;
- EIA and HCW regulations should be uniform, practical and workable for implementation in all provinces throughout SA;
- RoD's issued by provincial departments should be based on the same nationally adopted standards and should not be more lenient towards SMME's and BEE companies, as BEE cannot be undertaken at the cost of environmental protection or the health and safety of communities;
- Processing of EIA and permit applications that are legally required should be speeded up as it is currently delaying the provision of additional HCRW treatment capacity in SA;
- All HCRW management treatment facilities previously issued with permits under the Air Pollution Prevention Act (APPA), should now be subjected to EIA processes based on uniform standards set for the whole of SA;
- Once promulgated, existing HCRW treatment facilities should be given a reasonable time to comply with the proposed new national Regulations on HCRW treatment efficiencies and air emissions, after which the regulations are to be strictly enforced without the ongoing issuing of temporary operational permit extensions;
- Legislation should be provided that would either prevent the use of crematoria for treatment of HCRW, or alternatively crematoria should meet the same emission standards set for HCRW incinerators;
- Special applications for the permitting of general waste incinerators, like in the case of the De Beers Mining Group wishing to incinerate general waste to prevent diamonds from being smuggled from their premises, should be considered only where such incinerators meet the same emission standards set for HCRW incinerators;
- Occupational Health and Safety measures that are specific to HCRW management and that are not yet addressed in the OHS Act, should be addressed in the HCW Regulations;
- Section 35 of the Medicines and Related Substances Act is to be reconsidered, since it is in practice very difficult to dispose of scheduled drugs. The SA Police does not have the required resources to witness handover of expired drugs sent for treatment and disposal. The presence of the police is further to coincide with the time at which HCRW collection is done;
- The use of puncture-resistant and leak-resistant HCRW containers should be legislated to prevent the use of inferior containers in order to cut back on service costs, thereby putting the health and safety of affected parties at risk;
- The need for pathological HCRW to be refrigerated when stored for more than 24 hours should be legislated. Suitable backup facilities, particularly in terms of power supply, are to be provided where refrigeration is undertaken at HCRW transfer stations or treatment facilities;
- Transporting of HCRW in hired vehicles should not be permitted since: (i) the vehicles are unlikely to comply with the required Road Transport Act standards for transporting of hazardous materials, and (ii)

it is unknown for what applications the vehicles would be used the following day (e.g. transport of food), which could result in the spread of diseases;

- The standards set for incineration and non-incineration HCRW treatment technologies should ensure the same treatment efficiency, irrespective of the technology used, thereby preventing discrimination against any of the treatment technologies;
- Online air emission monitoring should be required to prevent a drop in operational standards (e.g. lowering in operating temperatures) as a cost-saving mechanism once the necessary emission testing has been done;
- It should become a legal requirement for appropriate and approved backup facilities to be nominated where HCRW treatment facilities are to be taken out of operation for extended periods of time due to modifications or upgrading of facilities;
- HCRW treatment facilities should not be shut down in the event of non-compliance without careful consideration of the downstream implications, as it could result in serious consequences in terms of available HCRW treatment capacity for SA. It may in such instances be more appropriate to impose financial penalties on the non-compliant treatment facilities in the form of stiff fines;
- The HCRW management Regulations should make provision for a series of stiff penalties that are to be applied where necessary (e.g. for illegal disposal or long term storage of HCRW), thereby serving as a deterrent to all HCW management stakeholders;
- Firm action is to be taken against HCRW management service providers that are found to contravene the proposed national HCW management regulations. Lowering such service provider's accreditation rating (referred to above) or even removal from the accreditation list (e.g. if found to dispose of HCRW illegally or storing it for extended periods of time) could become part of the penalty. This could however be in addition to fines imposed by courts;
- All HCRW service providers, irrespective of their size or company profile, should be treated in the same manner when Regulations are contravened, thereby protecting the environment as well as the health and the safety of local communities;
- BEE is already given preference through the Preferential Procurement Act. Additional preference, in particular in a manner that put the environment or the health and safety of communities at risk, could be illegal;
- Where considered to be necessary / justified for PPP's to be entered into between DEAT and private HCRW service providers, appropriate legal agreements are to be entered into between the affected parties to define the respective roles and responsibilities;
- Implementation of the WIS is to be enforced and where it is found that HCRW service providers are providing incorrect information in an attempt to mislead the regulating authorities in their strategic planning, the regulations should allow for penalties to be imposed, in addition to the downgrading of such a service provider in terms of the proposed service provider's accreditation system. Parties being dishonest in reporting to the WIS cannot be trusted to render HCRW management services on provincial level;
- The use of HCRW tracking systems, in addition to the existing manifest systems, should become a legal requirement. It is however to be recognised that this may be difficult to implement on minor HCRW generators, in particular home based care patients;
- A database of minor HCRW generators is to be compiled by the various municipalities to allow for ongoing inspections and verification by service providers that HCRW from minor generators is in fact collected, treated and disposed of in the required manner;
- All municipalities are to make allowance in its Bylaws for HCRW management issues that are specific to the particular municipality and that are not addressed in provincial / national legislation;
- Illegal abortion clinics are to be tracked down and closed after the owners / operators have been brought to justice, as the HCRW generated at such facilities is mostly disposed of illegally, inter alia through the municipal sewer system;

- Appropriate law-enforcement agencies are to be established in all provinces, with law-enforcement agents effectively trained in terms of their roles and responsibilities as well as in terms of compliance monitoring procedures;
- The roles and responsibilities in terms of legal compliance monitoring are to be clearly defined between provincial departments of health and environment, as well as between similar departments on provincial and national level. The authority mandated to undertake the law-enforcement should be appropriately capacitated and the necessary resources provided to allow for effective enforcement of legislation;
- Department of Transport is to fulfil the monitoring process once HCRW is transported by road. Inspectors are to be trained in the identification of HCRW, as well as on the aspects to be considered when vehicles transporting HCRW are inspected on the roads;
- The Department of Public Works is to be advised of the need for EIA's to be undertaken before any HCRW treatment facilities are erected;
- Where poor interdepartmental relations exist between affected departments on the same level, or between affected departments on different levels, this is to be addressed in the "spirit of cooperative governance" as required by the Constitution, thereby ensuring a combined effort towards improvement of the HCW management situation in SA;
- The possibility of introducing an "Environmental Ombudsman" for SA should be investigated; as such a process could reduce the number of lengthy and expensive court cases entered into by various role-players in the HCW industry.

8.6.1.2 Operations:

- Agreement is to be reached between the NDoH and DEAT on which party should be responsible for the promulgation of HCW Regulations on national level, i.e. whether it is to be done under the Health Act or under the Waste Management Act. Should agreement not be reached, it is to be determined whether there is a practical way in which the Regulations can be split according to the lines of responsibility e.g. HCW generation to central storage under the Health Act and HCW collection to final disposal under the Waste Management Act. There would however be some crosscutting issues that would have to be duplicated in both sets of Regulations. Should the Regulations be split, it will be important for the 2 sets to be developed together to ensure that there would not be any risk of contradictions between the 2 sets of Regulations. Making use of the Draft HCW Regulations developed as part of the NWMSI project, should be considered as a point of departure;
- HCRW management legislation is to be preceded by the adoption of a HCW Policy, which is in turn to be taken through a thorough consultation process. The Policy will set reasonable targets on which the service standards can be pitched. By having gone through the proposed Policy consultation process, it can be expected that there will be buy-in from the various stakeholders by the time that any proposed Regulations are consulted;
- Extensive consultation is required to determine the level at which HCRW management standards are ultimately to be set; also ensuring that the required objectives are met. More innovative and cost effective HCRW management systems are to be developed for such services to remain cost effective and therefore affordable and sustainable in the long term;
- Before HCRW management Regulations are promulgated on national level, consultation workshops should be held with the various stakeholders that were in the past subjected to provincial HCW management Regulations to determine the shortcomings identified in existing provincial regulations. Shortcomings identified are to be rectified in the national HCRW management Regulations;
- Emission standard setting should be done against the background of other sources of air pollution caused by waste management (e.g. illegal burning of landfills, methane generation on landfills, etc.) to ensure integrated pollution control across the board, without focussing on HCRW incineration only;
- Legally compliant hazardous waste disposal sites / cells are to be provided in all provinces for the safe disposal of treated HCRW residues;

8.6.1.3 Training and Awareness:

- Provincial Departments of Environment are to be capacitated and equipped with the necessary human and other resources required to implement effective environmental monitoring systems. Monitoring procedures and standards should be uniform throughout SA;
- Provincial Departments of Environment should be capacitated to evaluate EIA's for existing as well as various new HCRW treatment technologies introduced to the market, thereby ensuring that officials are in a position to evaluate treatment efficiencies and emission standards against uniform norms set for the whole of SA;
- Provincial and local government waste management facility owners (HCRW transfer / treatment facilities as well as disposal sites) are to be capacitated and supported by national departments to ensure legal compliance by their facilities;
- Members of the community are to be made aware of their legal rights in terms of their health and safety as well as their right to a clean environment. Informed members of the community should be encouraged to become whistle blowers where such rights are put at risk through inappropriate HCRW management practices.

8.6.2 HCRW Generators:

8.6.2.1 Standard setting and monitoring:

- HCRW generators are to be informed about their roles and responsibility in terms of duty-of-care. They are also to be informed that their duty of care does not stop at the inspection of HCRW treatment facilities, but goes as far as the legally compliant disposal of the treated HCRW residues. HCRW generators are further to be guided in terms of the standards that should be met by their HCRW service providers in order to be legally compliant;
- Ways to transfer duty of care from the HCF to the mother wishing to take her placenta home for traditional burial should be investigated and a system developed to deal with such situations. Mothers not expressing a desire to take her placenta home should not be forced to do so just because the hospital / clinic is not equipped to deal with pathological HCRW;
- A system of accreditation of HCRW management service providers (similar to the CIDB - Construction Industry Development Board - ratings done for public tenders in the building / civil engineering industry) is proposed to prevent opportunists from entering the market and managing HCRW in an irresponsible manner. Criteria for accreditation should inter alia include availability of human and other resources, availability of backup facilities, the service provider's previous experience and track record, environmental compliance and occupational health and safety compliance. In addition to the aforesaid, the need should also be expressed for a "fit and proper person" to be tasked to manage the HCRW management contract from the side of the service provider;
- Tender specifications are to be enforced and penalties imposed where required, thereby ensuring compliance with the relevant legislation. Non-compliance by the service provider makes the HCRW generator liable for prosecution in terms of the duty-of-care principle.

8.6.2.2 Operations:

- HCW Regulations would be required to avoid a situation where HCRW management systems are selected on price only, with the client (often procurement department) not having taken cognisance of the environmental as well as the health and safety aspects related to the selection of a HCRW management system;

- Tenders submitted at service rates below the financially viable level should not be considered for award, since a service offered at such low rates is unlikely to be sustainable at the service level defined by the tender specification, which would in turn result in contractual disputes;
- HCRW generators are to verify mass recordings when HCRW is collected to avoid discrepancies and subsequent legal disputes around the HCRW mass removed from the respective HCF's;
- Tender documents are to be developed by technical and financial experts, but are ultimately to be approved by legal experts before the tender letting process commences;
- Although they should address the specific needs of a particular province, provincial HCRW management tender specifications should all be based on the same minimum service standards;
- HCRW management service Tenderers should be required to provide proof of availability of their nominated HCRW treatment facility, in addition to the need for similar proof to be submitted on the availability of their nominated backup facility;
- As part of performance monitoring, all HCRW generators making use of external HCRW management services are to provide proof that services are in fact rendered by accredited service providers (and that they are in fact using such a service provider). Only accredited HCRW service providers should for instance be eligible to tender on public HCRW management service tenders;
- HCRW management tender letting is to be completed within what could be considered to be a reasonable time (90 days maximum). Should the process however take longer, Tenderers are not to be disadvantaged by delaying the Consumer Price Index (CPI) base date any further than the 90 days initially allowed for in the tender;
- The Public Finance Management Act (PFMA) should be complied with in totality and HCRW management service providers should not repeatedly be appointed on 3-month contracts based on quotations, simply to avoid the necessity of going out on tender;
- Infrastructure provided for HCRW management at public and private HCRW generators as well as HCRW management facilities should be legally compliant;
- Open pit burning of HCRW at rural clinics and hospitals, or disposal of placentas into placenta pits, should not be permitted;
- The burning of expired pharmaceuticals in illegal manners is to be prevented as it is not only an environmental hazard, but it is also creating a health risk for members of the community;
- The use of "homemade" incinerators operated by minor HCRW generators is to be prevented and where identified, stiff penalties are to be imposed to prevent further occurrence of such practices. Tyres are reportedly used as a fuel source for the burning of HCRW;
- Control is to be exercised over the supply and installation of new HCRW treatment facilities or the replacement of existing facilities by departments of Public Works without the execution of EIA's, as that is resulting in onsite incinerators still being erected that are unlikely to meet the required standards;
- Cement kilns are not to be used for treatment / disposal of the industry's clinical HCRW until such time that the facility has followed the same legal processes for approval as a HCRW treatment facility;
- Removal of human organs at some mortuaries where cultural traditions require embalming of bodies, is not only creating HCRW management problems, but is also contravening sections of the Body Tissue Act;
- Incineration of segregated HCGW should not be allowed, irrespective of whether such HCW generators are operated by municipalities or not, as it will either be done at a standard that is not legally compliant, or alternatively it will result in very expensive disposal of HCGW which will also put an additional burden on the already limited number of HCRW treatment facilities available in SA.

8.6.2.3 Training and Awareness:

- As per their legal duty to prioritise the life of their patients, HC professionals should also be given the legal duty not to put the health and safety of downstream parties in danger by disposing of HCRW in HCGW containers. Professional disciplinary procedures should be initiated where HC professionals are found to be guilty of irresponsible HCRW management;

- The legal agreement entered into between the NW DoH and the German donors of a HCRW treatment facility (North West province) is either to be honoured, or alternatively the agreement is to be legally cancelled through mutual consent.

8.6.3 HCRW Service Providers:

8.6.3.1 Standard setting and monitoring:

- Disposal of HCRW residues from all treatment processes should be done in a legally compliant manner.

8.6.3.2 Operations:

- HCRW management service providers that do not have access to their own facilities for treatment of all HCRW categories (including pathological waste), are to issue HCRW generators with a legally binding statement by the nominated third party, confirming that HCRW collected by the appointed contractor will be treated / incinerated to the legally required standards, with the treated HCRW residues disposed of in the required manner;
- Cross-boundary movement of HCRW should be limited, with systems being devised for HCRW to be treated as close as possible to the point of generation, irrespective of who the owner of the nearest HCRW treatment facility with spare capacity is.

8.6.3.3 Training and Awareness:

- It is to be ensured that the people appointed to drive HCRW collection vehicles are suitably trained and qualified in accordance with the standards legally set for that;
- It is to be ensured that the people appointed to operate both incineration and non-incineration HCRW treatment facilities are suitably trained and qualified in accordance with the legally compliant standards.

8.7 Information and Awareness Needs:

The following are considered to be the most prominent Information and Awareness needs:

8.7.1 Authorities:

8.7.1.1 Standard setting and monitoring:

- Guidance is to be given by DEAT on the air emission standards that will ultimately be set for HCRW treatment facilities, thereby allowing investors to make an informed assessment of what would be required at the time when capital investments are to be made;
- There is a need for a database to be generated and updated, providing HCRW generators with information on alternative available treatment capacities in the event of appointed HCRW service providers failing to render the services to the required standards;
- HCRW generators are to be capacitated to have a better understanding and knowledge of the compliance monitoring requirements when inspecting their HCRW service providers in terms of the HCRW generator's duty of care;
- Implementation of the WIS is to be enforced and where it is found that HCRW service providers are providing incorrect information in an attempt to mislead the regulating authorities in their strategic planning, the regulations should allow for penalties to be imposed, in addition to the down-grading of such a service provider in terms of the proposed service provider's accreditation system.

8.7.1.2 Operations:

- Better lines of communication regarding HCRW are to be created interdepartmentally; between the different levels of government; as well as between government and the various role players in the HCW industry (HCRW generators and service providers);
- Department of Transport is to fulfil a monitoring role once HCRW is transported by road. Inspectors are to be trained in the identification of HCRW, as well as on the aspects to be considered when vehicles transporting HCRW are inspected on the road;
- There needs to be a system for dissemination of information from national government to the provinces, local authorities and HCF's. The HCW Interest Group of the Institute of Waste Management for Southern Africa is a possible vehicle that could be used for information dissemination. A HCW management website, emails and newsletters are but a few of the available mechanisms that can also be considered for information dissemination;
- Systems are to be introduced for effective data generation and capturing as part of the WIS on various levels (national, provincial, municipal and facility level), for use as management tools. It is also important that control systems be introduced to ensure that the data generated is accurate;
- The WIS is to provide strategists and decision makers in various positions in the HCRW management industry with accurate and updated information. Where such information is to be submitted to politicians, it is to be ensured that the context within which the information is provided is clearly understood.

8.7.1.3 Training and Awareness:

- The information contained in the HCW Policy as well as Strategy and Action Plans is to be presented to people on operational level in a format that is condensed and easy to understand;
- Officials from Provincial Departments of Environment and Health should be informed that the EIA standards and tender specifications for BEE and SMME service providers are to be dealt with in the same manner as for established service providers. The Preferential Procurement Act makes provision for the development of BEE companies, without putting the environment or the health and safety of communities at risk. It is also to be recognised that the duty of care places the responsibility for appropriate HCRW management with the HCRW generators, irrespective of the criteria used during the award of contracts;
- Officials from the Provincial Departments of Environment are to be capacitated on the way in which EIA submissions for various HCRW treatment technologies are to be handled, thereby assisting them in processing EIA's faster and more effectively, whilst also ensuring that uniform standards are applied throughout SA;
- Law enforcement agents are to be effectively trained in terms of their roles and responsibilities as well as in terms of compliance monitoring processes;
- HCW management training is to be included in the curriculum for HC professionals (both doctors and nurses) as well as onsite during the "hospital year". There should be a clear indication of the risks associated with inappropriate HCRW management. The possibility of instituting disciplinary action against HC professionals acting irresponsible should be considered;
- The HCW management-training course developed as part of the Gauteng HCW project is to be revised to ensure that it meets the needs of all provinces in SA. The training material is then to be accredited and the course material made available to the relevant training institutions for implementation;
- Awareness is to be created within municipalities around the need to have accurate records of all major as well as minor HCRW generators within their respective areas of jurisdiction and to undertake ongoing inspections to ensure compliance with the relevant legislation;
- Awareness is to be created within municipalities on the environmental risks associated with poor general waste management; in particular as far as operation of waste disposal sites is concerned;

- Minor HCRW generators are to be made aware of the risks associated with irresponsible HCRW management, not only to their own staff, but also to municipal workers, landfill operators (and reclaimers) as well as the public at large;
- More awareness-creation is required for home-based care patients to ensure that they understand the risks associated with irresponsible HCRW management. Such patients are also to be informed about the appropriate way in which HCRW is to be handled. Systems for drop-off / collection of such HCRW is to be developed and implemented and information around such systems is also to be conveyed to home based care patients;
- Public awareness must be increased around the risks associated with irresponsible HCRW management, in particular in disadvantaged communities where children could come in contact with illegally disposed syringes and needles. Informed members of the communities are then to be capacitated to assist the authorities in acting as whistle blowers. Existing community structures could be used for such awareness creation;
- Public awareness must be increased and disposal facilities should be provided for HCRW generated in public places by for instance diabetes patients and drug addicts. Such HCRW is often disposed of as part of the general waste stream or in municipal street litterbins. Such practices put the health and safety of members of the public as well as municipal workers at risk;
- Members of the public are to be informed around the serious health risks associated with the use of illegal abortion clinics, in order to limit their operations as far as possible;
- There is a need for public awareness around waste management in general.

8.7.2 HCRW Generators:

8.7.2.1 Standard setting and monitoring:

- It is important that all stakeholders in the HCW industry, from both the private and public sector, have access to the latest revisions of the SANS 10248 code of practice;
- It is suggested that HCRW courses be accredited and that HC professionals be awarded CPD points for attendance at such training sessions. Due to the limited time available and / or an attitude that HCW segregation is not their concern, it is difficult to get doctors to attend HCW training courses.

8.7.2.2 Operations:

- Procurement staff should acquire the necessary technical input during development of HCRW management tender specifications, as well as during contract management over the full duration of the contract;
- The party responsible for the development of provincial tenders is to ensure that sufficient information was obtained around the particular needs of the HCF's to be serviced to ensure that all needs are effectively dealt with in the tender. Public facilities to be included in the provincial tender should, in addition to hospitals and clinics, also include mobile clinics, emergency services, mortuaries, etc.
- Department of Public Works is to be informed about the particular infrastructure required in HCF buildings to allow for effective HCRW management. Where required, such provisions are to be made by means of modifications to existing facilities, or during the design stage of new HCF buildings;
- Measures are to be introduced to prevent the high turnover of staff at HCF's, which increases the need for training and awareness creation. This problem is particularly evident where contractors are used to render cleaning services, as the turnover of such cleaners is even higher than in the case of HC professionals.

8.7.2.3 Training and Awareness:

- Senior management / decision makers are to be informed about the responsibilities of HCRW generators as well as the need for appropriate HCRW management, thus also ensuring that sufficient funds are allocated towards HCRW management service delivery;
- HCRW generators are to be better informed about their responsibility in terms of the duty of care, thereby resulting in them acquiring more information on the standards for, and legal compliance of, the HCRW treatment and disposal facilities used for the treatment and disposal of their HCRW;
- HCRW generators are to be informed about the particular requirements of Section 35 of the Medicines and Related Substances Act that requires Police presence during the collection of scheduled pharmaceutical HCRW;
- The need for effective HCW segregation is to be conveyed to all HCRW generators, i.e. from a health, safety, environmental as well as financial perspective;
- HCF staff should be informed not to dispose of heavy metal objects in the HCRW stream, as it could damage shredders used with autoclaves;
- HCF staff are to be informed about the legal implications as well as the health and safety implications of transporting HCRW in sedan vehicles, ambulances or any other unauthorised vehicles;
- Workers are to be informed about the health and safety risks associated with the management of HCRW (for instance removal of HCRW spillage) as part of their training on appropriate use of Personal Protective Equipment (PPE);
- Workers are to be informed about the environmental as well as the health and safety risks in handling HCRW containers inappropriately, e.g. the risk of damaging specicans or sharps containers as a result of inappropriate handling;
- Rural clinic staff are to be informed of the environmental as well as the health and safety risks associated with HCRW being burnt in pits and placentas either being disposed of in placenta pits, or alternatively being sent home with mothers wanting to bury the placentas without being informed on the risks;
- Awareness is to be created around the risk of spreading diseases by means of food that has come into contact with patients. Although kitchen waste can be used as pigswill, leftover food from the wards should be treated and disposed of as HCRW;
- Information on the environmental impact as well as the health implications associated with the use of inferior onsite incinerators is not only to be distributed to the HCF's where such facilities are still in use for the destruction of HCRW and even HCGW, but also to the respective Departments of Public Works that are still installing such facilities without the required EIA's or permits;
- Capacity building and training programmes are to be implemented for officials responsible for the design, construction and/or operation of public HCRW treatment facilities as well as municipal waste disposal sites;
- Officials / staff members responsible for the procurement of HCRW management services are to be trained around the development of tender documentation, execution of tender letting processes (with emphasis on unbiased adjudication of tenders), award of tenders and finally contract management subsequent to award of contracts. They are also to be trained in the development of tender specifications that would meet the HCF's particular needs in the short, medium and long term. It is further important for such documents to be developed in a way that would make contract management more effective over the full duration of the contract;
- HCRW generators as well as service providers are all to be informed around correct data recording and capturing for the WIS;

8.7.3 HCRW Service Providers:

8.7.3.1 Standard setting and monitoring:

- It is important that all stakeholders in the HCW industry, from both the private and public sector, have access to the latest revision of the SANS 10248 code of practice;

8.7.3.2 Operations:

- The reasons for various operational requirements, e.g. the cold storage of pathological HCRW, are to be conveyed to the general workers in order for them to have a better understanding of the situation and therefore contribute more fully during the execution of various activities.

8.7.3.3 Training and Awareness:

- More information dissemination around the effective treatment of sanitary waste is required. The current treatment processes are primarily aimed at deodorising sanitary waste, rather than disinfecting it;
- Workers are to be informed about the health and safety risks associated with the management of HCRW (for instance removal of HCRW spillage) as part of their training on appropriate use of Personal Protective Equipment (PPE);
- Workers are to be informed about the environmental as well as the health and safety risks in handling HCRW containers inappropriately, e.g. the risk of damaging specicans or sharps containers as a result of inappropriate handling;
- HCRW transporters are to be informed about the qualifications and level of training required for HCRW collection vehicle drivers;
- HCRW treatment facility owners (for incineration as well as non-incineration technologies) are to be informed about the qualifications and level of training required for HCRW treatment facility operators;
- HCRW treatment facility owners / operators are to be informed around the appropriate method for disposal of treated HCRW residues, as well as the impact that incorrect management of such residues could have on the environment and / or humans that may come into contact with such residues.

8.8 Public Health Needs:

The following are considered to be the most prominent Public Health needs:

8.8.1 Authorities:

8.8.1.1 Standard setting and monitoring:

- An agreement is to be reached between DEAT and the Dept. of Labour for routine inspections to be undertaken on regional HCRW treatment facilities, thereby ensuring the health and safety of the workers as well as that of the surrounding communities;
- Where crematoria are to be used for the treatment of HCRW, such crematoria should meet the same operational and emission standards set for HCRW incinerators to prevent the public from being exposed to unhealthy emissions;
- Municipalities are to exercise a monitoring role in terms of HCRW being generated in their areas of jurisdiction, thereby limiting the risk of exposing their communities to untreated or poorly treated HCRW;
- Action should be taken against minor HCRW generators that burn HCRW by means of 'home made' treatment facilities, sometimes even making use of tyres as a fuel source;
- Illegal abortion clinics are to be shut down to prevent the generation and illegal disposal of HCRW generated at such facilities. HCRW management systems used at legal abortion clinics should not be considered as minor generators, since the generation of pathological HCRW would require the system to be similar to that for public clinics;

8.8.1.2 Operations:

- Mechanisms are to be introduced that will allow for better control over HCRW generated by minor HCRW generators, including home-based care generators, which are becoming more prevalent due to a shortage in available hospital facilities;
- Appropriate HCRW management systems are to be introduced on municipal level for the collection, transport, treatment and disposal of HCRW from minor HCRW generators. Where required, sharps containers are to be provided to home-based care patients to prevent such HCRW from being dumped illegally or alternatively disposed of illegally by means of the municipal waste collection systems;
- No further onsite HCRW incinerators are to be erected and onsite incinerators still operating at HCF's where patients and visitors are exposed to unhealthy emissions are to be shut down. All existing onsite HCRW incinerators are to be made unserviceable by removing the burners as well as the incinerator doors until such time that they can be demolished.

8.8.1.3 Training and Awareness:

- The public is to be informed on the risks associated with inappropriate HCRW management, not only to prevent them from disposing of HCRW with municipal waste or to warn children about the dangers associated with HCRW and therefore avoid contact when exposed to HCRW, but also enabling them to assist the regulating authorities to act as "whistle blowers". Different strategies are to be followed in capacitating different sectors of the community;
- Public awareness is be increased and facilities are to be provided for HCRW generated in public places by for instance diabetes patients and drug addicts, which waste is often disposed of as part of the general waste stream or in municipal street litterbins where it places the health and safety of members of the public as well as municipal workers at risk.

8.8.2 HCRW Generators:

8.8.2.1 Standard setting and monitoring:

- Ongoing emission control is to be exercised on all onsite HCRW treatment facilities to prevent members of the public from being exposed to pollutants released to air.

8.8.2.2 Operations:

- Pit-burning, illegal dumping or disposal of HCRW from minor generators and clinics in rural areas on municipal general waste landfills is to be prevented by the introduction of appropriate HCRW management systems for such areas, thereby preventing public exposure to untreated or poorly treated HCRW;
- Placentas generated at rural clinics should not be disposed of by means of placenta pits or passed on to mothers not wishing to take the placentas home. Where it is for cultural reasons required that mothers take placentas home for burial, it is to be ensured that the mothers are well informed about the risks associated with the handling of pathological HCRW and that the necessary measures are put in place by the HCF to transfer the duty of care in this instance to the mother;
- HCRW generated by emergency services should be included in all public contracts, thereby preventing inappropriate HCRW management that could ultimately put the health and safety of the public at risk;
- In addition to collection or drop-off facilities required for sharps HCRW generated by home-based care patients, there is also a need for facilities where the public can drop expired medicines off for environmentally sound treatment and disposal;

- Appropriate HCRW storage facilities are to be provided inside and outside of HCF's to ensure that HCRW can be stored and secured in areas where it will not be accessible to the public (patients / visitors);
- Transporting of HCRW from clinics to district hospitals should be undertaken in appropriate HCRW collection vehicles, as transporting of HCRW in sedan vehicles and ambulances places the health and safety of the public at risk;
- The HCRW procurement systems used in both the public and private sectors should allow for HCRW service providers to be paid a fair price for meeting the required service standards, thus ensuring sustainability of services that will reduce the risk of HCRW being disposed of illegally;
- Public HCRW management services should not be rendered on a quotation basis leading to 3-month contracts, as the lack of continuity results in confusion and inappropriate HCRW management practices being followed that can put the health and safety of patients and visitors at risk;
- Where it is traditional to embalm bodies, appropriate measures are to be introduced for the controlled and safe treatment and disposal of organs removed from such bodies at private and public mortuaries. Current uncontrolled practices not only put the health and safety of the community at risk, but also contrave the Human Tissue Act.

8.8.2.3 Training and Awareness:

- Training on appropriate HCRW management is to be provided to ensure that HCRW is appropriately segregated to prevent HCRW from being disposed of as part of the general waste stream where municipal workers as well as informal reclaimers could be exposed to it;
- Public HCF's are to be capacitated on responsible HCRW management service delivery, enabling them to set an example to the private sector in terms of responsible HCRW management;
- Where HCRW containers are accessible to patients or visitors, the necessary warning signage is to be provided, with containers positioned such that people will not accidentally bump into them. Sharps containers should in particular be designed such that they are leak-resistant, puncture-resistant and tamper-proof, with lids securely fitted.

8.8.3 HCRW Service Providers:

8.8.3.1 Standard setting and monitoring:

- Ongoing emission control is to be exercised on all HCRW treatment facilities to prevent members of the public from being exposed to pollutants being released to air.

8.8.3.2 Operations:

- Sanitary waste generated in larger volumes is to be disposed of appropriately. (Some of the systems currently used in effect only deodore the waste instead of disinfecting it);
- Service level agreements issued by HCRW management service providers for a once-off HCRW pickup should not be considered to be proof of an ongoing service agreement, as some minor HCRW generators never call for further collections and often use the sharps containers initially supplied as reusable containers;
- Long-haul transport of HCRW across provincial borders is to be limited by having HCRW treatment undertaken as close as possible to the point of generation, thereby limiting the risk of accidents that could result in road users being exposed to untreated HCRW;
- The backlog in untreated HCRW is to be addressed as that will lead to ongoing illegal disposal, burning and long term storage of HCRW. Stiff financial penalties are to be imposed for such activities to serve as a deterrent to HCRW service providers;

- Residues from treated HCRW, irrespective of whether it is from incineration or non-incineration treatment processes, is to be disposed of on appropriately permitted designed, constructed and operated waste disposal sites that will prevent the public from coming in contact with such residues;
- With HCRW being an extremely dangerous substance, rendering of such services should not be placed in the hands of irresponsible service providers in an effort to empower inexperienced and unqualified SMME / BEE companies.

8.8.3.3 Training and Awareness:

- HCRW generators, including minor generators, are to be informed about the principle of duty-of-care that requires them to ensure that all HCRW generated on their premises is treated and disposed of in an environmentally sound manner, thereby preventing the public from being exposed to inappropriately managed HCRW.

9. Conclusions.

The investigation undertaken during the study was comprehensive and covered what could be considered to be the full spectrum of HCW management activities on management as well as strategic planning level. Although it is appreciated that there are still various operational problems at HCF's (colour coding of plastic liners, internal transport, storage, etc.), such aspects are to a large extent already covered by the revised SANS 10248 Code. The purpose of this study was therefore not to focus on the micro level, but rather to look at HCRW management on a macro level, i.e. management and strategic planning around HCRW management related aspects from national level down to health district or municipal level.

The needs assessment was based on a wide range of problems identified throughout SA. Having listed such needs in Chapter 9, it is not justified to repeat the items already mentioned. This chapter is therefore not dealing with the long list of shortcomings identified, but is rather intended to look at the bigger picture; to look at the development of HCRW management over the last 6 – 7 years and to try and identify the root cause of the problems currently experienced. By identifying the symptoms and not the root cause of the current "HCRW management crisis", the problems may be addressed superficially, but it is likely to reoccur in future, putting HCRW management in SA right back to where it started off from a couple of years ago.

The "HCRW management crisis" currently experienced in South Africa is nothing new and tends to reoccur at intervals of around 5 years. After award of HCRW management service contracts for Gauteng early in the new millennium, large volumes of HCRW were found to be illegally stored for extended periods of time in residential properties in Roodepoort during 2002. Even though various investigations as well as the development of policies, regulations, guidelines, strategies and action plans on both provincial and national level followed on from the Roodepoort incident, a similar situation recently occurred in Ekurhuleni, where significantly larger volumes of HCRW were not only stored in warehouses, but were also dumped illegally where it placed the health and safety of poor communities at risk. It does therefore seem like all efforts made to date and all local as well as international donor funds spent to date, have not achieved the desired results.

Various state-of-the-art HCRW treatment facilities, that are virtually 100% compliant with European Union (EU) standards, were commissioned in Gauteng, KZN and the Western Cape since 2002. Provincial Departments of Health were persuaded not to make use of on-site incinerators any longer due to their poor treatment efficiency and air emission standards. A survey undertaken by the CSIR in 2005 indicated that SA in fact had a 35% oversupply of HCRW treatment capacity, assuming that all facilities with permits previously issued in terms of the Air Pollution Prevention Act (APPA) were compliant.

The present study has established that total HCRW generation across South Africa now amounts to some 42,200 tons per year. Against this, available commercial treatment capacity (non-burn facilities plus incinerators with air-emission control) totals only 31,690 tons per year, although his figure increases to approximately 52,350 tons per year if commercial incinerators without air-emission control are included. New capacity that is expected to come on stream during 2008 (non-burn facilities plus incinerators with air-emission control) is estimated to total 36,860 tons per year, which means that by the end of 2008, total available capacity (non-burn facilities plus incinerators with air-emission control) should amount to approximately 68,500 tons per year, i.e. well in excess of likely HCRW generation levels. A further 18,000 tons per year capacity could possibly come on stream within 2-3 years (i.e. by the end of 2010), according to service-providers interviewed.

On the HCRW treatment demand side, there were also significant changes since 2005. Instead of the five provincial DoH's that were outsourcing their HCRW management services in 2005 , this number increased

to the current eight recorded by December 2007, with the 9th province, Mpumalanga, making use of 3-monhtly contracts based on quotations. The private health care sector followed the example set by the provincial Departments of Health, resulting in very few private HCF's still making use of onsite HCRW incinerators. It is therefore evident that although the supply in commercial HCRW treatment capacity increased, the demand for such facilities also increased, resulting in the creation of a fine balance between supply and demand.

The balance was however dramatically disturbed when two of the large Electro Thermal Deactivation (ETD) plants located in Gauteng and the Western Cape were shut down with the insolvency of Evertrade. Although Solid Waste Technologies subsequently reopened the ETD plant in the WC, the plant in Gauteng is still not operational. Further disturbances to the HCRW supply / demand balance came when the Clinical Waste Management Plant in Gauteng burnt down, followed by the closure of the Aidsafe plant in Gauteng due to non-compliance to the EIA and permit conditions. It is therefore evident that whilst the demand for commercial HCRW treatment facilities increased due to an increased outsourcing of HCRW management services, together with increased HCRW generation due to population growth as well as the HIV/ AIDS pandemic, the supply of treatment capacity at the same time decreased as a result of the reasons referred to above. New HCRW treatment facilities subsequently installed are either in the process of having their EIA's and permits approved (or permits for the residue disposal sites being amended), or the facilities could simply not be erected due to the unavailability of appropriate waste disposal sites.

A matter that is however of serious concern, is the possibility of misrepresentation on the current HCRW management situation given by some members of the HCRW industry when asked to report on their available HCRW treatment capacity. Facilities claimed to be in operation and meeting certain air emission standards with excess HCRW treatment capacity available, were far from compliant, whilst other facilities reported to be erected was never made available for physical inspection. The Waste Information System (WIS) is expected to form a cornerstone of the HCRW management system and is intended to provide regulating authorities with accurate data that is to be used for the development of short, medium and long-term strategies that will have far-reaching implications for HCRW management in SA. It is therefore essential that service-providers supply accurate and reliable data to the WIS; it may be necessary to institute a system for independent verification of data.

Since the first major incident where HCRW collected by commercial service-providers was illegally dumped in Gauteng in 2002, provincial as well as national Departments of Health and Environment launched various initiatives. With most of the illegal HCRW management activities at the time occurring in Gauteng, the initiatives were in particular focused on Gauteng. One such activity was a DANIDA-funded pilot project launched in Gauteng. The intention was for lessons learnt in Gauteng to be elevated to national level for dissemination to other provinces. Since it was recognised that studies undertaken in Gauteng, which does not have any rural areas, were not necessarily appropriate for implementation throughout SA, a HCRW management component was included on the National Waste Management Study Implementation (NWMSI) project to address the remaining shortcomings. In addition to Gauteng, some other provinces also took the initiative and developed their own provincial HCRW management Policies and Regulations. Most of these HCW Policies and Regulations were however developed independent of the national departments, thus creating the risk of conflict in Policies and Regulations between national and provincial departments.

Comprehensive tender documents were developed for outsourcing of HCRW management services in Gauteng. Although the tender specification provided detailed information on the level of services required, with various control mechanisms like the requirement for sureties as well as penalties for various contraventions allowed for in the tender specifications, the specifications were not enforced. With no sureties required at the time of contract award, and with the contract manager not having recognised the risk of one of the service-providers running into financial difficulties, the Gauteng DoH not only incurred

financial loses when the service-provider went insolvent, but they also found themselves in an operational dilemma.

Rollout of the HCRW management services required by the tender specification was not enforced and the reusable HCRW container system was only implemented in a few of the HCF's. Because the Gauteng HCRW Regulations only applied to Gauteng, the tender specification further made provision for all HCRW generated at public HCF's in Gauteng to be treated in Gauteng, thereby ensuring that Regulating Authorities in Gauteng have control over the HCRW treatment and disposal standards. This was however not enforced and the bulk of the HCRW generated at public HCF's in Gauteng was not treated and disposed of in accordance with the Gauteng Regulations.

Although various provinces outsourced HCRW management services from its public HCF's, the HCRW from such provinces was often transported across provincial boundaries for treatment. Most other provinces do not have HCRW regulations and the SANS 10248 Code was often used to specify HCRW management service standards, even though it is not legally enforceable. The standard of tender documentation varied significantly from one province to the next. Some provincial DoH's adopted the Gauteng Tender Specifications without making adjustments for their own particular needs, whilst others developed their own specifications, requiring HCRW to be treated "in an environmentally sound manner", without defining what is meant by the term.

Poor enforcement of HCRW management tender specifications was to the benefit of some service-providers. Service-providers failing to allow in their pricing for the required standards to be met, often undercut prices of Tenderers that did allow for full compliance with the tender specifications.

Discrepancies in standards for the management as well as the treatment and disposal of HCRW between various provinces further contributed to the distortion of the market. Service-providers with HCRW treatment facilities in Gauteng were at a disadvantage when compared to those from other provinces, in particular with regard to incineration. The disparity in standards ('uneven playing field') resulted in service-providers with state-of-the-art and legally complaint HCRW treatment facilities having gone insolvent, which in turn created more opportunities for service-providers not complying with the standards to acquire an even larger share of the HCRW management market. Award of contracts to service-providers that treat and dispose of HCRW in illegal manners, without firm action being taken against them when contravening the regulations / tender specifications, resulted in responsible HCRW management service-providers leaving the industry as the capital investment required to comply to the standards cannot be recovered.

It is believed that the current situation of unfair competition in the HCRW management market contributes significantly towards the unhealthy and often tense relationships between the various HCRW management service-providers. The price-war brought about by the poor relationships is in turn putting the environment as well as the health and safety of all affected parties at risk, since ongoing price-cutting results in service delivery not being sustainable and service-providers having to lower their service standards in order to survive financially. Cooperation between service-providers is at a very low level, with service-providers often refusing to assist any competitors. Even where spare HCRW treatment capacity may be available to assist those that do not have sufficient HCRW treatment capacity, such capacity is in principle not made available to competitors. This situation is preventing some service-providers from treating HCRW to the required standards, even though they committed themselves to provide the treatment capacity required to render the HCRW management service to the standards described in the tender specifications at the time of tender.

It is at the order of the day for HCRW to be transported in all directions across SA. Such long distance transport is firstly the result of HCRW not being treated at the nearest available HCRW treatment facility, but rather at the facility owned by the party to whom any particular HCRW removal contract was awarded.

The second reason for this is a lack of appropriate HCRW treatment facilities in each of the provinces, suitably sized to deal with HCRW generated in any particular province. To illustrate the point and based on public contracts only, it is to be recognised that half of HCRW currently generated in the Eastern Cape is transported to KwaZulu Natal for treatment, whilst the remaining half is transported to Northwest Province for treatment by a third party. Waste from Northwest Province is transported to Gauteng for treatment, with 2/3rd of Gauteng's HCRW being transported to Northwest Province for treatment and the remainder being treated in Gauteng. During the time of non-compliance closure of a treatment facility in Gauteng, HCRW from Gauteng was partially transported to Western Cape for treatment and partially to Northwest Province. The HCRW from the Northern Cape is transported to Free State and Gauteng for treatment, whilst the HCRW from the Free State is partially treated in the Free State and partially in KwaZulu Natal. Limpopo's HCRW was treated in Gauteng until such time that the Gauteng plant was shut down for non-compliance, after which it was transported to Western Cape for treatment. HCRW from Western Cape is treated within the Western Cape, with most of the HCRW (excluding pathological HCRW) from KwaZulu Natal being treated in KwaZulu Natal. The HCRW from Mpumalanga is often still incinerated on-site, but ad-hoc 3-month contracts based on quotations are entered into from time to time, in which case the HCRW is mainly treated in Gauteng or KwaZulu Natal.

Further aspects hampering the provision of appropriate HCRW treatment facilities throughout SA, are the EIA and permitting processes required for the erection and commissioning of HCRW treatment facilities. Based on the observations made during the investigations, the following are considered to the major stumbling blocks in as far as the issuing of RoD's and the permits are concerned:

- No uniform standards on treatment efficiencies or emissions legislated throughout SA for use by the various provincial Departments of Environment during the evaluation of EIA's;
- Insufficient capacity (both in terms of human resources and available skills) at provincial and national level to evaluate the various HCRW treatment technologies submitted for approval;
- A high turnover in staff at the regulating authorities, resulting in both skills and institutional memory being lost whenever there is a resignation.

Linked to the above is also the lack of effective law enforcement. Not only is there uncertainty as to whether compliance monitoring for HCRW treatment facilities should be done by provincial or national departments of environment, but there is also for most of SA no standards against which such monitoring can be undertaken. Closure of non-compliant HCRW treatment facilities in provinces where regulations are in place, instead of applying appropriate financial penalties, results in a worsening of the current HCRW management situation.

Similar to the need for better communication and cooperation between the various role players in the HCRW management industry, there is also a need for better communication between the various affected departments on national as well as on provincial level, with a similar need for better communication between the various spheres of government. Information dissemination to provincial and local level is not done, resulting in each authority having to go through the same learning process, often repeating the same mistakes.

What came out very clearly from the investigations is the need for continuity in terms of HCW planning and strategising on provincial as well as national levels. The impression is that whenever a HCW management project is undertaken with input from external experts on either provincial or national level, the process is improved: policies are developed, regulations are compiled, guidelines are produced, strategies and action plans and compiled and tender specifications are developed. The problem does however arise when such consultant-supported projects come to an end and there is a need for the initiatives to be taken forward: Comprehensive Strategies and Action Plans developed as part of the projects are never implemented. A lack of capacity is once again resulting in the rollout of project outcomes not being fulfilled. Policies are not

consulted and approved by the relevant legislatures; regulations are not formally promulgated and tender specifications are not enforced and subsequently not adhered to. A high turnover of staff is once again resulting in a loss of institutional memory and skills. This is creating a situation where there is no dedicated person on either provincial or national level, in either the departments of health or environment, tasked to take the lead in matters related to HCW management planning and coordination on either provincial or national level. HCW management planning is subsequently mostly crisis management, instead of the coordinated and planned implementation of short, medium and long term strategies and action plans for the various provinces, and SA as a whole.

The final observation was the lack of awareness in particular by HCRW generators in terms of their duty of care. HCRW treatment facilities are seldom inspected during tender evaluation processes or subsequent to the award of public or private sector contracts, even though the duty of care principle requires that such inspections be undertaken. It is also evident that where HCRW generators do visit the HCRW treatment plants, they are not informed on aspects to be taken into consideration. For the few HCRW generators taking cognisance of their duty of care, the duty of care stops at the HCRW treatment facility, rather than taking the process through to final disposal of residues.

As regards 'minimal costs' for HCRW management, the various components (relating to the containerisation, transport and treatment / disposal) have been modelled, and 'viable' rates for these components, and for the provision of an overall HCRW service to public health-care facilities, have been determined.

These viable rates need to be interpreted in the light of the various assumptions which have been made, and in particular the assumptions (i) that the provision of such HCRW services will generate a 'real' internal rate of return of at least 12% per annum for the service-providers (ii) that consumable containers, including liners, are marked-up by 33% on cost, (iii) that average round-trip distances for collection of HCRW from the health-care facilities do not exceed approximately 300 km and (iv) that the pathological- and sharps-waste percentages are approximately 4% and 12% respectively (by mass) of the total HCRW stream.

Based on the financial modelling undertaken, it was found that viable current (January 2008) rates (excluding VAT) for **treatment** of HCRW were as follows:

- Incineration (with air-emission control): R 4.58 per kg (250kg/hr plant capacity), reducing to R 3.69 per kg (1,000 kg/hr plant capacity)
- Autoclaving: R 3.06 per kg (350 kg/hr plant capacity), reducing to R 2.70 per kg (1,400 kg/hr plant capacity)

The results indicate further that 'viable' overall rates excluding containerisation, (i.e. for collection, treatment and disposal) range between R 5.00 and R 8.50 per kilogram of HCRW for treatment by incineration, depending on the containerisation system in use and the average round-trip collection distance involved. The equivalent rates for treatment by autoclaving range from R 4.00 to R 7.50 per kilogram. (All rates are exclusive of VAT.)

If containerisation is included (including consumable and re-usable items), the viable overall rates range from R 7.50 to R 11.50 per kilogram (treatment by incineration), and from R 6.50 to R 10.00 (treatment by autoclaving).

The models that have been developed to determine the 'viable' rates may be used on an on-going basis by DEAT in order to up-date these rates in the light of likely increases in input costs over time, or to cater for different pathological or sharps waste percentages. In addition, the treatment and containerisation models

could be adapted relatively easily in order to determine viable rates for alternative treatment technologies and containerisation systems, if required.

10. Recommendations.

A list of needs was identified for implementation throughout SA, as presented in Chapter 8. In addition to the list of needs, there are various strategic actions to be taken by DEAT and NDoH, aimed at providing guidance on the way forward, for HCRW management ultimately to be undertaken in a coordinated manner throughout SA.

Although not prioritised, the following actions are considered to be of strategic importance:

- High-level consultation is required between DEAT and NDoH to reach agreement on a clear definition of roles and responsibilities on both national as well as provincial level. This agreement should also define the way forward for finalisation of the HCW Policy as well as the HCW Regulations. Should no agreement be reached on the promulgation of HCW Regulations, the areas of jurisdiction should be clearly defined, with NDoH taking ownership of HCRW up to the point of onsite storage, from where DEAT is to take the process through to final disposal. Since this will result in two sets of Regulations, the Regulations are to be developed together to ensure that there are no clashes between the two sets of Regulations. The agreement reached in terms of roles and responsibilities is to be communicated to provincial level for implementation by the provinces.
- Department of Public Works and Department of Transport should also be consulted on national level, and agreements once again communicated with the relevant provincial departments. Consultation with Department of Public Works should inter alia address discontinuation of onsite incinerator installation as well as the removal of existing incinerators, whilst the Department of Transport should be approached around the requirements for transport of HCRW generated by minor generators.
- Develop effective lines of communication between affected government departments on the same level, as well as from the national departments down to the HCF's or municipalities, as required. Such lines of communication are also to be used for information dissemination and capacity building in all spheres of government. In addition to the need for public lines of communication, communication with HCRW generators and service-providers in the private sector should also be established by means of websites and emails and the Institute of Waste Management for Southern Africa's HCW Interest Group could be used very effectively as a vehicle for such communication.
- Develop training and capacity building programmes that will inter alia address the need for (i) training on appropriate HCW management (training the trainers), (ii) tender letting for outsourcing of HCW management services, as well as (iii) evaluation of EIA's and compilation of RoD's for HCRW treatment technologies. Course materials should be accredited where possible and HC professionals should be awarded CPD points as an incentive to attend the HCW management training. Consultation should also be undertaken with tertiary health care training institutions to introduce HCW management into the training curriculum for nurses and doctors. Public awareness is further to be improved through activities like for instance electronic and printed media campaigns.
- The results obtained from the various HCW management studies and pilot projects undertaken on both provincial and national level are to be disseminated. Initiate further studies where there may still be information outstanding (e.g. effective HCRW collection from minor HCRW generators) as part of a research and development programme. Project partners like the HCW generators and service-providers from the private sector, World Health Organisation (WHO) and the John Snow Institute (JSI) could be approached for financial assistance, where the outcome of such investigations could be of benefit to such partners.
- Undertake a more comprehensive HCRW management mass-balance study for the whole of SA by means of which the HCRW generation profile for the country is compared to the available HCRW treatment capacity. Based on the outcome of the study, determine areas where there is a need for the supply of additional HCRW treatment capacity. By making use of this information, the study should be

extended to determine the viability of private sector intervention on its own to address such needs and where it is not considered to be financially viable for the private sector to get involved in such activities, the possibility of establishing a Private-Public Partnership (PPP) between DEAT and the private sector should be investigated, with DEAT perhaps providing the required capital investment and the private sector taking responsibility for the operation of the HCRW treatment facilities.

- Despite the fact that there is limited interaction and cooperation between HCRW service-providers in the industry, a system should be devised through consultation with the various role-players, according to which HCRW is, wherever possible, to be treated at HCRW treatment facilities closest to the respective sources. The long distances over which HCRW is currently transported not only results in unnecessary money being spent that can be shared between the interfacing HCRW collection and HCRW treatment contractors, but it also presents environmental as well as health and safety risks associated with long distance transport of HCRW.
- Provincial Departments of Environment are to be assisted by DEAT to ensure that each province has access to at least one hazardous waste disposal facility / cell that is designed, constructed and operated according to Minimum Requirements for Waste Disposal by Landfill. Where there is no financial incentive for the private sector to venture into projects for areas that may be financially risky due to a lack of economies of scale, it may once again create a need for DEAT to enter into PPP's with the waste disposal contractors from the private sector for the development and operation of such facilities, on the same basis as for the supply of additional HCRW treatment facilities.
- It is recommended that a national database be developed through which HCRW service-providers are to be accredited (similar to the CIDB rating system used in the civil engineering industry). Criteria are to be developed to rate the service-provider for instance in terms of experience and expertise, human and equipment resource availability, compliance with legal requirements and previous track records. The service-provider's rating will then in turn determine the size and complexity of the contract for which it can tender. The system also allows for the continuous development of contactors, but is intended to prevent service-providers from being appointed above their level of expertise and capability, which often results in operations like illegal dumping of HCRW or long term storage thereof. Where a service-provider was found to contravene the HCRW regulations, it could then result in a lowering of it's rating or even removal from the rating list, depending on the seriousness of the contravention. In addition to the aforesaid, the need should also be expressed for a "fit and proper person" to be tasked to manage the project from the side of the service-provider.
- It is recommended that an environmental Ombudsman be appointed to reduce the impact that environmental lawsuits have on the courts in SA. This will not only allow for speedy resolution of legal differences, but it will also be a much smoother and cheaper way of getting such matters resolved.
- Develop and implement a provincial HCRW management pilot plan in a province with a large percentage of rural areas without direct access to regional HCRW treatment facilities. This provincial pilot project is then to serve as a prototype for replication in all other provinces. The following broad outline for a provincial HCRW management plan is proposed:
  - Develop and implement a rural HCRW collection system with a LDV and trailer to collect HCRW from the clinics for delivery to a transfer station that is to be established at the largest provincial hospital in the health district / town. Should the provincial department of health not be able / prepared to accommodate such a transfer station on the hospital premises, it can be established in a suitably zoned area like an industrial area or even an existing municipal waste management facility. The transfer station should however comply with all legal requirements in terms of zoning, EIA approval and permitting. Ownership of transfer stations not located on hospital land could be with the provincial department of health, provincial department of environment or the local municipality.
  - All areas where pathological HCRW is to be stored for more than 24 hours (including HCRW generators and the transfer station) should be equipped with suitable freezer(s) for the refrigeration of pathological HCRW.

- Develop and implement a minor HCRW generator collection and / or drop-off systems for implementation in towns. The service charge should be fixed for each category of minor generator, e.g. commercial and non-commercial minor HCRW generators respectively.
- HCRW collected from minor generators is to be delivered to the transfer station referred to above. The transfer station is also to serve as the depot from which HCRW containers are supplied for distribution to the minor generators. The decision is to be taken as to whether sharps containers would be provided free of charge to some categories of minor HCRW generators (e.g. non-commercial HCRW generators).
- Private HCRW generators like clinics and small hospitals should also be allowed to deliver their HCRW to the transfer station (by using a legally complaint means of transport), with payment by such HCRW generators being based on the mass of HCRW delivered, and with payment made directly to the HCRW service-provider appointed for the province.
- Any large private hospital that justifies HCRW collection onsite rather than to have it delivered to the transfer station, should however be allowed to participate in the HCRW management service contract entered into for the public HCF's.
- The provincial HCRW service tender is then optionally to allow for all minor HCRW generators as well as private major HCRW generators wishing to participate in the provincial contract, to make use of the service. By effectively having a single provincial service contract servicing both public and private major and minor HCRW generators, the economies of scale can be achieved that will make it finically viable for a service-provider to collect HCRW from all large private and public hospitals, as well as from all clinics and minor HCRW generators having their HCRW delivered to the HCRW transfer stations centrally situated in health districts / municipalities.
- Details like the responsibility for HCRW mass recoding at the transfer station and the overall management of transfer stations in each of the health districts / municipalities are to be determined, but such activities could also be included in the Terms of Reference for the HCRW management service-provider appointed on the provincial contract. Even the function of invoicing individual minor HCRW generators and collection of service fees can be passed on to the service-provider, with individual HCRW generators witnessing the HCRW mass at the time of HCRW collection from their premises, possible as part of a minor HCRW generator collection system, or during HCRW delivery to the transfer stations.
- Although the provincial contract is in fact only creating a system for the private sector to participate in the economies of scale already created by the provincial hospitals (with the various private HCRW generators still invoiced separately), it is important that all parties participating in the contract be given the opportunity to provide input in the development of the tender specifications.
- Opportunities for development of SMME contractors, under the guidance of the main HCRW contractor, exists for the collection of HCRW from the rural clinics, collection of HCRW from the minor HCRW generators as well as for the operation and maintenance of the HCRW transfer station.
- Irrespective of the number of HCRW service-providers appointed for the province and the health districts awarded to each of them, there is still the need for HCRW from that point to be transported to the nearest available HCRW treatment facility for treatment and disposal.

- The 'viable rates' for HCRW management, as determined within this study, should be disseminated to any national and provincial government departments that have responsibility for the awarding of contracts to commercial service-providers, or for the monitoring and administration of such contracts. Where rates offered / charged by such service-providers differ significantly from the rates determined here, satisfactory explanations should be sought.
- In particular, the awarding of HCRW management contracts to the "lowest bidder" should be avoided in cases where the rates offered are significantly below the viable rates determined here. Although this will not guarantee sustainability of the service offered by the service-provider, it should go some way to avoiding situations where the service-provider is "set up to fail" from the outset.

- *To prevent the need for biannual surveys or the need for external resources to be used in updating the data on HCRW generation and treatment, implementation of the WIS is to be enforced.*

Annexure 1: HCRW Mass per Container

HCRW Mass per container

Source	W-bins		Bags	Boxes		Re-usable boxes		Sharps #				Specicans #		
	770 lit	240 lit	85 lit	142 lit	50 lit	100 lit	50 lit	7.6 lit	10 lit	20 lit	25 lit	10 lit	20 lit	
DMSA 2002 - Private				7.49	4.39				1.47	6.01		4.48	7.67	
DMSA 2002 - Public				7.74	3.12				1.70	5.65		6.48	6.67	v. small sample
Add: tare mass				0.70	0.35				0.48	0.81		0.45	0.75	
Gross mass				**8.44**	**3.47**				**2.18**	**6.46**		**6.93**	**7.42**	
DACEL 2000 study			4.18	8.3	4.2			1.69				5.21		
Sanumed 2000				9.10	8.00			1.95	2.30					Incl. wet waste
Leratong+ Itireleng pilot studies 2003	91.0	20.0				6.80	5.00					8.77		
Service provider 2007		30.0												
Adopted for this study	**90.0**	**25.0**	see below	**8.4 #**	**4.0 #**	**6.8**	**5.0**	**1.7**	**2.2**	**6.4**	**8.1**	**6.0**	**10.0**	Values for dry
Unit costs (excl. VAT)	**R 3,500**	**R 330**	see below	**R 8.40**	**R 5.50**	**R 130**	**R 85**	**R 15.00**	**R 16.50**	**R 27.00**	**R 32.00**	**R 20.00**		Imputed values

These are gross mass figures; others are net.

LLDPE Liner usage figures (from Leratong pilot study 2003)

System(s)	Item	Dimensions: w x h x t	Nominal capacity HCRW	Where used	Nominal* consumption (* i.e. not actual HCRW mass per liner)	Cost per 1,000 units (excl.)
Both liner-based and reusable box-based systems	Small red liner	46 x 54 cm x 50 micron	12 litres	Kick-about trolleys & pedal-bins	1 per 7kgs HCRW generated	**R 630**
	Medium red liner	56 x 66 cm x 60 micron	30 litres	Nursing-trolley baskets	1 per 5 kgs HCRW generated	**R 1,120**
Liner-based system only	Large red liner (thick)	75 x 95 cm x 80 micron	85 litres	Stands in sluice-rooms	1 per 5 kgs HCRW generated	**R 2,880**
Re-usable box system only	Large red liner (thin)	75 x 95 cm x 50 micron	85 litres	50-litre re-usable containers	1 per 14 kgs HCRW generated #	**R 1,800**
	Extra large red liner	100 x 95 cm x 50 micron	100 litres	100-litre re-usable containers	1 per 10 kgs HCRW generated #	**R 2,400**

These figures were applicable where both container sizes were in use simultaneously. In the present case, where only the 100 litre container is used in the model, it would be reasonable to assume that one liner is required per container, i.e. one per 6.8 kg of waste.

Annexure 2: Cost Model : Incineration

DEAT HCRW STUDY 2007

Cost Model: Incineration

	Incinerator Designation:			**250kg/hr incl. ceramic filter & doser**	
	Existing / New / Upgraded		**New**	Place:	**Various**
	Annual HCRW capacity		**1,425**	**tons**	
1	**Property Parameters: (all costs exclude VAT)**				
	Site Area		2,000	square metres	
	Estimated Land Cost		R 400	/m2	**R 800,000**
2	**Development Costs:**		**m2**	**Cost/m2**	**Amount**
	Earthworks, roads & drainage		600	R 500	300,000
	Building		350	R 3,500	1,225,000
	Subtotal "A":				**R 1,525,000**
	Electrical: Switchgear & Reticulation	KVA required:	70		300,000
	Diesel stand-by generator for 'burn-down' purposes:				75,000
	Diesel storage tanks & equipment		40,000	litres	0
	Fire-fighting & emergency equipment				150,000
	Environmental Impact Assessment				400,000
	Subtotal "B":				**R 925,000**
	Estimated annual maintenance cost: Switchgear etc.:			7.50%	R 39,375
3	**Incinerator:**				
	Make & Model:			No. of units:	1
	Operating hours per day:				19
				Per Unit	**Total**
	Capacity:		kgs/hour	250	250
			kgs/day	4,750	4,750
	Rated Power		kw	6	6
	Daily Power consumption:	(allow 1hr/day startup)	kwh	120	120
	Diesel consumption		lit/hr	37.5	37.5
	Diesel consumption	(allow 1hr/day startup)	lit/day	750	750
	Installed cost:			R 3,500,000	**R 3,500,000**
	Estimated annual maintenance cost:			7.50%	R 262,500
4	**Dry ceramic filter with doser:**				
	Make & Model:			No. of units:	1
	Operating hours per day:				20
				Per Unit	**Total**
	Rated Power		kw	23	23
	Daily Power consumption:		kwh	450	450
	Sorbent usage		kg/hr	25	25
	Sorbent usage		kg/day	500	500
	Water usage		lit/day	0	0
	Installed cost:	(incl. above)			
	Estimated annual maintenance cost:	(incl. above)			
5	**Sundry Equipment:**				
	Office & Washroom furniture				40,000
	Computer equipment				30,000
	Store				10,000
	Coldroom		10m3		35,000
	Ash skips				0
	Total Sundry Equipment cost:				**R 115,000**
	Estimated annual maintenance cost:			5.00%	R 5,750
	Total Capital Cost:				**R 6,865,000**
	Estimated total annual maintenance cost: Subtotal "C":				R 308,000
	Annual insurance cost:			4.00%	R 166,000
6	**Power & Consumables**				
	Working days per annum:	300			
	Annual usage & cost:	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
	Incinerators:				
	Electricity	36,000	kwh	R 0.2100	8,000
	Diesel	225,000	lit	R 6.95	1,564,000
	Other				0
	Filter:				
	Electricity	135,000	kwh	R 0.2100	29,000
	Sorbent	150	tons	R 4,500	675,000
	Water	0	m3	R 12.00	0
	Sundry services & consumables:				
	Clothing				6,000
	Other consumables				18,000
	Telecoms				40,000
	Water	500	m3	R 12.00	6,000
	Ash removal & disposal (5% by mass), tons		72	R 3,000	216,000
	Ash treatment @ 2.5% by mass lime (tons)		1.8	R 4,500	9,000
	Waste (wet) removal & disposal, tons		0	R 1,000	0
	Monitoring, testing and auditing				30,000
	Electricity (other)	65,000	kwh	R 0.21	14,000
	Power & Consumables: variable component				2,615,000
	Eskom charge: service				5,000
	Eskom charge: demand	40	kVA	R 54.00	26,000
	Power & Consumables: fixed component				31,000
	Total Annual Power & Consumables Cost				**R 2,646,000**
7	**Personnel costs**	0	R 500,000	R 0	
		1	R 150,000	R 150,000	
		3	R 75,000	R 225,000	
		9	R 42,000	R 378,000	
	Total annual personnel cost:				**R 753,000**
8	**Ancilliary costs**				
	Security services			R 150,000	
	Medical screening of personnel			R 15,000	
	Total annual ancilliary costs:				**R 165,000**

Projected Income Statement, Cash Flows, NPV's, IRR's and approx. payback periods

	% of full capacity	All Rand figures in these columns are '000s Year 0	1	2	3	4	5	6	7
Tons HCRW treated per annum	50%		713	713	713	713	713	713	713
	75%		1,069	1,069	1,069	1,069	1,069	1,069	1,069
	100%		1,425	1,425	1,425	1,425	1,425	1,425	1,425
Income @ treatment price of R 4.94 per kilogram	50%		R 3,517	R 3,517	R 3,517	R 3,517	R 3,517	R 3,517	R 3,517
	75%		R 5,276	R 5,276	R 5,276	R 5,276	R 5,276	R 5,276	R 5,276
	100%		R 7,034	R 7,034	R 7,034	R 7,034	R 7,034	R 7,034	R 7,034
Fixed costs:									
Repairs & maintenance (subtotal "C")			R 308	R 308	R 308	R 308	R 308	R 308	R 308
Insurance			R 166	R 166	R 166	R 166	R 166	R 166	R 166
Eskom			R 31	R 31	R 31	R 31	R 31	R 31	R 31
Depreciation:									
(1) Subtotal "A" items	R 1,525,000								
Annual depreciation charge:	5%		R 76	R 76	R 76	R 76	R 76	R 76	R 76
(2) Subtotal "B" items	R 925,000								
Annual depreciation charge:	10%		R 93	R 93	R 93	R 93	R 93	R 93	R 93
(3) Incinerator + scrubber + sundry equip.:	R 3,615,000								
Depreciation charge (40/20/20/20/0%):			R 1,446	R 723	R 723	R 723	R 0	R 0	R 0
Subtotal: Depreciation			R 1,615	R 1,397	R 1,397	R 1,397	R 674	R 674	R 674
Subtotal: Fixed costs			R 2,120	R 1,902	R 1,902	R 1,902	R 1,179	R 1,179	R 1,179
Variable costs:									
Power & consumables:	50%		R 1,308	R 1,308	R 1,308	R 1,308	R 1,308	R 1,308	R 1,308
	75%		R 1,962	R 1,962	R 1,962	R 1,962	R 1,962	R 1,962	R 1,962
	100%		R 2,615	R 2,615	R 2,615	R 2,615	R 2,615	R 2,615	R 2,615
Personnel & ancilliary costs (semi-variable):	50%	75%	R 689	R 689	R 689	R 689	R 689	R 689	R 689
	75%	100%	R 918	R 918	R 918	R 918	R 918	R 918	R 918
	100%	100%	R 918	R 918	R 918	R 918	R 918	R 918	R 918
Subtotals: Variable costs	50%		R 1,997	R 1,997	R 1,997	R 1,997	R 1,997	R 1,997	R 1,997
	75%		R 2,880	R 2,880	R 2,880	R 2,880	R 2,880	R 2,880	R 2,880
	100%		R 3,533	R 3,533	R 3,533	R 3,533	R 3,533	R 3,533	R 3,533
Total costs (to nearest R 000)	50%		R 4,117	R 3,899	R 3,899	R 3,899	R 3,176	R 3,176	R 3,176
	75%		R 5,000	R 4,782	R 4,782	R 4,782	R 4,059	R 4,059	R 4,059
	100%		R 5,653	R 5,435	R 5,435	R 5,435	R 4,712	R 4,712	R 4,712
Profit before interest & tax (PBIT)	50%		-R 600	-R 382	-R 382	-R 382	R 341	R 341	R 341
	75%		R 276	R 494	R 494	R 494	R 1,217	R 1,217	R 1,217
	100%		R 1,382	R 1,600	R 1,600	R 1,600	R 2,323	R 2,323	R 2,323
Tax at 30%	50%		-R 180	-R 114	-R 114	-R 114	R 102	R 102	R 102
	75%		R 83	R 148	R 148	R 148	R 365	R 365	R 365
	100%		R 415	R 480	R 480	R 480	R 697	R 697	R 697
Net profit after tax (NPAT)	50%		-R 420	-R 267	-R 267	-R 267	R 239	R 239	R 239
	75%		R 193	R 346	R 346	R 346	R 852	R 852	R 852
	100%		R 967	R 1,120	R 1,120	R 1,120	R 1,626	R 1,626	R 1,626
Calculation of operating cash flows:									
Add back: Depreciation (see above)			R 1,615	R 1,397	R 1,397	R 1,397	R 674	R 674	R 674
Operating cash flows	50%		R 1,195	R 1,130	R 1,130	R 1,130	R 913	R 913	R 913
	75%		R 1,808	R 1,743	R 1,743	R 1,743	R 1,526	R 1,526	R 1,526
	100%		R 2,582	R 2,517	R 2,517	R 2,517	R 2,300	R 2,300	R 2,300
Additions to net working capital		-R 500	R 0	R 0	R 0	R 0	R 0	R 0	R 500
Capital expenditure	R 6,865,000	-R 6,865							
Projected total cash flows	50%	**-R 7,365**	**R 1,195**	**R 1,130**	**R 1,130**	**R 1,130**	**R 913**	**R 913**	**R 1,413**
	75%	**-R 7,365**	**R 1,808**	**R 1,743**	**R 1,743**	**R 1,743**	**R 1,526**	**R 1,526**	**R 2,026**
	100%	**-R 7,365**	**R 2,582**	**R 2,517**	**R 2,517**	**R 2,517**	**R 2,300**	**R 2,300**	**R 2,800**
Cumulative cash flows	50%	-R 7,365	-R 6,170	-R 5,040	-R 3,911	-R 2,781	-R 1,868	-R 955	R 458
	75%	-R 7,365	-R 5,557	-R 3,814	-R 2,072	-R 329	R 1,197	R 2,722	R 4,748
	100%	-R 7,365	-R 4,783	-R 2,266	R 250	R 2,767	R 5,066	R 7,366	R 10,166

	Net present values @ 25%	Internal rate of return	Approx. payback (years)
50%	(R 3,810)	1.5%	> 5
75%	(R 1,873)	14.3%	4.2
100%	R 574	28.1%	2.9

'Snapshot' of part of summary worksheet:

Summary:		%-age of full capacity			%-age of full capacity			
		50%	75%	100%	50%	75%	100%	Weighted IRR
Tons/year	**Price/kg**	**Probabilities**			**IRR's**			
1,425	**R 4.94**	0.03	0.71	0.26	1.5%	14.3%	28.1%	**17.5%**
2,850	**R 4.35**	0.09	0.66	0.25	2.3%	15.3%	28.9%	**17.5%**
5,700	**R 3.96**	0.20	0.58	0.22	3.8%	17.3%	30.5%	**17.5%**

Annexure 3: Cost Model : Autoclave Treatment

DACE HCRW STUDY 2007

Cost Model: Autoclave treatment

	Autoclave Designation:		**350 kg/hr**		
	Existing / New / Upgraded		**New**	Name:	**Various**
	Annual HCRW capacity		**2,520**	**tons**	
1	**Property Parameters: (all costs exclude VAT)**				
	Site Area		2,000	square metres	
	Estimated Land Cost		R 500	/m2	**R 1,000,000**
2	**Development Costs:**		**m2**	**Cost/m2**	**Amount**
	Earthworks, roads & drainage		750	R 500	375,000
	Building		300	R 3,500	1,050,000
	Subtotal "A":				**R 1,425,000**
	Electrical: Switchgear & Reticulation				
		KVA required:	70		350,000
	Fire-fighting & emergency equipment				150,000
	Environmental Impact Assessment				500,000
	Subtotal "B":				**R 1,000,000**
	Estimated annual maintenance cost: Switchgear etc.:			7.50%	R 37,500
3	**Autoclave**				
	Make & Model:			No. of units:	1
	Operating hours per day:				24
				Per Unit	**Total**
	Capacity:		kgs/hour	**350**	350
			kgs/day	8,400	8,400
	Rated Power		kw	20	20
	Daily Power consumption:		kwh	480	480
	Water		lit/day	6,000	6,000
	Steam		kg/day	3,024	3,024
	Installed cost:			R 5,400,000	**R 5,400,000**
	Estimated annual maintenance cost:			5.00%	R 270,000
4	**Steam generator:**	250	kg/hr =	6,000	kg/day
	Make & Model:	***Applied Heat P/L***		No. of units:	1
	Operating hours per day:				24
	Percent of rated capacity		50%	**Per Unit**	**Total**
	Electricity kwh/hr at rated cap.		kwh	1.8	1.8
	Daily power consumption:		kwh	22	22
	Diesel consumption at rated cap.		lit/hr	20	20
	Daily diesel consumption:		lit/day	242	242
	Water lit/hr at rated cap.		lit/hr	275	275
	Water usage		lit/day	3,300	3,300
	Installed cost:			R 200,000	**R 200,000**
	Estimated annual maintenance cost:			10.00%	R 20,000
5	**Sundry Equipment:**				
	Office & Washroom furniture				60,000
	Computer				40,000
	Store				20,000
	Coldroom		15m3		40,000
	Waste skips				50,000
	Total Sundry Equipment cost:				**R 210,000**
	Estimated annual maintenance cost:			10.00%	R 21,000
	Total Capital Cost:				**R 9,235,000**
	Estimated total annual maintenance cost: Subtotal "C":				R 349,000
	Annual insurance cost:			4.00%	R 253,000
6	**Power & Consumables**				
	Working days per annum:	300			
	Annual usage & cost:	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
	Autoclave:				
	Electricity	144,000	kwh	R 0.21	31,000
	Water	1,800	m3	R 12.00	22,000
	Other				0
	Steam generator:				
	Electricity	6,532	kwh	R 0.21	2,000
	Diesel	72,600	lit	R 6.95	505,000
	Water	990	m3	R 12.00	12,000
	Sundry services & consumables:				
	Clothing				6,000
	Other consumables				18,000
	Telecoms				40,000
	Water	600	m3	R 12.00	7,200
	Disposal of residues:	2,520	tons	R 250.00	630,000
4%	Treatment & disposal of pathological waste:	100,800	kg	R 15.00	1,512,000
	Monitoring, testing and auditing				36,000
	Electricity (other)	70,000	kwh	R 0.21	15,000
	Power & Consumables: variable component				2,836,200
	Eskom charge: service				5,000
	Eskom charge: demand	40		R 54.00	26,000
	Power & Consumables: fixed component				31,000
	Total Annual Power & Consumables Cost				**R 2,867,200**
7	**Personnel costs**	0	R 500,000	R 0	
		1	R 150,000	R 150,000	
		3	R 75,000	R 225,000	
		10	R 42,000	R 420,000	
	Total annual personnel cost:				**R 795,000**
8	**Ancilliary costs**				
	Security services			R 150,000	
	Medical screening of personnel			R 15,000	
	Total annual ancilliary costs:				**R 165,000**

Projected Income Statement, Cash Flows, NPV's, IRR's and approx. payback periods

	% of full capacity	All Rand figures in these columns are '000s Year 0	1	2	3	4	5	6	7
Tons HCRW treated per annum	50%		1,260	1,260	1,260	1,260	1,260	1,260	1,260
	75%		1,890	1,890	1,890	1,890	1,890	1,890	1,890
	100%		2,520	2,520	2,520	2,520	2,520	2,520	2,520
Income @ treatment price of R 3.33 per kilogram	50%		R 4,196	R 4,196	R 4,196	R 4,196	R 4,196	R 4,196	R 4,196
	75%		R 6,294	R 6,294	R 6,294	R 6,294	R 6,294	R 6,294	R 6,294
	100%		R 8,392	R 8,392	R 8,392	R 8,392	R 8,392	R 8,392	R 8,392
Fixed costs:									
Repairs & maintenance (subtotal "C")			R 349	R 349	R 349	R 349	R 349	R 349	R 349
Insurance			R 253	R 253	R 253	R 253	R 253	R 253	R 253
Eskom			R 31	R 31	R 31	R 31	R 31	R 31	R 31
Depreciation:									
(1) Subtotal "A" items	R 1,425,000								
Annual depreciation charge:	5%		R 71	R 71	R 71	R 71	R 71	R 71	R 71
(2) Subtotal "B" items	R 1,000,000								
Annual depreciation charge:	10%		R 100	R 100	R 100	R 100	R 100	R 100	R 100
(3) Autoclave + steam gen. + sundry equip.:	R 5,810,000								
Depreciation charge (40/20/20/20/0%):			R 2,324	R 1,162	R 1,162	R 1,162	R 0	R 0	R 0
Subtotal: Depreciation			R 2,495	R 1,966	R 1,966	R 1,966	R 804	R 804	R 804
Subtotal: Fixed costs			R 3,128	R 2,599	R 2,599	R 2,599	R 1,437	R 1,437	R 1,437
Variable costs:									
Power & consumables:	50%		R 1,419	R 1,419	R 1,419	R 1,419	R 1,419	R 1,419	R 1,419
	75%		R 2,128	R 2,128	R 2,128	R 2,128	R 2,128	R 2,128	R 2,128
	100%		R 2,837	R 2,837	R 2,837	R 2,837	R 2,837	R 2,837	R 2,837
Personnel + ancilliary costs (semi-variable):	50%	75%	R 720	R 720	R 720	R 720	R 720	R 720	R 720
	75%	100%	R 960	R 960	R 960	R 960	R 960	R 960	R 960
	100%	100%	R 960	R 960	R 960	R 960	R 960	R 960	R 960
Subtotals: Variable costs	50%		R 2,139	R 2,139	R 2,139	R 2,139	R 2,139	R 2,139	R 2,139
	75%		R 3,088	R 3,088	R 3,088	R 3,088	R 3,088	R 3,088	R 3,088
	100%		R 3,797	R 3,797	R 3,797	R 3,797	R 3,797	R 3,797	R 3,797
Total costs (to nearest R 000)	50%		R 5,267	R 4,738	R 4,738	R 4,738	R 3,576	R 3,576	R 3,576
	75%		R 6,216	R 5,687	R 5,687	R 5,687	R 4,525	R 4,525	R 4,525
	100%		R 6,925	R 6,396	R 6,396	R 6,396	R 5,234	R 5,234	R 5,234
Profit before interest & tax (PBIT)	50%		-R 1,071	-R 542	-R 542	-R 542	R 620	R 620	R 620
	75%		R 78	R 607	R 607	R 607	R 1,769	R 1,769	R 1,769
	100%		R 1,467	R 1,996	R 1,996	R 1,996	R 3,158	R 3,158	R 3,158
Tax at 30%	50%		-R 321	-R 163	-R 163	-R 163	R 186	R 186	R 186
	75%		R 23	R 182	R 182	R 182	R 531	R 531	R 531
	100%		R 440	R 599	R 599	R 599	R 947	R 947	R 947
Net profit after tax (NPAT)	50%		-R 750	-R 380	-R 380	-R 380	R 434	R 434	R 434
	75%		R 54	R 425	R 425	R 425	R 1,238	R 1,238	R 1,238
	100%		R 1,027	R 1,397	R 1,397	R 1,397	R 2,210	R 2,210	R 2,210
Calculation of operating cash flows:									
Add back: Depreciation (see above)			R 2,495	R 1,966	R 1,966	R 1,966	R 804	R 804	R 804
Operating cash flows	50%		R 1,745	R 1,587	R 1,587	R 1,587	R 1,238	R 1,238	R 1,238
	75%		R 2,550	R 2,391	R 2,391	R 2,391	R 2,042	R 2,042	R 2,042
	100%		R 3,522	R 3,363	R 3,363	R 3,363	R 3,015	R 3,015	R 3,015
Additions to net working capital		-R 500	R 0	R 0	R 0	R 0	R 0	R 0	R 500
Capital expenditure	R 9,235,000	-R 9,235							
Projected total cash flows	50%	**-R 9,735**	**R 1,745**	**R 1,587**	**R 1,587**	**R 1,587**	**R 1,238**	**R 1,238**	**R 1,738**
	75%	**-R 9,735**	**R 2,550**	**R 2,391**	**R 2,391**	**R 2,391**	**R 2,042**	**R 2,042**	**R 2,542**
	100%	**-R 9,735**	**R 3,522**	**R 3,363**	**R 3,363**	**R 3,363**	**R 3,015**	**R 3,015**	**R 3,515**
Cumulative cash flows	50%	-R 9,735	-R 7,990	-R 6,403	-R 4,816	-R 3,230	-R 1,992	-R 753	R 985
	75%	-R 9,735	-R 7,185	-R 4,794	-R 2,403	-R 12	R 2,030	R 4,072	R 6,615
	100%	-R 9,735	-R 6,213	-R 2,850	R 514	R 3,877	R 6,891	R 9,906	R 13,421

	Net present values @ 25%	Internal rate of return	Approx. payback (years)
50%	(R 4,766)	2.5%	> 5
75%	(R 2,224)	15.3%	4.0
100%	R 850	28.5%	2.8

'Snapshot' of summary worksheet:

Summary		%-age of full capacity			%-age of full capacity			
		50%	75%	100%	50%	75%	100%	**Weighted**
Tons/year	**Price/kg**	**Probabilities**			**IRR's**			
2,520	**R 3.33**	0.08	0.67	0.25	2.5%	15.3%	28.5%	**17.6%**
5,040	**R 3.11**	0.18	0.60	0.22	3.9%	17.0%	30.2%	**17.6%**
10,080	**R 2.94**	0.38	0.45	0.17	6.7%	20.5%	33.7%	**17.5%**

Annexure 4: Cost Model : Transportation

DEAT HCRW STUDY 2007

Cost Model: Transportation

1 Vehicle Parameters: (all costs exclude VAT)

			A	B	C	D
Designation			Toyota	Toyota	Toyota	Toyota
Vehicle Make			Dyna 4-093	Dyna 5-104	Dyna 6-105	Hino 10-176
Model			Diesel	Diesel	Diesel	Diesel
Fuel			12	18	18	22
Urban cycle fuel consumption: lit/100 km			Custom	Custom	Custom	Custom
Body			no	no	**yes**	**yes**
Mechanical (lifting) tailgate			3.1/2.0/1.70	4.8/2.1/2.1	5.3/2.3/2.1	7.0/2.4/2.1
Load-space (int.) dimensions (l,w,h) (m)			10.54	21.10	25.60	35.30
Body capacity: Volumetric (cub. m)			1,100	2,400	2,500	5,000
Max. load mass (kgs)						
Max. capacity: Std. 142 lit. waste containers:		number	**48**	**120**	**165**	**225**
Gross mass / container (kg):	8.4	Load mass (kg)	403	1,008	1,386	1,890
		% of permissible load mass	37%	42%	55%	38%
Max. capacity: 100 lit. plastic waste containers:		number	**40**	**96**	**135**	**180**
Gross mass / container (kg):	13.3	Load mass (kg)	532	1,277	1,796	2,394
		% of permissible load mass	48%	53%	72%	48%
Max. capacity: 240 L wheelie bins (per floor/layer) :		number	**12**	**18**	**24**	**36**
Gross mass / container (kg):	40	Load mass (kg)			960	1,440
		% of permissible load mass			38%	29%
Max. capacity: 770 L wheelie bins (per floor/layer) :		number			**8**	**15**
Gross mass / container (kg):	134	Load mass (kg)			1,072	2,010
		% of permissible load mass			43%	40%

2 Vehicle Costs:

Unit cost (incl. purpose-built body)			250,000	300,000	400,000	550,000	2007 figs.
Less: Tyres			5,000	6,000	8,000	12,000	
Salvage value			50,000	60,000	80,000	110,000	
Cost for depreciation purposes			195,000	234,000	312,000	428,000	
Annual fixed costs (excl. depreciation):							
Insurance @	**6.0%**		15,000	18,000	24,000	33,000	
License			1,500	3,000	4,000	6,000	
Total Annual Costs:			**R 17,000**	**R 21,000**	**R 28,000**	**R 39,000**	
Per Kilometer Costs:							
Repairs & Maintenance			0.35	0.45	0.45	0.61	
New tyres every	40,000		0.13	0.15	0.20	0.30	
Fuel: diesel price per litre of	**R 7.50**		0.90	1.35	1.35	1.65	2007 figs.
Total Per-Kilometer Costs:			**R 1.38**	**R 1.95**	**R 2.00**	**R 2.56**	

3 Crew Costs (per shift):

		Per Month	Annual				
Driver:	Salary	5,000	60,000				
	Bonus		3,500				
	Med. Aid	1,000	12,000				
	Pension	375	4,500				
	UIF	50	600				
	Supervision		0				
	Other		0				
	Total	R 6,425	R 80,600				
Helper:	Salary	3,000	36,000				
	Bonus						
	Med. Aid	1,000	12,000				
	Pension	225	2,700				
	UIF	30	360				
	Supervision		0				
	Other		0				
	Total	R 4,255	R 51,060				
Helpers per shift:			**1**	**2**	**2**	**2**	
Helper cost per shift:			R 51,060	R 102,120	R 102,120	R 102,120	
Surcharge to cater for annual leave:			20%	20%	20%	20%	
Adjustment factor for shift longer than 8 hours:			1.00	1.00	1.00	1.00	
Total Crew Cost (per crew per shift):			**R 158,000**	**R 220,000**	**R 220,000**	**R 220,000**	2007 figs.

4 Containers & collections per load

		% of max. capacity					Net HCRW mass/cont.	Fixed allowance (mins.) for each loading cycle:	Fixed allowance (mins.) for each un-loading cycle:	Per-unit allowance (mins.) for loading + unloading:
Containers per average load:	**142 L boxes**	80%	38	96	132	180				
	100 L plastic boxes	80%	32	77	108	144				
	240 L wheelies	80%	10	14	19	29				
	770 L wheelies	75%	0	0	6	11				
	Av. HCRW mass/collection		**100**	**100**	**100**	**100**				
Ave. number of collections per trip:	**142 L boxes**		2.9	7.4	10.2	13.9	7.7			
	100 L plastic boxes		2.2	5.2	7.3	9.8	6.8			
	240 L wheelies		2.5	3.5	4.8	7.3	25.0			
	770 L wheelies				5.4	9.9	90.0			
Load + unload time per trip (hrs):	**142 L boxes**		1.3	2.9	3.9	5.3		10.00	15.00	0.90
	100 L plastic boxes		1.3	2.8	3.8	5.0		10.00	15.00	1.30
	240 L wheelies			1.9	2.4	3.5		20.00	20.00	1.50
	770 L wheelies				2.5	4.3		20.00	20.00	3.60

5 Unit costs for various average round-trip distances and shifts/ day

Shift length: 8 hrs.

Number of shifts/day: 2

Working days / year = 300

Assumed average round trip: 300 km

Assumed average road speed:	**km/hr**		**50**	**48**	**45**	**40**
Trips/day:	**142 L boxes**		**2.0**	**0.0**	**0.0**	**0.0**
	100 L plastic boxes		**2.0**	**0.0**	**0.0**	**0.0**
	240 L wheelies			**0.0**	**0.0**	**0.0**
	770 L wheelies				**0.0**	**0.0**
Total kms travelled/year:	**142 L boxes**		**180,000**	**0**	**0**	**0**
	100 L plastic boxes		**180,000**	**0**	**0**	**0**
	240 L wheelies			**0**	**0**	**0**
	770 L wheelies				**0**	**0**
Total km cost/year:	**142 L boxes**		**R 248,000**	**R 0**	**R 0**	**R 0**
	100 L plastic boxes		**R 248,000**	**R 0**	**R 0**	**R 0**
	240 L wheelies			**R 0**	**R 0**	**R 0**
	770 L wheelies				**R 0**	**R 0**
Estimated no. of containers transported/year:	**142 L boxes**		**22,800**	**0**	**0**	**0**
	100 L plastic boxes		**19,200**	**0**	**0**	**0**
	240 L wheelies		**0**	**0**	**0**	**0**
	770 L wheelies				**0**	**0**

							HCRW mass/cont.
Estimated total HCRW transported / year:	**142 L boxes**	**176,000**	**0**	**0**	**0**	7.7
	100 L plastic boxes	**131,000**	**0**	**0**	**0**	6.8
	240 L wheelies	**0**	**0**	**0**	**0**	25.0
	770 L wheelies			**0**	**0**	90.0

Annexure 5: Cost Model : Containerisation

DEAT HCRW STUDY 2007

Cost Model: Containerisation

Computation for a total HCRW mass of: **1,000** **kg**

HCRW composition:	*Percentage*
Infectious	84%
Pathological	4%
Sharps & chemical	12%

Use spinner buttons to change path. and sharps %-ages

		Sharps	Pathological	General Infectious			
		120 kg	40 kg	840 kg			
	System:	All	All	Liner-based		Re-usable box	Cardboard box
				240 w/b	770 w/b		
Container or liner	**Mass per container or liner (kg)**	***Number of containers or liners required:*** *Note: 'Mass' for items denoted * is a rate determined by relating liner usage to overall HCRW generation, and does not represent the average actual mass of HCRW in a liner of the given size.*					
10 litre sharps (gross mass)	2.2	54.5					
10 litre specican (gross mass)	6.0		6.7				
142 litre cardboard box (gross mass)	8.4						100.0
Small red liner *	7.0			120.0	120.0	120.0	
Medium red liner *	5.0			168.0	168.0	168.0	
Large red liner (thick) *	5.0			168.0	168.0		
Extra large red liner (thin)	6.8					123.5	
Re-usable box 100 lit (net mass)	6.8					123.5	
Wheelie-bin 240 lit (net mass)	25.0			33.6			
Wheelie-bin 770 lit (net mass)	90.0				9.3		
Consumable items:	**Unit costs:**						
10 litre sharps	R 16.50	R 900.00					
10 litre specican	R 20.00		R 133.33				
142 litre cardboard box	R 8.40						R 840.00
Small red liner	R 0.63			R 75.60	R 75.60	R 75.60	
Medium red liner	R 1.12			R 188.16	R 188.16	R 188.16	
Large red liner (thick)	R 2.88			R 483.84	R 483.84		
Extra large red liner (thin)	R 2.40					R 296.47	
Total consumable cost by column:		**R 900.00**	**R 133.33**	**R 747.60**	**R 747.60**	**R 560.23**	**R 840.00**
Add mark-up on cost:	**33%**	R 297.00	R 44.00	R 246.71	R 246.71	R 184.88	R 277.20
Consumable selling price by column:		**R 1,197.00**	**R 177.33**	**R 994.31**	**R 994.31**	**R 745.11**	**R 1,117.20**
Re-usable items: usage costs (see relevant worksheets)		*IRR check:*					
Re-usable box 100 lit	R 6.70	*17.5%*				R 827.49	
Wheelie-bin 240 lit	R 11.50	*17.5%*		R 386.45			
Wheelie-bin 770 lit	R 94.31	*17.5%*			R 880.27		
Re-usable items: cleaning & disinfection costs (see relevant worksheet)							
Re-usable box 100 lit	R 1.70	*17.5%*				R 210.00	
Wheelie-bin 240 lit	R 2.60	*17.5%*		R 87.36			
Wheelie-bin 770 lit	R 7.90	*17.4%*			R 73.73		
Column totals:		**R 1,197.00**	**R 177.33**	**R 1,468.12**	**R 1,948.31**	**R 1,782.60**	**R 1,117.20**

System:	**System totals**						
Cardboard box	**R 2,492**	R 1,197.00	R 177.33				R 1,117.20
Re-usable box	**R 3,157**	R 1,197.00	R 177.33			R 1,782.60	
Liner: 240 lit w-bins	**R 2,842**	R 1,197.00	R 177.33	R 1,468.12			
Liner: 770 lit w-bins	**R 3,323**	R 1,197.00	R 177.33		R 1,948.31		

Summary:

Containerisation system	**Overall rate per kg**
Cardboard box	**R 2.49**
Re-usable box	**R 3.16**
Liner system: 240 lit w-bins	**R 2.84**
Liner system: 770 lit w-bins	**R 3.32**

Annexure 6: Questionnaires

A6.1 Department of Environment

Provincial Department of Environment Interview.

1. Attached please find the questionnaire on Health Care Risk Waste (HCRW) treatment facilities. Please complete one questionnaire per facility in the province, providing as much information as possible.			
2. What tonnage HCRW is <u>generated</u> per month in the province by:			
▪ Public health care facilities?	ton/mth	▪ Private health care facilities?	ton/mth
3. What tonnage HCRW is <u>treated</u> per month in the province by:			
▪ Onsite treatment facilities?	ton/mth	▪ Commercial treatment facilities?	ton/mth
4. How many HCRW treatment facilities are operational in the province? (Please complete the attached questionnaire for each facility)			
▪ Incineration:		▪ Non-burn:	
5. What is the <u>total</u> HCRW treatment capacity in the province per month?			
▪ Incineration:	ton/mth	▪ Non-burn:	ton/mth
6. What is the <u>commercial</u> HCRW treatment capacity in the province per month?			
▪ Incineration:	ton/mth	▪ Non-burn:	ton/mth
7. How much of the <u>commercial</u> HCRW treatment capacity is committed?			
▪ Incineration:	ton/mth	▪ Non-burn:	ton/mth
8. What additional monthly HCRW treatment capacity is planned for the province to be commissioned within the next (i) 1 year, (ii) 3 years, (iii) 5 years?			
▪ Incineration: (i)	(ii)	(iii)	
▪ Non-burn: (i)	(ii)	(iii)	
9. What environmental monitoring programmes are in place and at what frequency is monitoring undertaken?			
▪			
▪			
▪			
10. What percentage of the HCRW generated in the province is currently expected to be:			
▪ Treated by means of compliant HCRW treatment facilities?			
▪ Treated by means of non-compliant HCRW treatment facilities?			
▪ Disposed of illegally?			
11. Comment on the general state of HCRW management in the province, in terms of:			
▪ Generation and management at source.			

▪ Collection and transport.	
▪ Treatment and disposal.	
12. Are there any general comments / important matters to be reported from the side of the Provincial Department Environment?	
Person Interviewed:	Contact Number:
Organisation:	Date:

A6.2 Department of Health and Private Hospital Groups

Provincial Dept. of Health and Private Hospital Group Interview

1. Attached please find the questionnaire on Health Care Risk Waste (HCRW) treatment facilities. Please complete one questionnaire per facility in the province, providing as much information as possible.			
2. How much HCRW is generated per month in the province / hospital group by:			
▪ The public sector?	ton/mth	▪ The private sector?	ton/mth
▪ The particular hospital group?	ton/mth		
3. What is the breakdown between HCRW generation from hospitals / clinics?			
Hospitals:	ton/mth	Clinics:	ton/mth
4. What is the estimated amount of HCRW generated by minor generators (GP's, dentists, etc.)?	ton/mth		
5. What type and sizes of containers are used for the various HCRW categories? (Indicate whether reusable / disposable)			
- General infectious HCRW:	Reuse / Disp.		
- Pathological HCRW:	Reuse / Disp.		
- Sharps:	Reuse / Disp.		
- Pharmaceutical HCRW:	Reuse / Disp.		
- Radioactive HCRW (if handled):	Reuse / Disp.		
- Other special containers (e.g. sputum cups):	Reuse / Disp.		
6. What facilities are predominantly provided inside hospitals / clinics for storage of HCRW?			
7. What internal transport systems are predominantly used?			
8. What facilities are predominantly provided outside hospitals / clinics for storage of HCRW?			
9. What tracking or manifest system is used for HCRW management?			
10. What training and awareness programmes related to HCRW are currently undertaken in the province / hospital group?			
11. Who is responsible for treatment of HCRW generated at provincial clinics?			

12. Who is responsible for treatment of HCRW generated at municipal clinics?

13. Are HCRW management services rendered in-house or is it outsourced?

14. <u>If HCRW is treated in-house:</u>

- What type and number of HCRW treatment facilities is available in the province / hospital group?

▪ Incineration:	▪ Non-burn:

- What is the capacity of the various HCRW treatment facilities and when were the treatment facilities commissioned? (Please complete the attached questionnaire for each facility)

Name	Capacity (kg/hr)	Date Commissioned
Name	Capacity (kg/hr)	Date Commissioned
Name	Capacity (kg/hr)	Date Commissioned

- Were EIA's undertaken for the HCRW treatment facilities?

- Are the HCRW treatment facilities permitted?

- How often are the facilities serviced / maintained?

- Who is responsible for the service / maintenance of the facilities?

- Are there future plans for expansion / upgrade / closure of the existing treatment facilities?

- Where is the treated HCRW from each of the treatment facilities disposed of? Are the disposal facilities used permitted and what is its classification?

Name:	Class:	Permitted?
Name:	Class:	Permitted?
Name:	Class:	Permitted?

- Are the disposal sites used permitted and what is its classification?

- Are there any important matters that need to be reported regarding inhouse HCRW treatment?

15. Where HCRW management services are outsourced:
▪ Was the service provided appointed based on a tender?
▪ What is the term of the contract? ……..…….Start date……..…..……..…End date…….....…
▪ Which service provider was appointed to render the service?
▪ Provide contact details for the appointed service provider:
▪ What is the annual value R…….. and total value R…….…..…….of the service contract?
▪ What does the service entail? (e.g. supply of containers, collection/transport, treatment, disposal, training)?
▪ Are both clinics and hospitals included in the service contracts?
▪ What types and size of HCRW vehicles are used?
▪ Are there any transfer stations in use, and if so, what is the throughput per month for each facility and where is it located?
▪ Were EIA's undertaken for the transfer stations and are the transfer stations permitted?
▪ Is HCRW at any point refrigerated? List areas where this is done as well as the categories of HCRW that is refrigerated.
▪ What treatment processes are used and where are the facilities located?
- General infectious HCRW & sharps: Location:
- Chemical / pharmaceutical HCRW: Location:
- Pathological HCRW: Location:
- Radio-active HCRW: Location:
▪ When were the treatment facilities commissioned?
▪ Were EIA's undertaken for the HCRW treatment facilities?
▪ Are the HCRW treatment facilities permitted?

▪ Are there future plans for expansion / upgrade / closure of existing HCRW treatment facilities?		
▪ Where is the treated HCRW from each of the treatment facilities disposed of? Are the disposal facilities used permitted and what is its classification?		
Name:	Class:	Permitted?
Name:	Class:	Permitted?
Name:	Class:	Permitted?
▪ What training is provided at the health care facilities as part of the service contract?		
▪ Who is responsible to coordinate HCRW management contract in the province / hospital group?		
▪ What other duties are allocated to the HCRW management coordinator?		
▪ Are there any important matters that need to be reported regarding outsourcing of HCRW management services?		
16. What percentage of the HCRW generated in the province is expected to be:		
▪ Treated by means of compliant HCRW treatment facilities?		
▪ Treated by means of non-compliant HCRW treatment facilities?		
▪ Disposed of illegally?		
17. Comment on the general state of HCRW management in the province in terms of:		
▪ Generation and management at source.		
▪ Collection and transport.		
▪ Treatment and disposal.		

18. Are there any general comments / important matters to be reported from the side of the HCRW generators?	
Person Interviewed:	Contact Number:
Organisation:	Date:

A6.3 HCRW Service Providers

HCRW Service Provider Interview.

1. Attached please find the questionnaire on Health Care Risk Waste (HCRW) treatment facilities. Please complete one questionnaire per facility, providing as much information as possible.	
2. What tonnage of HCRW is collected on a monthly basis from:	
▪ Public health care facilities? ton/mth	▪ Private health care facilities?
3. What tonnage of HCRW is treated and disposed of on a monthly basis from:	
▪ Public health care facilities? ton/mth	▪ Private health care facilities?
4. What provincial contracts are currently awarded to the contractor? List province, monthly tonnage and contract period.	
▪ Province: …… ……..ton/mth	Start date: ……End date: ……
▪ Province: …… ……..ton/mth	Start date: ……End date: ……
▪ Province: …… ……..ton/mth	Start date: ……End date: ……
▪ Province: …… ……..ton/mth	Start date: ……End date: ……
▪ Province: …… ……..ton/mth	Start date: ……End date: ……
5. What hospital group contracts are currently awarded to the contractor? List group, monthly tonnage and contract period.	
▪ Group: …… ……..ton/mth	Start date: ……End date: ……
▪ Group: …… ……..ton/mth	Start date: ……End date: ……
▪ Group: …… ……..ton/mth	Start date: ……End date: ……
▪ Group: …… ……..ton/mth	Start date: ……End date: ……
▪ Group: …… ……..ton/mth	Start date: ……End date: ……
6. Where comprehensive HCRW management services are provided to public or private health care facilities:	
▪ What does the service entail? (e.g. supply of containers, collection/transport, treatment, disposal, training)?	
▪ Are both clinics and hospitals included in the service contracts?	
7. What type and sizes of containers are used for the various HCRW categories? (Indicate whether reusable / disposable)	
- General infectious HCRW:	Reuse / Disp.
- Pathological HCRW:	Reuse / Disp.
- Sharps:	Reuse / Disp.
- Pharmaceutical HCRW:	Reuse / Disp.

- Radioactive HCRW (if handled):		Reuse / Disp.
- Other special containers (e.g. sputum cups):		Reuse / Disp.
▪ What tracking or manifest system is used for HCRW management?		
▪ What types and number of each size of HCRW vehicles are currently used?		
▪ Are there any transfer stations in use, and if so, what is the throughput per month for each facility and where is it located?		
▪ If applicable, were EIA's undertaken and are the transfer stations permitted?		
▪ Is HCRW at any point refrigerated? List areas where this is done as well as the categories of waste that is refrigerated.		
▪ Where is the HCRW treated? (Please complete attached form for each of the treatment facilities)		
▪ Where is the treated HCRW from each of the treatment facilities disposed of? Are the disposal facilities used permitted and what is its classification?		
Name:	Class:	Permitted?
Name:	Class:	Permitted?
Name:	Class:	Permitted?
Name:	Class:	Permitted?
▪ What training is provided at the health care facilities?		
▪ Who is responsible for the HCRW contract management?		

▪ What other duties are allocated to the HCRW contract manager?			
8. How many HCRW treatment facilities does the service provider own?			
▪ Incineration:		▪ Non-burn:	
9. What is the service provider's <u>total</u> HCRW treatment capacity available?			
▪ Incineration:	ton/mth	▪ Non-burn:	ton/mth
10. What is the <u>total</u> HCRW treatment capacity currently contracted / allocated?			
▪ Incineration:	ton/mth	▪ Non-burn:	ton/mth
11. Are the incinerators equipped with scrubbers, and if so, what percentage of the overall incineration capacity is equipped?			
12. What additional <u>monthly</u> HCRW treatment capacity is planned for commissioning within the next (i) 1 year, (ii) 3 years, (iii) 5 years, and where is it to be provided?			
▪ Incineration: (i)	ton/mth (ii)	ton/mth (iii)	ton/mth
Location: (i)	(ii)	(iii)	
▪ Non-burn: (i)	ton/mth (ii)	ton/mth (iii)	ton/mth
Location: (i)	(ii)	(iii)	
13. What percentage of the HCRW generated in SA is expected to be:			
▪ Treated by means of compliant HCRW treatment facilities?			
▪ Treated by means of non-compliant HCRW treatment facilities?			
▪ Disposed of illegally?			
14. Comment on the general state of HCRW management in SA, in terms of:			
▪ Generation and management at source.			
▪ Collection and transport.			
▪ Treatment and disposal.			

15. Are there any general comments / important matters to be reported from the side of the service providers?	
Person Interviewed:	Contact Number:
Organisation:	Date:

Health Care Risk Waste (HCRW) Treatment Facilities.

▪ Facility Name:	▪ Facility Name:
▪ Owner:	▪ Owner:
▪ Contact Peron:	▪ Contact Peron:
Name:	Name:
Position:	Position:
Tel:	Tel:
Cell:	Cell:
E-mail:	E-mail:
▪ Physical Address:	▪ Physical Address:
▪ GIS Coordinate: X	▪ GIS Coordinate: X
▪ GIS Coordinate: Y	▪ GIS Coordinate: Y
▪ Treatment Process:	▪ Treatment Process:
▪ Manufacturer:	▪ Manufacturer:
▪ Model Number:	▪ Model Number:
▪ Serial Number:	▪ Serial Number:
▪ Theoretical Capacity:	▪ Theoretical Capacity:
▪ Operational Capacity:	▪ Operational Capacity:
▪ Approx. “book” value of facility:	▪ Approx. “book” value of facility:
▪ Approx. running cost for facility:	▪ Approx. running cost for facility:
▪ Operating Hrs / week:	▪ Operating Hrs / week:
▪ Number of staff at plant::	▪ Number of staff at plant::
▪ EIA Ref:	▪ EIA Ref:
▪ Permit No:	▪ Permit No:
▪ Date Commissioned:	▪ Date Commissioned:
▪ Landfill Used:	▪ Landfill Used:

Annexure 7: International HCRW treatment technologies in use

A7.1 Introduction to HCRW Treatment Technologies

Incineration used to be the method of choice for HCRW treatment and is still widely used. However, recently developed alternative treatment technologies are becoming increasingly popular, not only in first world countries, but also in SA. Aspects to be considered in the selection of the most appropriate HCRW treatment technology inter alia include the following:

- Disinfection efficiency required;
- Air emission standards to be achieved;
- Environmental considerations;
- Occupational health and safety considerations;
- Categories of HCRW to be treated and disposed of;
- Need for volume and mass reduction;
- Mass of HCRW to be treated and disposed of in relation to the capacity of the system;
- Space available;
- Infrastructure required;
- Operation and maintenance considerations;
- Local availability of treatment options and technologies;
- Options available for final disposal;
- Training requirements for operation of the system;
- Location and surrounding of HCRW treatment site and disposal facility;
- Investment in operating costs;
- Public acceptance;
- Regulatory requirements.

HCRW treatment technologies can be grouped into 2 main categories, i.e. Incineration (high temperatures) Technologies and Non-incineration (low temperature) Technologies. Non-incineration technologies are in turn subdivided into 4 sub-categories, i.e.:

- Low-heat thermal processes;
- Chemical processes;
- Irradiative processes;
- Biological processes.

The main HCRW treatment options within each of the main 2 categories include:

- **Incineration (high temperature) Technologies:**

  - Incineration which includes: excess air, controlled air, rotary kiln and fluidised bed, and
  - Pyrolysis and Plasma

- **Non-incineration Technologies:**

  Low-heat thermal processes:

  - Wet heat (Steam sterilisation), e.g. Autoclaving and micro waving;
  - Dry heat (Hot Air), e.g. conduction, natural or forced convection and thermal radiation.

  Chemical processes:

- Chemical sterilisation, e.g. with chlorine dioxide, bleach, (sodium hypochlorite), peracetic acid, or dry inorganic chemicals;
- Encapsulation.

Irradiation processes:

- Electron beams;
- Cobalt-60 gamma rays;
- Ultra violet.

Biological processes:

- Enzymes.

All of the above treatment technologies result in a residue that has to be disposed to landfill, i.e. ash in the case of incineration technologies or a sterilised / disinfected HCRW in case of non-incineration technologies.

In the sections below, incineration technologies and selected non- incineration technologies are discussed in more detail.

There are various fundamental differences between incineration and non-incineration technologies and the most important of these are the HCRW categories that can be treated and the residues resulting from the treatment process, as illustrated in Figure 7.1. In the diagram it is assumed that the incineration treatment technologies can accept three of the major HCRW categories, i.e. infectious HCRW including sharps, chemical HCRW including pharmaceuticals and pathological HCRW, and that a gas cleaning system is used. For the non-incineration treatment technologies, chemical and pathological (anatomical) HCRW, which includes human parts, should be excluded from the allowable HCRW stream.

Radioactive waste is not included in Figure 7.1. Although selected low-level radioactive HCRW generated in HCF's could be treated by means of an appropriate incinerator, medium level or high-level HCRW should not be incinerated. Non-incineration technologies should however not accept any radioactive HCRW for treatment. Radioactive HCRW that exceeds the safety limits must be disposed to specially permitted radioactive waste landfills / depositories or alternatively stored safely for a number of half-lives until sufficiently low levels of radioactivity are reached before further treatment or land filling can take place.

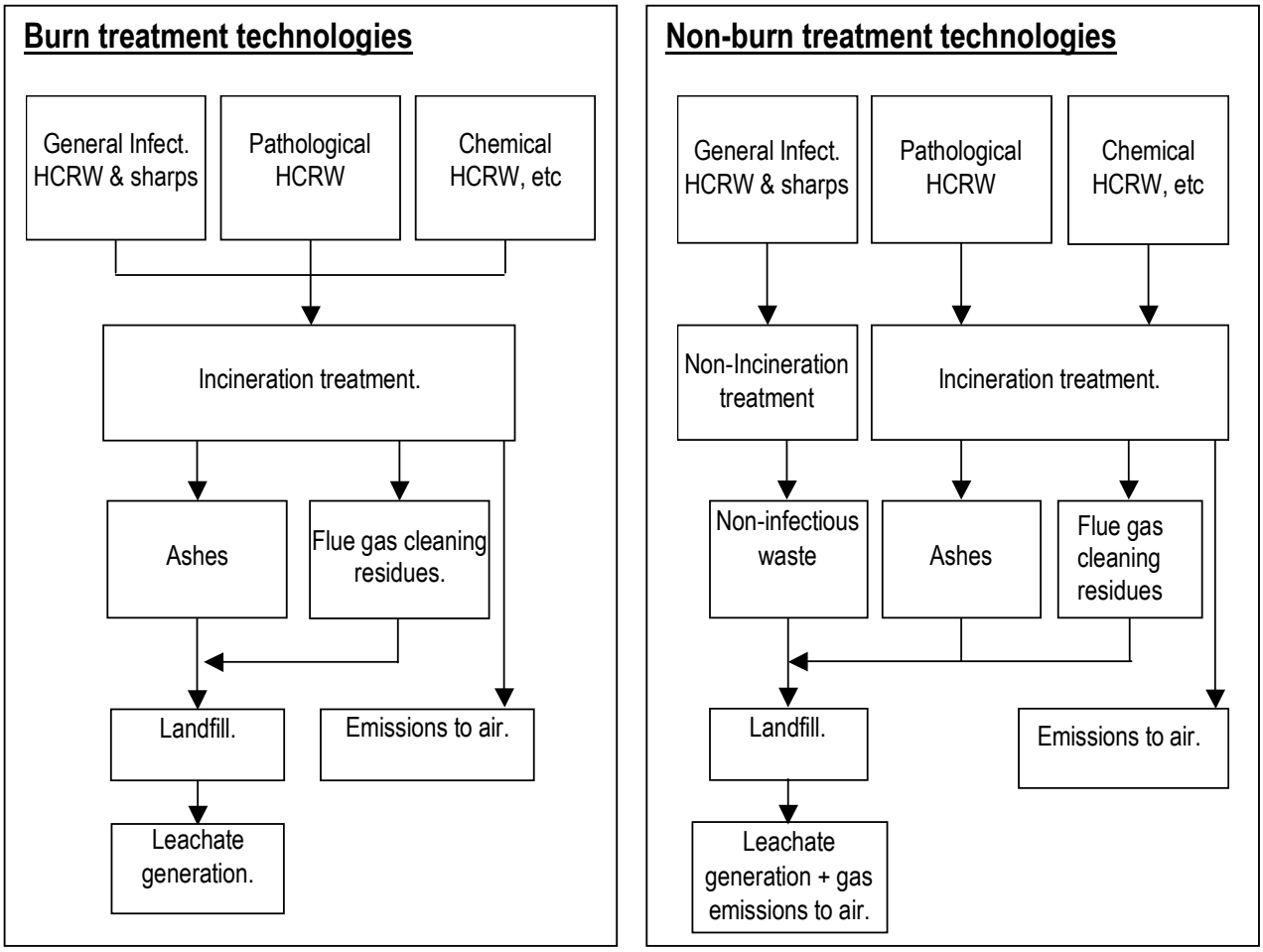


Figure A7.1: *Generic Differences Between Incineration and Non-incineration Technologies for the Treatment of Health Care Risk Waste (Radioactive waste excluded)*

In the Sections 7.2 and 7.3 below, the HCRW treatment technologies listed are briefly described, highlighting their respective advantages and disadvantages.

A7.2 Overview of Incineration (high temperature) Technologies;

Incineration was for many years the only HCRW treatment technology used in South Africa, with most of the incinerators situated on the HCF sites. Similar to many first world countries however, non-incineration technologies are rapidly becoming the dominant treatment technologies primarily due to the increased costs associated with raised air emission control standards required for incineration facilities.

Historically **single chambered incinerators** have been used, with some still in use onsite at HCF's in South Africa. However, the major objective was the achievable level of sterilisation of the HCRW, with the subsequent impact of the incinerator on the environment being a secondary consideration.

Developments in incineration however included the introduction of **multi-chambered incinerators**, both excess air and starved air/controlled air types that were specifically designed for the treatment of the infectious HCRW stream. Such incinerators are however only capable of handling small quantities of chemical hazardous waste, thus including expired pharmaceuticals.

Other common incineration technologies include rotary kilns and fluidised beds.

Rotary kilns are widely used in the lime and cement industries in SA and, internationally, are used for the treatment of chemical hazardous waste. Rotary kiln incinerators are versatile and are capable of handling slurries, bulk solids as well as sludges. The smaller plants are, however, expensive to operate and maintain and are therefore not often used for treatment of HCRW. In some countries rotary kilns are however used to treat some categories of hazardous / chemical waste as well as HCRW. Separation at source of especially chemicals, pharmaceuticals etc. are not all that critical where a rotary kiln is used, as rotary kilns operating at high temperature is capable of causing decomposition of genotoxic substances and heat resistant chemicals. Radioactive HCRW is however still to be separated. High temperature incineration of chemical and pharmaceutical waste in industrial cement and steel kilns is practiced in many countries and is a valuable option; no additional investments are required and industry benefits from a supply of free combustible matter.

Fluidised bed technology is used in South Africa for the treatment of hazardous waste, but mainly for end of pipe applications, i.e. a single waste stream from a chemical plant is destroyed. Passing air through the bed fluidises a bed of sand and the rapid motion allows rapid heat exchange to occur between the hot bed and the waste giving high combustion efficiencies. To date, such technologies have not been used for the treatment of HCRW in South Africa.

Pyrolysis involves the high temperature treatment of waste in the absence of oxygen. Pyrolysing incinerators or retorts operate at temperatures of 545 – 1 000^{o} C in the pyrolyser, where the two products are carbon and volatiles. The volatiles are sent to an afterburner, where it is burnt with an excess of oxygen at temperatures above 1100^{o} C. The carbon may have some commercial value, e.g. as a fuel, although the material would have to be separated from non-combustibles such as metal and its reuse evaluated in terms of the Minimum Requirements and the emission standards. Pyrolysing incinerator facilities do however produce residues with a very high carbon contents.

In a **Plasma** system, an electric current is used to ionise an inert gas (e.g. argon) to cause the formation of an electric arc to create temperatures as high as 6 000^{o} C. HCRW within the system is brought to temperatures between 1 300 to 1 700^{o} C, destroying potentially pathogenic microbes and converting the HCRW into a glassy rock or slag, ferrous metal, and inert gases. All waste streams can clearly be treated except radioactive HCRW. The cost of treatment is however high and the technology is therefore not cost effective for the treatment of HCRW.

A7.2.1 Technical Description of Incineration Technology

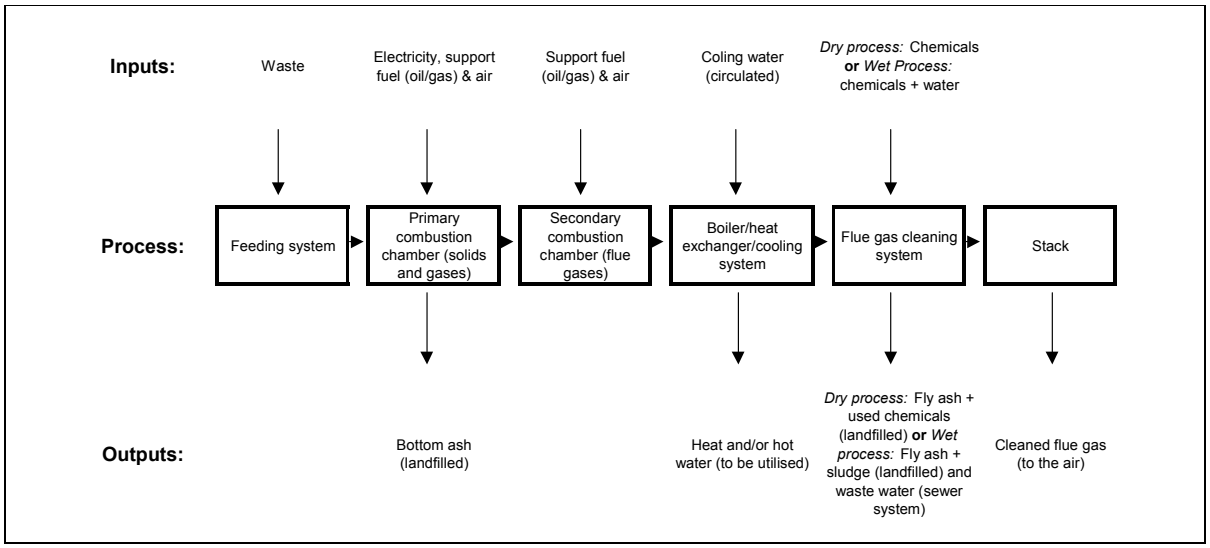
The main elements of modern incineration technology are listed in Table A7.1 and illustrated schematically in Figure A7.2:

Table A7.1: *Elements of a Modern HCRW Incineration Plant*

System	Description/Comment
Feeding System:	An automatic or manual lift and feeding system is used for feeding the HCRW into the incinerator. Automatic doors or similar devices restrict the input of any excess air during insertion of the HCRW into the primary chamber.
Primary chamber:	In the primary combustion chamber, the HCRW is combusted / pyrolysed in a stoichiometric deficit of air at temperatures ranging from 650^{o}C to 1100^{o}C. A support burner, usually fired by fuel oil or gas, is used both during start up and intermittently during operation to achieve and maintain the required temperature. The result is a bottom ash or slag and a gas stream containing combustible volatile organic compounds, particulates and potential pollutants.

System	Description/Comment
Bottom ash collection:	The bottom ash collects in the primary chamber and is manually deashed daily or automatically deashed by conveying it mechanically to a trench or sluice for removal.
Secondary chamber:	In the secondary combustion chamber, an excess of air is added and a secondary support burner fired by fuel oil or gas is used, if required, to maintain the temperature above 1100°C to give complete burning of the combustible gases and solids from the primary chamber. A minimum retention time of 2 seconds is usually required.
Energy recovery:	In principle, energy can be recovered via a water/steam boiler giving steam or hot water for sterilisation, heating, cleaning of waste containers, personal hygiene etc. The financial feasibility of energy recovery depends mainly on the availability/demand situation for energy produced and cost of conventional energy. Due to the limited availability of energy recovered, a full back-up system based on conventional energy sourced would normally be required. Despite the current energy shortage in SA, the relatively low cost of energy in SA is not making energy recovery from relatively small HCRW incinerators financially feasible.
Flue Gas Cleaning:	The flue gas is cleaned using either wet, dry or semi-dry flue gas cleaning including a dust filter. Normally wet flue gas cleaning is not economic for the relatively small size of HCRW incinerators. Hence, most plants make use of semi-dry or dry flue gas cleaning. By using appropriate flue gas cleaning systems, the strict emission limits set by many countries for acid gases, particulates, heavy metals and dioxins/furans can be achieved. Filters mostly used are bag house filters or the more temperature tolerant ceramic filters. Typical neutralising agents for acid gases used are lime or bicarbonate products, possibly with activated carbon added for dioxin or heavy metal removal.

Figure A7.2: *Flow Diagram for a Modern Incineration Plant.*



A7.2.2 Inputs and Outputs from the Incineration Process

The typical inputs and outputs of materials and energy for the modern incineration process are listed in Table A7.2

Table A7.2: *Inputs and Outputs for a Typical Modern Incineration Plant*

Item	Inputs	Outputs
Energy	▪ Fuel (fuel oil or gas) ▪ Electricity for motors, fans etc.	▪ Recovered energy from the combustion of waste and support fuel to produce hot water and/or steam
Solids & Liquids	▪ Waste	▪ Bottom ash to be landfilled

Item	Inputs	Outputs
	▪ Chemicals/water for flue gas treatment	▪ Fly ash/chemicals to be landfilled ▪ If wet scrubber system: Waste water to be lead to the sewer system after cleaning
Gases/air	▪ Air for the combustion process	▪ Cleaned flue gases emitted via the stack
Other	▪ Replacement of air/water filtration materials as required. ▪ Operational and maintenance costs, e.g. PPE and other consumables, spare parts and monitoring/auditing costs.	▪ Used fabric filters to be incinerated or landfilled
Staff	▪ Plant manager, assistants and general workers; numbers depend on the size and type of plant	

Currently, no incinerators used for HCRW in South Africa recover energy in the form of hot water or steam, as this is usually not economic on the relative small incinerators used in SA. However, increasing fuel costs, higher operational standards and competition from non-burn technologies could see the introduction of energy recovery in the future. The ash, other solids and / or liquid wastes, e.g. from gas cleaning, must be classified, as required by the Department of Water Affairs and Forestry's Minimum Requirements for the Handling, Classification and Disposal of Hazardous Waste, and disposed to an appropriate waste disposal site.

A7.2.3 Advantages and Disadvantages of Incineration

The main advantages and disadvantages of incineration as a technology for the treatment of HCRW are listed in Table A7.3

Table A7.3: *Advantages and Disadvantages of Incineration*

Advantages of incineration	Disadvantages of incineration
▪ Safe elimination of all infectious organisms in the HCRW at temperatures above ~700^{o}C ▪ Flexible, as it can accept pathological HCRW and depending on the technology used, also chemical HCRW. ▪ Residues are not recognisable. ▪ Reduction of the HCRW by up to 95% by volume or 85 to 95% by mass. Depending on the type of flue gas cleaning system used, additional residues are generated which is in turn reducing the volume and weight reduction. ▪ Very well proven technology. ▪ No pre-shredding required. ▪ No special requirements for packaging of HCRW. ▪ Full sterilisation is assumed to have occurred, provided the high temperatures are maintained and the ash quantity is adequate. No monitoring of sterilisation efficiency is required.	▪ Normally higher investment costs required for incinerator and flue gas cleaning compared to non-burn technologies. ▪ Point source immediate emissions to the air (as opposed to attenuated emission of CH_4 and CO_2 from landfill body over a period of decades). ▪ Production of the highly hazardous dioxins and furans and heavy metals, which is to be minimised and controlled. ▪ High cost of monitoring gas emissions and demonstrating compliance to emission standards. ▪ Solid and liquid by-products must be handled as potentially hazardous waste. ▪ Incineration is perceived negatively by many sections of the community. ▪ PVC and heavy metals in the HCRW provide a significant pollutant load on the gas cleaning system (and for heavy metals on the quality of bottom ash also).

Separation at source is a key requirement for the correct management of HCRW, but incineration with flue gas cleaning is more forgiving than many other technologies, as it can accept pathological HCRW and, depending on the amount, the type of incinerator and its construction, chemical HCRW.

For many of the pyrolytic dual chamber incinerators currently in use in South Africa, the amounts of chemical, including pharmaceutical HCRW that can be accepted is low. Thus, like normal household waste, which contains small amounts of hazardous chemical waste, the infectious HCRW stream must be expected to include small amounts of pharmaceuticals as well as chemicals used in wards, such as disinfectants, solvents, etc., even when a programme for separation at source has been instituted. An incinerator can readily accept this HCRW stream.

However, most of the incinerators currently still in use in SA should not deliberately accept chemical, including pharmaceutical, HCRW due to damage to the incinerator and significantly increased requirements for gas cleaning. Rotary kilns, fluidised bed incinerators, plasma arc and other facilities specifically designed and permitted for the acceptance of hazardous chemical waste should be used.

A7.3.4 Environmental, Health and Safety Impact of Incineration

Incineration has proven to be a very effective way of sterilising HCRW and no special tests to determine the efficiency of the sterilisation process is normally required. However, in the past, most of the HCRW incinerators in SA have been poorly operated, with most of the incinerators used not fitted with emission control equipment. Incinerators must be registered in terms of Air Pollution Prevention Act (APPA) as a schedule 39 Process and must in Gauteng meet the DEAT emission guidelines that include limits for dioxins and furans plus heavy metals. These standards, except for acid gases and particulates, generally compare well to those in Europe and the USA. Most of the incinerators currently used in SA are incapable of meeting these DEAT emission guidelines.

Gauteng Province requires compliance with the DEAT Emission Guidelines as a provincial minimum requirement, thus making the use of gas-cleaning equipment on incinerators a prerequisite. Although modern wet or dry gas cleaning techniques enabled incinerators to meet the stricter standards imposed in the USA and the European Union, the problems associated with the emissions of dioxins and furans by incinerators and the generally poor management of incinerators in the country, resulted in a significant anti-incineration lobby in SA.

Apart from gas emissions, incinerators produce an ash, which is normally classified as hazardous. It can however be delisted for disposal on general waste sites if it is chemically stabilised with lime or treated by cementation. Gas cleaning can be accomplished by both wet and dry scrubbing. Dry scrubbing is generally preferred, as it is more economic for the typical HCRW incineration plant capacity. The resulting solids which may be classified as hazardous, can be disposed to hazardous waste landfill, whereas the liquid wastes generated by wet scrubbing is charged a higher disposal fee when disposed to landfill.

Incineration is still a very common technology for HCRW treatment internationally, as it can meet the required strict environmental requirements, provided they are well operated and have good emission control equipment. However, in countries with no or limited incineration of domestic or commercial waste, steam sterilisation, microwave treatment and other non-incineration technologies are fast becoming the most cost effective HCRW treatment technology, mainly as a result of increasing costs associated with flue gas cleaning.

A7.3 Non-Incineration Technologies:

Increasing emission requirements resulting in increasing cost of flue gas cleaning for incineration plants, as well as unfavourable perceptions of incineration in many parts of the world, lead to the development of a range of non-incineration technologies for the treatment of HCRW.

Over the last few years a number of HCRW management service-providers in SA prepared Environmental Impact Assessments for non-incineration technologies; specifically Autoclaving, Microwaving, Electro-thermal Deactivation (ETD) and Dry Heat Sterilisation (DHS). Although the aforesaid four non-incineration technologies will be discussed in this section, this does not imply specific endorsement of these technologies, or alternatively incineration compared to any others listed above. For all of the non-incineration technologies listed, HCRW is sterilised by heating the HCRW to moderate temperatures, 90^{o}C to 160^{o} C, leading to sterilisation. It is however important for the HCRW to be subjected to the required temperatures for sufficient time. All of these non-incineration technologies have advantages and disadvantages compared to incineration, which is discussed below.

Gauteng Province has determined that the minimum level of sterilisation that must be demonstrated by HCRW sterilisation technologies, i.e. inactivation is required to be demonstrated for vegetative bacteria, fungi, lipophilic/hydrophilic viruses, parasites and mycobacteria at $\geq$6 Log_{10} reduction (99.9999% or 1 survival probability in a million).

Inactivation of B. sterothermophilus spores or B. subtilis spores at $\geq$ 4 Log_{10} reduction (99.99% or 1 survival in 10000 in a spore population) (ref. 15, 9 and 10).

A7.3.1 Brief Technical Description of Non-Incineration Technologies

Low-heat thermal processes

- Wet Heat (Steam Sterilisation) - Autoclaving

Steam sterilisation of HCRW has been practised worldwide for some decades firstly as a simple sterilisation process and later by inclusion of reduction / shredding prior to the treatment, with compaction subsequent to treatment. In a modern autoclave, the HCRW is shredded and placed inside an autoclave, where, after evacuation of the air, steam is introduced under pressure from a boiler. Figure 7.3 illustrates the essential features of an autoclave plant for the treatment of HCRW. A combination of temperature, of 130^{o}C to 160^{o}C, pressure and time for periods of around 30 minutes ensures that the numbers of pathogens are reduced to below the permitted levels. The technology is however not suitably for the treatment of pathological or chemical HCRW, or radioactive HCRW.

Steam sterilisation gained popularity in some markets, because compared to incineration, the technology results in no or limited emission of gases. It is further increasingly competitive from a financial point of view, especially in countries where advanced flue gas cleaning is required on incinerators.

Shredding and compaction further reduce the volume of the treated HCRW residues, with the mass of the residue being about 80 to 90% of the original mass, as some drying occurs.

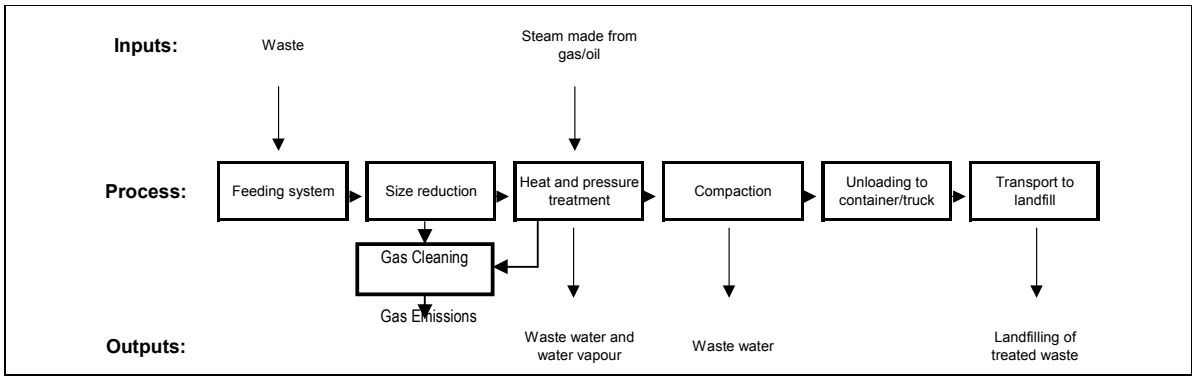


Figure A7.3: *Flow diagram of a Typical Autoclave Steam Sterilisation Plant*

- Wet Heat (Steam Sterilisation) - Microwave

In the microwaving process, infectious HCRW is normally wetted or exposed to steam, shredded and the moisture in the HCRW heated by a series of microwave generators for a specified period. The temperatures reach ~95^{o}C and the microorganisms are killed in the process, resulting in a residue that is confetti-like and slightly moist. Microwaving has been used to treat such items as sharps, microbiological materials, blood, and biological fluids. It is however not suitable for the treatment of pathological or chemical HCRW, or radioactive HCRW. Large quantities of metals can further reduce the effectiveness of the microwaves' penetration of the HCRW.

Air emissions from the shredder and treatment plant are usually treated to remove moisture and volatile organic carbon compounds. The volume of the finally treated residues is reduced significantly by shredding and compaction, but almost no mass reduction occurs.

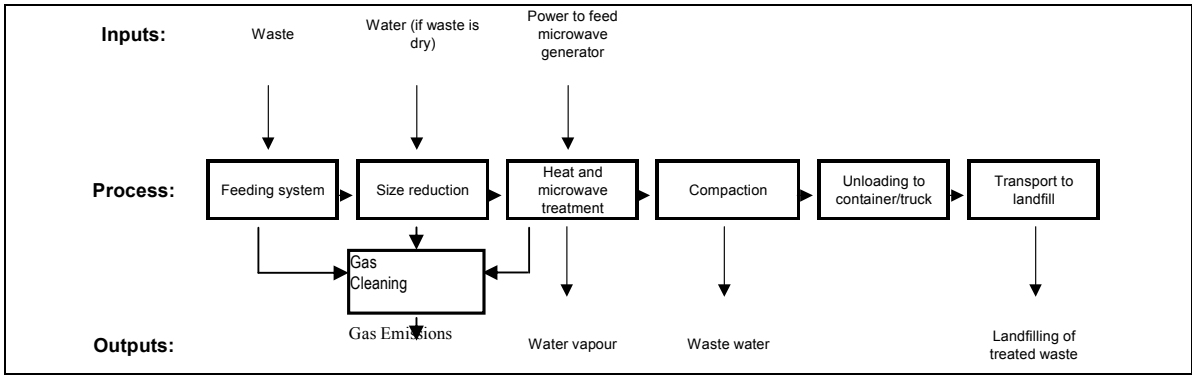


Figure A7:4 *Flow Diagram of a Typical Microwave Plant*

- Wet Heat (Steam Sterilisation) - Electro-thermal Deactivation

The process involves shredding of HCRW, loading it into special containers, and heating with low frequency radio waves for a period that is adequate to destroy microorganisms. The temperature used is similar to that of microwaving, ~95^{o}C. The flow diagram would be similar to that given in Figure 7.4 for a microwaving plant except that the HCRW is exposed to a high-intensity, oscillating electric field generated by low frequency radio waves (14 MHz), rather than microwaves. Heating is caused by absorption of the electrical energy. Air and potential dust and volatile emissions from the reduction plant and treatment unit are passed through cyclones, a dust filter and finally a carbon filter to remove volatile organic compounds. For optimised use of the facility, HCRW is segregated and some items are processed separately.

Composition of the treated HCRW is identical to the original materials, except that it is shredded and disinfected. Shredding and compacting the final product significantly reduce the volume of the final treated HCRW residues, with the mass being about 80 to 90% of the original, as some drying occurs.

- Dry Heat (Hot Air Sterilisation)

With this technology the infectious waste is shredded and then passes into the processor, which consists of an internally heated screw conveyer, where the HCRW is sterilised. The flow diagram is once again similar to that for Microwaving illustrated in Figure 7.4, except for the fact that the HCRW is treated by passing it through a number of screw conveyors where hot oil is passed through the centre of the screw. The HCRW temperature reaches about 105^{o} C, which is maintained for approximately 2 hours; moisture is removed and sterilisation is achieved. The moisture and other volatiles are condensed and the residual gases passed through an air filtration system, which includes passing it through carbon as a final polishing step. The sterilised HCRW residues are then compacted before being transported to landfill for disposal. The volume of the HCRW is significantly reduced from that of the untreated HCRW, but there is not a significant mass reduction.

A7.3.2 Inputs and Outputs for Non-Incineration Processes

The typical inputs and outputs of materials and energy for the non-incineration processes described above are listed in Table A7.4. The table does however not include any resources utilised or produced other than those from the main plant itself, e.g. water utilised for cleaning containers or washing down the premises is excluded.

Table A7.4: *Inputs and Outputs for Non-Incineration Plants described above.*

Item	Inputs	Outputs
Energy	▪ Electricity for motors, pumps, fans etc. ▪ Electricity for shredders ▪ Electricity for generating microwaves or the electric field for ETD ▪ Electricity, gas, coal or oil for generating steam for Autoclaving ▪ Electricity for heating oil for DHS	
Solids & Liquids	▪ HCRW ▪ Carbon or similar filters for polishing of gas emissions ▪ Water for Microwaving	▪ Sterilised HCRW to be landfilled ▪ Water to sewer for autoclaving and DHS ▪ Used filters to be incinerated or landfilled
Gases/air		▪ Fugitive emissions from waste. ▪ Steam and vapour
Other	▪ Operational and maintenance costs, e.g. PPE and other consumables, spare parts and monitoring / auditing costs.	
Staff	▪ Plant manager, assistants and general workers; numbers depend on the size and type of plant	

The HCRW residues generated by the non-incineration technologies are either dry, or in the case of microwaving slightly damp, material that is no longer infectious. However, in line with the Department of Water Affairs and Forestry's Minimum Requirements, the waste must be assumed potentially hazardous until proven otherwise. The USA EPA's Toxicity Characteristic Leaching Procedure must be applied and any leachable inorganic or organic species must be compared to the appropriate standard, i.e. the

acceptable risk limit for the species. Treatment intended to reduce the toxicity may be required, particularly if inadequate separation at source has resulted in hazardous chemical waste being present in the original HCRW stream. However, the overall principle and the plant's financial viability is based on the assumption that there will be suitable separation of chemicals and heavy metals that will lead to the residue being classified as non-hazardous, i.e. similar to domestic waste, thus, allowing disposal in a general waste disposal site.

A7.3.3 Advantages and Disadvantages of Non-Incineration Technologies

The main advantages and disadvantages of autoclaving, microwaving, ETD and DHS are in many ways similar and these are listed in the first row of Table A7.5. There is however some differences as highlighted in rows 2 to 4.

Table A7.5: *Advantages and Disadvantages of Autoclave, Microwave, Electro Thermal Deactivation (ETD) and Dry Heat Sterilisation (DHS) Technologies*

Advantages	Disadvantages
Autoclaving, Microwaving ETD and DHS (Cross cutting) ▪ High sterilisation efficiency under appropriate conditions ▪ Volume reduction depending on type of shredding/compaction equipment installed ▪ Formation of harmful dioxins and furans very low and often below detection limits ▪ Low risk of air pollution ▪ Moderate operating costs ▪ Easier to locate as generally more acceptable to neighbouring communities than incineration ▪ Recovery technologies can be used on sterilised HCRW, e.g. for plastics	▪ Not suitable for pathological HCRW and chemical HCRW, including pharmaceuticals and cytotoxic compounds ▪ Good HCW segregation required ▪ No or limited mass reduction ▪ Shredders are subject to breakdowns and blockages, with repairs difficult when the HCRW is infectious ▪ It is not possible to visually determine that HCRW has been sterilised ▪ HCRW is not rendered unrecognisable or unusable if not shredded either before or after sterilisation ▪ Significant monitoring costs to demonstrate compliance with sterilisation standards ▪ Treated HCRW must be disposed to landfill ▪ Air filtration is needed ▪ Operation requires highly qualified technicians
Autoclaving ▪ Proven technology that is familiar to health-care providers ▪ Relatively High Sterilisation Temperature	▪ Significant amounts of volatile organic carbon compounds produced ▪ Contaminated water must be discharged to sewer ▪ HCRW and containers must have good steam permeability, especially if there is no prior shredding ▪ No waste reduction
Microwaving ▪ Low capacity units are available for small HCRW producers e.g. clinics and GPs ▪ Moderate investment costs ▪ Low Sterilisation Temperature may lower energy costs	▪ Unsuitable for very high quantities of infected metal (e.g. needles from inoculation campaigns) ▪ Low sterilisation temperature increases time required for treatment.
Electro-thermal Deactivation ▪ Low Sterilisation Temperature may lower energy costs	▪ Relatively high investment and operating costs ▪ Low sterilisation temperature increases time required for treatment.
Dry Heat Sterilisation	

▪ Low investment costs ▪ Relatively low maintenance costs for steriliser ▪ Low Sterilisation Temperature may lower energy costs	▪ Low sterilisation temperature increases time required for treatment.

Autoclave, Microwave, ETD and DHS cannot accept all the HCRW streams. Pathological (anatomical) HCRW, chemical HCRW and radioactive HCRW should be separated at source to the best possible degree. However, it is estimated that these components only represent 5% of the total HCRW stream, resulting in non-incineration technologies being able to treat the bulk of the HCRW stream.

It does however happen in practice that some of the relatively small amounts of source separated chemical waste be sent to the few commercially operated hazardous waste landfills. Hence, non-burn technologies may in some instances be disadvantaged compared to incinerators by their inability to treat the full HCRW stream generated at most district and regional hospitals, with chemical HCRW having to be disposed of on hazardous waste disposal sites or incinerated, whilst pathological HCRW is to be incinerated. .

Thus, good separation at source is an essential requirement of non-incineration technologies to be used. Considering the poor status of HCRW management in many health care facilities in SA, it is unlikely that good separation at source will be generally attained in the short to medium term. Provision must therefore be made to handle HCRW received at a sterilisation facility that contains some hazardous chemicals and therefore the facility should include using absorption columns to remove potentially volatile emissions that are obtained during shredding or during the sterilising process.

A7.3.4 Environmental, Health and Safety Impact of Non-Incineration Technologies

The environmental and health impacts of the Autoclaving, Microwaving, ETD and DHS are potentially low compared to incineration, which generates large quantities of gas that is immediately emitted to the air. Clearly, landfilling of sterilised HCRW will result in biodegradation of the residues, which can however result in the generation of methane gas, which is a greenhouse gas with greater impact than carbon dioxide. Table A7.6 gives a general comparison of the relative impacts of the two types of technologies. Note that many of the disadvantages of a particular technology can often be minimised, e.g., application of technology for the cleaning or capture of emissions, utilising the appropriate protective equipment, by training, etc., which is to be included as part of an overall environmental management programme by well operated facilities.

Table A7.6: *Comparison of Principle Environmental Impacts Depending on Choice of Technology*

Step of process	Impact by incineration technology	Impact by non-incineration technologies	Principle Difference in impacts
Separation at Source	▪ Except for radioactive waste separation at source is not that critical provided the facility is designed to accept chemical waste	▪ Radioactive, chemical (incl. pharmaceutical), and pathological HCRW must be separated at source and should not be treated	▪ Chemical HCRW increases the toxicity of sterilised waste
Generation, Sorting and Collection	▪ Impact during production of disposable and reusable receptacles as well impact from distribution and collection of receptacles	▪ Impact during production of disposable and reusable receptacles as well as impact from distribution and collection of receptacles	▪ None, except: Sterilisation technologies may require the use of particular temperature sensitive bags etc.
Storage	▪ Energy consumption for cooling (if required)	▪ Energy consumption for cooling (if required)	▪ None
Transportation for	▪ Emissions from vehicles (fuel consumption)	▪ Emissions from vehicles (fuel consumption)	▪ None

Step of process	Impact by incineration technology	Impact by non-incineration technologies	Principle Difference in impacts
treatment			
Treatment - shredding	▪ Not normally used	▪ Utilises electricity or hydrocarbon fuels (emissions) ▪ Can result in gaseous emissions of VOC's, water vapour, etc ▪ Possible health impact when cleaning or maintaining shredders	▪ Energy used and emissions generated by non-burn technologies ▪ Difference in potential health impact on staff
Treatment	▪ Conversion of organic matter/carbon to CO_2 and other gases immediately ▪ Use of support fuel, if calorific value low ▪ Possibility of energy recovery (waste-to-energy)	▪ Delayed conversion of organic matter/carbon to CO_2, methane and other gases ▪ Considerable use of energy (electricity) ▪ No possibility for energy recovery ▪ Recovery technologies can be used on sterilised waste, e.g. for plastics ▪ Some non-burn technologies use electromagnetic radiation which could have a health impact	▪ Difference in duration of degradation process for organic matter and the products of this process. ▪ Difference in net energy consumption ▪ May be differences in radiation exposure
Transportation of residues to landfill	▪ Mass reduction resulting in reduced need for transportation of residues	▪ Limited mass reduction resulting in higher emissions from vehicles	▪ Larger quantities of emissions caused by transportation of residues from non-burn technologies
Disposal of residues	▪ The volume of residues reduced by 90% and mass reduced by 80% ▪ Residue is inert and does not lead to the formation of landfill gas (CH_4, CO_2 etc.) ▪ Leachate produced at landfill does not contain any nutrients, but only salts/metals	▪ Volume reduction of 15-70% depending on technology used, with no or limited mass reduction ▪ Residue is degradable and leads to formation of methane (CH_4) and/or carbon dioxide depending on quality of landfill operation and use of cover, moisture content, etc. ▪ Leachate produced at landfill contains both nutrients and salts/metals	▪ Difference in volume and mass of residues ▪ Difference in landfilling properties as well as the quality of leachate ▪ Difference in the duration and type of gases emitted due to degradation / combustion of carbon / organic matter ▪ Non-burn technologies lead to higher negative impact on the greenhouse gas emissions
Gas Cleaning	▪ Significant quantities of gas produced ▪ Highly toxic dioxins/furans can be produced under poor operating conditions ▪ Solid and/or liquid gas cleaning residues for disposal	▪ Small amounts of water and VOCs can be produced ▪ Minor amounts of gas cleaning residues disposed	▪ Differences in gas volume and quality ▪ Differences in type and quantities of residues for disposal
Dismantling of installations after end of use and rehabilitation of area	▪ Recycling and disposal of infrastructure ▪ Land rehabilitation	▪ Recycling and disposal of infrastructure ▪ Land rehabilitation	▪ None

As discussed above, small amounts of gaseous emissions could be released during the shredding and sterilisation process, particularly if the HCW was poorly segregated at source. Appropriate precautions must therefore be taken to remove such emissions. In addition to that, most non-incineration technologies require that HCRW to be shredded and, if accomplished before the sterilisation process, there are potentially significant health and safety risks for the staff when a shredder breaks down or becomes blocked, e.g. by a large metal object disposed of in the HCRW stream. The cleaning procedure must be well defined, including the use of appropriate PPE and preferably include disinfection or sterilisation of the HCRW before manual cleaning and repair is undertaken.

For the microwaving and ETD processes, special precautions are taken to protect personnel against the electromagnetic radiation that is used.

For all of these technologies, the main operational requirement is to ensure that all HCRW is treated, e.g. the steam used during autoclaving must be able to penetrate throughout the HCRW batch. Compared to incineration, the temperatures used for sterilisation are relatively low, but are sufficient, provided all HCRW reaches the desired temperature and sufficient time is allowed for the sterilisation process to take place. This is normally achieved by maintaining the required temperature for two to three times the actual time required.

The non-incineration process does not lead to significant amounts of mass reduction compared to incineration. As indicated above, such HCRW residues must be considered to be potentially hazardous waste and then disposed to an appropriate permitted landfill.

Annexure 8: Abbreviations

APPA	Air Pollution Prevention Act
CPD	Continuing Professional Development
DACE	Department of Agriculture Conservation and Environment
DANIDA	Danish International Development Aid.
DEAT	Department of Environmental Affairs and Tourism
DHS	Dry Heat Sterilisation
DoH	Department of Health
DPTR&W	Department of Public Transport, Roads and Works
DTPW	Department of Transport and Public Works
DWAF	Department of Water Affairs and Forestry
EADP	Environment and Development Planning
EC	Eastern Cape
EIA	Environmental Impact Assessment
ETD	Electro-thermal deactivation
EU	European Union
FS	Free State
GDACE	Gauteng Department of Agriculture Conservation and Environment
GDoH	Gauteng Department of Health
HCF	Health care facility
HCF's	Health care facilities
HCGW	Health care general waste
HCRW	Health care risk waste
HCW	Health care waste
HCWIS	Health care waste information system
HCWM	Health Care Waste Management
HIV	Human Immune Deficiency Syndrome
KZN	KwaZulu-Natal
MSW	Municipal solid waste
NC	Northern Cape
NDoH	National Department of Health
NGO	Non-Governmental Organisation
NWMS	National Waste Management Strategy
NWMSI	National Waste Management Strategy Implementation
NWP	North West Province
OHS	Occupational Health and Safety
REL	Rear End Loader
PPE	Personal Protective equipment
PPP	Public Private Partnership
PVC	Polyvinyl chloride
R	South African Rand
RSA	Republic of South Africa
SA	South Africa / South African
TOC	Total Organic Carbon
US	United States
USA	United States of America
WC	Western Cape
WHO	World Health Organisation

Annexure 9: Glossary

The following definitions are related to the HCWM and can as such not without reformulation be applied for other disciplines.

Air Pollution	The presence of a material or substance in air that may be harmful to either the natural or human environment.
Air Quality Standards	The level of pollutants that by law cannot be exceeded during a specified time in a defined area.
Autoclaving	A sterilisation system making use of high-pressure steam for sterilisation of HCRW. The steam is led into the chamber, where the HCRW is heated over a specific period of time to ensure that all infectious micro-organisms present in HCRW are killed.
Awareness	Raising of knowledge of Health Care Waste in specific and defined target groups e.g. communities, pickers and households. Implemented by means of instruments like awareness campaigns, folders, public meetings, television spots, etc. The term is normally not used in relation to formal training programmes.
Biomedical and Healthcare Waste	Solid or liquid waste arising from healthcare (medical) activities such as diagnosis, monitoring, treatment, prevention of disease or alleviation of handicap in humans or animals, including related research, performed under the supervision of a medical practitioner or veterinary surgeon or another person authorised by virtue of their professional qualifications.
Capacity	The Quantity of solid waste that can be processed in a given time under certain specified conditions, usually expressed in terms of mass per 24 hours.
Capacity Building / Capacity Development	The improvement of knowledge on matters related to HCW Management through the dedicated efforts of training and transfer of skills to both individuals and facilities. Capacity Building is normally undertaken as formal training like on-the-job training, courses, study tours, development of systems and tools for facilities.
Chemical Waste	Wastes generated from the use of chemicals in medical, veterinary and laboratory procedures, during sterilisation processes and research.
Collection	The act of removing accumulated containerised solid waste from the generating source. Collection of solid and liquid waste by individuals or companies from residential, commercial, health facility or industrial premises; the arrangements for the service are made directly between the owner or occupier of the premises and the collector.
Community	The people living in the vicinity of a proposed, planned or developed activity.
Container	Reusable or disposable vessel in which HCW is placed at source for further handling, transport, storage, treatment and/or final disposal. The HCW container is an integral part of HCW management equipment.
Containerisation	The packing and storing of HCW in dedicated containers, specially designed and manufactured for the purpose, thereby ensuring the minimum risk of infection or injuries to persons responsible for handling the waste.
Cradle-to-grave	A policy of controlling a HCRW from its inception to its final disposal.

Danger Group	For transport purposes, hazardous substances that are listed in SABS Code 0228 are placed in a Danger Group.
Decontamination	The process of reducing or eliminating the presence of harmful substances, such as infectious agents, so as to reduce the likelihood of disease transmission from those substances.
Destruction	To neutralise or get rid of a waste by incineration or other physical or chemical means.
Discounting (financial)	The process of finding the present value of a series of future cash flows.
Discount rate (financial)	The interest rate used in the discounting process; also called the capitalisation rate.
Disinfection	Treatment aimed at reducing the number of vegetative micro-organisms to safe or relatively safe level. Normally the treatment should result in destruction of pathogenic micro-organism leading to a 10^{-5} reduction in microbial concentration.
Domestic waste	Municipal solid waste generated from households
Duty of Care	This requires that any person who generates, transports, treats or disposes of waste must ensure that there is no unauthorised transfer or escape of waste from her/his control. Such a person must retain documentation describing both the waste and any related transaction. In this way, he retains responsibility for the waste generated or handled.
Electro Thermal Deactivation	Electro thermal deactivation is the selective absorption of energy at differential rates by the cells of the microbe, resulting in the weakening of the cell membrane under the imposed high voltage field, which ruptures the cells and causing it to die.
Emergency	A situation created by an accidental release or spill of hazardous chemicals or infectious materials, which poses a threat to the safety of workers, residents, environment or property.
Emissions	Gases or fumes emitted from a burn or non-burn HCRW treatment technology.
Environment	Environment is defined as i) the natural environment, consisting of air, water, land and all forms of life, ii) the social, political, cultural, economic and working context and other factors that determine people's place in and influence on the environment, and iii) natural and constructed spatial surroundings.
Environmental Impact Assessment (EIA)	An investigation to determine the potential detrimental or beneficial impact on the surrounding communities, fauna, flora, water, soil and air, arising from the development or presence of a facility.
Environmental Impact Control Report (EICR)	A report that details how any detrimental impacts, identified in the Environmental Impact Assessment, can be prevented or ameliorated by means of the design and operation of a facility.
Exposure	The intake of radiation or pollutant by organisms present in a particular environment (i.e. human, natural), which represents a potential health threat to the living organisms in that environment.
Flue gas (or exhaust gas)	Gases and suspended particles emitted from an incinerator or industrial stack or generally through a chimney.

Full capacity (HCRW treatment plant)	Denotes the amount of HCRW (by mass) that can be treated sustainably by a given treatment plant over a long period (generally a month or year).
General Infectious Waste	Infectious waste excluding sharps and pathological waste
General Waste	Waste that does not pose an immediate threat to humans or the environment, i.e. household waste, builders' rubble, garden waste, and certain dry industrial and commercial waste. It may, however, with decomposition, infiltration and percolation, produce leachate with an unacceptable pollution potential (see Waste).
Generator	The Generator is an industry or other party whose activities result in the production of waste. The responsibility for a Hazardous Waste remains from cradle-to-grave with the Generator of that waste and the Generator is held liable for any damage that the waste may cause to humans or to the environment.
Genotoxic	Description of a substance that is capable of interacting directly with genetic material, causing DNA damage that can be assayed. The term may refer to carcinogenic, mutagenic or teratogenic substances.
Groundwater	The water contained in porous underground strata as a result of infiltration from the surface. Water occupying pores in the soil and cavities and spaces in rocks in the saturated zone of the profile. This water may rise from a deep, magmatic source or be due to the infiltration of rainfall (recharge).
Hazardous Waste	Waste that may, by circumstances of use, quantity, concentration or inherent physical, chemical or infectious characteristics, cause ill-health or increase mortality in humans, fauna and flora, or adversely affect the environment when improperly treated, stored, transported or disposed of. (See Waste)
Health Care General Waste (HCGW)	International term for waste generated in the health care system with characteristics similar to general waste, excluding general waste generated in isolation wards and TB wards. The latter will be regarded at HCRW.
Health Care Risk Waste (HCRW)	International term for waste generated in the health care system sector, which requires special management and treatment. HCRW includes infectious waste. General waste generated in isolation wards and TB wards will be included in this.
Health Care Waste (HCW)	International term for all waste generated in the health care system. HCW is the sum of HCGW and HCRW.
Human Tissue	The tissue, organs, limbs, blood, and other body parts that are removed during surgery and autopsy.
IMDG-RSA Code=SABS Code 0228	A code in which over 4 000 hazardous substances are listed and assigned a danger group for transport purposes. The Code forms the basis of the present system for classifying Hazardous Waste and is being upgraded for waste disposal purposes. In future hazardous substances will be assigned a hazard rating for waste disposal in the SABS Code 0228.
Incineration	The controlled burning of solid, liquid or gaseous combustible wastes to produce gases and residues containing little or no combustible material. Incineration is both a form of treatment and a form of disposal. It is simply the controlled combustion of waste materials to a non-combustible residue or ash and exhaust gases, such as carbon dioxide, acidic gases and water

	vapour.
Infectious waste	As defined in the DWAF Minimum Requirements: Any waste which is generated during the diagnosis, treatment or immunisation of humans or animals; in the research pertain to this; in the manufacturing or testing of biological agents – including blood, blood products and contaminated blood products, cultures, pathological wastes, sharps, human and animal anatomical wastes and isolation wastes that contain or may contain infectious substances.
Informal Reclamation	The manual sorting of solid waste at a landfill or at other places where waste is dumped, and recovering the valuable materials.
Integrated Health Care Waste Management	Is a holistic and integrated course of action that specifies the institutional, infra-structural and technological support, as well as human and financial resources required to establish and implement an integrated Health Care Waste Management Strategy.
Internal rate of return (IRR)	The interest rate which equates the present value of future returns to the investment outlay.
Irradiation	Exposure to radiation of wavelengths shorter than those of visible light (gamma, x-ray, or ultraviolet), for medical purposes, the destruction of bacteria in milk or other foodstuffs, or initiation of polymerisation of monomers or vulcanisation of rubber.
Landfill (v)	To dispose of waste on land, whether by use of waste to fill in excavations or by creation of a landform above grade, where the term 'fill' is used in the engineering sense.
Landfill Operation Monitoring	The auditing and assessing of a waste disposal operation to determine whether it conforms to the site design and to the Minimum Requirements.
Leachate	An aqueous solution with a high pollution potential, arising when water is permitted to percolate through decomposing waste. It contains final and intermediate products of decomposition, various solutes and waste residues. It may also contain carcinogens and/or pathogens.
Liquid Wastes	Any waste material that is determined to contain "free liquids" – liquids, which readily separate from the solid portion of waste under ambient temperature and pressure.
Manifest System	A system for documenting and controlling the fate of HCRW from "cradle-to-grave".
Medical Waste	Waste generated from such places as hospitals, clinics, doctors' rooms, laboratories, pharmacies, and research facilities (refer to HCW/HCRW)
Micro-organisms	Any microbiological entity, cellular or non-cellular, capable of replication or of transferring genetic material.
Microwaving	Microwaving of HCRW is the sterilisation process making use of microwaves for heating the water within the HCRW, thereby destroying the pathological micro-organisms.
Minimum Requirement	A standard by means of which environmentally acceptable e.g. waste disposal practices can be distinguished from environmentally unacceptable waste disposal practices.
Monitoring	Continuous or periodic surveillance of the physical implementation of a

	project or activities to ensure that inputs, activities, outputs and external factors are proceeding according to plan.
Municipal solid waste	General waste for collection by municipalities, generated mainly by households, commercial activities and street-sweeping refer to HCGW: Municipal waste generated at health care facilities is characterised as HCGW
Non-incineration HCRW treatment process	Non-incineration HCRW treatment primarily combines moisture, heat, and pressure to inactivate microorganisms, thus making the process suitable for the disinfection of certain HCRW categories.
Off-site Facility	A clinical and related waste treatment, storage or disposal facility that is located away from the generating site.
On-site Facility	A clinical and related waste treatment, storage or disposal facility that is located on the generating site.
Permit	The permit issued by Department of Environmental Affairs and Tourism for the operation or closure of a landfill, in terms of Regulation 1549, promulgated under the Environment Conservation Act (Act 73 of 1989).
Permit Holder	The person who, having obtained a permit to operate a waste disposal site or other facilities that require a permit, in terms of Section 20(1) of the Environmental Conservation Act, is legally responsible for the site, both during operation and after closure.
Permit Procedure	The procedure to be followed and the necessary investigations to provide the Department with the necessary information so that a Permit can be issued.
Pharmaceutical Waste	Wastes from the production, preparation and use of pharmaceutical products.
Precautionary Principle	Where a risk is unknown; the assumption of the worst-case situation and making provision for such a situation.
Present value (PV)	The value today of a future payment or stream of payments. The present value is determined by discounting at an appropriate discount rate.
Pyrolysis	The decomposition of organic material by heat in the absence of, or with limited supply of oxygen
Radioactive substances	Material containing, or contaminated with, radionuclides at concentrations or activities greater than clearance levels and for which no use is foreseen.
Radioactive waste	Material contaminated with a radio-isotope which arises from the medical or research use of radionuclides. It is produced, for example, during nuclear medicine, radio immunoassay and bacteriological procedures, and may be in a solid, liquid or gaseous form. These materials must be disposed of in terms of the Nuclear Energy Act (Act 92 of 1982) and the Hazardous Substances Act (Act 15 of 1973). In particular Section 3A, Hazardous Substances Act (Act 15 of 1973) regulates radioactive substances used for medical, scientific and industrial purposes.
Residual Wastes	Those materials (solid or liquid) which still require disposal after the completion of a treatment or resource recovery activity e.g., slag and liquid effluents following a pyrolysis operation, plus the discards from front-end separation systems.
Residue	A substance that is left over after a waste has been treated or destroyed. For incineration it includes wastes such as ash or slag.

Response Action Plan	A plan intended to counter or minimise the adverse effects of any malfunction of a landfill design element with immediate effect. A Response Action Plan is usually associated with the disposal of Hazardous waste.
Responsible Person	The Permit Holder or her/his legally appointed representative who takes responsibility for ensuring that all or some of the facets of any of the following are properly directed, guided and executed, in a professionally justifiable manner: investigating work, design, preparation, operation, closure and monitoring.
Risk	The probability of dangerous substances contained in the waste, leached there from, or released by emission, entering into the air, the surface environment or the water regime in unacceptable quantities or concentrations. The consequences of such occurrences could be manifested as a threat to public health or as the impairment of an eco-system or resource. Generally, risk is the scientific judgement of probability of harm.
Risk Assessment	The identification of possible impacts of a landfill on the environment, so that they can be addressed in the design phase.
Sanitary landfill	An engineering method of disposing of solid waste on land in a manner that protects the environment, e.g. by spreading the waste in thin layers, compacting it to the smallest practical volume, and covering it with soil by the end of each working day, constructing barriers to infiltration, evacuating the gases produced etc.
Sanitation	The control of all the factors in the physical environment that exercise or can exercise a deleterious effect on human physical development, health and survival.
Scavenging	The manual sorting of solid waste at a landfill or at other places where waste is dumped, and recovering the valuable materials.
Segregation	The systematic separation of solid waste into designated categories
Service-provider or HCRW service-provider	An individual or entity that provides one or more services to a HCRW generator or other HCRW service-provider. Such services include the supply of containers for HCRW, the collection of (full) HCRW containers, the transport of HCRW to a treatment or temporary storage facility, the operation of a temporary storage facility, the treatment / disposal of HCRW and the training of HCF personnel in the segregation, containerisation and handling / internal transport of HCRW.
Sharps	Objects or devices having sharp points or protuberances or cutting edges capable of cutting or piercing the skin.
Sludge	The accumulated solids that separate from liquids such as water or wastewater during processing, or deposits on the bottom of streams or other bodies of water
Stakeholders	Any person, group of persons or organisation that may have a direct or indirect interest or involvement with any aspect related to the “cradle-to-grave” management of HCW. Often termed Interested and Affected Parties (I&AP).
Sterilisation	This is a process that kills virtually all micro-organisms, including bacteria, viruses, spores and fungi, thereby making an object free from micro-organisms.

	In practical terms it is a reduction of the content of micro-organisms of more than 10^6 (more than 99.9999% of the micro-organisms are killed), achieved by physical, chemical or mechanical methods or by irradiation.
Sustainability	A sustainable project should lead to improvements that will persist and spread beyond the project boundaries.
Tail-lift (or mechanical tail-lift)	A platform attached to the rear of a truck which can be mechanically raised / lowered between ground-level (or loading-dock level) and the truck floor level, so obviating the need for manual lifting of items into / out of a truck.
Throughput (HCRW treatment plant)	The actual mass of HCRW treated by an HCRW treatment plant or plants over a given historical period (generally a recent monthly figure that has been annualised).
Transport	Internal transport is the conveyance of the HCRW from the point of generation to the point of treatment (when on the same premises as the generation) or temporary storage, if treated at a site other than the waste generation site. External transport is the conveyance of HCRW from the point of on-site storage, to the point of treatment, when treatment is done on a site other than that of the HCRW generation.
Transporter	A person, organisation, industry or enterprise engaged in or offering to engage in the transportation of waste.
Treatment	Any method, technique or process for altering the biological, chemical or physical characteristics of waste aimed at destroying or at least reducing infectiousness in order to minimise its pollution impact on the environment and its risk to the health of humans and animals. It is further intended to reduce the costs of disposal.
Uplift mass	The mass of HCRW collected by a service-provider from a generator on any single occasion
Waste	An undesirable or superfluous by-product, emission, or residue of any process or activity, which has been discarded, accumulated or stored for the purpose of discarding or processing. It may be gaseous, liquid or solid or any combination thereof and may originate from a residential, commercial or industrial area. This definition excludes industrial wastewater, sewage, radioactive substances, mining, metallurgical and power generation waste. After definition in Government Gazett No. 12703, August 1990. (See General Waste and Hazardous Waste)
Waste Disposal Site	Any place at which more than 100kg of a Hazardous Waste is stored for more than 90 days or a place at which a dedicated incinerator is located is termed a Waste Disposal Site. It must be registered as such in terms of the Environment Conservation Act (Act 73 of 1989).
Waste Disposal Site	In the context of this document, a waste disposal site is referred to as a landfill, because the vast majority of all waste is ultimately disposed of on land, whether it be in trenches or other excavations, or above grade.
Waste management	All activities, administrative and operational, involved in the handling, conditioning, storage and disposal of waste (including transport).
Waste Minimisation	The application of activities such as waste reduction, reuse and recycling to minimise the amount of waste that requires disposal.
Waste Segregation	The process of keeping source separated wastes apart during handling,

	accumulation (interim storage), storage and transport and to assist resource recovery and ensure appropriate designated treatment and/or disposal methods are utilised. Waste segregation should be practised both by generators and waste handling companies at the source for efficient waste management.
Waste Stream	A continuous flow of waste from an industry, activity, process or group.
Working Face	The active part of the landfill; where waste is deposited by incoming vehicles, then spread and compacted on the sloped face of the cell by a compactor. The width of the working face is determined by manoeuvring requirements of the vehicles depositing waste.