ASSESSMENT FOR THE BEST PRACTICABLE ENVIRONMENTAL OPTION FOR MANAGING PRIORITY HAZARDOUS WASTE STREAMS FOR THE WESTERN CAPE

DEPARTMENT OF ENVIRONMENTAL AFFAIRS AND DEVELOPMENT PLANNING

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BACKGROUND AND METHODOLOGY

The Department of Environmental Affairs and Development Planning (DEADP) in the Western Cape has recognised that lack of knowledge with regards to technology and methods applied to the management of hazardous waste is a major constraint in the implementation of a successful Hazardous Waste Management Plan for the Western Cape.

A study to determine the Best Practicable Environmental Option (BPEO) for the management of the following priority hazardous waste streams was undertaken as a starting point for updating hazardous waste management systems and practices for the Province.

- Sewage Sludge
- Agricultural Waste – Pesticide
- Health Care (medical) Waste
- Abattoir Waste – Condemned Food
- Industrial Hazardous Waste
- Special Hazardous Waste
  - Waste Asbestos
  - Waste Fluorescent Lamps
  - Waste Batteries
  - Waste Paints & Solvents
  - Waste Electronic, Electrical Equipment

These waste streams involve various waste generating sectors including those from provincial authorities, municipalities, industrial and commercial sectors and the general public.

The aim of the BPEO assessment process was to identify a number of viable management options for the predetermined priority hazardous waste streams by assessing their performance against a number of decision criteria (such as environmental, social, and economic factors, and practicability), in order to determine which scenario is the BPEO.

The following BPEO assessment methodology was followed:

- A waste management review was undertaken in order to gain an understanding of the current waste management practises for each of the defined waste streams, the capacity and operation of existing waste management infrastructure, as well as the characteristics of each waste stream.
- Identification of options - Waste management options were broadly identified, taking cognisance of provincial and national objectives and targets for waste management, and existing waste management arrangements and associated legislation.
- Assessment of options – Waste management options were broadly assessed in terms of environmental, social, economic and practicability criteria.
- Identification of the BPEO. The current BPEO was presented with the focus on practicable waste management technology currently available in the Western

Cape with the vision of moving toward more advanced, internationally accepted disposal options that could be developed in the future (i.e. current BPEO and future BPEO).

Semi-qualitative scoring was undertaken in support of some BPEO assessments for which a number of potential waste management options were identified. The results of the BPEO assessment for each waste stream are briefly summarised below in descending order of their relative preference.

BPEO ASSESSMENT RESULTS

Sewage Sludge

Current BPEO	Future BPEO
Land application.	Land application / restrictions on disposal of sludge to landfill and a procedure of special motivation.
	Development of new inorganic pollutant limits for sludges in respect of land application of sludges.
	Removal and/or remediation of existing sludge stockpiles and lagoons.

Agricultural Waste – Pesticide

Current BPEO	Future BPEO
Separation and landfilling.	Reduced pesticide dependence.
Low-cost controlled storage facility.	Environmentally sound disposal technologies currently under development.
Modified cement kiln safe incineration.	Shift away from landfilling and cost-effective long-term controlled storage.
Waste avoidance - educational programs.	Regional pesticide collection network system

Health Care Waste

Current BPEO	Future BPEO
Incineration at appropriately licensed medical waste management facilities. Landfill of certain items after sterilisation or disinfection.	More extensive use of non-burn technologies such as autoclaving.

Abattoir Waste – Condemned Food

Current BPEO	Future BPEO
Recovery of Abattoir Meat Products for Human Consumption. Process Abattoir Waste as Animal Feed. Production of Leather from Hides. Landfill with control procedures. Condemned Food - Landfill with control procedures.	Abattoir Waste - Central rendering facility. Condemned Food Waste – Carefully review status of food waste to minimise edible food going to waste and allow for immediate distribution to the disadvantaged.

Industrial Hazardous Waste

The strategy for dealing with non-priority (general industrial) hazardous waste types requires the application of best practice waste management involving the following:

- Waste Characterisation and Risks
  - Waste Survey -Identify potential hazardous waste streams
  - Classification according to SANS Code 0228
- Application of Waste Management Hierarchy - Source Reduction, Reuse, Recycle, Treatment, and Disposal.

Waste Asbestos

Current BPEO	Future BPEO
Landfill with correct treatment and control procedures.	Upgrade legislation and encourage best practice in all aspects of asbestos management. Review the delisting and disposal procedures for small volumes of asbestos waste so that smaller general wastes site may be permitted for asbestos containing materials (ACM) disposal.

Waste Fluorescent Lamps

Current BPEO	Future BPEO
Industry guidelines to reduce the volume of used fluorescent bulb waste. Crushing and hazardous landfill disposal. Landfill with correct treatment and control procedures.	Use of Mercury-free lighting. Mercury lamp recycling programme.

Waste Batteries

Current BPEO	Future BPEO
Use of Rechargeables. Recycling - returning batteries to the supplier. Recovery of metal fractions. Hazardous Landfill site (with treatment).	Increasing recycling and recovery activities.

Waste Paints & Solvents

Current BPEO	Future BPEO
Off-site recovery of solvents. Landfill with correct treatment and control procedures. Waste paint recycling programme to address the issue of hazardous household waste.	Non-hazardous substitution. Promotion of on-site recovery technology. Modified cement kiln safe incineration.

Waste Electronic, Electrical Equipment

Current BPEO	Future BPEO
Refurbish and re-use programme. Hazardous landfill disposal.	Extended producer responsibility and recycling and general landfill disposal.

WAY FORWARD

In order to ensure that the views of potentially affected stakeholders are taken into account in the subsequent planning process, it is recommended that the findings of the report should be workshopped in an appropriate public forum. It is envisaged that this process will add value to the BPEO assessment in terms of the identification of potential additional waste management options and opportunities, and the assessment of options in terms of the provided scoring and ranking guidelines.

Several of the BPEOs, particularly future options, will require detailed feasibility investigations, the results of which could significantly modify the opinions expressed in this report. In addition to the waste management planning recommendations contained in Section 3.5 (Gap Analysis), waste specific recommendations included further investigation of the BPEOs for sewage sludge, pesticide waste, abattoir waste and asbestos waste.

1 Background and Methodology

1.1 Background

The Department of Environmental Affairs and Development Planning (DEADP) in the Western Cape has recognised that lack of knowledge with regards to technology and methods applied to the management of hazardous waste is a major constraint in the implementation of a successful Hazardous Waste Management Plan for the Western Cape.

A study to determine the Best Practicable Environmental Option (BPEO) for the management of the following priority hazardous waste streams is thus a starting point for updating hazardous waste management systems and practices for the province.

- Sewage Sludge
- Agricultural Waste – Pesticide
- Health Care Waste
- Abattoir Waste – Condemned Food
- Industrial Hazardous Waste
- Special Hazardous Waste
    - Waste Asbestos
    - Waste Fluorescent Lamps
    - Waste Batteries
    - Waste Paints & Solvents
    - Waste Electronic, Electrical Equipment

These waste streams include various waste generating sectors including those from provincial authorities, municipalities, industrial and commercial sectors and the general public.

1.2 Aim and Objectives

The aim of the BPEO assessment process is to identify a number of viable options for the aforementioned priority hazardous waste streams by assessing their performance against a number of decision criteria (such as environmental, social, economic, and practicality), in order to determine which scenario is the BPEO.

The objectives of the study were:

- to inform the DEADP on the range of best practicable environmental options for managing the priority waste streams listed above and their associated elements;
- to promote the environmentally sound management of hazardous waste amongst authorities and households, business and industry with emphasis of promoting cleaner production and minimisation of hazardous wastes (i.e. prevention, reduction, reuse, recovery and recycling);
- to compile a comparative analysis of various options for each waste stream that includes costing, environmental impacts, and processing capacity volumes to demonstrate best practicable environmental options; and
- to assist waste managers to achieve set goals with regard to the reduction of hazardous waste and to ensure compliance with respect to safe management, i.e. storage, treatment and final disposal of hazardous waste.

A number of issues were determined to be specifically outside the scope of the BPEO, as follows:

- Capacities and specific locations - Decisions on these require consideration of specific local issues which it is not possible to address at the provincial level.
- Unproven technologies - The BPEO is based on technologies which have been proven for similar wastes at a commercial scale in other developed countries.
- Stakeholder consultation – Whilst key stakeholders were consulted during the waste management options identification stage, the short time constraints for the project did not allow for broad stakeholder consultation. Such consultation is likely to be required subsequent to the BPEO study.
- Detailed Studies (phase 2) - Given the strategic intention of the investigation, it does not include provision for detailed investigations, which could include transportation modelling, detailed costing, risk assessment etc. More detailed studies are likely to be required subsequent to the BPEO study. Such studies may be informed by the work undertaken within the BPEO study. A final decision should not be made until these additional studies have been completed.

1.3 Methodology

The approach for the BPEO study is intended to support strategic decision making at the provincial level. The process will therefore be strategic, geared towards identifying preferred waste stream management options.

The approach involved the appraisal of strategic waste planning options taking into account environmental, social, economic and practicality aspects. The BPEO assessment process is outlined as follows:

- Waste Management Review
- BPEO Identification and Screening
    - Option identification
    - Identification of assessment criteria
    - Option analysis and BPEO Selection

1.3.1 Waste Management Review

In order to gain an understanding of the current waste management practises for each of the defined waste streams, the capacity and operation of existing waste management infrastructure, as well as the characteristics of each waste stream was identified and reviewed. The following data was assembled by means of desktop research, and through consultation with DEADP:

- Regional waste management context:
    - Legislative and policy - Current and pending (e.g. White Paper) local and international requirements pertinent to waste management;
    - Waste infrastructure - The type and general location of existing and proposed waste management facilities, the physical and operational characteristics of the facilities (e.g. current throughput of facilities, maximum capacity, and the projected lifetime), and transport distances involved by different modes (e.g. road and rail);
    - Generation areas – Geographic distribution of major waste generation areas, associated waste types and waste management issues.
- Waste characterization
    - Description of waste type;

- Waste characterisation;
- Characterisation and risks; and
- Current waste management practices.

1.3.2 Identification of Options

Waste management options were broadly identified, taking cognisance of provincial and national objectives and targets for waste management, and existing waste management arrangements and associated legislation. Options were categorised according to the waste management hierarchy, which sets forth several waste management strategies or options according to importance and preference in a descending order (reduce, re-use, recycle, treat and dispose).

1.3.3 Assessment Criteria

Four basic assessment criteria were considered in the assessment of each option, each of which must be adequately addressed if the BPEO solution is to be sustainable. More detailed aspects were identified under each of these criteria (see Appendix A for details), against which to judge the various options:

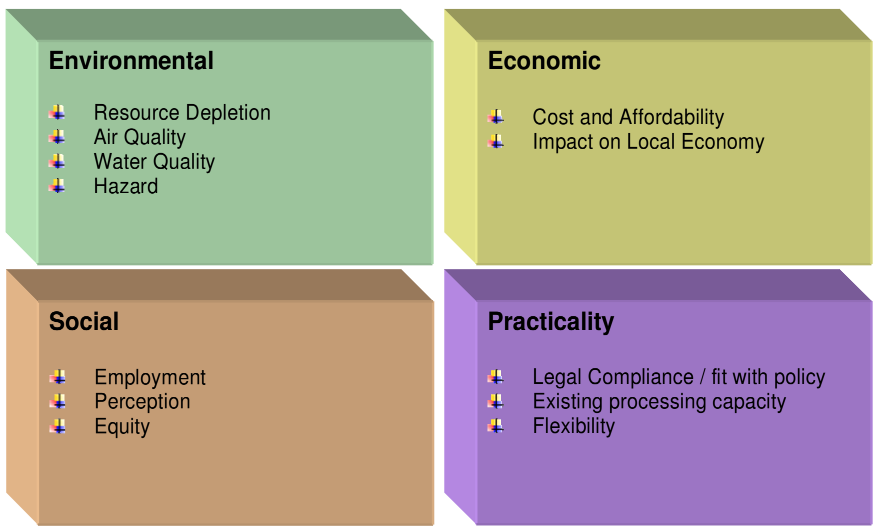


Figure 1. BPEO Assessment Criteria

1.4 Option Analysis and Results

Each of the waste management options was considered with general reference to the assessment criteria. The current BPEO was presented with the focus on "practicable" (economic and efficient) disposal methods in the Western Cape with the vision of moving toward more advanced, internationally accepted disposal options that could be developed in the future (i.e. current BPEO and future BPEO).

1.5 Scoring and Ranking

Scoring and ranking of options is an effective tool that can be used to gain insight into the BPEO. This method requires extensive participation from all sectors of society and could therefore not be used within the constraints of this strategic level BPEO study.

A semi-qualitative scoring system and ranking process based on the assessment criteria has been developed to provide the basis for a qualitative comparison of options. The recommended scoring system is semi-quantitative, with no variable considered to have greater significance than the other; it is envisaged that post-factor weighting could be introduced to the ranking in the consultative stage. The scoring system was applied to the following waste streams for which a number of options were identified:

- Health care waste;
- Pesticide waste; and,
- Paint and solvent waste.

The assessment matrices developed for the above waste streams are included in Appendix D.

2 Regional Waste Management Context

2.1 Provincial Overview

In world terms the Western Cape is a relatively low generator of hazardous waste. However, it does have nodes of heavy and light industrial production, and significant agricultural, forestry and fisheries related waste generation. The total waste generation of the Western Cape Province is estimated to be 8 827 000m^3 per year (excluding mining waste) about 6% of the total waste stream is disposed of as hazardous waste.

The Western Cape contributes approximately 11% to the gross domestic product of South Africa. The City of Cape Town Metropolitan makes up 75% of the provincial economy of which about 26% is contributed by industrial manufacturing in a wide variety of sectors. Outside the City of Cape Town agriculture, forestry and fisheries contribute 6% to the gross geographical product. The generation of hazardous waste in the province is thus strongly influenced by local economic factors. Outside the City of Cape Town logistics are the major problem experienced in the effective management of hazardous waste, which tends to be generated as low volume wastes, geographical dispersed over large areas. There are a few major industrial sites that have well developed waste management programmes that include permitted treatment or disposal facilities (for example PetroSA near Mossel Bay and Saldanha Steel).

The City of Cape Town Metropolitan area is well serviced by two hazardous waste landfills located at Vissershok, namely the Vissershok Waste Management Facility operated by Enviroserv-Wasteman and the City of Cape Town Vissershok Facility. The associated infrastructure for collection, treatment, disposal and management advice is centred around these facilities and their operators. For hazardous waste generators located at distances of greater than 100 km from Vissershok there is a significant financial implication in waste haulage which has resulted in historical problems of waste stockpiling, illicit dumping of hazardous materials, uncontrolled burning of waste and a general reluctance to release information relating to waste volumes being generated.

Within the structures of provincial and local district municipalities in the Western Cape the day to day responsibility for implementation of waste management services devolves down to the lower tier of local government administration. Small municipalities in country districts have a very limited capacity and capability to manage the generally small volumes of hazardous waste associated with local industrial and agricultural waste generators, as well as small quantities of household hazardous waste. There is the obvious risk that the general landfill sites that service these communities have disposed of unknown quantities of unrecorded hazardous wastes in the past and unless control and guidance can be implemented this will be an on-going problem.

2.2 Hazardous Waste Generation

An assessment of hazardous waste generation for the province was published in September 2003 (A Situation Analysis of Hazardous Waste Management in the Western Cape Province, Eichstadt and Naude, 2003), although much effort was made to ensure that the study was comprehensive it was acknowledged that there are significant gaps in our knowledge relating to certain waste streams and particularly in the country districts.

It was estimated that approximately 504 000 tons of hazardous waste per year was generated in the Western Cape. That figure includes 348 000 tonnes of treated sewage sludge and water treatment sludges from municipal treatment works, which represents the largest sectoral source of waste.

Disposal of hazardous waste to the two hazardous disposal facility were recorded as 215 000 m^3 per year for Enviroserv-Wasteman (2002) and 50 000 tonnes per year City of Cape Town (2002). Disposal of sewage sludge to the City of Cape Town facility in

2003 caused the annual hazardous waste to double to over 100 000 tonnes. This was practice was curtailed in 2004. Slight increases in hazardous waste volumes are predicted for future years, although much depends on policy related to sewage sludge disposal.

The PetroSA hazardous waste facility near Mossel Bay disposes of 103 427 tonnes of acidic oil waste, plus 130 tonnes of organo-lead wastes per annum. About 670 tonnes of oils are recycled. In comparison the Caltex operated oil refinery near Milnerton generates 969 tonnes of oil sludge for disposal at Enviroserv-Wasteman at Vissershok, with a combined total of 981 tonnes of amine sludge, caustic waste and spent aluminium and vanadium catalyst.

Koeberg nuclear power plant produces low to medium level radioactive waste which is currently disposed of at Vaalputs in the Northern Cape. In addition it stores high level radioactive waste on site. One 210 l barrel of high level radioactive waste has been produced per annum since 1984.

Institutions generating health care wastes are serviced by three existing private health care waste treatment facilities. The three facilities have adequate capacity to deal with approximate 3500 tonnes of health care waste generated per year.

2.3 Future Trends for Hazardous Waste Disposal

The generally favourable geological conditions, dry climate and low impact on surface water and groundwater resources favours the possible expansion of the Vissershok Waste Management facility and City of Cape Town Vissershok facility over time, although land ownership and social issues may prevent this. At present the City of Cape Town site has approximately 5 to 8 year of landfill airspace. The VWMF has adequate airspace for approximately 10 years of operation.

City of Cape Town has embarked on the identification of candidate sites for future waste disposal facilities and is assessing the feasibility of extending the Vissershok site. The Situation Analysis of Hazardous Waste Management in the Western Cape identifies the need to provide replacement remitted hazardous sites in the medium term as being a significant issue.

Future site selection will depend largely on social and ecological concerns and be influenced by public perceptions concerning the merits of hazardous waste landfilling as a sustainable approach to hazardous waste management. Although there are international trends towards reducing the reliance on hazardous waste disposal to landfill many of the serious constraints that influence this trend, particularly conflicting land demands and cost of land, are not as marked in the Western Cape. The historically low cost of hazardous waste disposal experienced in Cape Town is thus a major short term factor in hazardous waste management and is converse to financial trends observed in many countries where high and rapidly escalating disposal costs have provided an impetus to industry towards waste minimisation and cleaner production. The main cost factors that are presently influencing hazardous waste management in the Western Cape are largely related to transportation costs. Recently costs of infrastructure associated with the construction and operation of landfill sites have been recognised and will be significant in the development of new sites in the medium term. Considering that the process of site selection, permitting and construction of a new hazardous waste facility could take at least 5 years there is obviously a critical need to instigate the process as a matter of urgency.

The majority of waste is transported by road. General waste transportation by rail has been introduced in Cape Town from Athlone Transfer Station to Vissershok and from Knysna to PetroSA. There is no hazardous waste transported by rail at present. As the only permitted hazardous waste disposal sites are both situated adjacent to each other at Vissershok the major cost control on hazardous waste disposal is the cost of haulage from the point of generation. In eastern parts of the province industries generating hazardous waste have transported waste to the Aloes site near Port Elizabeth in the Eastern Cape. The costs associated with haulage of large bulk volumes of low hazard waste have placed severe financial constraints on the safe disposal of certain types of wastes, particularly contaminated soil from polluted sites. This has lead to instances of unlawful disposal to unlicensed dumps, illegal stockpiling and hording of hazardous waste. This is particularly prevalent along the Garden Route, where a number of industrial development nodes exist. The situation is less problematic for the West Coast industrial region where major industries are situated closer to Visserhok and are able to transport at reasonable cost or have obtained approvals and licenses for their own waste disposal facilities (Saldanha Steel) to minimise disposal costs. The PetroSA site at Mossgas is unwilling to accept hazardous waste from outside private sources and therefore there is a need for a new hazardous waste site to be situated in the eastern part of the province. The growth of light industry in George, Mossel Bay and other smaller towns in the area suggests that hazardous waste generation will increase significantly in this part of the Western Cape in the next ten years.

Financial considerations and cooperative agreements between municipalities and Provincial Government are likely to be important aspects of the permitting and operating any new hazardous waste sites in the Western Cape.

2.4 Recycling Initiatives

Waste lubricant oils are recycled as part of a national programme administered and promoted on behalf of the oil industry by the Rose Foundation. Oilkol operate the collection, transportation and storage facilities. FFS Refiners at Visserhok are the reprocessing agents. Approximately 7000 tonnes per year of oil waste is processed, the majority is refined and blended for use as fuels. Solvent recycling is in its infancy with a small plant located at Spin Street, Bellville. High voltage transformer oil is recycled by Castrol. Cape Precious Metals has a silver recycling plant that recovers silver from the photographic sector.

At present waste minimisation, recycling and reuse initiatives play a relatively small role in hazardous waste management in the Province. In order to reduce hazardous waste generation it will be necessary to develop both financial incentives and enforcement measures within an appropriate regulatory and financial policy framework. In order to promote recycling it will be necessary to developing and strengthening markets for recycled goods and materials.

For household and small business hazardous waste it is regarded as important to develop simple and effective waste separation, with special bins or bags together with door to door collection. The investment in infrastructure is considerable and may prove uneconomic in the smaller centres.

The DEA&DP Cleaner Production and Waste Minimisation Programme is an example of a provincial government initiative to prevent pollution through minimisation of waste. The effect of these programmes has not been assessed specifically for hazardous wastes, although the impact of the pilot programmes on total waste generation has been highly successful to date.

In order to further develop waste reduction in the manufacturing sector it will be necessary to apply extended producer responsibility in terms of hazardous waste generation. Although generally this concept has been used to influence the nature of product packaging it could play an important role in controlling certain special waste streams, including electrical and electronic wastes.

2.5 Gap Analysis

The Integrated Waste Management Plan for the City of Cape Town (Jeffares and Green & Ingerop Africa, 2004) listed key findings with respect to hazardous waste management in the City. Most of these issues relate to the province as a whole. There are missing elements related to both policy and management structures that are hindering the application of best practice measures in the City of Cape Town. Other gaps relate to education and awareness of hazardous waste management in general and the need to develop management and control of all parts of the supply chain, and to empower the regulators in an enforcement role done by both legislation of bylaws and skills development. The following points should be considered:

- Lack of integration in hazardous waste management:
    - A key link to a waste minimisation strategy needs to be developed. There is a need for co-ordinated management in terms of education and awareness, and a need for co-ordinated monitoring, control, reporting and legal inspectorate.
- Develop Waste Information System:
    - Need centralised database of all current information.
- Enforcement:
    - Train regulatory agents to monitoring, control and enforced hazardous waste legislation at all levels.
    - Update legislation pertaining to hazardous waste. A national initiative is required to update and integrate all guidance documents related to hazardous waste activities.
    - Update bylaws to deal with specific waste generating activities (i.e. control of spillages and waste handling associated with ships and boats in harbours and ports).
    - Introduce bylaws to govern drop-off centres for temporary storage of household and industrial hazardous wastes (typically category 3 and 4 wastes), including batteries, fluoresecent tubes and old tyres.
- Capacity Building:
    - Need to improve the capacity and skills of regulatory authorities dealing with hazardous wastes.
- Infrastructure:
    - Infrastructure is required for management of household and industrial hazardous waste and need to review and assess the future implementation of alternatives technologies.
- Communication strategy:
    - There is no formal complaints system for dealing hazardous waste mismanagement.
- Education and awareness:
    - Need to educate hazardous waste generators on their responsibilities and liabilities.
    - Need to educate and empower hazardous waste generators on international best practice.
    - Need to educate on waste minimisation by product redesign options to phase out hazardous constituents.
    - Need to educate retailers and consumers about their roles in reducing hazardous wastes.
    - Need to develop clear labelling of all hazardous ingredients in household products.

3 Sewage Sludge BPEO

3.1 Waste Review

3.1.1 Description of Waste Type

The treatment of domestic wastewater involves the aerobic and/or anaerobic digestion of organic matter by microbiological organisms. The digestion process results in the accumulation of a residue or sludge of dead cells mass with varying degrees of partially digested or wholly undigested organic matter depending on the type and efficacy of the process.

Where raw or partially digested organic matter is present, the sludge is regarded as unstable and is likely to have a high potential to cause odour nuisance and fly-breeding as well as to transmit pathogenic organisms. Where complete digestion is achieved, the resulting sludge is described as stabilised and should not cause significant odour nuisance or fly-breeding. Pathogenic organisms would, however, still be expected to be present in such sludge and would be of concern with respect to handling and disposal or recycling. Further treatment, such as pasteurisation, heat treatment, irradiation, composting or lime-stabilisation, may be undertaken to eliminate the pathogenic risks associated with these sludges.

In addition to consideration of the hygienic quality of sludges, levels of metals and other chemical contaminants may be of concern if the wastewater treatment works (WWTW) receives industrial wastewaters or effluents. The quantities and quality of industrial effluents received by different WWTWs varies significantly and depends on the specific types of industrial activity located within the area serviced by the WWTW. Some WWTWs may receive significant quantities of industrial effluent whilst others may receive no industrial effluent.

In terms of effluent treatment any metals or organic compounds present in industrial effluents will be heavily concentrated within the sludge through a range of physico-chemical processes including adsorption onto cell membranes, absorption into the cell body and formation of complexes with organic matter present in the sludge. WWTWs receiving large quantities of industrial effluents would in general be expected to contain elevated levels of various heavy metals, and would not be considered suitable for recycling unless subjected to further treatment and/or proven to meet various prescribed limits and criteria.

3.1.2 Waste Generation

There are approximately 130 WWTW in the Western Cape Province that treat an estimated 2000 Ml of domestic and industrial wastewater per day. The production of sludge is estimated at 900 tonnes per day.

3.1.3 Waste Characterisation and risks

Sewage sludges are classified as either Type A, B, C or D based on guidelines issued by the Department of Health and Population Development in 1991. These guidelines were updated and re-issued in 1997 under the title Permissible Utilisation and Disposal of Sewage Sludge. An addendum to the 1997 document was published in 2002. A summary of the classification scheme for sludges is provided below.

Table 3.1.3.1: Classification of Sewage Sludge

TYPE	ORIGIN (TREATMENT PROCESS)	CHARACTERISTICS/QUALITY
TYPE A SLUDGE	■ RAW SLUDGE ■ COLD DIGESTED SLUDGE ■ SEPTIC TANK SLUDGE ■ OXIDATION POND SLUDGE	■ USUALLY UNSTABLE AND CAN CAUSE ODOUR NUISANCES AND FLY-BREEDING. ■ CONTAINS PATHOGENIC ORGANISMS. ■ VARIABLE METAL AND INORGANIC CONTENT.
TYPE B SLUDGE	■ ANAEROBIC DIGESTED SLUDGE ■ SURPLUS ACTIVATED SLUDGE ■ HUMUS TANK SLUDGE	■ FULLY OR PARTIALLY STABILISED AND SHOULD NOT CAUSE SIGNIFICANT ODOUR. ■ CONTAINS PATHOGENIC ORGANISMS. ■ VARIABLE METAL AND INORGANIC CONTENT.
TYPE C SLUDGE	■ PASTEURISED SLUDGE ■ HEAT-TREATED SLUDGE ■ LIME-STABILISED SLUDGE ■ COMPOSTED SLUDGE ■ IRRADIATED SLUDGE	■ STABILISED AND SHOULD NOT CAUSE ODOUR NUISANCES OR FLY-BREEDING. ■ CONTAINS NO VIABLE ASCARIS OVA PER 10G DRY SLUDGE. ■ ZERO SALMONELLA ORGANISMS PER 10G DRY SLUDGE. ■ MAX 1000 FAECAL COLIFORM PER 10G DRY SLUDGE. ■ VARIABLE METAL AND INORGANIC CONTENT.
TYPE D SLUDGE	■ PASTEURISED SLUDGE ■ HEAT-TREATED SLUDGE ■ LIME-STABILISED SLUDGE ■ COMPOSTED SLUDGE ■ IRRADIATED SLUDGE	■ COMPLIES WITH THE ODOUR AND MICROBIOLOGICAL CRITERIA AS FOR TYPE C, AND ■ METAL AND INORGANIC LEVELS ARE BELOW SPECIFIED MAXIMUM LIMITS FOR THE FOLLOWING: CD, CO, CR(III), CU, HG, MO, NI, PB, ZN, AS, SE, B AND F.

Source: WRC, 1997

In terms of the classification scheme only a Class D sludge can be disposed of at a general landfill site and only at a rate of 8 tonnes/ha/year unless it is formally delisted in accordance with DWAF Minimum Requirements for Handling and Disposal of Hazardous Waste. All other types of sludge are considered hazardous waste requiring disposal to hazardous waste landfill.

Type C and D sludges are essentially the same in respect of the absence of any odour nuisance and or pathogenic organisms of concern i.e. hygienic quality. However, levels of metals in Type D sludges meet prescribed limits and are considered acceptable for unrestricted land application. Only Class D sludge may be sold and/or used for growing household vegetables that may be consumed raw.

For Type D sludges to be used freely in agriculture it is required to register the sludge derived product as a fertilizer in terms of the Fertiliser, Farm Feeds, Agricultural Remedies and Stock Remedies Ac.t (36 of 1947). A maximum limit of 8 tons dry sludge/ha/year is set for land application purposes.

The use of Class A,B and C sludges for land application or other forms of beneficial use is strictly controlled and subject to a full Environmental Impact Assessment (EIA). Mitigatory chemical treatment (pre-liming of the soil) or mitigatory engineering (use of cut-off trenches to control leachate) are typically required.

3.1.4 Current Waste Management Practices

Because sewage sludges contain a very high water content, removal of as much excess water as practically possible is always a key aspect of sludge management. Traditionally sludges have been dried in drying beds or sludge lagoons. However, because of the detrimental environmental impacts of sludge lagoons there have been efforts, particularly with the larger WWTWs, to employ mechanical dewatering.

Once dried a large proportion of sludges have been composted and then stockpiled or buried on the site of the treatment works or to a lesser extent actively land farmed or sent for formal disposal to landfill.

With the phasing out of sludge lagoons, the City of Cape Town made a concerted effort to remove all lagooned and stockpiled sludge and during the period March 2001 to August 2002, 77 000m^3 of sludge was taken to landfill. However, it was not possible to maintain an appropriate co-disposal ratio at the City of Cape Town Vissershok site and eventually the leachate build-up resulted in an unstable waste pile developing in the landfill cell being used for disposal. Further disposal was discontinued.

Land application of sludge has been practiced for over 20 years in the Melkbosstrand and Atlantis areas in the roll-on lawn industry. All types of sludge are excellent soil conditioners that improve the structure and water retaining ability of soils. It also contains major nutrients such as nitrogen, phosphates and potassium.

Although guidance documentation has been available for a number of years sludges are still regarded as a problem waste stream due to the large volumes generated and the level of management control required to inform the correct selection of disposal or recycling in land application. It appears that most of the sludge generated by smaller municipalities is taken to land application by local farmers with very little control or chemical testing to monitor conformance with the Sludge Guidelines. The extent of heavy metal contamination associated with uncontrolled sludge use on farmland in the Western Cape is unknown, although there have been no substantiated reports of significant environmental impacts to date.

3.2 Waste Management Options

3.2.1 Reduce

There is limited opportunity for reduction of sewage sludge volumes from the perspective of wastewater treatment processes modification.

Hazardous waste minimization can be achieved by strict control of industrial discharges to sewer allowing a larger volume of sludge to conform with Type D metal concentration criteria and therefore become available for land application.

3.2.2 Re-use

The concept of re-use is not applicable to sewage sludge.

3.2.3 Recycle

The recycling of sewage sludge for agricultural uses has been well studied and is recognised as one of the most beneficial uses for sludge. Appropriate selection of suitable land and choice of crops are the most significant factors in management of environmental risk associated with land application.

Current guidance provides a set of limits for metals levels along with a maximum dry sludge disposal rate per hectare that are sufficiently conservative to be applicable as generic criteria that are protective of the environment and human health in even the most sensitive of land-use settings. There is sufficient field research to demonstrate that significantly higher metal levels and/or application rates can, however, be acceptable in specific circumstances without resulting in unacceptable risk. There is considered to be significant opportunity for use of Type C sludges in land application provided that a holistic assessment process is followed and that all local factors that influence the safe and sustainable use of the sludge are assessed and suitably motivated on a site specific basis.

Other recycling options for management of sewage sludge waste include:

- Brick making – the use of sewage sludge in the manufacturing of bricks is a well-proven process and has been successfully implemented for many years in Port Elizabeth. This is an industrial use that can be considered. The quantities of sewage sludge that could be utilised for this purpose are, however, expected to be very small and would not provide any significant reduction in total waste volume generated. There is also no economic incentive for brick manufacturers to make use of the waste material as there are many local sources of high quality clay available.
- Cement manufacture as fuel stock and ash – use of sludges as a source of heat in cement kilns, with the resultant ash being incorporated into the cement matrix is technically feasible. However, there are limited opportunities for such usage in the Province and costs associated with transport distances would render any opportunities economically unfeasible.
- Gasification and energy generation – gasification is a process in which high pressure and heat is utilised to transform the sludge into a gas that can be utilised as a source of fuel. Gasification is being considered for large-scale disposal of sewage sludges in Europe, Australia and elsewhere. The process only becomes economically viable within densely populated areas where large quantities of sludge are generated and where a market demand for the resultant gas supply exists. The relative scale of sludge generation in the province along with transport distances and absence of significant demand for gas as an energy source are considered to render this option inappropriate.

- Land rehabilitation particularly of mine dumps – given the large number of mine dumps requiring remediation and rehabilitation in South Africa, use of sludge on remediated mine dumps as a nutrient rich growing medium for rehabilitation purposes may prove to be a highly beneficial use for this waste. Sludges with elevated metals could in principle be safely utilised for this purpose given the absence of risk of uptake by edible crops. Opportunities for such recycling are, however, limited in the province.

3.2.4 Treat

Treatment processes include pasteurisation, heat treatment, irradiation, lime-stabilisation and composting and are utilised to improve the hygienic quality of the sludge such that it does not cause any odour nuisance or fly-breeding and has no significant pathogenic risk. Effective treatment reduces the risk associated with pathogens and allows for the sludges to be classified as Type C or Type D depending on metal content.

3.2.5 Dispose

In terms of disposal, Class A, B and C sludges are regarded as hazardous waste requiring disposal to hazardous waste landfill unless delisted in terms of DWAF Minimum Requirements. Class D sludges can be disposed of to general landfill. However, the disposal rate of 8 tonnes/ha-year applies unless it is delisted.

Even after mechanical dewatering sludges have a very high moisture content and co-disposal ratios with general solid waste are at around 10:1. Where less effective means of dewatering have been utilised, much higher co-disposal ratios are necessary to main landfill stability. This represents a significant practical limitation to disposal of large quantities of sludge to landfill.

From a waste management perspective, it is regarded as highly undesirable to dispose of waste materials that may be beneficially recycled for agricultural or other land applications. Special motivation should be required from the waste generator to substantiate instances where disposal to landfill has been determined to be the only safe and acceptable option.

The release of sludge to sea via sea outfalls is not regarded as acceptable waste management.

3.3 BPEO

3.3.1 Current Options

Land application is considered to represent the best environmental option for management of sewage sludges. Improved control on sludge characterisation and site selection is required to ensure safe application in accordance with the current sludge guidelines.

Recycling of sewage sludge through land application was selected as the BPEO based on exclusion of other recycling options which were considered to be economically unfeasible. Disposal is regarded as a less favourable option in terms of the waste management hierarchy and hence should only be applied to sludges that have been proven through detailed assessment to be unfit for recycling by land application.

3.3.2 Future Options

In terms of future land application of sludges, the current guidelines are necessarily precautionary and conservative in the setting of metal limits and sludge application rates so as to be protective of environment and human health in even the most sensitive of land-use settings. However, there is considered to be significant opportunity for safe land application of sludges that do not conform to the current Type D classification, provided that a holistic assessment process is followed and that all local factors that influence the safe and sustainable use of the sludge are suitably assessed and motivated on a site specific basis.

Restrictions should be placed on disposal of sludge to landfill and a procedure of special motivation should be implemented by which the waste generator is required to demonstrate that all recycling options have been assessed and substantiate why disposal is necessary for the safe management of a specific sludge.

Further research is on-going in developing new inorganic pollutant limits for sludges in South Africa and will need to be considered in respect of land application of sludges.

Existing sludge stockpiles and lagoons still require sludge removal and remediation. A process of in-situ rehabilitation may have to be developed. Some of the sludges are unsuitable for off-site land application because they are too wet or too sandy and cannot easily be dried, handled and transported.

3.4 Bibliography

- DNH&PD (1991). Guide: Permissible Utilisation and Disposal of Sewage Sludge. Department of National Health and Population Development, Pretoria. Ref A11/2/5/4.
- WRC (1997). Permissible Utilisation and Disposal of Sewage Sludge. Joint Publication with the Departments of Agriculture, Health, Water Affairs and Forestry, and Water Institute for Southern Africa. WRC Report No TT85/97.
- WRC (2002). Addendum No 1 to Edition 1 (1997) of Permissible Utilisation and Disposal of Sewage Sludge. Joint DWAF and WRC Report No TT154/01.
- King, P.B. and Kloppers, W. (2003). Wastewater Sludge: What do we do with it? Landfill Interest Group Seminar, Institute of Waste Management, Western Cape.

4 Agricultural Waste / Pesticide BPEO

4.1 Waste Type

Pesticide is a term used for a broad range of agrichemicals including insecticides, herbicides fungicides, rodenticides and avicides. A pesticide is any substance or mixture of substances used to control or kill a biological pest.

Various terminologies, which include, obsolete pesticides, pesticide waste, unwanted pesticides and pesticide as hazardous waste are used in the literature that may cause a certain amount of confusion for the general public and are therefore briefly defined and discussed here.

Chemical toxicity is highly variable and a wide variety of organic, inorganic and organo-metallic compounds have been in common agricultural, commercial and household use for many years.

Nine of the 12 persistent organic pollutants (POPs) listed in the Basel Convention are pesticides.

4.1.1 Waste Generation Processes

Obsolete pesticides - According to the United Nations Food and Agriculture Organisation (FAO), obsolete pesticides are stockpiled pesticides that can no longer be used for their intended purpose or any other purpose and therefore such pesticides would require disposal. Common causes leading to the accumulation of obsolete pesticides include:

- Pesticide products that have been banned or its use has been severely restricted for human health and environmental reasons.
- The product has deteriorated as a result of prolonged storage or due to poor storage conditions and can no longer be used nor can it be made usable again.

Pesticide wastes - In some articles and publications, obsolete pesticides are also referred to as *pesticide waste*. Pesticide wastes, however, is a much broader definition than just obsolete pesticides since it also includes waste generated during production of pesticides. By definition pesticide waste is any substance or material containing pesticide that cannot or will not be used and will be discarded and disposed of. Pesticide wastes may include, but are not restricted to:

- Surplus spray solution, pesticide dusts, granules or baits remaining in the application equipment after use.
- Pesticide-contaminated water produced by cleaning pesticide application equipment or from rinsing empty pesticide containers.
- Pesticide-contaminated absorbent, water, or other materials generated from cleaning up spilled solutions.
- Empty contaminated (unrinsed) pesticide containers.
- Wastes generated during manufacture of the pesticide

4.1.2 Waste Characterisation and risks

If an obsolete pesticide or a pesticide waste exhibits at least one hazardous waste characteristic it should be regarded as a hazardous waste. Generally, most commercial pesticide concentrates intended for disposal will be classified as hazardous waste if the criteria of the SANS Code 0228 Classes described in the South African minimum requirements for handling, classification and disposal of hazardous waste are used. Pesticide wastes fall into three of the 9 hazard classes as many are flammable with low flash points (Class 3), are highly poisonous and/or toxic (Class 6) are carcinogenic or have other dangerous character (Class 9).

Most obsolete pesticides (particularly POPs) and pesticide wastes would have a Hazard Rating of 1 (Extreme Hazard) using the South African Hazard Rating System as most are extremely toxic, contain certain carcinogens and are very persistent in the natural environment. However, some biodegradable and slightly lower toxic pesticides may have a Hazard Rating of 2 (High Hazard). The exact determination of the Hazard Rating of a pesticide may not be possible as LD_{50} and LC_{50} values are not available for many pesticides.

In Europe and the USA, pesticide wastes are generally considered to be hazardous wastes. The World Health Organization (WHO) has a pesticide hazard classification system that appears to be mostly qualitative in nature and does not involve calculation of a Hazard Rating. The WHO hazard classes are indicated in words (e.g. level of toxicity), symbols and an appropriately coloured band (Table 2). A broad indication of the quantities that may be regarded as small or large/bulk are also provided in the WHO hazard classification system for pesticides.

Table 4.1.2.1. The WHO hazard classification and product label system for pesticides

WHO hazard class	Info to appear on label	Hazard statement	Band colour	Symbols/ words	Small quantity	Large Quantity
1a	Extremely Hazardous	Very toxic	Red	Very toxic	<2.5kg/L	>2.5kg/L
1b	Highly hazardous	Toxic	Red	Toxic	<10kg/L	>10kg/L
II	Moderately Hazardous	Harmful	Yellow	Harmful	<25kg/L	>25kg/L
III	Slightly hazardous	Caution	Blue	Caution		
Less hazardous than Class III	Less hazardous than Class III		Green			

Old and obsolete pesticides that have not been properly labelled should always be assumed to be extremely hazardous (Class 1a) according to the system. Similar unidentified products, including unlabelled containers, materials that have been contaminated by unidentified products, or products that have been transferred into other containers should also be regarded as Class 1a in the WHO hazard system. If the mass of such materials exceeds 2.5 kg they are treated as bulk quantity and not small quantity. Bulk quantities of obsolete or unwanted pesticides should be dealt with in accordance with the FAO guidelines on the disposal of bulk quantities of pesticides in developing countries.

4.1.3 Waste Characterisation and Risks

Control on the potentially hazardous effects of pesticides on human health and the environment and difficulties in implementing appropriate legislation and methods that allows for their safe handling and disposal is a global problem affecting many developing countries in Africa and the Near East. In conjunction with the United Nations Environment Program (UNEP), the World Health Organization and the Government of the Netherlands, the United Nations Food and Agriculture Organization (FAO) has taken the lead on attempting to dispose of stockpiled obsolete pesticide and has developed two sets of guidelines, one dealing with the disposal of bulk quantities of obsolete pesticide and the second set outlining the disposal of small quantities of unusable pesticide stocks, pesticide-related waste and contaminated containers. Both sets of guidelines are available on the FAO website (www.fao.org).

As for many developing countries, large uncertainty exists in the estimate for historically accumulated pesticide waste in South Africa to date. This uncertainty is also exemplified by unknown quantities of buried pesticide containers and other pesticide wastes randomly distributed across South Africa's agricultural land as well as volumes of contaminated soil. The quantities of internationally banned garden pesticides, still in use in South Africa, and their associated wastes are also uncertain. The Department of Environmental Affairs and Tourism aims at updating the inventory for pesticide waste as part of the first phase under the Africa Stockpiles Program.

Preliminary inventory lists have been compiled by the FAO for various developing countries. In a FAO report in 1997, "Prevention and disposal of obsolete and unwanted pesticides in Africa and the Near East", South Africa was reported to have accumulated 390 tonnes of obsolete pesticides consisting of about 30 different types of pesticide products. A preliminary list provided in a later report by the FAO in 2001 (www.fao.org/news/2001) indicates that obsolete pesticide stocks have increased to 603 tonnes, however, unlike most other African countries it is indicated that all 603 tonnes of waste in South Africa has been disposed of. The nature of the disposal mechanism is not indicated but may have involved packaging and export to Europe for high temperature incineration funded by the FAO. Given this history of obsolete pesticide accumulation in South Africa it may be speculated that over the past 5 years since 2001, quantities of accumulated obsolete pesticide stock may be around 300 tonnes.

Pesticide wastes have only been quantified for farms in the Stellenbosch area of the Western Cape. This has been done in a model study done by M.A. Dalvie and L. London of the University of Cape Town (1995). A total of 6427.3 kg of pesticide waste was documented and recorded. Of the total wastes recorded, 1103 kg was classified as low hazardous waste. This waste was diluted prior to addition of lime or ash and was landfilled at the Vissershok Waste Management Facility. The balance of the pesticide namely the more hazardous material could not be landfilled and required encapsulation in 210 litre drums before disposal at the Vissershok Waste Management Facility. Although, the total quantity of historical pesticide waste in the Western Cape region is unknown, based on previous records for South Africa (from the FAO), it may be speculated that the Western Cape contribution to historical agricultural pesticide waste is probably around at least 50 tonnes of material.

4.1.4 Current Practice

In the Western Cape the only legal disposal method in use for pesticide waste is landfilling at the Vissershok H:h Waste Management Facility. Contrary to international legislation even high hazardous pesticide waste (although encapsulated in steel drums) is landfilled. High-temperature incineration, chemical treatment and long-term controlled storage are disposal options that are at presently not available locally. Illegal dumping of pesticide waste is known to be taking place, however, it is not know what proportion of total pesticide waste is illegally disposed.

4.2 Waste Management Options

4.2.1 Reduce

4.2.1.1. Minimize Use of Pesticides

The best method of minimizing the generation of pesticide waste is to avoid or at least minimize the use of pesticides and thereby stopping the problem at its source. Often, pests, diseases and weeds in agriculture can be controlled using methods, such as organic farming and integrated pest management (IPM) systems, that have been very successful in eradicating or significantly reducing the use of pesticides in some cases.

Simple hygiene may also prevent and reduce pesticide use. Also of importance, should be the implementation of educational programs informing users and farm workers of the hazards of pesticide and to avoid using them if possible.

4.2.1.2. Prevent Degradation of Pesticides

Pesticide waste can also be generated during prolonged storage under poor conditions. The active ingredient in badly stored pesticide is likely to degrade with time rendering the pesticide unusable or obsolete. Pesticide should be kept in a secure, dry, cool and well ventilated place out direct sunlight and should not be stored in living or sleeping quarters.

Educational programs and workshops for the Western Cape agricultural and public sectors should be implemented to inform buyers of the BPEO for pesticide waste and minimization of pesticide use and waste generation. Just-in-time-procurement should be promoted to minimise the extended storage of pesticides.

4.2.2 Reuse

4.2.2.1. Re-use as Pesticides

Non-POPs pesticide products that have been stored for a prolonged period of time but can be positively identified, are within their expiry date and are still in usable condition should be used up as instructed on the label or transferred to people who have an appropriate use for them. Pesticide suppliers should, ideally, manage such transfers as they are capable of identifying the product and its most appropriate uses.

Certain non-POPs pesticides that have been characterized as obsolete based on their expiry date can also be reused. However, this can only be considered following analysis of the product to determine its suitability for use in accordance with the FAO Code of Conduct. A maximum period of two years (since the date of analysis) should be given as the extended shelf life to a product that is found to be within specification. These products should be used in priority to newly bought or imported stock.

4.2.3 Recycle

4.2.3.1. Re-formulation

For certain out of date (expired), non-POPs pesticide stock, it may be possible to reformulate/rework the original stock into a usable formulation that is of use and benefit to a country. A wide range of factors should be taken into account if this option is to be considered, which may include:

- The potential need for the reformulated product.
- The need to use pesticide stocks that have expired to prevent the accumulation of obsolete stock.
- Reworking is carried out at facilities that meet the highest international standards of compliance with regard to Health, Safety and Environment.

POPs pesticides are not considered for any reformulation/reworking. Highly toxic chemicals belonging to the WHO Class 1a or 1b, on the other hand, can be considered for reformulation.

All empty pesticide containers should be considered for recycling in accordance with the FAO. In some cases the plastic or steel drum container can be returned to the supplier for recycling. Empty steel drums that are still in good condition can be used for repacking the same pesticide product from leaking or deteriorating drums. Old and deteriorated drums and surplus drums can be used as raw material at steel smelters as an empty 200 litre steel drum represents about 25 kg of good quality scrap metal. They should be rinsed (thoroughly), punctured or crushed before being sent to the smelter. Steel drums that are still in good condition can also be sent to a drum reconditioning company. Strict standards of safety and environmental control are, however, required where container are recycled.

In countries where collection and recycling of decontaminated pesticide containers are in place, a number of guidelines have been outlined on how to correctly manage empty pesticide containers. Methods of how to deal with empty pesticide containers in the USA and in Australia, for example, are very similar (therefore these methods are probably universally accepted).

4.2.4 Treatment

4.2.4.1. Induced Degradation

Chemical treatment of pesticide waste using hydrolysis (including alkaline and acid hydrolysis) as well as other chemical reagents such as ammonia, bleach (NaOCl), sodium hydroxide (NaOH), can be used to degrade various types of pesticide.

4.2.5 Disposal

4.2.5.1. Incineration

In industrialized countries the preferred method of pesticide waste disposal is high-temperature incineration. Three other internationally accepted methods include chemical treatment, long-term controlled storage and specially engineered landfill.

4.2.5.2. Landfill Disposal

Internationally, disposal of obsolete pesticide and pesticide waste by landfilling is not accepted practice. However, specially engineered or lined landfill facilities is regarded suitable for disposal of powder formulations with a low active ingredient content, incinerator ashes and slag, pesticide contaminated soils and decontaminated pesticide containers. Low hazardous powder formulations and pesticide liquids are landfilled after solidification with a binding agent such as cement or polymers.

4.2.5.3. Other

Disposal methods that are regarded as **unsuitable** for disposal include:

- Open burning
- Burying or landfill disposal
- Discharge to sewer
- Solar evaporation
- Land farming/superficial application
- Deep well injection
- Other methods primarily developed for soil remediation and groundwater decontamination (including ultraviolet treatment, ozonation, ion exchange, precipitation or flocculation, activated charcoal adsorption)

4.3 BPEO

4.3.1 Current

- Landfilling of pesticide waste - biodegradable pesticide waste should be treated separate from non-biodegradable POPs pesticide waste. Low hazardous, biodegradable waste could still be disposed of at a H:h or H:H landfill site such as the H:h Vissershok Waste Management Facility. POPs-type high hazardous pesticide waste should be immobilized with a strong mixture of cement, lime or other binding agent and disposed of at a lined landfill facility or, alternatively, encapsulated in good quality, leak-proof drums before disposal at the H:H Vissershok Waste Management Facility.
- Low-Cost Controlled Storage Facility – Another possible option for POPs –type, high hazardous pesticide waste is storage in a low-cost, but safe and controlled storage facility. This type of facility should be constructed in a remote environment away from the public. Hazardous pesticide waste should be encapsulated and labelled in steel drums or special containers, stored and inspected according to international standards. A financial and management opportunity may arise later (within the 5 year period) for a better disposal option (e.g. shipment to another country for high-temperature incineration or development of local technology). Pre-existing unutilised facilities such as the Denel Somchem facilities in Somerset West that has a history of managing dangerous and hazardous explosive material could be considered as a cost effective option as a short-term or long-term, controlled storage facility.
- Modified Cement Kiln Safe Incineration – landfilling of pesticide waste at the Vissershok Waste Management Facility (or similar regional facility) and low cost controlled storage is preferred over cement kiln incineration as the 5 year BPEO in the Western Cape. However, cement kiln incineration could be considered as a “once-off” short-term option. The main problem with cement kiln incineration is the potential for poor operational control resulting in emission of hazardous gases. Also many cement kiln company owners may not want the responsibility of incinerating hazardous material. A lower cost for kiln modification may be realized if financial assistance is received from the cement industry as their effort and marketing plan for a cleaner environment and/or financial input from the Africa Stockpiles Programme (ASP). This might be a cost-effective method as liquid pesticide waste mixed with fuel acts as high-energy mixture allowing for high temperature combustion and incineration. If this option is considered it should include the following modifications to reduce emission of POPs:

    - Waste stream introduction system.
    - Cooling system for rapid quenching and trapping of potential furan and dioxin emissions.
    - Special filter system for additional collection of dioxins and furans.
    - Scrubber system with NaOH and water solution to trap and collect released halogens such as Br and Cl.

It is important to note that not all pesticides are suitable for incineration (e.g. inorganic pesticides, organic pesticides containing mercury, etc.) and only liquid, non-halogenated pesticide compounds should be considered (therefore a scrubber system with NaOH may not be required).

In addition to these disposal options, educational programs involving teaching and training of farm workers and general public of the potential hazards of using pesticide and the their avoidance as far as possible should be implemented at this early stage through programs such as the Occupational Environmental Health Research Unit (OEHRU) at the University of Cape Town. Educational programs informing the public and the agricultural sector of BPEO for pesticide disposal in the Western Cape should be implemented at an early stage.

4.3.2 Future

- Pesticide dependence in the agricultural sector reduced to a minimum through national education programs. Accumulation of obsolete or unwanted pesticide stock completely avoided.
- A shift to more advance, and environmentally sound disposal technologies that are currently still being developed today.
- A complete shift away from landfilling and cost-effective long-term controlled storage.
- Regional pesticide collection network system, established by the pesticide industry and funding by government through ASP assistance over the 15-year period, completely in place. This will allow for collection of small amounts of obsolete pesticide at local collection points throughout the Western Cape (e.g. annually) and their safe disposal at a simple chemical treatment facility (or at this stage advanced chemical treatment), industry developed treatment plants or other environmentally sound disposal methods available.

4.4 Bibliography

- Situation analysis of hazardous waste management in the Western Cape Province. Department of Environmental Affairs and Development Planning. Volume 1. August, 2003.
- Guidelines for the management of small quantities of unwanted and obsolete pesticides (UNEP, WHO, FAO). Rome, 1999.
- WHO. 1998. Recommended classification of pesticides by hazard. Document WHO/PCS/98.21/Rev.1. Geneva.
- Prevention and disposal of obsolete and unwanted pesticide stocks in Africa and the near East: The second FAO consultation meeting. Rome, 1997.
- Disposal of bulk quantities of obsolete pesticides in developing countries: Provisional technical guidelines. Rome, 1996.
- www.fao.org/news/2001: Preliminary list of countries with known obsolete pesticide stocks.
- www.groundwork.org.za/Press%20Releases/POPs.asp. Will South Africa violate new UN Convention on POPs?
- www.gda.no-burn.org/index.php. 2005 Global Day of Action against waste and incineration.

5 Health Care Waste BPEO

5.1 Waste Review

5.1.1 Description of Waste Type

Health care waste is a highly diverse waste stream which includes Health Care General Waste, which is similar to domestic waste and is dominated by sterile packaging, and sanitary wastes including cleaning materials. Health Care Risk Waste is the term used for the hazardous component of the waste stream. This includes infectious waste (including sharps), chemical wastes, and radioactive wastes. Health care risk wastes include:

- Infectious waste – wastes from infected patients, cultures of infectious agents, wastes contaminated with blood, discarded samples, swabs and bandages, infected animals from laboratories and contaminated disposable equipment;
- Pathological wastes – body parts and animal carcasses;
- Sharps – syringes and blades;
- Genotoxic waste – highly hazardous waste that may have mutagenic, teratogenic or carcinogenic properties such as certain cytostatic drugs;
- Pharmaceuticals – expired and unused or used and contaminated drugs, vaccines or sera. High hazard genotoxic wastes, such as cytotoxic drugs used in cancer treatment;
- Chemical waste – solid, liquid or gaseous chemicals
- Radioactive matter such as glassware contaminated with radioactive diagnostic material or radiotherapeutic materials; and,
- Waste with heavy metals – including but not limited to waste mercury from thermometers and batteries.

5.1.2 Waste Generation

The generators of health care waste are generally grouped into two categories based on the volume of waste generated. Large hospitals, clinics and blood transfusion centres represent the largest volume of waste and the small individual medical practices, including dentists, veterinary hospitals, medical laboratories, mortuaries, prisons and pharmacies that are classified as widely dispersed low volume generators. Private households also generate small volumes of what could be widely termed health care waste. It is estimated that there are over 2500 generation points for health-care risk waste in the Province.

5.1.3 Waste Characterisation and risks

A relatively large amount of health care waste consists of non-hazardous packaging, increasingly plastic based. This aspect of the health care waste stream is the opposite to very low volumes of Hazard Rating 1 high risk, infectious and pathogenic wastes requiring safe handling, treatment and disposal. It is thought that 30% of the health care waste processed as hazardous waste is actually non-hazardous.

The issue of health care waste generation is one of waste reduction by careful control and waste separation at source. Given the risk of infection a cautionary approach tends to favour the adoption of waste management systems in which wastes will generally be assumed and designated to be hazardous unless they are obviously and intuitively non-hazardous.

Protocols for management of health care waste have evolved over many years of practice. In general hospitals would traditionally incinerate their waste in their boilers or purpose built incinerators.

Waste management issues identified in the study by Eichstadt and Naude (2003) include the following:

- Lack of control over transport collectors.
- Lack of regulatory monitoring of health and related standards in the health-care waste industry.
- Operation of old incinerators in Provincial Hospitals, particularly those close to residential areas and disposal of waste ash to general and fill.
- Compliance of incinerators with airborne emission guidelines.

There is a general fear in most communities that infectious waste is not disposed of responsibly and is either becoming mixed in the general waste in general landfills, or is being illegally dumped. Contaminated needles and syringes are a particular concern in that these materials could be scavenged for reuse without any form of disinfection.

5.1.4 Current Waste Management Practices

Health Care Waste Management in the Western Cape was reviewed in detail by Eichstadt and Naude (2003). A preliminary audit of 26 health care institutions was conducted. The annual tonnage of health care waste was reported to be 3044 tonnes.

There is a well established health care waste service industry in the Western Cape. There are three existing health care treatment facilities, including two incinerators and one electrothermal destruction (ETD) facility. They include

- Solid Waste Technology ETD – Cape Town
- Sanumed Incinerator – Cape Town
- BCL Medical Waste Management Incinerator – Cape Town

A third incinerator was operated by Envirologic in Mossel Bay, however, it was closed down as it was not liscenced. Envirologic Mossel Bay now serves as a collection depot for health care waste which is transported to Sanumed in Cape Town for incineration.

A number of provincial hospitals have operated medical waste incinerators. The operating temperatures are generally much lower than modern specialist waste incinerators and most are unlikely to comply with prescribed emission standard if compliance monitoring were to be applied to these facilities.

5.2 Waste Management Options

5.2.1 Reduce

5.2.1.1. Separation of packaging

There is the acceptance in health care institutions that reduction of hazardous waste has benefits in terms of overall waste management objectives and a reduction in costs. However, private institutions are particularly sensitive to liability concerns and thus there has been a significant growth in the use of disposable medical equipment. The use of disposables is effective in controlling infections and also reduces the labour costs associated with in-house sterilisation and disinfection. There is the additional benefit of reducing the use of hazardous chemicals in process in disinfection processes. There are however, important administrative drivers that favour the use of disposables. The pricing inventory strategy used for health care is based on the use of pre-packaged single use items. Many of these disposable items are considered to be low risk general waste and therefore should not in theory influence the hazardous waste generated.

Most of the waste reduction programmes in use aim to reduce packaging waste, which is rarely hazardous. The reduction of plastics and particularly chlorinated plastics (PVC) that go to incineration is the key to controlling harmful emissions associated with medical waste incineration. The most effective way of reducing hazardous health care waste is to operate careful waste separation using well trained personnel and efficient operational systems.

5.2.2 Re-use

5.2.2.1. Re-usable Safe Containers

Due to the inherent risks involved recycling initiatives are limited to materials that can be adequately sterilised or disinfected to be safe from infectious substances. This tends to be limited to more expensive items of medical equipment and surgical instruments, and everyday household products such as batteries. The largest component of the hazardous waste stream is the red bags and boxes used for infectious waste. The use of reusable safe containers is thus the most significant recycling initiative that can be adopted for the waste stream.

In the case of household health care wastes it is possible for regular uses of needles and syringes to safely disinfect and re-use their equipment. Home destruction kits are available once usable lifespan has been exceeded.

Dangerous practices in the recycling and repackaging of contaminated needles and syringes has been cited as a major factor in spread of the Hepatitis B virus and a minor factor in the spread of Hepatitis C and HIV.

5.2.3 Recycle

5.2.3.1. Glass and Plastic Recycling

Glass and plastic wastes can be recovered and recycled provided the correct level of sterilisation and/or disinfection is applied. It is however difficult to find a market for recycling hospital glass waste as it is perceived to be infectious medical waste.

5.2.4 Treatment

5.2.4.1. Sterilisation and Disinfection

Treatment methods are applied to enable reuse and recycling and include all non-destructive methods of sterilisation and disinfection. Autoclaving is a process of steam sterilization and is the most frequently employed alternative to waste incineration. Other technologies than can be employed include steam disinfection, chemical disinfection, microwaving and irradiation. These methods render the waste stream non-infectious and allow the waste to be either reused or recycled and disposed to landfill, depending on the nature of the waste treated. There are waste streams that cannot be treated, e.g. pathological wastes and cytotoxic wastes, and must be incinerated.

Solidification of Asbestos Containing Waste (ACW) can be accomplished using cement and other fixation agents such as water based silicates. Cementation with Ordinary Portland Cement can be cost effective in reducing Class A fibrous ACW to lower risk categories and hence ‘delist’ the waste.

5.2.4.2. Disposal

5.2.4.3. Incineration

The majority of hazardous health care wastes in the Province are incinerated at one of the three facilities listed above. The use of old incinerators at Provincial Hospitals has been largely discontinued. The use of incineration is considered the most effective method of eliminating the disease burden from exposure to infectious agents and toxins and is regarded by WHO as the best interim solution for hazardous health care wastes in developing countries.

The adverse characteristics of waste incineration are the production of toxic air emissions and the generation of incineration ash which may contain hazardous substances. Mitigatory management solutions should be applied to incineration process including:

- Waste segregation to reduce incinerated mass and to recover reusable and unsuitable items, i.e. glass and plastics;
- Correct siting and licensing of the facility;
- Proper design, construction and operation of the incinerator;
- Proper maintenance, inspection and record keeping; and
- Proper training of operators.

5.3 BPEO

5.3.1 Current Options

- Incineration at appropriately licensed medical waste management facilities is considered to represent best current local practice.
- Landfill of certain items after sterilisation or disinfection is considered acceptable.

Issues related to the current BPEO include:

- Present practice is not consistent with waste minimisation as a significant proportion of the waste stream consists of non-hazardous materials which are being incinerated.
- There are health concerns which place constraints of reuse and recycling. Waste segregation supported by well developed systems and training are necessary to minimise the waste stream.
- Unacceptable practices include disposal to general waste and uncontrolled burning and ineffective incineration.
- Illegal dumping is a societal concern.

5.3.2 Future Options

More extensive use of non-burn technologies such as autoclaving are to be encouraged. The forms of waste incineration are likely to be controversial given the risk of airborne contamination. However, certain health care wastes will always require high temperature thermal destruction as no alternative technologies presently exist. The issue is thus one operational care and of regulatory control of the waste management facilities.

5.4 Bibliography

- WRC (2005). Draft Report: Guidelines for the Classification, Rating and Disposal of Common Industrial Hazardous Waste Streams, *WRC Research Project No. 1548. WRC and Environmental Business Strategies.*
- World Health Organisation (2004) Health Care Waste Management. *www.who.int*
- US Congress Office of Technology Assessment OTA-0459 (1990) Finding Rx for Managing Medical Wastes.

6 Abattoir Waste / Condemned Food BPEO

6.1 Waste Review

6.1.1 Description of Waste Type

Agriculture is a source of animal carcasses, either from food production or due to disease, predation, accidents and even age. Abattoir waste can be defined as waste (excluding waste water for the purposes of this study) from an abattoir which could consist of the pollutants such as animal faeces, blood, fat, animal trimmings, paunch content and urine. The different sources of waste in red meat abattoirs could be categorised as:

- Lairagus / animal pens;
- Bleeding / stunning;
- Carcass processing / cleaning;
- Offal processing; and
- By-products processing.

Most food processing industries are a source of condemned food, usually due to cleaning of machinery or the rejection of food during processing or refining. Condemned Food Waste can be defined as food processing by-products and residues (food processing vegetative wastes and/or food processing residuals generated from food processing and packaging operations or similar industries that process food products). Typical examples include:

- Vegetative waste (produce trimmings and over-ripe produce generated by supermarkets, produce brokers and produce distributors),
- Off-specification food products, food product over-runs, and similar food waste materials.

* Note - Small quantities of household food waste are regarded as general domestic waste and are not included in this category.

6.1.2 Waste Generation

The following key food waste generation activities have been identified in the Western Cape:

- Industries for the manufacturing animal (red meat, poultry, and dairy) food products, (‘off-spec’ food);
- Industries for the growth, harvesting and processing of vegetables (liquid food rests).
- The Western Cape has a well developed tourist economy which supports a thriving restaurant and catering trade. There is thus a significant volume of edible food waste generated that goes to general waste disposal. Edible food waste would not normally be considered as hazardous waste unless its handling and storage would lead to it become condemned as unfit for human consumption.

6.1.3 Waste Characterisation and risks

Perished foods can cause illness if consumed, even after they have been thoroughly cooked. Putrefaction of food wastes can lead to the development of infectious diseases posing a risk to human health.

6.1.4 Current Waste Management Practices

- Abattoirs tend to produce relatively large amounts of liquid effluent to comparison to solid wastes. The most widely used route for disposal of abattoir waste is municipal sewers. Discharge costs due to the high organic strength of untreated abattoir waste are relatively high. Abattoirs normally also have difficulty in meeting municipal by-laws for fats, oils, greases and suspended solids. Both general food wastes and abattoir wastes are disposed of to landfill. In Cape Town disposal to hazardous landfill is available.
- In country districts it considered that the proportion of animal product wastes being disposed of to general landfill is higher and is cause for concern.

6.2 Waste Management Options

6.2.1 Reduce

6.2.1.1. Recovery of meat products for human consumption

This option involves optimising the recovery of edible portions from the meat processing cycle for human consumption.

6.2.1.2. Distribution of Food Products to the Disadvantaged

This option involves the collection or recovery of wholesome food from farmer fields, retail stores, or food service establishments for distribution to the disadvantaged. Once surplus food has been recovered or prevented from going to waste, volunteers pickup and deliver the food to groups that serve the needy, either directly through charitable organizations or indirectly through food banks. In addition to providing additional quantities of food to the needy, the recovery of reusable food also provides charitable organizations with more variety and nutrients by adding fresh fruits and vegetables to the typical non-perishable canned and boxed goods. Feedback Food Redistribution was established in 2002 in Cape Town. It is a collection and delivery services that redistributes excess food from catering industries to organisations involved in community feeding programmes. Feedback does not warehouse the collected food, it delivers immediately so as to minimise waste. It is estimated that sufficient food of good quality is presently redistributed in South Africa to provide 20 000 meals per day.

However, food redistribution is not without cost. Recovery operations face a number of logistical and economic obstacles in the minimisation of food waste and in the quality controls that have to be applied in ensuring the food products are acceptable for human consumption.

6.2.2 Re-use / Recycle

6.2.2.1. Process as Animal Feed or Fertiliser

This option involves the processing of solid abattoir waste (hair, hoof, hide, trimmings, blood, intestinal tracts and condemned carcasses) as animal feed. Products include:

- Meat meal, and meat and bone meal
- Pet food (pelletized)
- Protein Paste (Protein Supplement for Feeding Pigs)
- Fertiliser for non-grazed pasture

Traditionally, most wastes used as animal feeds are heat-treated to sterilise the materials and if the heat-treated product cannot be utilised locally or in a short time the product would then be dehydrated to facilitate storage and transport. Such processing is generally carried out where waste materials are available in large quantities on a regular basis and where the final product is of medium to high value. Such circumstances are unlikely to apply to smallholders.

Processing facilities (generally referred to as rendering plants) typically utilise thermal treatment, preferably complete sterilization, in order for the products to be safely used. In South Africa the processing method is regulated by the "Guidelines for Feed Production". The main equipment needed is a horizontal autoclave designed for interior mechanical movement. An average temperature of 130ºC and a pressure of 2 atmospheres during 60 minutes can convert all of this material, including sectioned, large, dead animals, into a feed resource for pigs of substantial biological value, known as "protein paste".

Despite the efficiency of thermal treatment technology, internationally recognised EU guidelines for feed production prohibit the 'like for like' use of animal feed due to the risk of infectious proteins and the formation of and transmission of diseases such as Bovine Spongiform Encephalopathy (mad cow disease).

6.2.2.2. Production of Leather from Hides

Hides could be sent to tanneries for processing leather. Standard production methods used at tanneries include fleshing, soaking, hair removal, liming, de-liming, bating, pickling, tanning and basification and sammying. As the market demand for leathers favours the premium products the economic benefits of hide recycling can be limited.

6.2.3 Dispose

6.2.3.1. Landfill Disposal of Condemned Food / Abattoir Waste

Proper and safe disposal of condemned food items must be in a manner that ensures that the items will not be easily accessible to consumers in trash containers or reappear as damaged merchandise in any outlet that would enable public consumption. Disposal of such items should be conducted properly and in a manner consistent with food safety requirements.

6.2.3.2. Incineration of Abattoir Waste

Incineration is most practical with dry, high energy waste that may be utilized as a fuel source. Food residuals, which are 70% water, are not a good fuel stock for incineration since the net energy output is zero. Incineration is most practical from an environmental view when the derived energy is used to generate electricity. In addition, a major cost and concern is the control of air emissions, especially dioxin, furan, nitrogen oxide and sulphur dioxide.

6.3 BPEO

6.3.1 Current Options

- Abattoir Waste:
    - Recovery of Abattoir Meat Products for Human Consumption - optimising the recovery of edible portions from the meat processing cycle for human consumption is the preferred option for abattoir waste in terms of the waste management hierarchy. It should however, not be done with condemned products. This option benefits the abattoir through the sale of such products and a reduction in the transport and disposal costs associated with landfilling. In light of these benefits, most abattoirs already avoid waste generation in this manner.
    - Process Abattoir Waste as Animal Feed – The reuse of abattoir waste that cannot be recovered for human consumption is the preferred waste management option due to its position in the waste management hierarchy.

Rendering plants are however only economically viable at large abattoirs were the waste stream is large enough to sustain the treatment process. In order to cater for the smaller abattoirs, the feasibility of a centralised rendering facility should be investigated. This facility would also be suitable for use by fish waste generators. A key consideration in assessing feasibility would be the cost of transportation to a centralised rendering facility versus cost of transportation to landfill.

  - Production of Leather from Hides - Hides should continue to be sent to tanneries for processing leather.
  - Landfilling – Landfilling of abattoir waste is a feasible option, however, it should only be selected when other waste management options (such as recovery, processing etc) have been exhausted. Proper and safe disposal of abattoir waste must take place to ensure that the waste is covered and not accessible to the public or animal scavengers on site.

- Condemned Food Waste:
  - Landfilling - Landfilling is a feasible option, however it should only be selected as a food waste management alternative when reuse and recycling is not possible. Close attention will need to be given to the disposal method (e.g. immediate covering), as well as the security of the landfill facility to prevent scavenging of potentially harmful food. This is the least preferred management strategy because food waste will decompose anaerobically and readily, and the high water content will add residual leachate.

6.3.2 Future Options

- Abattoir Waste:
  - Central rendering facility - Implementation of a central rendering facility dependant on feasibility investigations.
- Condemned Food Waste:
  - Minimisation by food redistribution - The collection or recovery of wholesome food from farmer fields, retail stores, or food service establishments for distribution to the disadvantaged is regarded as the preferred option for waste minimisation. This option only applies to food stuffs that can be successfully redistributed in a state that is fit for human consumption before the food becomes condemned. In general this can only be applied to excess or surplus food, usually of catering grade. Food waste minimisation benefits the generator through the reduction in the transport and disposal costs associated with landfilling, and has social benefits in supporting needy communities. This option is likely to be regarded as risky due to the potential health and safety liability associated with food beyond the generators sphere of control, and is likely to be met with resistance and thus may have a limited application outside of existing food redistribution programmes.

6.4 Bibliography

- www.fao.org (2006) - D H Machin, CAMBAC Associates, England – The potential use of tropical silage for livestock production with special reference to smallholders.
- Rena Perez (1997) Feeding pigs in the Tropics, Chapter 6 Organic Wastes. FAO Annual Production and Health Paper 132 (www.fao.org)
- Friends of the Earth (May 2004) – Biowaste: Towards a Friends of the Earth Position (www.foe.co.uk).
- National Department of Agriculture, South Africa – Guidelines for Farm Feeds (www.nda.agric.za)
- International Development Research Centre, Canada (2005) Re-use of Waste for Food Production in Asian Cities: Health and Economic Perspectives.
- In-Sink-Erator Food Waste Management Position Paper (Sept. 2005) Facts to Consider for the Various Methods of Managing Food Waste.
- Walsall Metropolitan Borough Council (Feb 2004) Draft Municipal Waste Management Strategy.
- World Health Organisation (2006) Microbiological risks in food (www.who.int)

7 Industrial Hazardous Waste BPEO

7.1 Background

In terms of current hazardous waste management in the Western Cape, the majority of hazardous waste generated is managed at the lower end of the waste management hierarchy, by treatment and/or direct disposal to landfill. There is also a concern that a significant proportion of waste generated is stockpiled. Some of the stockpiled wastes are often referred to as recyclables but many industries do not keep accurate records to enable auditors to determine the volumes of hazardous materials that are reused, recycled or recovered. In some cases hazardous wastes have been stored on some industrial sites for periods of greater than ten years

Current waste management policy and efforts within DEADP are aimed at shifting waste management to the upper end of the waste management hierarchy, namely prevention and minimisation, if feasible in terms of applicable social, economic, technological and environmental constraints. In this respect this BPEO study serves to identify where current industrial hazardous waste management practice does not reflect best practice for the management of specific priority hazardous waste streams in the Western Cape.

It is recognised that there are numerous sources of hazardous industrial waste that require identification and management that are not specifically addressed as priority waste streams in this BPEO study. The purpose of this section is to address such wastes by reflecting best practice that should be applied to management of all hazardous wastes generated within the province.

7.2 Waste Review

7.2.1 Description of Waste Type and Generation Processes

Hazardous waste is defined in DWAF Minimum Requirements for the Handling, Classification and Disposal of Hazardous Waste as any waste that (even in low concentrations), has the potential to cause a significant adverse effect on public health and the environment because of its inherent toxicological, chemical and physical characteristics. In terms of this definition, hazardous wastes are considered to be generated from a wide range of industrial, commercial, agricultural and domestic activities and may take the form of a liquid, sludge or solid.

Common types and sources of industrial hazardous waste may include the following:

- Clean-up Residuals. Absorbent material used in the clean up of spillage of a hazardous substance becomes a hazardous waste as it inherits the characteristics of the spill.
- Solvents and Organic Solutions. A wide range of solvents and organic solutions are commonly used during the manufacture of pharmaceuticals, rubber, plastics and organic chemicals. After use they become contaminated with the solute creating residual chemical mixtures.
- Anion Complexes. Certain industrial process such as coatings on metal products and electrical machinery require the use of negatively charged ion (anions). A large component of this waste stream include cyanide- and sulphide-bearing effluents that are corrosive and/or reactive and are often found in association with metals or high-salt solutions.
- Oils and Greases. These wastes include dirty oils with solid contaminants generated mainly from vehicles and industry machinery.
- Organic and Oily Residuals. These wastes include organic compounds mixed with inorganic constituents such as thick petroleum-type sludges or solids, and may contain toxic metals.

- Organic Sludges and Still Bottoms. The by-products of organic chemical production are often thick tar-like organic sludge substances (called 'still bottoms'). Organic sludges may also be formed during the treatment of wastewaters or from the degreasing of metal parts with solvents.
- Paint and Organic Residuals. Organic solvents, metal-based pigments, dyes, glues and adhesives, and wastewater used in the production of paints all fall into this waste category.
- Pesticides. Pesticides including insecticides, herbicide, fungicides, etc. contain synthetic chemical compounds that may be hazardous in nature. Pesticide waste such as expired or degrade pesticide may be more toxic and or carcinogenic than the original pesticide itself.
- Solid Inorganic Residuals. Includes wastes that are mostly ash or solids with low water content.
- Metal and Inorganic Solutions and Sludges. The largest portion of these wastes is derived from petroleum-refining processes using metal catalysts, metal finishing processes and the manufacture of metal-based inks.

7.2.2 Waste Characterisation and Risks

Hazardous waste should be classified according to SANS Code 0228 as detailed in DWAF Minimum Requirements for the Handling, Classification and Disposal of Hazardous Waste (HCDHW). The classification system consists of nine classes defined on the basis of the chemical or physical hazard posed by the waste.

SANS Code 0228: Class Definitions

Class 1.	**Explosives**
Division 1.1	Substances and articles that have a mass explosion hazard.
Division 1.2	Substances and articles that have a projection hazard, but not a mass explosion hazard.
Division 1.3	Substances and articles that have a fire hazard and either a minor blast hazard or a minor projection hazard or both, but not a mass explosion hazard.
Division 1.4	Substances and articles that present no significant hazard.
Division 1.5	Very insensitive substances that have a mass explosion hazard.
Class 2.	**Gases: compressed, liquified or dissolved under pressure**
Class 2.1	Flammable gases
Class 2.2	Non-flammable gases
Class 2.3	Poisonous gases
Class 3.	**Flammable liquids**
Class 3.1	Low flashpoint group of liquids; flashpoint below –18°C c.c.
Class 3.2	Intermediate flashpoint group of liquids; flashpoint of –18oC up to 23°C
Class 3.3	High flashpoint group of liquids; flashpoint of 23°C up to, and including, 61°C c.c.
Class 4.	**Flammable solids or substances**
Class 4.1	Flammable Solids
Class 4.2	Substances liable to spontaneous combustion
Class 4.3	Substances emitting flammable gases when wet
Class 5.	**Oxidizing substances (agents) and organic peroxides**
Class 5.1	Oxidizing substances (agents)
Class 5.2	Organic peroxides
Class 6.	**Poisonous (toxic) and infectious substances**
Class 6.1	Poisonous (toxic) substances.
Class 6.1(a)	All toxic substances including pesticides in Hazard Ratings 1 and 2.
Class 6.1(b)	All toxic substances including pesticides in Hazard Rating 3.
Class 6.2	Infectious substances.
Class 7.	**Radioactive substances**
Class 8.	**Corrosive substances**
Class 9.	**Miscellaneous dangerous substances**

7.3 Best Practice for Management of Hazardous Wastes

The flow diagram in **Figure 7.3.1** outlines best practice for management of potentially hazardous or known hazardous industrial wastes and is based on the waste management hierarchy.

7.3.1 Waste Identification and Classification

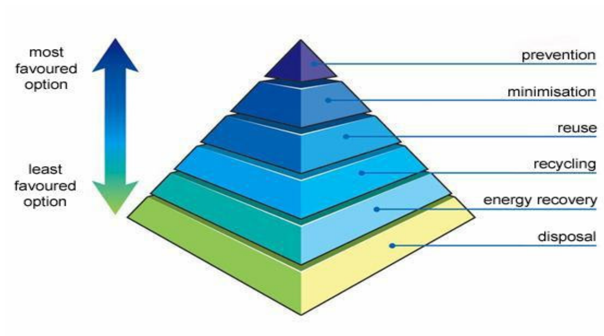
Before appropriate options for management of a waste can be assessed, it is imperative to clearly define waste volumes being generated and the chemical and physical characteristics of the waste stream.

- Waste Survey -Identify potential hazardous waste streams and inventory of all chemicals and raw materials used in the manufacturing process(es). Estimate the quantity/volume of waste generated by each of the potential hazardous waste streams during inventory taking.

- Test and Analyse - Testing and analysis to identify hazardous substances and characteristics in terms of SANS Code 0228 and DWAF Minimum Requirements.
- Classification - Results of chemical testing should be used to confirm whether the waste consists of or contains any hazardous constituents. If it does it should be classified in terms of SANS Code 0228 discussed above.

7.3.2 Application of Waste Management Hierarchy

The waste management hierarchy is a conceptual structuring of waste management principles in order of importance and priority and should be applied in the development and assessment of options for the management of a specific waste, irrespective of its hazard status. There are five tiers to the hierarchy - Source Reduction, Reuse, Recycle, Treatment, and Disposal. Waste prevention and minimization are reflected at the top of the hierarchy and disposal at the bottom as the last and least desirable waste management option.



Typical Waste Management Hierarchy (Source: UK Environmental Protection Agency).

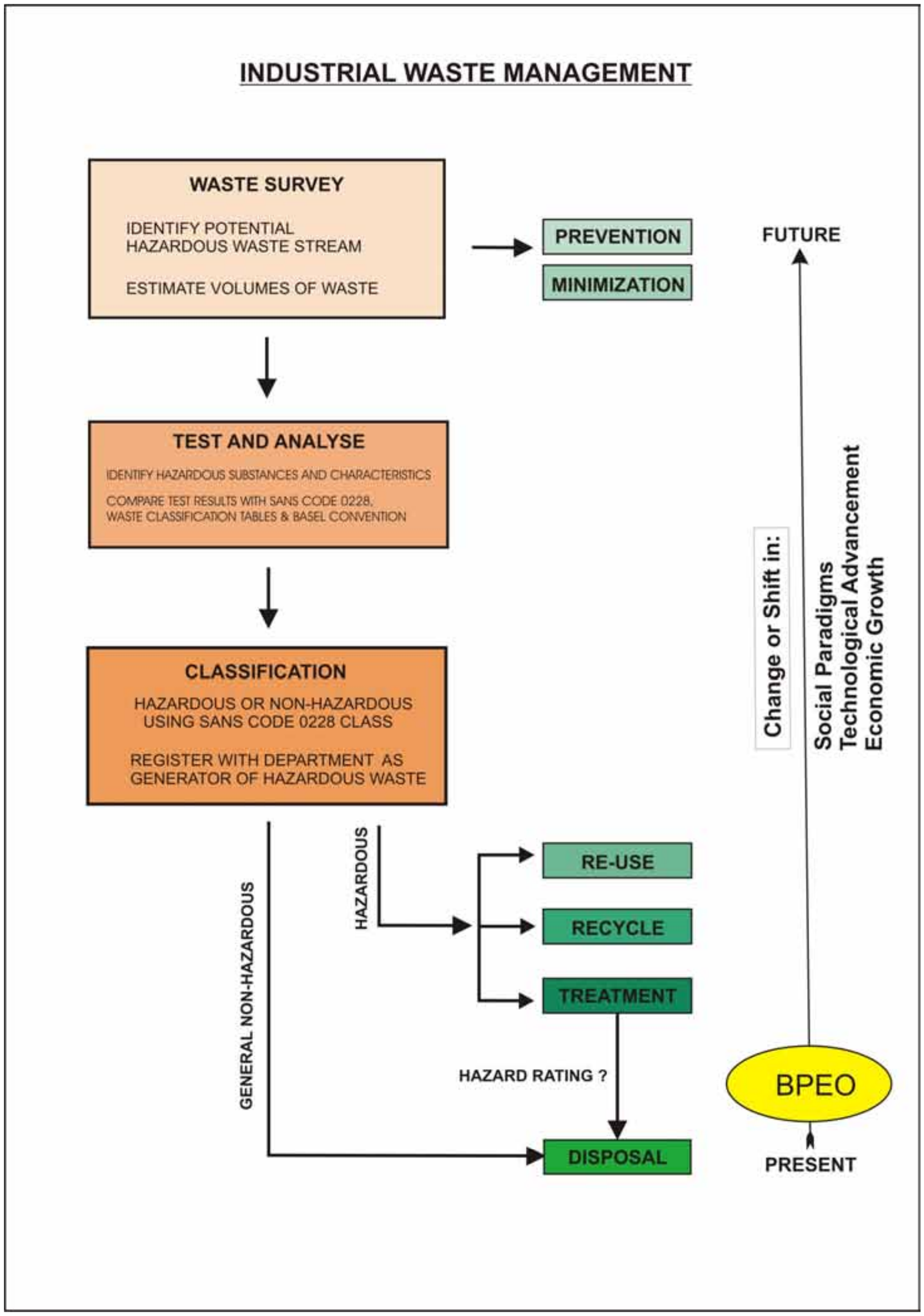


Figure 7.3.1 - Industrial Waste Management Flow Diagram

7.3.2.1. Source Reduction

Source reduction includes "pollution prevention and waste minimization". A successful hazardous waste management program first involves careful assessment of possible ways to reduce hazardous waste at the source. Source reduction may involve modifying a process, increasing the efficiency of the process, acquire more efficient technology, changing the product line, substituting safer materials and/or materials that generate less hazardous waste, minimize waste by extending the product lifetime.

7.3.2.2. Reuse and Recycle

If source reduction is not a feasible option, the next optimum management strategy is to reuse or recycle hazardous waste materials. Recycling involves recovering and treating "waste" by-products to be used as raw materials in the same or another process. Reuse involves recovery with possibly no need for treatment. Materials destined to become wastes may be exchanged or transferred to a different part of the manufacturing facility (on-site) or to a different plant (off-site) to be reused as sources of material (e.g. industry chemicals).

7.3.2.3. Treatment

Treatment can be characterized as any chemical, physical, biological or thermal process that destroys, detoxifies, or neutralizes hazardous wastes, reduces the volume or makes the waste suitable for recovery, storage and transport. Treatment of hazardous waste is often performed in conjunction with recycling processes either on-site or off-site.

- Chemical treatment technologies treat wastes by modifying the chemical structure of the hazardous waste constituents. The modifications may reduce the toxicity or reactivity of the waste material, rendering it less hazardous or non-hazardous. Chemical treatment typically involves minimal air emissions. Commonly used chemical processes include:
    - Precipitation – a chemical process for removing dissolved components from a liquid waste stream containing soluble toxic metals.
    - Neutralization – process that reduces the acidity or alkalinity of hazardous wastes in a waste stream to a more neutral condition.
    - Ion exchange – is a process used to remove ions (primarily inorganic ions) from solution.
    - Oxidation/reduction (redox) – processes that lead to the breaking of chemical bonds by passing electrons from one reactant to another.

- Physical treatment technologies involve the physical separation and concentration of the components within a waste stream, e.g. solid-liquid separation, membrane separation, distillation and evaporation.
- Biological treatment (or biodegradation) uses microorganisms to decompose wastes. The microorganisms use the waste constituents as food sources, allowing the digestive breakdown of complex organic molecules into simpler less toxic molecules.
- Thermal treatment (incineration) – is a process designed to destroy organic and other wastes at elevated temperatures usually greater than 850°C.

7.3.2.4. Disposal

Where all opportunities for prevention and minimisation have been exhausted and/or where a residue waste exists following re-use, recycling or treatment, then disposal to landfill would be the final option to be considered in management of a hazardous waste. The waste must be classified in terms of DWAF Minimum Requirements for the Handling, Classification and Disposal of Hazardous Waste, and depending on the waste classification, would require disposal to a H:H or H:h disposal facility. In cases where treatment of the waste has been undertaken to lower the hazard rating of the waste, disposal to a G:B$^+$ disposal site as ‘delisted’ hazardous waste may be possible if approved by DEAT.

8 Special Hazardous Waste - Waste Asbestos

8.1 Waste Review

8.1.1 Description of Waste Type

Asbestos waste is classified as extremely hazardous (Hazard Rating 1 in terms of DWAF Minimum Requirements) due to its ability to cause cancer over a period of years following exposure to fibres and dust normally via inhalation. Asbestos is composed of a variety of chemically inert refractory silicate minerals, including the serpentine group mineral chrysotile (commonly known as 'white asbestos') and the fibrous amphibole minerals, crocidolite ('blue asbestos') and amosite ('brown asbestos'), other amphiboles than can be classified as asbestos include fibrous tremolite, actinolite and anthophyllite, although rarely encountered in South African asbestos products.

8.1.2 Waste Generation

There are no asbestos mines in the Western Cape. Production of asbestos materials did occur at the old Everite factory in Brackenfell. The factory landholding has a series of asbestos dumps and contaminated areas which have been rehabilitated.

The bulk of asbestos waste is generated by demolition and refurbishment of buildings, particularly old factories. The decommissioning of power stations and other forms of high temperature installations including boilers, furnaces and marine engine rooms on ships generates the largest volume of friable asbestos waste.

8.1.3 Waste Characterisation and risks

Pure asbestos does not pose a chemical hazard to water quality by chemical leaching and is essentially an air quality problem. Since asbestos also appears in various products and materials, four classes of asbestos waste are recognised, from class A to class D. Any of these classes of asbestos containing waste can be delisted to the status of general waste if it can be conclusively proven that release of asbestos fibres do not exceed the action limit value of 0.5 asbestos fibres per mm. Such delisted waste can be disposed of on approved and permitted GB^+ rated disposal sites.

Table 8.1.3.1 Classification of Asbestos Containing Waste (DWAF, 2005)

ASBESTOS WASTE CLASS	EXAMPLES
▪ CLASS A - FRIABLE ACW	▪ RAW ASBESTOS FIBRES. ▪ BAGS PREVIOUSLY USED TO STORE AND TRANSPORT RAW ASBESTOS (THAT HAVE NOT BEEN MELTED INTO A SOLID MASS). ▪ ASBESTOS INSULATION, LIMPET SPRAY OF PIPE LAGGING FROM POWER STATIONS, BUILDINGS, BOILERS OR PIPE WORK. ▪ ASBESTOS ROPE OR TEXTILES.
▪ CLASS B - ANY NON-FRIABLE ACW THAT HAS BECOME PULVERISED OR POWDERED DURING THE MANUFACTURING, INSTALLATION, RENOVATION OR DEMOLITION, SUCH THAT IT IS LIKELY TO RELEASE FIBRES INTO THE AIR.	▪ DRY SWARF OR CUTTING DUST FROM ASBESTOS-CEMENT. ▪ USED FILTER BAGS FROM DUST EXTRACTION UNITS AT THE WORKPLACE. ▪ ASBESTOS-CEMENT THAT HAS BEEN CRUMBLED, POWDERED OR PULVERISED DURING DEMOLITION WORK. ▪ DISPOSAL EQUIPMENT AND CLOTHING CONTAMINATED WITH ASBESTOS.
▪ CLASS C - ANY CLASS B ACW THAT HAS BEEN ADEQUATELY WETTED OR OTHERWISE ENCAPSULATED SUCH THAT IT WILL NOT RELEASE FIBRES INTO THE AIR.	▪ WET SWARF OR CUTTING DUST FROM ASBESTOS-CEMENT. ▪ SLUDGE, SLURRY OR WET ASBESTOS WASTE FROM THE PRODUCTION PROCESS. ▪ BAGS USED TO TRANSPORT ASBESTOS THAT HAVE BEEN MELTED INTO A SOLID MASS IN AN AUTOCLAVE.
▪ CLASS D - ANY NON-FRIABLE ACW THAT IS IN ESSENTIALLY THE SAME CONDITION WHEN MANUFACTURED AND IS UNLIKELY TO RELEASE RESPIRABLE FIBRES AFTER BEING DECLARED A WASTE PRODUCT.	▪ ASBESTOS-CEMENT SHEETS OR PIPES. ▪ OFF-CUTS OF ASBESTOS-CEMENT SHEETS OR PIPES. ▪ DISUSED FRICTION PRODUCTS SUCH AS GASKETS, BRAKE PADS OR CLUTCH PLATES.

Friable asbestos material is defined by the United States Environmental Protection Agency (USEPA) as any material containing more than 1% asbestos as determined using polarised light microscopy, that when dry can be crumbled, pulverised or reduced to powder by hand pressure. This definition has been adopted in South Africa under the Health and Safety Executive (MDHS, 2001). Due to problems associated with encountering ACW in the workplace any waste material suspected of containing asbestos that is friable falls into Class A. In most asbestos waste likely to be encountered during building maintenance and demolition the fibres are visible with the naked eye and physical state of the material is obvious.

8.1.4 Current Waste Management Practices

- All operational, handling, transportation and disposal methods must follow the Asbestos Regulations, no 155 of 2002 of the Department of Labour.
- Asbestos cement products that are intact with no powdering or danger of fibre release can be maintained (carefully cleaned and painted) and if re-used in this manner waste from demolition sites can be minimised. However, particularly in costal environments cement sheeting becomes weathered over time (a lifespan of approximately 30 to 40 years is appropriate) and cement bonds are weakened. This material is not suitable for re-use and should be disposed of as waste. It is recognised that in informal settlement old asbestos-cement sheeting is commonly used as a building material and thus is sought after by waste scavengers. These materials are hazardous and should be disposed following the approved methods outlined below.
- Landfilling. – Application for disposal of ACW is site specific matter involving approval of design and operational plans for asbestos disposal at the site. There are approved sites that are mono-disposal sites and there is co-disposal. In most cases in the Western Cape ACW will go to co-disposal at either of the Vissershok sites.
- H:h or GB+ landfills can apply for a permit to accept asbestos wastes provided the correct treatment and control procedures are in place. The practice of disposal should not constitute a hazard and permission for disposal will not be granted where informal recycling is taking place or where there is a potential risk to workers on site or the public. Demarcated areas mustbe surveyed and set aside for asbestos disposal.
- All fibrous material must be double bagged in plastic bags (minimum thickness 75 microns). The purpose of the outer bag is to protect against exposure to the dust of contaminated inner bag as ACW is handled from working areas to clean storage areas. Transparent bags are preferred as the waste can be easily inspected without exposure. Class D wastes include large items such as pipes and sheets. The materials should be covered by tarpaulins and wetted prior to transportation.
- On a co-disposal site the ACW a trench should be dug in the waste pile and ACW deposited and immediately covered domestic waste and then carefully compacted. During deep trenching of large volumes of ACW layers of ash or other protective covering fill should be used to separate and protect ACW from pulverising during landfilling.
- During landfilling care must be taken not to break bagged waste. Only essential personnel should be allowed close to the aste during disposal. Personal protective clothing conforming the Asbestos Regulations must be worn at all times.
- No scavenging or reclamation activities should be allowed on or near demarcated ACW disposal areas within a waste site.
- No further trenching should be allowed on top of an area used for ACW unless it is covered with at least 4m of compacted ACW.
- Monitoring of all staff involved in the disposal is required by the Occupational Health and Safety Act (181 of 1993).

8.2 Waste Management Options

8.2.1 Reduce

8.2.1.1. Banning of Asbestos Products

The Department of Environmental Affairs and Tourism supports the banning of asbestos products in South Africa and in most cases alternative natural and synthetic fibre products are available so as to make asbestos obsolete as a commercial product. Abatement of asbestos in existing use should be undertaken as the need arises and asbestos containing materials should be disposed of as hazardous waste and replaced with non-asbestos containing substitutes during maintenance and refurbishment of facilities. It is thus predicted that there will be a gradual reduction of asbestos waste volumes over time, but that this gradual abatement of asbestos may take at least 20 years.

8.2.2 Re-use

8.2.2.1. Re-use of Old Asbestos

Reuse of asbestos products is regarded as unacceptable practice. A large amount of asbestos cement sheeting and asbestos cement pipework is technically suitable for reuse in construction, being intact and non-friable, however, this reuse is contrary to the principles of abatement.

The informal reuse of asbestos sheeting in informal settlements in South Africa is cause for concern as this material is normally damaged and then further cut to shape for reuse without any precautions to prevent fibre release. The recovery of this hazardous waste is a long term issue which needs to be addressed in re-housing schemes.

8.2.3 Recycle

8.2.3.1. Recycling of Old Asbestos

Recycling of asbestos waste is unacceptable practice.

8.2.4 Treatment

9.2.4.1 Treatment of Old Asbestos

Simple treatment techniques are applied in the safe removal, handling and transportation of asbestos wastes. Wetting is the simplest technology used to control the emissions of particulate asbestos during demolition and removal is to sufficiently penetrate the ACW with liquid to prevent powdering and fibre release. Suitable liquids include a wetting agent, surfactant chemicals, and or plain water. The waste should be visibly wet and measures should be taken during handling, transport or disposal to ensure it does not dry out.

Solidification of ACW can be accomplished using cement and other fixation agents such as water based silicates. Cementation with Ordinary Portland Cement can be cost effective in reducing Class A fibrous ACW to lower risk categories and hence ‘delist’ the waste.

9.2.5 Disposal

9.2.5.1 Disposal of Old Asbestos

Application for disposal of ACW is site specific matter involving approval of design and operational plans for asbestos disposal at the site. There are approved sites that are mono-disposal sites and there is co-disposal. In most cases in the Western Cape ACW will go to co-disposal at either of the Vissershok sites.

H:h or GB+ landfills can apply for a permit to accept asbestos wastes provided the correct treatment and control procedures are in place. The practice of disposal should not constitute a hazard and permission for disposal will not be granted where informal recycling is taking place or where there is a potential risk to workers on site or the public. Demarcated areas must be surveyed and set aside for asbestos disposal.

All fibrous material must be double bagged in plastic bags (minimum thickness 75 microns). The purpose of the outer bag is to protect against exposure to the dust of contaminated inner bag as ACW is handled from working areas to clean storage areas. Transparent bags are preferred as the waste can be easily inspected without exposure. Class D wastes include large items such as pipes and sheets. The materials should be covered by tarpaulins and wetted prior to transportation.

On a co-disposal site a trench should be dug in the waste pile and ACW deposited and immediately covered domestic waste and then carefully compacted. During deep trenching of large volumes of ACW layers of ash or other protective covering fill should be used to separate and protect ACW from pulverising during landfilling.

During landfilling care must be taken not to break bagged waste. Only essential personnel should be allowed close to the aste during disposal. Personal protective clothing conforming the Asbestos Regulations must be worn at all times.

No scavenging or reclamation activities should be allowed on or near demarcated ACW disposal areas within a waste site.

No further trenching should be allowed on top of an area used for ACW unless it is covered with at least 4m of compacted ACW.

Monitoring of all staff involved in the disposal is required by the Occupational Health and Safety Act.

8.3 BPEO

8.3.1 Current Options

The current waste disposal practices as outlined in section 0 is regarded as good practice conforming with international standards.

8.3.2 Future Options

In the last few years in South Africa there has been a considerable effort to upgrade legislation and encourage best practice in all aspects of asbestos management. The Department of Environmental Affairs and Tourism imposed prohibition on the use of asbestos. However imports of asbestos products do continue to enter the country, mainly from Zimbabwe The historic use of the material has resulted in considerable volumes of asbestos still being in everyday use particularly as thermal insulation and as asbestos-cement building materials. Hence, despite predicted reductions in the generation of asbestos waste in future, safe disposal of asbestos is likely to be a waste management issue for many years.

The fly tipping of asbestos waste as building rubble on open ground and particularly close to informal settlements is a problem. This problem is likely to exist in areas further away from Vissershok. It is suspected that uncontrolled disposal of asbestos waste to smaller general waste sites is commonplace. In this case it may be necessary to review the delisting and disposal procedures for small volumes of asbestos waste so that smaller general wastes site may be permitted to dispose of the ACW if an adequate disposal plan can be implemented.

8.4 Bibliography

- US EPA: Asbestos NESHAP Adequately Wet Guidance; EPA 340/1-90-019, December 1990.
- US EPA: Guidelines. Waste containing asbestos: removal transport and disposal. 2004
- Department of Water Affairs and Forestry, 'Minimum Requirements for the Classification, Handling and Disposal of Hazardous Waste' 3RD edition, Pretoria, 2005 in draft
- Health and Safety Executive, MDHS 100, surveying, sampling and assessment of asbestos-containing materials. 2001.

9 Special Hazardous Waste - Waste Fluorescent Lamps

9.1 Waste Review

9.1.1 Description of Waste Type

Fluorescent tubes, compact fluorescents, incandescent lighting (homes) and high-intensity discharge (HID) lamps all contain small quantities of toxic mercury. HID lamps include high-pressure sodium, metal halide and mercury vapour lamps. Low-pressure sodium lamps do not contain mercury or other heavy metals. These and other “green” or low-mercury content lamps are not considered hazardous waste.

The primary concern regarding such products is that when they are broken, compacted or incorrectly disposed of, they can release mercury into the air, water or soil. This poses a serious threat both to human health and the environment. It is estimated that 70% of all artificial light produced in the world is generated by fluorescent lighting (WRC, 2005).

9.1.2 Waste Generation

Lighting waste is generated from the spent tubes and lamps that were used for various lighting applications. Fluorescent and compact fluorescent lamps are mostly used in factories, offices, schools, homes, hotels and restaurants. Incandescent bulbs are mostly used for lighting in residential homes. HID lamps are used primarily for industrial purposes and security lighting, railway and road lighting, and motor vehicles.

Fluorescent tubes and similar types of lighting are considered hazardous “universal wastes” due to the many sources of waste generation. Because universal wastes are such commonly used products, they generally pose relatively low risks during storage or transport and can be collected for recycling.

9.1.3 Waste Characterisation and risks

Table 9.1.3.1: Waste characterisation, risk and disposal of lamps.

LAMP TYPE	HAZARDOUS CONSTITUENT	AVERAGE QUANTITY/LAMP	HAZARD RATING	LANDFILL DISPOSAL
FLUORESCENT LAMPS	MERCURY	5 – 15 MG (ECO: 3 – 5 MG)	1	H:H
COMPACT FLUORESCENTS	MERCURY	5 MG	1	H:H
SODIUM VAPOUR: LOW AND HIGH PRESSURE (HID)	SODIUM AS SODIUM OXIDE	< 0.2%	2 2	H:H H:H
MERCURY VAPOUR (HID)	MERCURY	20 – 30 MG	1	H:H
METAL HALIDE (HID)	MERCURY	10 – 15 MG	1	GENERAL (SMALL QUANTITIES)
	SODIUM IODIDE		4	
INCANDESCENT	LEAD	VERY SMALL QUANTITIES	2	GENERAL

Source: Water Research Commission, 2005

Mercury is a class C&D carcinogen and mutagen, the DWAF Acceptable Environmental Risk for protection of water resources is 0.024 parts per million (ppm) for aquatic ecosystems and 0.03 ppm for human exposure (DWAF Minimum Requirements, 2005).

In theory a fluorescent tube contains enough mercury to pollute water above the safe-to-drink level of 5µg Hg per litre.

Fluorescent tubes contain elemental mercury mixed with phosphor powder which, when crushed, releases mercury vapour which, once released, is very difficult to contain. Any product containing greater than 0.2 milligrams per litre mercury must be managed as hazardous waste. Mercury is toxic to all organisms and is bio-accumulative in fatty tissues.

Light ballasts, the electrical components at the end of fluorescent light fixtures, have small capacitors that may contain polychlorinated biphenyls (PCBs), another hazardous substance. Ballasts manufactured prior to 1979 may contain PCBs and another hazardous, oily fluid. Ballasts produced after this date are marked "Non-PCB" but may contain a PCB replacement, di-ethylhexyl phthatlate (DEHP), a human carcinogen replaced by dry capacitors after 1991. The major concern regarding disposal of used fluorescent ballasts is the potential health risk associated with PCBs. Exposure to this carcinogen can cause skin, liver and reproductive disorders.

Fluorescent, incandescent and HID lighting also contain small amounts of a range of potentially harmful substances such as cadmium and lead, although technological improvements have reduced the quantities of these metals as well as mercury.

9.1.4 Current Waste Management Practices

Fluorescent lighting and HID lamps were traditionally disposed of at landfills or incinerated. This is regarded as unsatisfactory due to the wasted resources, including manufacturing costs and the environmental costs of production and disposal or damage. The BPEO for such products nowadays is to prevent waste through minimising the use of dangerous substances in the manufacturing of the product, and by collection and treatment prior to disposal or recovery and re-use. Recovery and re-use applies mostly to metal compounds present in such lighting or lamps. Recycling of tubes and lamps is currently not practiced in South Africa.

9.2 Waste Management Options -

9.2.1 Reduce

9.2.1.1. Reduction in Mercury Content

There is a global trend towards the reduction in the mercury content of fluorescent lights. The amount of mercury in fluorescent lamps has reduced, with the average 1.2 metre lamp containing 75% less mercury than in the past (WRC, 2005).

9.2.1.2. Use of Mercury-free Lighting

Generally, mercury-free electric lamps cannot be substituted for mercury containing lamps because of incompatibilities of light output, shape, colour, life, electrical characteristics, and excessive heat, or because their increased energy consumption may violate energy codes, and overload electrical circuits. Despite continuous research by the private sector, government research laboratories, and academia, no viable replacement has been discovered for mercury in general purpose fluorescent lights. Mercury-free xenon-based fluorescent discharges are available in a flat panel format, however these are only suitable for back lighting of liquid crystal displays. The efficiency is approximately 30% of a normal mercury-based fluorescent lamp, and therefore this technology is environmentally counterproductive for general lighting applications.

9.2.1.3. Reduction in Mercury Content

There is a global trend towards the reduction in the mercury content of fluorescent lights. The amount of mercury in fluorescent lamps has reduced, with the average 1.2 metre lamp containing 75% less mercury than in the past (WRC, 2005).

9.2.1.4. Reduction in Waste Volume

Crushing of fluorescent lamps can reduce the waste volume by approximately 80%. Crushing reduces transportation and storage costs and can reduce the risk of releasing mercury vapours if accidentally broken during storage and transportation. The recommended crushing method involves the use of high quality crushers that utilise mercury filters or other technology that reduces mercury emissions. The drum or container used to store the tubes must be kept tightly sealed and stored in a cool, dry and ventilated area. The tubes are collected and pushed into purpose made drums which allows the tubes to be crushed inside the drum. Once full, the drum is sealed and disposed of on a hazardous landfill site. Crushing of lighting waste reduces the volume of waste to be landfilled resulting in increased availability of airspace at hazardous landfill sites. The person crushing the waste should wear personal protective equipment (PPE).

9.2.1.5. Reduction in Energy Consumption

Compact fluorescent lamps consume 80% less energy and last longer than the incandescent lamp. Replacing incandescent lamps with the compact fluorescent lamps will result in more energy efficient lighting.

9.2.2 Recycle and Recovery

9.2.2.1. Recycling and Recovery of Mercury

The practice of recycling fluorescent tubes to recover mercury is not currently undertaken in South Africa, however, it has been taking place in USA and Europe for many years. The reprocessing of fluorescent tubes occurs in two stages:

1. The tubes are dry processed via crushing, sieving and magnetic separation. This results in the generation of three fractions – fluorescent powder, a glass scrap fraction and an aluminium/metal socket-end fraction.
2. The fluorescent powder is heated under vacuum while simultaneously supplying oxygen to the afterburner. The mercury is ventilated off from the powder and collected in condensers. This method allows 99% of the mercury to be recovered with a purity of 99.98%.

9.2.2.2. PCB Ballast Recycling

In some parts of the world qualified recyclers are capable of separating glass, mercury and other metals – keeping lamps intact prevents mercury exposure. Recyclers remove PCB ballasts for high temperature incineration, which breaks down PCBs in the ballasts, permanently removing them from the waste stream and leaving safely disposable waste and metals such as aluminium, copper and steel which can be reclaimed for recycling or disposed of at municipal landfills.

Options for ballast recycling depend on the date of manufacture (i.e. PCB content) and whether they are leaking or not: Non-leaking PCB ballasts can be recycled at PCB-capable operators. The most suitable option for non-PCB ballasts is recycling.

9.2.3 Treat

Fluorescent tubes in large quantities are considered extremely hazardous due to the high mercury content. DWAF policy on the disposal of large quantities of fluorescent tubes states that the waste can only be disposed of at a hazardous landfill site after treatment. Treatment involves the addition of a 50% sodium sulphide – 50% sulphur solution in a 1:10 ratio. This solution is added to the tubes crushed under controlled conditions in a drum.

9.2.4 Dispose

9.2.4.1. Disposal at General Landfill

Small quantities of lighting, HID and incandescent lamps can be disposed of in a general landfill site. The source of this waste would be primarily from residential household use.

9.2.4.2. Incineration

Incinerators must prevent the release of mercury into the atmosphere via flue smoke. Heated mercury turns into mercury vapour which poses a long term environmental risk as it is deposited in streams, lakes and waterways from the atmosphere when it rains.

9.2.4.3. Disposal at a Hazardous Landfill facility

Large quantities of lighting waste from commercial and industrial activities must be disposed of in a controlled manner at a hazardous landfill site after treatment (see Section 10.2.3 above). DWAF policy on disposal of fluorescent tubes states that under no circumstances may large quantities of fluorescent tubes be disposed of in a general landfill site (WRC, 2005). Mercury may only be disposed of at an H:H facility and only after treatment to fix the mercury to an immobile state. Fluorescent tube crushers (drums) must be fitted with mercury filters or rubber seals; storage drums must also be fitted with rubber seals and a tight-fitting cap and must be disposed of at an H:H waste facility.

Leaking PCB ballasts must be handled with extreme caution to avoid exposure and contamination. Leaking ballasts are handled as PCB waste and disposed of at a hazardous waste facility.

9.3 BPEO

9.3.1 Current Options

- Due to the energy efficiency of fluorescent bulbs it is currently not considered feasible to reduce waste through switching to non-fluorescent lighting techniques. Large volume generators can follow the following guidelines to reduce the volume of used fluorescent bulb waste.
  - Replace 38mm fluorescent bulbs with 26mm fluorescent bulbs which have a longer lifespan (this may not be possible in some older fittings).
  - Use natural light wherever possible.
  - Make sure lights can be switched off manually, particularly near windows.
  - Run 'Switch Off' campaigns. Contrary to popular belief, it is always cheaper to switch off lights, however short the time period.
  - Ensure that lighting levels are not excessive. It may be able to reduce the level of background lighting in some areas by removing alternate bulbs.
  - Consider the installation of presence detector lighting controls in places not in constant use, such as lavatories and meeting rooms.
  - Ensure that occupants are well briefed on automatic control systems and how to get the most efficient lighting performance from them. Staff need to

understand what the control system is trying to do, and how best to interact with it.

- Crushing and hazardous landfill disposal – a preferred method of dealing with large volumes of fluorescent waste is to reduce the volume of the waste by carefully controlled crushing (see Section 10.2.1.4) prior to disposal in crushing drums at a hazardous landfill site.
- Landfill Disposal (with treatment) – The disposal of large quantities of fluorescent waste at a hazardous landfill site with treatment is the most suitable option. See Section 10.2.3 and 10.2.4.3. Small quantities of lighting waste can be disposed of at general landfill facilities, see Section 10.2.4.1.

9.3.2 Future Options

- Use of Mercury-free lighting – It is possible that replacements will be discovered for mercury in general purpose fluorescent lights, however this option is technology is currently not available.
- Recycling program – The most preferred option for managing fluorescent waste is to undertake mercury lamp recycling. A mercury lamp recycling programme should be initiated based on international precedents. The aim of this program would be to promote mercury lamp recycling by commercial and industrial users and to increase awareness of proper disposal methods, and open economic opportunities for recycling businesses. The recycling of fluorescent waste has numerous benefits including reducing use of raw materials, reducing waste volumes, and promoting economic opportunities.

9.4 Bibliography

- EHSO.com (2005). EHSO's Fluorescent Lights and Lighting Disposal and Recycling Page, Environmental, Health and Safety Online.
- Govlink.org (2005). Fluorescent Lamp Waste: Spotlight on the Rule. Local Hazardous Waste Management Program, King County, Washington, 2pp.
- www.epa.gov
- www.dwaf.gov.za/Documents/Policies – Disposal of Fluorescent Tubes in Large Quantities
- H2e-online.org (2004). Universal Waste. Hospitals for a Healthy Environment.
- SEPA (2001). No Option but Change – Fourth Valley Draft Area Waste Plan. Scottish Environment Protection Agency, 52pp.
- WRC (2005). Draft Report: Guidelines for the Classification, Rating and Disposal of Common Industrial Hazardous Waste Streams, WRC Research Project No. 1548. WRC and Environmental Business Strategies, 119pp.

10 Special Hazardous Waste - Waste Batteries

10.1 Waste Review

10.1.1 Description of Waste Type

- Wet cell (lead-acid) Batteries - Wet cell batteries are used in cars, trucks, motorcycles, boats, and other motorised equipment. They are rechargeable and consist of a polypropylene plastic case containing lead plates immersed in a sulphuric acid electrolyte. The main hazardous constituents found in wet cell batteries are:

▪ LEAD ▪ LEAD OXIDE ▪ LEAD SULPHATE	▪ SULPHURIC ACID ▪ ANTIMONY

- Dry Cell Batteries
  - Non-rechargeable (primary) dry cell batteries are those commonly used in general household appliances and are disposed of after a single use. General household battery types include zinc carbon and zinc chloride (used in torches, clocks etc); alkaline manganese (used in personal stereos); mercury oxide and zinc air batteries (used in hearing aids pacemakers, and photographic equipment); silver oxide (used for watches and calculators) and lithium (watches and photographic equipment). In terms of international guidance, alkaline and zinc carbon batteries as low volume household waste are not regarded as hazardous waste.
  - Rechargeable (secondary) dry cell batteries are used in electric appliances such as cellular phones, video cameras, cordless power tools, etc. Types of rechargeable dry cell batteries include nickel cadmium (used for cordless power tools, portable telephones, and laptops), nickel metal hydride which is a less environmentally harmful alternative to nickel cadmium; lithium ion and lithium polymer batteries (used for cellular phones and notebook computers).

  The elements and compounds found in dry cell batteries include:

▪ ZINC ▪ MERCURIC OXIDE ▪ MERCURY ▪ MANGANESE ▪ NICKEL ▪ CARBON BLACK	▪ ZINC CHLORIDE ▪ MERCURY CHLORIDE ▪ AMMONIUM CHLORIDE ▪ SILVER ▪ CADMIUM ▪ LITHIUM

10.1.2 Waste Generation

Batteries are used in domestic, commercial and industrial activities. Batteries are considered hazardous ‘universal wastes’ due to the many sources of waste generation. Depending on the scale of waste generation guidelines can be developed to assist generators of both large and small volumes of universal waste. Universal wastes include commonly used household products, and they generally pose relatively low risks during storage or transport and can be collected for recycling. As intact household waste in small volumes they are considered as an unwanted but inevitable component of the general domestic waste output.

10.1.3 Waste Characterisation and risks

The variable heavy metal content of the different battery types classify the battery wastes as hazardous materials according to DWAF Minimum Requirements. For example wet cell batteries have an overall hazard rating of 2 (or 1, if antimony is used as an alloying metal (WRC, 2005).

Wet cell batteries: Hazard rating according to constituent elements and compounds:

HAZARDOUS CONSTITUENT	HAZARD RATING
LEAD	2
LEAD OXIDE	2
LEAD SUPHATE	4
ANTIMONY	1
ARSENIC	2
SULPHURIC ACID	4

Source: WRC, 2005

Dry cell batteries: hazard rating according to constituent elements and compounds.

NON RECHARGEABLE		RECHARGEABLE	
HAZARDOUS CONSTITUENT	HAZARD RATING	HAZARDOUS CONSTITUENT	HAZARD RATING
ZINC	2	CADMIUM	1
ZINC CHLORIDE	2	NICKEL	2
MERCURIC OXIDE	1	LITHIUM	2
MERCURY	1		
MANGANESE	2		
AMMONIUM CHLORIDE	2		
SILVER	1		

Source: WRC, 2005

The waste loading of the small volumes of household battery waste that are generated in the domestic solid waste stream is such that this waste stream delists to a general waste.

10.1.4 Current Waste Management Practices

- Common practice is for batteries to be discarded with other general waste and disposed of in general landfill sites. Disposal of large quantities of batteries in this manner could contribute significantly to soil, surface water and groundwater contamination.
- According to the City of Cape Town Integrated Waste Management Plan (Ch. 10) batteries from the ferrous metals industry are landfilled with ash blend at the Vissershok Waste Management Treatment Facility.
- There is a current trend towards the increased use of rechargeable batteries, the recycling of Ni-CD batteries and the reduction of the mercury content in batteries (WRC, 2005).

10.2 Waste Management Options

10.2.1 Reduce

10.2.1.1. Rechargeables

The use of rechargeable batteries reduces the overall battery waste produced. This requires the initial investment into a battery charger, thereafter the use of rechargeable batteries is much less expensive in the long run. In the last year the increased availability and reduced cost of rechargeables has made this option realistic and there is an anticipated worldwide trend in reduction of battery wastes as a result.

10.2.2 Recycle

10.2.2.1. Return to Supplier

Wet cell batteries are returned to the supplier for recycling. Most manufacturers take back used or old batteries for recycling of the lead and plastic. Old battery acid is either neutralised or treated and discharged to the effluent system; or converted into sodium sulphate, an odourless white powder used in laundry detergent, glass and textile manufacturing. In South Africa, approximately 95% of used or old wet cell batteries are returned to suppliers and recycled (WRC, 2005). Options for the recycling of dry cell batteries are limited.

10.2.2.2. Recover metal elements

Rechargeable batteries contain metals like cobalt, nickel, cadmium and iron that can be recovered by recycling. Recycled nickel and iron are used in stainless steel industry for production of many industrial and domestic products. Recycled cobalt may be used for magnet alloy, ceramics and aircraft industry. Recycled cadmium is used to make new rechargeable batteries.

The South African Batteries Manufacturers Association collects about 85% of lead-acid batteries. The recovery occurs during the replacement phase of the product life-cycle. A levy is applied at the point of sale of the replacement battery if the old battery is not returned for recycling (a ‘one for one’ approach). Other collection sources include scrap metal dealers and the informal waste scavenging sector. The recovered batteries are traded to recycling plants. In South Africa there are four secondary lead smelters and the bulk of the lead smelted comes from recycled batteries. There are inherent environmental risks associated with lead smelting in terms of airborne emissions and both occupational and community health issues. The lead recycling industry thus requires stricter control measures than previously applied.

Waste management initiatives that can be applied to reduce waste generation include retail collection and buy-back for commercial and certain household battery products, and waste separation for larger waste generators.

10.2.3 Dispose

10.2.3.1. Hazardous landfill disposal

Wet and dry cell batteries should be disposed of at a hazardous H:H waste site where these is proper leachate management. Treatment, such as encapsulation, may be required prior to disposal.

10.2.3.2. Incineration

Incineration is not regarded as an acceptable disposal option as hazardous compounds are released into the atmosphere. In particular, cadmium (contained in some types of dry cell batteries) is volatised and released into the atmosphere when incinerated and metallic cadmium condenses onto the smallest particles of incinerator smoke, which are difficult to contain by pollution control devices (WRC, 2005).

10.3 BPEO

10.3.1 Current Options

- Use of Rechargeables – This is the preferred option as the re-use of rechargeable batteries significantly reduces the volume of battery waste. This option would best be introduced through a general waste management awareness programme.

- Recycling – this is the most suitable method of dealing with used wet cell batteries. This involves returning batteries to the supplier. Most manufacturers take back used or old batteries for recycling of lead and plastic. This is the preferred option for dealing with wet cell batteries from an economic and environmental perspective. The options for recycling dry cell batteries are limited.
- Recovery of metal fractions - metals like cobalt, nickel, cadmium and iron can be recovered by recycling. The result is a reduction in the use of raw materials for new products as well as resources for the production of new rechargeable batteries.
- Hazardous Landfill site (with treatment) - in the absence of recycling and recovery opportunities, the landfilling of battery waste is the preferred option. This is most suitable as leachate and gas management systems at hazardous landfill sites reduce the possible environmental impacts associated with emissions.

10.3.2 Future Options

- Increasing recycling and recovery activities – Recycling and recovery activities are currently taking place. In the long term these can be expanded and encouraged. This would result in further reuse of useful fractions and reduce the overall e-waste stream to a minimum.

10.4 Bibliography

- WRC (2005). Draft Report: Guidelines for the Classification, Rating and Disposal of Common Industrial Hazardous Waste Streams, WRC Research Project No. 1548. WRC and Environmental Business Strategies.
- WSP Environmental (2003) Anglo Gold Waste Management Strategy. Waste Management Guidelines.
- www.epd.gov.za – Environmental Protection Department, Hong Kong. Ways to reduce battery waste.
- www.hazardouswaste.utah.gov – Utah Department of Environmental Quality. Pollution Prevention Fact Sheet, Used Battery Disposal.
- www.epa.gov – US Environmental Protection Agency. Streamlined Regulations for Universal Waste.
- www.rayovac.com – Are batteries hazardous waste?

11 Special Hazardous Waste - Waste Paints & Solvents

11.1 Waste Review

11.1.1 Description of Waste Type

Paint is generally categorised as non-solvent based and solvent based paint. Typical examples include:

- Solvent Based:
  - Oil based paint including enamel, lacquer, shellac and/or varnish.
  - Hobby or artist paint which may include solvents and/or heavy metals.
  - Aerosols (spray paint) which may include solvents and propellants.
- Non-solvent Based:
  - Water based paint (latex)

Solvents are generally produced from petroleum or alcohol feedstock. They are used to dissolve other substances to form a uniformly dispersed mixture (solution). The following solvents are identified as hazardous:

ACETONE	ETHYL ETHER
N-BUTYL ALCOHOL	METHANOL
CARBON DISULPHIDE	METHYL ETHYL KETONE
CARBON TETRACHLORIDE	NITROBENZENE
CRESOLS	PYRIDINE
CYCLOHEXANONE	TETROCHLOROETHYLENE
1,2-DICHLOROBENZINE	TOLUENE
ETHYL ACETATE	1,1,1-TRICHLOROETHANE
ETHYL BENZENE	TRICHLOROETHYLENE
	XYLENE

Source: WRC, 2005

The most common types of paint and solvent waste are described as follows:

- Empty tins or containers of paint or solvent that still contain the residual contents;
- Full containers of solute (paint, grease, ink, oil etc.) / solvent solution; and
- Obsolete containers of paint and solvent (e.g. past their expiry date / contaminated).

11.1.2 Waste Generation

The following key paint waste generation activities have been identified in the Western Cape:

- Industries for the manufacturing of adhesives, sealants and non-solvent based paint (non-solvent paint waste and water based pit sludge);
- Industries for the manufacturing of explosives and propellants (paint sludge); and

- Diffused source - maintenance activities or activities involving the painting of surfaces, articles, products, machines etc, (residual paint and empty paint containers).

The following key **solvent waste** generation activities have been identified in the Western Cape:

- Food Sector - extraction of oils from seeds;
- Steel works and foundries (mainly solvent cleaning waste);
- Production of electricity (gas turbine) (mainly from plant washings);
- Metal finishing industries (halogenic and non-halogenic solvent waste);
- Manufacturing of adhesives, sealants and non-solvent based paint (benzene and toluene);
- Laboratories linked to the manufacturing of pharmaceuticals;
- Tyre converters (conversion and moulding of retreads);
- Paper and cardboard (mainly white spirits); and
- Printing and publishing (mainly ink / solvent sludge from equipment cleaning).

The above information is referenced from the City of Cape Town Integrated Waste Management Plan (Ch. 10). The volumes of hazardous waste produced by each industry contained therein are not accurate and have not been reproduced here.

11.1.3 Waste Characterisation and risks

- Paint waste (solvent based):
  - SANS (0228) Class 3 - Flammable liquid and/or Class 6 - Poisonous and infectious.
  - SANS (0228) Danger group II (serious risk) to danger group III (relatively low risk).
- Paint waste (non-solvent based) :
  - SANS (0228) Class 3 - Flammable liquid and/or Class 6 - Poisonous and/or infectious.
  - NB. Paint containing heavy metals may lead to contamination of surface water. Bioaccumulation may occur in the food chain.
- Solvent waste:
  - SANS (0228) Class 3 - Flammable liquid (low, medium and high flashpoint) and/or Class 6 - Poisonous and infectious.
  - Danger grouping ranges from 1 (extreme risk) to 4 (low risk) and may have tetrogen, mutgen, and/or carcinogen properties.
  - NB. Chlorinated solvents bio-accumulate and are difficult to destroy. They can cause a range of air quality, surface and ground water impacts.

11.1.4 Current Waste Management Practices

Current solvent and paint waste management practices include legal disposal, illegal disposal, accumulation and recycling.

11.1.4.1. Legal disposal

- The encapsulation of chlorinated solvents (and PCB's) is still commonly used by the Vissershok Waste Management Treatment Facility (Enviroserv/Wasteman).

- Non-chlorinated solvents are disposed at Vissershok Waste Management Treatment Facility and Vissershok Complex of the City of Cape Town using the following methods:
  - Landfilling without treatment; and
  - Landfill ash blend
- Solvent and non-solvent Paint waste is disposed at Vissershok Waste Management Treatment Facility by Landfilling without treatment.

11.1.4.2. Illegal disposal

It is likely that large quantities of household (civil sector) paint and solvent waste are discharged directly to open waters, the stormwater system (e.g. drains, gutters or pits), the sewer or general landfill. Such practices are likely to be a result of:

- Lack of knowledge with regards to environmental and health risks;
- Disposal and transport costs associated with proper disposal; and
- Lack of nearby / suitable facilities for safe disposal.

11.1.4.3. Accumulation

Large quantities of paint and solvent waste are likely to have accumulated at industrial operations. Such accumulations may be stored without secondary containment, resulting in potential environmental and health risks. The primary reason for accumulation is the disposal and transport costs associated with proper disposal and/or lack of knowledge with regards to recycling opportunities.

11.1.4.4. On/off-site Solvent Recycling

In some industries, solvents are recovered through the use of on-site recovery. Dirty solvents are also collected (usually purchased) by solvent recovery companies for recovery of solvents; heavily contaminated solvents are generally not suitable for recovery.

11.2 Waste Management Options

11.2.1 Reduce

11.2.1.1. Non-hazardous Paint and Solvent Substitution

Businesses may be able to eliminate their hazardous paint and solvent wastes by finding an aqueous or semi-aqueous cleaner to replace the solvent, or water based heavy metal free paint. Extensive literature is available on the World Wide Web (E.g. http://www.epa.state.oh.us/opp/solvents/fact9.html) including fact sheets on solvent substitution and alternatives to ozone depleting substances.

11.2.1.2. On-site Solvent Recovery (industrial sector)

Solvent waste generation can be reduced through the implementation of industrial process modifications, which reduce the volume of solvents consumed through recycling. Typical on-site solvent recovery systems include:

- Simple distillation units - solvent wastes are heated, driving off the solvent in vapour form. The vapour is reverted back to liquid form in the condenser and collected. The still bottoms, or waste remaining in the bottom of the still is then collected and disposed.
- Fractional distillation units – these produce a higher purity of recycled product. A fractional still may separate an industrial solvent blend into its pure

constituents. Fractional distillation units are generally more expensive to operate and are generally better suited to larger volumes.

- Thin film evaporators - distil by running a thin film of dirty solvent down a heated cylindrical vessel where it is vaporized. The vapors are collected and condensed back into liquid form for reuse.

11.2.2 Re-use

11.2.2.1. Waste Paint Recycling Programme

Paint Reuse programs can facilitate the collection of leftover household or industrial paint, from where it can be put to use again in community projects. Internationally such programmes have been successful and could be implemented at the municipal level in public / private (e.g. large DIY chains) partnerships.

11.2.3 Recycle

11.2.3.1. Off-site Solvent Recycling

Solvent waste can be transported for recovery at a private sector solvent recovery facility. Since the recovered solvent has commercial value through re-use, most service providers will pay for the waste solvent. Quality control is an important consideration as unknown and/or variable composition of the processed mixtures could affect the recovery process.

Waste solvents are generally treated by vapour recovery, or mechanical separation. Vapour recovery entails removal of solvent vapours from a gas stream in preparation for further reclaiming operations. In mechanical separation undissolved solid contaminants are removed from liquid solvents. Vapour recovery or collection methods employed include condensation, adsorption, and absorption. Technical feasibility of the method chosen depends on the solvent’s miscibility, vapour composition and concentration, boiling point, reactivity, and solubility, as well as several other factors.

After initial treatment, waste solvents are distilled to remove dissolved impurities and to separate solvent mixtures. Separation of dissolved impurities is accomplished by simple batch, simple continuous, or steam distillation. Mixed solvents are separated by multiple simple distillation methods, such as batch or continuous rectification.

11.2.3.2. Off-site Paint Recycling

Local paint reuse and recycling programs may collect paint from residents and commercial businesses. The paint is then taken to a company that will then recycle it into recycled-content paint. This type of paint is created through two processes - reprocessing and re-blending.

- Reprocessed paint is mixed with virgin materials, tested and then packaged for distribution or sale.
- Re-blended paint is remixed, screened and packaged for distribution or sale. Typically re-blended paint comes in only a handful of basic neutral colors. It has a much higher percentage of recycled content paint then reprocessed paint, which may influence its overall quality. Re-blended paint can be used for interior/exterior painting, graffiti abatement, and local improvement projects.

11.2.4 Dispose

11.2.4.1. Disposal of Paint and Solvents at a Hazardous Landfill

Disposal options include Ash blending and/or landfilling without treatment:

- Ash Blending - the blending of waste with fly-ash usually has a two-fold purpose. The fly-ash contains a property of adsorption and absorption as well as neutralisation of acidic properties by the high calcium oxide (CaO) content of the fly-ash.

- Co-disposal – this usually involves the excavation of a small pit and disposal of non-blended liquid into an absorbent waste substrate.

11.2.4.2. Disposal of Solvents by Incineration

Internationally, a common option for the treatment of waste solvents is incineration/thermal destruction in hazardous waste incinerators. Alternatively, the waste solvents can be used as fuel in cement production.

Generally, international cement manufacturing companies do not directly operate programs for marketing, distribution, mixing, and blending of waste derived fuels, these functions of sourcing and supply are being handled by a new group of operations known as fuel blenders, many of which also provide solvent recycling services.

During the early history of waste fuels programs in the United States, the majority of the materials originated from solvent recycling facilities and consisted of process still bottoms, distillation cuts, and other fractions or residues from solvent recovery work. As separate stand alone fuel blending units were located at some cement plants in the US, direct bulk loads from major factories and plants could be added. Some of the plants also added capabilities to receive waste materials in smaller container sizes.

11.3 BPEO

11.3.1 Current Options

- Off-site Recovery of Solvents - This is the preferred method of waste management based in the principle of the waste management hierarchy (Reduces waste to landfill and associated environmental management requirements (cost, environmental, social)). The option would be most accessible to industrial operations consistently generating large volumes of solvents. Since there is only one solvent recycling plant located at Spin Street, Bellville, additional capacity will be required. Strict controls on the quality of waste solvents accepted would potentially preclude some industries with highly contaminated solvent waste.
- Landfilling (with treatment) of Solvents – This method is less preferred to recovery based on it's position in the waste management hierarchy (disposal costs to the waste generator / loss of potential revenue through recycling. The current practice of ash blending and disposal on hazardous landfill sites is regarded as the most practical method for highly contaminated solvent waste streams not suitable for recovery. There is existing capacity at the Vissershok Waste Management Treatment Facility and Vissershok Complex Cape Town area, both are well managed facilities.
- Waste Paint Recycling Programme – This option addresses the issue of hazardous household waste / environmental implications of improper management the possibility of a pilot project should be investigated with the major DIY/home renovation companies and charity organisations.

11.3.2 Future Options

- Non-hazardous substitution - This is the BPEO in preferred method of waste management based in the principle of the waste management hierarchy. Eliminates the generation of hazardous waste / reduces on-site and transportation, occupational health and safety (OHS) and environmental risk associated with handling of hazardous substances. Possible cost / quality implications and or perceptions associated with substitutes will need to be considered as would the availability of suitable substitutes in the South African Market place. Requires capacity building at supply level.

- Promotion of On-site Recovery Technology - This is the preferred method of waste management based in the principle of the waste management hierarchy. Eliminates the generation of hazardous waste / reduces transportation OHS and environmental risk associated with handling of hazardous substances.
- Modified Cement Kiln Safe Incineration – This option should be pursued as a potential option as solvents are suitable for use as kiln fuel. The following issues will need to be addressed before cement kiln incineration can be considered as a safe alternative to landfilling:
    - Potential for poor operational control resulting in emission of hazardous gases.
    - Cement kiln company owners may not want the responsibility of incinerating hazardous material.
    - Public resistance to EIA processes for cement kiln hazardous waste projects - Various South African NGO's and CBO's have consistently voiced their concerns on the burning of hazardous waste in cement kilns. Such activity recently resulted in the refusal of Holcim Cements EIA application to burn hazardous waste in their cement kiln in Dudfield, outside Lichtenberg in the North West Province.

11.4 Bibliography

- UCLA Environment, Health and Safety - Managing Waste Paint & Other Art Supplies (http://www.ehs.ucla.edu/Chemical_Waste.html)
- Gabbard, William D: Hazardous Waste Fuels and the Cement Kilns - The Incineration Alternative (http://gcisolutions.com/libtpub.htm)
- US EPA: Onsite Solvent Recycling Equipment (http://www.epa.state.oh.us/opp/solvents/fact9.html
- Iowa Waste Reduction Centre: *Paints, Solvents and Related Wastes* (http://www.epa.state.oh.us/opp/solvents/fact9.pdf)

12 Special Hazardous Waste - Waste Electronic, Electrical Equipment

12.1 Waste Review

12.1.1 Description of Waste Type

E-waste (electronic and electrical waste) includes computers, cell phones, cathode ray tubes, printed circuit boards, printer and toner cartridges, and white products, which refers to electronic household appliances (fridges, stoves etc).

Computer waste consists of the following:

- Central Processing Unit (CPU) – a case containing the primary printed circuit board (motherboard), and its components (chips, capacitors, connectors, etc), disc drives, a transformer, power cord etc.
- Monitor – a cathode ray tube, or flat panel display (known as liquid crystal display), its case, interior wires and circuitry.
- Printer – a case and contents containing ink or laser cartridges, interior wires, cables, power cords etc.
- Miscellaneous peripheral devices – keyboard, mouse, scanner, CD writers, web camera, loudspeaker, etc

Computers contain the following substances of concern:

ANTIMONY	CHLORINE AND/OR BROMINE
BARIUM OXIDE	LITHIUM
BERYLLIUM	MERCURY
CADMIUM	PHOSPHOR
LEAD	PVC

Source: WRC, 2005

Printed circuit boards contain Antimony, Silver, Chromium, Zinc, Lead, Tin and Copper. They are particularly valuable components of computers as they may contain chips that can be removed and sold for re-use and because they contain valuable metals that can be removed in a smelter. A substantial quantity of copper and other metals such as gold, silver, and palladium are usually recovered through copper smelting followed by metal-specific refining. A cathode ray tube contains by far the greatest amount of all substances of concern in a computer. An older polychrome cathode ray tube can contain up to 3kg of lead, while a new one contains no more than 1kg of lead. The lead is encapsulated in glass, and cannot be released into the environment unless broken into relatively small pieces.

Cell phone waste consists of the following (dependent on model and technological advances):

PLASTIC (ABS-PC) 29% CERAMICS 16% COPPER & COMPOUNDS 15% SILICON PLASTICS 10% EPOXY 9% OTHER PLASTICS 8% IRON 3%	PLASTIC (PPS) 2% FLAME RETARDANT 1% NICKEL AND COMPOUNDS 1% ZINC AND COMPOUNDS 1% SILVER AND COMPOUNDS 1% AL, SN, PB, AU, PD, MN ETC. LESS THAN 1%

Source: WRC, 2005

White product waste includes washing machines, fridges, freezers, stoves etc. Brown products include air-conditioners, microwaves, radios, other audio visual appliances. Fridges, freezers and air-conditions can contain CFC's. Halogenated hydrocarbons have been used extensively as aerosol-spray propellants, refrigerants, and solvents.

12.1.2 Waste Generation

E-waste is generated during household, commercial, manufacturing and industrial use at office buildings, households, schools, universities, industries and government departments. It is only in the major centres that significant amounts of e-waste are generated. The volume of e-waste being generating is increasing as a result of the high rate of technological in this sector which encourages people to buy the latest equipment even when their existing equipment is still functioning.

12.1.3 Waste Characterisation and Risks

Computers - Human health and environmental concerns associated with the substances contained in computer equipment arise as a result of the inappropriate landfilling or incineration. Lead and mercury can leach out in landfill sites and contaminate soil, groundwater and surface water. Lead oxide dust or lead fume may be released during high temperature metal processing such as smelting. Incineration can lead to the release of lead and cadmium into the air. Cadmium may be released in the form of cadmium dust if plastic is burned. Cadmium compounds are classified as toxic with a possible risk of irreversible effects on human health.

Cellphones - A hazardous constituent of cell phones is brominated flame retardants which are added to plastics to reduce the risk of fire. These can be persistent, bio-accumulative and toxic. They have been associated with cancer and disruption of the immune and endocrine system. These substances can form dioxins and furans when products are incinerated or recycled.

PVC - Polyvinyl chloride (PVC) is the most widely used plastic. The burning of PVC generates dioxins and furan, which contribute to air pollution and respiratory ailments. PVC is hazardous as it contains a high percentage of chlorine which when burned produces hydrogen chloride gas and when combined with water forms hydrochloric acid which is dangerous and can lead to respiratory problems.

Fridges and Freezers - CFCs found in the cooling system and in the insulation is an ozone depleting substance.

12.1.4 Current Waste Management Practices

A significant proportion of e-waste is disposed of in general landfills without any form of treatment. In some cases e-waste is incinerated or burned illegally. In South Africa, the e-waste system is still in its infancy (www.baselpretoria.org.za). According to the Basel Convention Regional Centre, Pretoria, the e-Waste Association of South Africa (eWASA) has been initiated to facilitate and encourage e-waste management. Technologies for handling e-waste in South Africa have been initiated in Gauteng and the following are undertaken in the management of e-waste (www.ewaste.ch/case_study_southafrica):

- Manual dismantling: any e-waste to be recycled is dismantled and manually sorted into the various fractions including printed circuit boards, cathode ray tubes, cables, plastic compounds, precious metals, strategic metals and base metals, condensers. More recently invaluable materials like batteries, liquid crystal displays (LCDs) and even wood are sorted.
- Screening and further processing, including heavy fraction recovery: The different waste fractions are processed to directly reusable components and to secondary raw material in a variety of refining and conditional processes by recyclers (such as Universal Recycling). Material such as aluminium and copper are recovered and stockpiled. Heavy fractions are manually extracted off conveyer belts after waste is pulverised.
- Conditioning: Metallic and other fractions are finely ground to facilitate refining (at facilities such as Rand Refinery and Impala Refinery Services).
- Refining: The sorted and conditioned metallic fractions are refined.
- Final Disposal: Solid waste is disposed of in a permitted municipal landfill site. Systematic gas and leachate collecting systems are installed in accordance with the Minimum Requirements for Waste Disposal by Landfill, hence significant emissions to water and air are controlled.

12.2 Waste Management Options

12.2.1 Re-use

12.2.1.1. Refurbish and re-use

E-waste generators can sell refurbished electronic equipment or donate it to schools or non-profit organizations for its original purpose. This practice has obvious benefits and extends the life of electronic equipment to some extent. However, this electronic equipment will eventually join the e-waste stream once redundant and will need to be managed correctly.

12.2.2 Recycle

12.2.2.1. Electronics Recycling and Material Recovery

Electronics recycling refers to the inspection, disassembly, sorting, and processing of discarded electronic equipment for potential re-use or re-manufacture. In general, old computer or electronic equipment would be dropped off at an electronics recycler, who would inspect the equipment. If it is determined to be no longer of value for re-use, would be broken down into its constituent parts; such as housings, circuit boards, wiring, and cathode ray tubes. These would then undergo further processing into base materials for use as feedstock in manufacturing new goods or in some cases disposal. Raw materials are extracted during processes of refining and conditioning. Heavy metal fractions are removed manually from conveyor belt systems.

12.2.2.2. Extended producer responsibility

Internationally, manufacturer responsibility and product stewardship is on the increase (WRC, 2005), placing the responsibility of e–waste disposal in the hands of the manufacturers of the electronic and electrical products rather than the consumer.

12.2.3 Dispose

12.2.3.1. Disposal of Residual Solid Waste (after recycling) at General Landfill

The solid waste remaining after recycling of components of e-waste can be disposed of in a permitted general landfill site, as is the case in South Africa. The recycling process has removed a high percentage of hazardous substances and metal fractions and the waste remaining is suitable for disposal in a general landfill.

12.2.3.2. Disposal at a Hazardous Landfill

E-waste which has not been subjected to recycling and removal of hazardous components must be disposed of at a hazardous landfill site. The sophisticated leachate and gas managements systems in place at these landfill facilities will prevent hazardous constituents polluting the water and air environments.

12.2.3.3. Incineration

Due to the variety of hazardous waste substances contained in e-waste incineration is associated with a major risk of generating and dispersing contaminants and toxic substances. The gases released during incineration and the residue ash is considered toxic. This is particularly the case for incineration of untreated e-waste and incineration without sophisticated flue gas purification.

12.3 BPEO

12.3.1 Current Options

- Refurbish and Re-use Programme – the refurbishment and re-use of electronic equipment, particularly computer equipment. Schools, non-profit organisations such as charities etc would benefit from this practice. This would extend the life of some electronic equipment and in the short term, reduce the volume of e-waste generated. This is considered to be the preferred option from an economic, social and environmental perspective.
- Hazardous landfill disposal – the current practice of landfill of e-waste at hazardous landfill facilities is regarded as the most practical method of dealing with hazardous compounds contained in e-waste. The sophisticated leachate and gas management systems employed at hazardous landfill sites will ensure environmental protections from harmful substances.

12.3.2 Future Options

- Extended producer responsibility - In South Africa, such a system would require a high level of capacity building, and the successful outcome of implementing such a philosophy is a long term objective. IBM, and Compaq, have embarked on Extended Producer Responsibility programmes, whereby companies become involved in the recycling, re-use and taking back of items.
- Recycling and general landfill disposal – This is considered to be the preferred future option for dealing with e-waste in the Western Cape. The recycling of e-waste has numerous benefits including reducing use of raw materials, reducing waste volumes, and promoting economic opportunities. The solid waste remaining after recycling is suitable for general waste landfill which reduces the airspace required at hazardous landfill facilities.
    - Further research into recycling and local facilities available would be requirement.
    - The feasibility of this option should be tested using a pilot study modelled on the Gauteng example.

12.4 Bibliography

- Green clippings, 18 October 2002, Issue No. 7
- Basel Convention Regional Centre, Pretoria (www.baselpretoria.org.za)
- Environmental Information Exchange (www.brookes.ac.uk)
- E-waste Guide – Case Study South Africa (www.ewaste.ch/case_study_southafrica/)
- Electronic and Electrical Waste Diversion Program, Ministry of Environment, Ontario, Canada (www.ene.gov.on.ca)
- Furter, Leigh, E-Waste has Dawned (ReSource, May 2004)
- Scottish Environmental Protection Agency (www.sepa.org.za) – Press Release 2004 – Guidance on Treatment of Electrical Waste Launched.
- East Sussex Country Council (www.eastsussex.gov.uk)
- Nevada Division of Environmental Protection, Bureau of Waste Management - E-waste in Nevada (ndep.nv.gov/bwm/hazard)

13 Conclusion and Recommendations

The BPEO assessment process identified viable and potentially viable, current and future options for the management of each priority hazardous waste steam. In order to ensure realistic and achievable waste management planning for the region, the current BPEO was presented with the focus on practicability, including economically viable and efficient waste management technologies currently available with the vision of moving toward more advanced, internationally accepted options that could be developed in the medium to long term.

The recommended BPEOs are based largely on qualitative assessment of existing waste management information for the region. This report should therefore be regarded as a support mechanism intended to assist strategic waste management planning, and the development of a hazardous waste management plan for the region.

In order to ensure that the views of potentially affected stakeholders are taken into account in the subsequent planning process, it is recommended that that the findings of the report should be workshopped in an appropriate public forum. It is envisaged that this process will add value to the BPEO assessment in terms of the identification of potential additional waste management options and opportunities, and the assessment of options in terms of the provided scoring and ranking guidelines.

Several of the BPEOs, particularly future options, will require detailed feasibility investigations and/or extensive capacity building. In addition to the waste management planning recommendations contained in Section 3.5 (Gap Analysis), the following waste specific recommendations may be considered:

- Sewage Sludge:
    - Further investigation of opportunities for safe land application of sludges that do not conform to the current Type D classification, provided that a holistic assessment process is followed and that all local factors that influence the safe and sustainable use of the sludge are suitably assessed and motivated on a site specific basis.
    - Strategy development for removal and/or remediation of existing sludge stockpiles and lagoons.
- Pesticide waste:
    - Feasibility assessment for the development of low-cost controlled storage facility options.
    - Feasibility assessment for the development of a regional pesticide collection network system, established by the pesticide industry and funding by government through ASP assistance over the 15-year period, completely in place.
- Abattoir Waste – feasibility assessment for the development of a shared/ centralised rendering facility.
- Asbestos Waste – Authority consultation and review of delisting and disposal procedures for small volumes of asbestos waste at smaller general wastes sites should be undertaken and an appropriate waste management plan for safe disposal implemented.

Appendix A – Decision Criteria

1 Environmental

1.1 Resource Depletion

Abiotic resources are natural, and essentially limited, resources, such as iron ore, crude oil and natural gas, as opposed to renewable, biotic sources such as biomass. Resource depletion is one the most frequently assessed impact categories in life cycle assessment (LCA) studies. The following should be considered for the assessment of waste streams:

- Grid electricity – resources are consumed in power generation.
- On site electricity – combustion of on site resources to create electricity (fossil fuels).
- Use of virgin materials – recycling reduces the need for the consumption of virgin materials.
- Transportation – internal combustion engine burn fossil fuels (diesel, petrol, etc).
- Water usage – South Africa is classified as a water-poor country by the United Nations World Health Organisation. Large volumes of water are used in (a) manufacturing processes and (b) waste treatment/recycling.

1.2 Air Quality

Natural and human activities release a range of substances to the atmosphere which can result in changes to the chemical composition of the atmosphere at local and global scale. Air pollution can threaten the health of human beings, trees, lakes, crops, and animals, as well as damage the ozone layer. The following should be considered:

- Emission of Green House Gas (GHG) – CO_2, CH_4 and other GHG's can be emitted due to the waste decomposition, and/or combustion. GHG's are known to trigger climate change.
- Emission of acidifying substances – SO_2, NO_x, HCL, HF and NH_3 are emitted during waste decomposition, and/or combustion. This can lead to acid rain polluting lakes, rivers, etc.
- Emission of noxious/hazardous air pollutants – Various noxious substances may be released during waste decomposition, and or combustion. Health impacts include cancer, respiratory ailments, eye infections.

1.3 Water Quality

The pollution of water has a serious impact on all living creatures, and can negatively affect the use of water for drinking, household needs, recreation, fishing, transportation and commerce.

- Contaminated leachate – direct or indirect pollution of ground water due to toxic leachate production.
- Pathogenic leachate – release of pathogens due to decomposition of medical waste, etc.
- Thermal pollution – release of heated water constitutes a threat to riverine ecology.
- Cultural eutrophication – excessive nutrients cause algae growth which suffocates aquatic life.

1.4 Hazard

Environmental hazard relates to the accidental risks associated with a particularly waste management option. Hazards include risk of accidents to people (both workers and general public), accidents on the roads, accident releases of pollutants, explosions, fires, etc. A health and safe environment for workers and the public is a basic legal requirement. No operation is 100% safe, there is always some level of risk associated with all tasks:

- Waste type – the nature of the waste stream to be handled by the waste management option will impact on the level of risk associated with the option.
- Transportation requirements – the greatest risk associated with waste management is road traffic accidents, therefore those options requiring less transportation have a lower risk profile.
- Technology – the need for workers to use heavy and mechanical plant, handling/contact with hazardous wastes, risk of accidental releases, risk of explosion or fires all increase the risk profile of a waste management option.

2 Economic

2.1 Costs and affordability

When identifying the most suitable waste management option, the economic objective is to satisfy waste management objectives with least overall cost to society. Lease economic cost does not necessarily mean least short term financial cost, for example, some activities such as recycling, might appear more expensive but yield bigger savings in raw materials and future cost of landfill provision.

- Establishment costs – some facilities may require a substantial upfront capital investment. In some cases private industry provides the facilities and services, in other cases public spending is required.
- Operating costs – including waste collection, handling, processing and disposal.
- Decommissioning costs.
- Revenues from recycled materials and energy recovery.
- Affordability – financial viability of the option for those providing the service and those paying for the service.

2.2 Impact on local economy

Waste management systems can impact positively or negatively on the local economy by providing new business opportunities, adversely affecting existing businesses, creating new market opportunities, increasing or decreasing costs to local businesses.

- Construction, operation and maintenance opportunities – the local economy would benefit if additional infrastructure or services (transport, processing etc).
- Employment opportunities – local income generating opportunities may be created.
- Market stimulation – new markets may be generated or existing markets stimulated by a waste management system, this would have an impact on the local economy.
- Secondary (indirect) costs or benefits – there may be indirect costs or benefits associated with a particular waste strategy, for example recycling of materials reduces manufacturer's costs.

3 Social

3.1 Employment

Waste management systems have the potential to impact positively or negatively on employment, in terms of number of jobs, their quality and distribution. Employment enables people to meet their needs and improve their standard of living, and is the single most effective way of tackling poverty.

- Job opportunities: the impact on the type, number, quality and distribution of job opportunities in waste management and recycling, some technologies are more labour intensive than others.
- Skills development: there may be an opportunity to provide more skilled job opportunities to the workforce through improving their skills through training.
- Employment via subsidiary activities: there may be opportunities provided in waste related activities, as a knock on affect of a waste management option/strategy.

3.2 Perception

Public perception of waste management systems in most cases relates to issues such as environmental quality and health risks. Historically, there has been a great deal of misconception amongst the general public, particularly relating to health effects. Public perception pays an important role in waste management systems, particularly if the public are required to participate in making the system work. Resistance to the development of new facilities can result in delays and difficulties in obtaining the necessary permissions from authorities.

- Public acceptability – is the waste management system acceptable to the public.
- Public involvement required – some waste management systems may require increase public participation for the system to work effectively.
- Education and awareness – it may be possible to overcome public resistance through public education and awareness.

3.3 Equity

Different waste management systems can result in different winners and losers and equitable distribution of cost and benefits must be considered. In South Africa there has been a history of environmental injustice towards previously disadvantaged communities who have often borne the brunt of environmental costs. When considering waste management options, care must be taken to identify whether the option would result in social benefits or costs within a surrounding area. The principle of inter-generational equity should be applied to ensure that future generations are not negatively affected through the gains of present generations.

- Distributional equity
- Procedural equity
- Inter-generational equity

4 Practicality

4.1 Legal Compliance / fit with policy

Legal compliance is essential in the choice of a waste management system option. Options not complying with South African legislation will not be considered.

4.2 Existing processing capacity

E.g. does the landfill have reasonable lifespan, is the incinerator currently running at full capacity etc.

4.3 Flexibility

It is important for waste management system options to incorporate or allow for response to future changes. System options with some level of flexibility are best able to accommodate changes in circumstances.

Appendix B – Scoring and Matrices

1 Conceptual Scoring System

Score	Description
1	Advantageous
0	Not Applicable
-1	Disadvantageous

2 Conceptual Scoring Matrix

2.1 Option X – e.g. Disposal at Landfill

Parameter	Criteria	Pros and Cons / Comments	Criteria Score	Parameter Score (Avg.)
Environmental	Resource Depletion	▪		
	Air Quality	▪		
	Water Quality	▪		
	Hazard	▪		
Economic	Cost and Affordability	▪		
	Impact on Local Economy	▪		
Social	Employment	▪		
	Perception	▪		
	Equity	▪		
Practicality	Legal / policy	▪		
	Processing capacity	▪		
			Total (cumulative)	

Appendix C – Waste Management Legal Summary

1 Introduction

DAEDP is obligated to operate within a national legal framework with regards to waste management. The most relevant legislation pertaining to waste management includes: The Constitution of the Republic of South Africa (108 of 1996); the Environment Conservation Act (73 of 1989); the National Environmental Management Act (107 of 1998); the National Water Act (36 of 1998); the Mine Health and Safety Act (29 of 1996); the Occupational Health and Safety Act (85 of 1993); and the Hazardous Substances Act (15 of 1973).

In addition to specific pieces of legislation dealing with waste management, a number of policy and guideline documents have been produced to inform future legislation. The principle of sustainable development has guided this process and consequently the cost of polluting the environment is largely born by the polluter as opposed to the community. It is important to recognise that this trend towards community empowerment will continue, thus it is in industries' best interest that waste management strategies are proactive and where possible go beyond the minimum legal requirements.

It should be noted that this legal interpretation is for guideline purposes only and should not be considered as a comprehensive legal register.

2 Scope

A full discussion of all legislation dealing with waste management is beyond the scope of the BPEO assessment; however it is important to have an understanding of the most relevant pieces of legislation and implications in terms of legal compliance for waste management.

3 Macro legislative framework

3.1 The Constitution of the Republic of South Africa (108 of 1996)

The Constitution of the Republic of South Africa is the legal source for all law, including environmental law, in South Africa. The Bill of Rights is fundamental to the Constitution of South Africa and in, Section 24 of the Act, it is stated that:

Everyone has the right (a) to an environment that is not harmful to their health or well-being; and (b) to have the environment protected, for the benefit of present and future generations through reasonable legislative and other measures that (i) prevent pollution and ecological degradation; (ii) promote conservation; and (iii) secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.

3.2 Environment Conservation Act (73 of 1989)

The primary objective of the Environment Conservation Act (73 of 1989) (ECA) is to provide for the effective protection and control of the environment.

In terms of the ECA, waste is defined as any matter, whether a solid, liquid or gas or any combination thereof designated by the Minister of Water Affairs as an undesirable or superfluous by-product, emission, residue or remainder of any process or activity.

Similarly a disposal site is defined as any site used for the accumulation of waste with the purpose of disposing or treatment of such waste.

In terms of Section 20 of the ECA;

(1) No person shall establish, provide or operate any disposal site without a permit issued by the Minister of Water Affairs…(5) The Minister of Water Affairs may from time to time by notice in the Gazette issue directions with regard to (a) the control and management of disposal sites in general; (b) the control and management of certain disposal sites or disposal sites handling particular types of waste; and (c) the procedures to be followed before any disposal site may be withdrawn from use or utilized for another purpose.

In terms of Schedule 1(8), the disposal of waste as defined in Section 20 of the ECA, excluding domestic waste, but including the establishment, expansion, upgrading or closure of facilities for all waste, ashes and building rubble, is considered an activity that may have a substantial detrimental effect on the environment.

Section 24 makes provision for the Minister to make regulations with regard to waste management, concerning;

…(a) the manner in which an application for a permit in terms of section 20(1) shall be submitted; (b) the submission, subject to the provisions of Section 3(3) of the Statistics Act (66 of 1976), of statistics on the quantity and types of waste produced; (c) the classification of different types of waste and the handling, storage, transport and disposal of such waste; (d) the reduction of waste by—(i) modifications in the design and marketing of products; (ii) modifications to manufacturing processes; and (iii) the use of alternative products; (e) the utilization of waste by way of recovery, re-use or processing of waste; (f) the location, planning and design of disposal sites and sites used for waste disposal; (g) control over the management of sites, installations and equipment used for waste disposal; (h) the administrative arrangements for the effective disposal of waste; (i) the dissemination of information to the public on effective waste disposal; (j) control over the import and export of waste; and (k) any other matter which he may deem necessary or expedient in connection with the effective disposal of waste for the protection of the environment.

In addition to the relevant clauses contained within the ECA, there are a number of relevant Regulations pertinent to the mining industry, including:

3.2.1 GN. 1986 GG 12703 24 August 1990 - Identification of Matter as Waste

In terms of this regulation waste is defined as an undesirable or superfluous by-product, emission, residue or remainder of any process or activity, any matter, gaseous, liquid or solid or any combination thereof, originating from any residential, commercial or industrial area.

3.2.2 GN. R. 1196 GG15832 8 July 1994 – Waste Disposal Site

In terms of this regulation, any person who intends to establish, provide or operate a disposal site must apply for a permit in terms of Section 20(1) of the ECA.

3.2.3 GN. 91 GG23053 1 February 2002 - Directions With Regard to the Control and Management of General Communal and General Small Waste Disposal Sites

This regulation describes the registration process for any person or organisation that wishes to establish and / or develop, operate, close and rehabilitate a general communal or a general small waste disposal site with a negative water balance. In addition, the regulation specifies what information needs to be supplied by the applicant (with a copy of the application form contained within Annexure A).

In terms of Section 20(5)(b) of the ECA, the aim with regards to hazardous waste management is to regulate and manage the effects of the generation, treatment, transportation and disposal of hazardous wastes in such a manner as to reduce, to a level acceptable to the broader national community the risk to human health and possible damage to the environment.

3.3 National Environmental Management Act (107 of 1998) (NEMA)

NEMA is South Africa's overarching environmental legislation and has, as its primary objective, to provide for co-operative governance by establishing principles for decision making on matters affecting the environment, institutions that will promote co-operative governance and procedures for co-ordinating environmental functions exercised by organs of state and to provide for matters connected therewith (Government Gazette, 1998)

The Act provides for the right to an environment that is not harmful to the health and well being of South African citizens; the equitable distribution of natural resources, sustainable development, environmental protection and the formulation of environmental management frameworks (Government Gazette, 1998).

Section 30 (1, 3 and 4) of NEMA states that:

(1) (a) "incident" means an unexpected sudden occurrence, including a major emission, fire or explosion leading to serious danger to the public or potentially serious pollution of or detriment to the environment, whether immediate or delayed. (b) "responsible person" includes any person who; (i) Is responsible for the incident; (ii) Owns any hazardous substance involved in the incident; or (iii) Was in control of any hazardous substance involved in the incident at the time of the incident;

(3) The responsible person or, where the incident occurred in the course of that person's employment, his or her employer must forthwith after knowledge of the incident, report through the most effective means reasonably available (a) the nature of the incident; (b) any risks posed by the incident to public health, safety and property; (c) the toxicity of substances or by-products released by the incident; and (d) any steps that should be taken in order to avoid or minimise the effects of the incident on public health and the environment to; (i) the Director-General; (ii) the South African Police Services and the relevant fire prevention service; (iii) the relevant provincial head of department or municipality; and (iv) all persons whose health may be affected by the incident.

(4) The responsible person or, where the incident occurred in the course of that person's employment, his or her employer, must, as soon as reasonably practicable after knowledge of the incident; (a) take all reasonable measures to contain and minimise the effects of the incident, including its effects on the environment and any risks posed by the incident to the health, safety and property of persons; (b) undertake clean-up procedures; (c) remedy the effects of the incident; (d) assess the immediate and long-term effects of the incident on the environment and public health.

3.4 National Water Act 1998 (Act 36 of 1998)

Section 19 of the National Water Act states that the person responsible for the land upon which any activity is or was performed which causes, has caused or is likely to cause, pollution of a water resource, must take all reasonable measures to prevent any such pollution from occurring, continuing or recurring.

Part 5 of the National Water Act (36 of 1998), deals with pollution of water resources following an emergency incident, such as an accident involving the spilling of a harmful substance that finds or may find its way into a water resource. In terms of Section 30 of NEMA and Section 20 of the National Water Act, the responsibility for remedying the situation rests with the person responsible for the incident or the substance involved. If there is a failure to act, the relevant Catchment Management Agency may take the necessary steps and recover the costs from every responsible person.

20 (1) In this section ``incident'' includes any incident or accident in which a substance; (a) Pollutes or has the potential to pollute a water resource; or (b) Has, or is likely to have, a detrimental effect on a water resource. (2) In this section, ``responsible person'' includes any person who; (a) Is responsible for the incident; (b) Owns the substance involved in the incident; or (c) Was in control of the substance involved in the incident at the time of the incident. (3) The responsible person, any other person involved in the incident or any other person with knowledge of the incident must, as soon as reasonably practicable after obtaining knowledge of the incident, report to; (a) The Department; (b)The South African Police Service or the relevant fire department; or (c) The relevant catchment management agency. (4) A responsible person must; (a) Take all reasonable measures to contain and minimise the effects of the incident; (b) Undertake clean-up procedures; (c) Remedy the effects of the incident; and (d) Take such measures as the catchment management agency may either verbally or in writing direct within the time specified by such institution. (5) A verbal directive must be confirmed in writing within 14 days, failing which it will be deemed to have been withdrawn. (6) Should; (a) The responsible person fail to comply, or inadequately comply with a directive; or (b) It not be possible to give the directive to the responsible person timeously, the catchment management agency may take the measures it considers necessary to; (i) Contain and minimise the effects of the incident; (ii) Undertake clean-up procedures; and (iii) Remedy the effects of the incident. (7) The catchment management agency may recover all reasonable costs incurred by it from every responsible person jointly and severally. (8) The costs claimed under subsection (7) may include, without being limited to, labour, administration and overhead costs. (9) If more than one person is liable in terms of subsection (7), the catchment management agency must, at the request of any of those persons, and after giving the others an opportunity to be heard, apportion the liability, but such apportionment does not relieve any of them of their joint and several liability for the full amount of the costs.

Section 21 of the National Water Act establishes general principles for regulating water use, including the disposal of waste in a manner that may detrimentally impact on a water resource'.

In general all water use must be licensed unless it is either a Schedule 1 activity, an existing lawful use, permissible under a general authorisation or if a responsible authority waives the need for a licence. The Minister of Water Affairs may limit the amount of water a responsible authority may allocate. In making regulations the Minister may differentiate between different water resources, classes of water resources and geographical areas (Section 22).

While currently not applied, it is the Department of Water Affairs and Forestry's intention to develop and implement a waste discharge pricing system that will be based on the polluter pays principle, to provide economic incentives to reduce water pollution.

3.5 Hazardous Substances Act (15 of 1973)

The Hazardous Substances Act classifies substances into Group I, II, III and IV hazardous substances according to their individual toxicity. The Act provides a list of substances that fall into each of these groups as well as the requirements for dealing with substances from the respective groups. Essentially the act aims at providing for the control of substances which may cause injury or ill-health to, or death of human beings by reason of their toxic, corrosive, irritant, strongly sensitising or flammable nature or the generation of pressure thereby in certain circumstances, and for the control of certain electronic products; to provide for the division of such substances or products into groups in relation to the degree of danger; to provide for the prohibition and control of the importation, manufacture, sale, use, operation, application, modification, disposal or dumping of such substances and products; and to provide for matters connected therewith.

3.5.1 GN. 227 GG20978 17 March 2000 - Draft White Paper on Integrated Pollution and Waste Management for South Africa

The vision of the Government, as articulated in the White Paper is:

To develop, implement and maintain an integrated pollution and waste management system which contributes to sustainable development and a measurable improvement in the quality of life, by harnessing the energy and commitment of all South Africans for the effective prevention, minimisation and control of pollution and waste.

In terms of the White Paper, pollution is defined as the introduction into the environment of any substance (including radiation, heat, noise and light) that has or results in direct harmful effects to humanity or the environment, or that makes the environment less fit for its intended use.

Similarly the Environment is defined as the biosphere in which people and other organisms live, and consists of both renewable and non-renewable natural resources such as air, water (fresh & marine), land and all forms of life; natural ecosystems and habitats; and ecosystems, habitats and spatial surroundings modified or constructed by people, including urbanised areas, agricultural and rural landscapes, places of cultural significance and the qualities that contribute to their value.

Integrated pollution and waste management is a process which, using the ideals of a holistic and integrated approach, aim to create a process of management suited to deal with pollution prevention and minimisation at the source as well as managing the impact of pollution and waste on the receiving environment and remediation of those effects. The Draft White Paper on Integrated Pollution and Waste Management for South Africa represents a paradigm shift towards:

- Pollution prevention;
- Waste minimisation;
- Cross-media integration;
- Institutional horizontal and vertical integration of departments and spheres of government; and
- Involvement of all sectors of society in pollution and waste management.

Key issues are divided into water pollution, air pollution, land pollution and pollution and waste. Issues discussed under water pollution include the harmful effects of the salinisation of fresh waters, enrichment of water bodies by plant nutrients, microbial quality of water, sediment and silt migration, the introduction of harmful inorganic and organic compounds, diffuse water pollution and marine pollution. Air pollution looks at industrial and domestics fuel combustion, dust problems, vehicle emissions, air pollution control and noise pollution. Land pollution problems are examined mainly in terms of waste disposal sites, especially those containing hazardous, medical, and veterinarian waste. Other problem areas include the siting of waste disposal sites, leachate, a lack of proper management of waste disposal sites, waste disposal sites located too close to residential areas, illegal waste disposal sites, a lack of suitable hazardous waste disposal sites and poor town planning. Furthermore, land is contaminated by industrial pollution, pesticides, ash disposal, mining and sludge disposal (Section 3).

3.6 Radioactive Waste Management Policy and Strategy for the Republic of South Africa

By definition radioactive, waste is waste that contains materials that emit ionising radiation, which has been recognised as a potential hazard to human health since the beginning of the 20th century. Consequently the safe management of radioactive waste is essential for human health and well as that of the environment. Radioactive waste is produced during the operational and decommissioning phases of facilities associated with the following activities:

- The extraction, processing and combustion of raw materials containing naturally occurring radioactive materials;
- Environmental restoration programmes associated with the above.

The levels of radioactivity of waste, which are considered unacceptable, are levels significantly different from natural background radiation to which everyone is exposed to in everyday life. Radioactive wastes generated by facilities range from low volumes, such as spent radioactive sources, to large and diffuse volumes such as tailings from mining and the milling of ores that contain uranium and thorium.

It is recognised that waste containing un-concentrated naturally occurring radioactive materials from the mining industry, minerals processing industries and the combustion of coal will also be managed as set out in the Integrated Pollution and Waste Management policy.

The International Atomic Energy Agency (IAEA) has developed a set of principles for the safe management of radioactive waste and includes:

- Protection of human health;
- Protection of the environment;
- Protection beyond South Africa's borders;
- Protection of future generations;
- Burden of future generations;
- National legal framework;
- Control of radioactive waste generation;
- Radioactive waste generation and management interdependencies;
- Safety of facilities where radioactive waste is generated.

3.7 Department of Water Affairs and Forestry – Minimum Requirements for Waste Disposal

The minimum requirements for waste disposal by landfill forms part of the Department of Water Affairs and Forestry's Waste Management Series. This series establishes a reference framework of standards for waste management in South Africa and serves to facilitate the enforcement of the landfills permitting system provided for in terms of Section 20 (1) of the Environment Conservation Act (73 of 1989).

This document reiterates Section 20(1) of the ECA, stating that no person or organisation is allowed to establish, provide or operate any disposal site without a permit obtained from the Minister of Water Affairs and subject to the conditions contained in such a permit.

The aim of the document is to establish minimum requirements so that proactive steps can be taken to prevent the degradation of water quality and the environment (as defined in Section 1 of NEMA) as well as to improve the standard of waste disposal in South Africa.

In addition, contained in the guideline document the minimum requirements are stipulated for the following landfill characteristics:

- Site selection;
- Permitting;
- Site investigation;
- Assessment and mitigation of environmental impacts;
- Landfill design;
- Liner components;
- Capping components;
- Site preparation and commissioning;
- Landfill operation;
- Landfill operation monitoring;
- Rehabilitation, closure and end-use; and
- Water quality monitoring.

3.8 Sustainable Development

The principle of Sustainable Development has been established in the Constitution of the Republic of South Africa (108 of 1996) and given effect by NEMA and the ECA. Section 1(29) of NEMA states that sustainable development means the integration of social, economic and environmental factors into the planning, implementation and decision-making process so as to ensure that development serves present and future generations.

Thus Sustainable Development requires that:

- The disturbance of ecosystems and loss of biological diversity are avoided, or, where they cannot be altogether avoided, are minimised and remedied;
- That pollution and degradation of the environment are avoided, or, where they cannot be altogether avoided, are minimised and remedied;
- That the disturbance of landscapes and sites that constitute the nation's cultural heritage is avoided, or where it cannot be altogether avoided, is minimised and remedied;
- That waste is avoided, or where it cannot be altogether avoided is minimised and re-used or recycled where possible and otherwise disposed of in a responsible manner;
- That a risk-averse and cautious approach is applied, which takes into account the limits of current knowledge about the consequences of decisions and actions;
- Negative impacts on the environment and on people's environmental rights be anticipated and prevented and where they cannot altogether be prevented, are minimised and remedied.

Appendix D – BPEO Preliminary Assessment Matrices

Note: Matrix assessment only applied to the following waste streams for which a number of waste management options were identified:

- Health care waste;
- Pesticide waste; and,
- Paint and solvent waste.

Agricultural / Pesticide Waste BPEO - Preliminary Assessment Matrix

Summary

Option	Environmental	Social	Economic	Practicality	Total
Reduce – Minimise use of Pesticides	3	-1	1	-1	2
Reduce – Prevent degradation of pesticides	3	1	1	1	6
Reuse – Re-use as pesticides	1	0	0	-1	0
Recycle – Reformulation	-1	1	-1	-1	-1
Treatment – Induced degradation	-1	0	0	-1	-2
Disposal - Incineration	0	1	-1	0	0
Disposal - Landfill	1	0	-1	-1	-1

Reduce – Minimise use of Pesticides

Parameter	Criteria	Pros and Cons / Comments	Criteria Score	Parameter Score (Total)
Environmental	Resource Depletion	▪ N/A	**0**	**3**
	Air Quality	▪ Reduces generation of toxic fugitive emissions in areas of storage and application (+)	**1**	
	Water Quality	▪ Reduces runoff contamination of natural watercourses (+).	**1**	
	Hazard	▪ Reduces risk from potential hazard as hazardous component removed (+).	**1**	
Economic	Cost and Affordability	▪ Potential increase in cost and/or application complexity for non-hazardous substitutes (-).	**-1**	**-1**
	Impact on Local Economy	▪ N/A.	**0**	
Social	Employment	▪ N/A.	**0**	**1**
	Perception	▪ Concept of hazardous waste avoidance is generally well received by society (+).	**1**	
	Equity	▪ N/A – non hazardous.	**0**	
Practicality	Legal / policy	▪ Waste management policy supports concepts of waste avoidance (+).	**1**	**-1**
	Processing capacity	▪ Practicality issue - substitution technology still under development in South Africa (-)	**-1**	
			Total (cumulative)	**2**

Reduce – Prevent degradation of pesticides

Parameter	Criteria	Pros and Cons / Comments	Criteria Score	Parameter Score (Total)
Environmental	Resource Depletion	▪ N/A	**0**	**3**
	Air Quality	▪ Waste avoidance - Reduces potential air quality issues associated with waste generation / management (+).	**1**	
	Water Quality	▪ Waste avoidance - Reduces potential contamination issues associated with waste generation / management (+).	**1**	
	Hazard	▪ Waste avoidance - Reduces potential hazard issues associated with waste generation / storage in large quantities (+).	**1**	
Economic	Cost and Affordability	▪ Waste avoidance - Reduces potential waste management costs associated with transportation and disposal (+).	**1**	**1**
	Impact on Local Economy	▪ N/A.	**0**	
Social	Employment	▪ N/A.	**0**	**1**
	Perception	▪ Concept of hazardous waste avoidance is generally well received by society (+).	**1**	
	Equity	▪ N/A.	**0**	
Practicality	Legal / policy	▪ Waste management policy supports concepts of waste avoidance (+).	**0**	**1**
	Processing capacity	▪ Low technology requirements (+)	**1**	
			Total (cumulative)	**6**

Reuse – Re-use as pesticides

Parameter	Criteria	Pros and Cons / Comments	Criteria Score	Parameter Score (Total)
Environmental	Resource Depletion	▪ N/A	**0**	**1**
	Air Quality	▪ Reduces generation of toxic fugitive emissions associated with disposal (+)	**1**	
	Water Quality	▪ Reduces potential surface water associated with disposal (+).	**1**	
	Hazard	▪ Potential spillage risk during transportation / old containers (-). This risk is mitigated by means of SANS codes of practice for transportation of hazardous substances (+).	**-1**	
Economic	Cost and Affordability	▪ Potential analysis costs for pesticides beyond expiry date (-). Feasible in the case of large quantities were analysis costs can be off-set against cost of new pesticides (+).	**0**	**0**
	Impact on Local Economy	▪ N/A.	**0**	
Social	Employment	▪ Potential employment opportunities through educational programmes (+).	**1**	**0**
	Perception	▪ Concept of hazardous waste avoidance is generally well received by society (+).	**-1**	
	Equity	▪ N/A.	**0**	
Practicality	Legal / policy	▪ Waste management policy supports concepts of waste avoidance (+).	**0**	**-1**
	Processing capacity	▪ Practicality issue – potentially not feasible for small volume generators (-).	**-1**	
			Total (cumulative)	**0**

Recycle – Reformulation

Parameter	Criteria	Pros and Cons / Comments	Criteria Score	Parameter Score (Total)
Environmental	Resource Depletion	▪ N/A	**0**	**-1**
	Air Quality	▪ Potential airborne emissions from re-formulation facilities (-). Strict environmental control would be a legal requirement in South Africa (+).	**0**	
	Water Quality	▪ Potential effluent emissions from re-formulation facilities (-). Strict environmental control would be a legal requirement in South Africa (+).	**0**	
	Hazard	▪ Potential spillage risk during transportation / old containers (-). This risk is mitigated by means of SANS codes of practice for transportation of hazardous substances (+). ▪	**-1**	
Economic	Cost and Affordability	▪ Potential analysis costs for pesticides beyond expiry date (-). Feasible in the case of large quantities were analysis costs can be off-set against cost of new pesticides (+).	**1**	**1**
	Impact on Local Economy	▪ N/A.	**0**	
Social	Employment	▪ Limited employment opportunities at potential re-formulation facilities (+).	**0**	**0**
	Perception	▪ Potential issues associated with perceptions towards reformulation facilities involving toxic substances (-). Mitigated through information sharing / responsible environmental planning (e.g. EIA process and environmental management) (+).	**0**	
	Equity	▪ N/A.	**0**	
Practicality	Legal / policy	▪ Existing environmental legislation does not preclude processing facilities for hazardous substances (+). ▪ Recycling / reformulation less preferred strategy in light of numerous waste avoidance options (-).	**0**	**-1**
	Processing capacity	▪ Limited local processing capacity / technology (-).	**-1**	
			Total (cumulative)	**-1**

Treatment – Induced degradation

Parameter	Criteria	Pros and Cons / Comments	Criteria Score	Parameter Score (Total)
Environmental	Resource Depletion	▪ N/A	**0**	**-1**
	Air Quality	▪ Potential airborne emissions from treatment facilities (-). Strict environmental control would be a legal requirement in South Africa (+).	**0**	
	Water Quality	▪ Potential effluent emissions from re-treatment facilities (-). Strict environmental control would be a legal requirement in South Africa (+).	**0**	
	Hazard	▪ Potential spillage risk during transportation / old containers (-). This risk is mitigated by means of SANS codes of practice for transportation of hazardous substances (+).	**-1**	
Economic	Cost and Affordability	▪ Potential analysis costs for pesticides beyond expiry date (-). Feasible in the case of large quantities were analysis costs can be off-set against cost of new pesticides (+).	**0**	**0**
	Impact on Local Economy	▪ N/A.	**0**	
Social	Employment	▪ Limited employment opportunities at potential treatment facilities (+).	**0**	**0**
	Perception	▪ Potential issues associated with perceptions towards treatment facilities involving toxic substances (-). Mitigated through information sharing / responsible environmental planning (e.g. EIA process and environmental management) (+).	**0**	
	Equity	▪ N/A.	**0**	
Practicality	Legal / policy	▪ Existing environmental legislation does not preclude treatment facilities for hazardous substances (+). ▪ Treatment less preferred strategy in light of numerous waste avoidance options (-).	**0**	**-1**
	Processing capacity	▪ Limited local treatment capacity / technology (-).	**-1**	
			Total (cumulative)	**-2**

Disposal - Incineration

Parameter	Criteria	Pros and Cons / Comments	Criteria Score	Parameter Score (Total)
Environmental	Resource Depletion	▪ Energy useage during incineration and transportation to the facility contributes to depletion of fossil fuels (-).	**0**	**0**
	Air Quality	▪ Emission of hazardous air pollutants (-). Emission control technology (e.g. scrubbers) required in order to meet emission standards.	**1**	
	Water Quality	▪ N/A	**0**	
	Hazard	▪ Potential spillage risk during transportation (-). This risk is mitigated by means of SANS codes of practice for transportation of hazardous substances (+). ▪ Potential health risk associated with airborne emissions (-). Compliance with emission standards is a mitigating factor (+).	**-1**	
Economic	Cost and Affordability	▪ Relatively high capital investment and operational (largely energy consumption) cost (-). Costs would be off-set by operational revenue in the case of commercial facilities. ▪ Affordable option (+).	**1**	**1**
	Impact on Local Economy	▪ N/A.	**0**	
Social	Employment	▪ Limited number of employment opportunities created (+).	**0**	**-1**
	Perception	▪ Strong public resistance to incineration as a waste management option (-).	**-1**	
	Equity	▪ Application of sustainable development principles during planning should prevent discriminatory siting of facilities (+).	**0**	
Practicality	Legal / policy	▪ No legal constraints / accepted means of disposal (+)	**0**	**0**
	Processing capacity	▪ Limited capacity exists in terms of suitably controlled facilities (-). Potential cement kiln incineration option in the long term (+)	**0**	
			Total (cumulative)	**0**

Disposal - Landfill

Parameter	Criteria	Pros and Cons / Comments	Criteria Score	Parameter Score (Total)
Environmental	Resource Depletion	■ Does not reduce raw material useage for production of new products (e.g. through recycling) (-). ■ Transportation to the landfill site contributes to depletion of fossil fuels (-).	**-1**	**1**
	Air Quality	■ Contributes towards landfill gas generation (particularly VOCs) and associated airborne emissions (-). Gas management systems reduce airborne emissions (+).	**0**	
	Water Quality	■ Landfilled waste will decompose anaerobically and add residual leachate (-). Leachate management systems minimise surface and groundwater contamination (+).	**0**	
	Hazard	■ Potential large scale spillage / explosion risk during transportation (-). This risk is mitigated by means of SANS codes of practice for transportation of hazardous substances (+).	**0**	
Economic	Cost and Affordability	■ Current option (existing landfill facilities) requires no establishment cost. ■ Establishment cost for future landfill facilities (-). ■ Generator pays disposal costs (-). ■ Landfill operator profits through disposal fees (+). ■ Cost associated with closure / decommissioning (-).	**0**	**0**
	Impact on Local Economy	■ Inhibits economic opportunities in the secondary waste management services sector (e.g. recycling) (-). ■ Promotes secondary (e.g. transportation / maintenance companies) economic opportunities (+).	**0**	
Social	Employment	■ Landfill sites provide limited employment opportunities (-).	**0**	**-1**
	Perception	■ Concept of landfilling is increasingly being rejected by society (-) ■ Perceived heath impacts associated with landfill emissions (-). Mitigated through information sharing / responsible environmental control (+).	**-1**	
	Equity	■ Landfilling creates future environmental liability (e.g. closure management (-). ■ Application of sustainable development principles during planning prevents discriminatory siting of landfill sites (+).	**0**	
Practicality	Legal / policy	■ Existing environmental legislation does not prohibit landfilling of hazardous substances (+). ■ Waste management policy identifies landfilling as the least preferred waste management strategy (-).	**0**	**-1**
	Processing capacity	■ Existing capacity exists (+).	**1**	
			Total (cumulative)	**-1**

Health Care Waste BPEO – Preliminary Assessment Matrix

Summary

Option	Environmental	Economic	Social	Practicality	Total
Reduce – Separation of packaging	1	1	-1	-1	0
Reduce – Re-useable safe containers	0	0	-1	-1	-2
Non-burn (Sterilisation and Disinfection) Technology and Landfill Disposal	0	1	1	2	4
Incineration and landfill disposal of ash	0	1	-1	1	1

Reduce - Separation of Packaging

Parameter	Criteria	Pros and Cons / Comments	Criteria Score	Parameter Score (Total)
Environmental	Resource Depletion	▪ N/A	**0**	**1**
	Air Quality	▪ Minimisation of plastics and PVC from the waste stream reduces harmful emissions during incineration (+).	**1**	
	Water Quality	▪ N/A	**0**	
	Hazard	▪ Increased risk of accidental infection to healthcare staff during separation (-). ▪ Increased risk of accidental release of hazardous waste to the general waste stream (-).	**-1**	
Economic	Cost and Affordability	▪ Reduction in volume results in reduced costs associated with expensive disposal options (incineration and non-burn treatment) (+).	**1**	**1**
	Impact on Local Economy	▪ N/A.	**0**	
Social	Employment	▪ N/A - Source separation unlikely to affect employment opportunities.	**0**	**-1**
	Perception	▪ Perceived negative risk associated with accidental exposure during separation and accidental release of hazardous waste to the general waste stream (-).	**-1**	
	Equity	▪ N/A	**0**	
Practicality	Legal / policy	▪ Waste management policy supports the concepts of recycling and recovery (+). ▪ Accidental release of hazardous waste to the general waste stream poses a potential issue in terms of the minimum requirements for disposal of waste at landfill sites (-).	**0**	**-1**
	Processing capacity	▪ NB*** Practicality issue – relatively low volumes may not justify the potential risk associated with separation and potential non-conforming landfill disposal (-)	**-1**	
			Total (cumulative)	**-1**

Reduce – Re-usable Safe Containers

Parameter	Criteria	Pros and Cons / Comments	Criteria Score	Parameter Score (Total)
Environmental	Resource Depletion	▪ Re-use of containers reduces consumption of raw materials for the production of new containers (+). Relatively small reduction in consumption based on percentage of total waste stream volume (-)	**0**	**0**
	Air Quality	▪ Minimisation of plastics and PVC packaging from the waste stream reduces harmful emissions during incineration (+).	**1**	
	Water Quality	▪ Potential for effluent to be generated by container disinfection for re-use (-).Effluent quality is controlled (treated to acceptable standards) in terms of the National Water Act and relevant municipal bylaws (+).	**0**	
	Hazard	▪ Potential exposure risk to staff involved in handling during treatment or incineration (-).	**-1**	
Economic	Cost and Affordability	▪ Limited reduction in volume results in reduced costs associated with expensive disposal options (incineration and non-burn treatment) (+). ▪ Cost savings due to re-use of containers (+). ▪ Potential additional cost associated with container disinfection / effluent management (-).	**0**	**0**
	Impact on Local Economy	▪ N/A.	**0**	
Social	Employment	▪ N/A	**0**	**-1**
	Perception	▪ Perceived negative risk associated with accidental exposure during handling at disposal facilities / subsequent non-encapsulation risks at landfill sites (-).	**-1**	
	Equity	▪ N/A	**0**	
Practicality	Legal / policy	▪ Waste management policy supports the concepts of recycling (+). ▪ Potential increased risk of accidental exposure during handling prior to treatment poses a potential issue in terms of occupational health and safety related policy and legislation.	**0**	**-1**
	Processing capacity	▪ NB*** Practicality issue – relatively low volumes may not justify the potential risk associated with separation and potential non-conforming landfill disposal (-)	**-1**	
			Total (cumulative)	**-2**

Non-burn (Sterilisation and Disinfection) Technology

Parameter	Criteria	Pros and Cons / Comments	Criteria Score	Parameter Score (Total)
Environmental	Resource Depletion	▪ Electricity useage in treatment and disinfection process and transportation to the facility contributes to depletion of fossil fuels (-).	**-1**	**0**
	Air Quality	▪ N/A	**0**	
	Water Quality	▪ Effluent generated during disinfection (steam based) process (-).Effluent quality is controlled (treated to acceptable standards) in terms of the National Water Act and relevant municipal bylaws (+).	**0**	
	Hazard	▪ Potential spillage risk during transportation (-). This risk is mitigated by means of SANS codes of practice for transportation of hazardous substances (+). ▪ Current technology demonstrates that risk during processing is negligible (hands off / 100% disinfection rate) (+).	**1**	
Economic	Cost and Affordability	▪ Relatively high capital investment and operational (largely electrical consumption) cost (-). Costs would be off-set by operational revenue / profit based enterprise (+). ▪ No significant increase in cost to generator / affordable option (+).	**1**	**1**
	Impact on Local Economy	▪ N/A	**0**	
Social	Employment	▪ Limited number of employment opportunities created (+)	**0**	**1**
	Perception	▪ Non-burn technology generally well received by society (+)	**1**	
	Equity	▪ N/A	**0**	
Practicality	Legal / policy	▪ Growing consensus that non-burn treatment is the preferred method of treatment. Incineration is being increasingly rejected by society due to environmental concerns (+).	**1**	**2**
	Processing capacity	▪ Existing capacity exists (+). Additional facilities viable. ▪ Pathological and cytotoxic waste types must be incinerated (-).	**1**	
			Total (cumulative)	**4**

Incineration

Parameter	Criteria	Pros and Cons / Comments	Criteria Score	Parameter Score (Total)
Environmental	Resource Depletion	▪ Energy useage during incineration and transportation to the facility contributes to depletion of fossil fuels (-).	**1**	**0**
	Air Quality	▪ Emission of hazardous air pollutants (incl. dioxins and furans) (-). Emission control technology (e.g. scrubbers) required in order to meet emission standards.	**-1**	
	Water Quality	▪ N/A	**1**	
	Hazard	▪ Potential spillage risk during transportation (-). This risk is mitigated by means of SANS codes of practice for transportation of hazardous substances (+). ▪ Potential health risk associated with airborne emissions (-). Compliance with emission standards is a mitigating factor (+).	**-1**	
Economic	Cost and Affordability	▪ Relatively high capital investment and operational (largely energy consumption) cost (-). Costs would be off-set by operational revenue in the case of commercial facilities. ▪ No significant increase in cost to generator / affordable option (+).	**1**	**1**
	Impact on Local Economy	▪ N/A.	**0**	
Social	Employment	▪ Limited number of employment opportunities created (+).	**0**	**-1**
	Perception	▪ Strong public resistance to incineration as a waste management option (-).	**-1**	
	Equity	▪ Application of sustainable development principles during planning should prevent discriminatory siting of facilities (+).	**0**	
Practicality	Legal / policy	▪ No legal constraints / accepted means of disposal (+)	**1**	**1**
	Processing capacity	▪ Existing capacity exists (+). Non-burn technology trends could reduce viability (-).	**0**	
			Total (cumulative)	**1**

Special Waste / Waste Paints and Solvents BPEO – Preliminary Assessment Matrix

Summary

Option	Environmental	Economic	Social	Practicality	Total
Off-site recovery of solvents	-1	2	2	2	5
Landfilling with treatment	-1	-1	0	1	-1
Non-hazardous substitution	3	1	1	0	5
Waste Paint Recycling Programme	2	0	2	1	5
On-site Recovery Technology	2	0	2	0	4

Off-site recovery of solvents

Parameter	Criteria	Pros and Cons / Comments	Criteria Score	Parameter Score (Total)
Environmental	Resource Depletion	■ Off-sets use of raw materials for production of new products (+). ■ Electricity useage in recovery process and transportation to the off-site recovery plant contributes to depletion of fossil fuels (-).	**1**	**-1**
	Air Quality	■ Fugitive VOC emissions during transfer of solvents at the recovery plant (-). Emissions would be controlled / regulated through application of relevant environmental laws (+). ■ Electricity useage (recovery process) and fuel combustion (transport) result in the emission of GHG's and acidifying substances in the case of coal derived electricity (-).	**-1**	
	Water Quality	■ Recovery process could potentially generate effluent which is ultimately discharged to natural watercourses with or without treatment (-). Effluent quality is controlled (treated to acceptable standards) in terms of the National Water Act and relevant municipal bylaws (+).	**0**	
	Hazard	■ Potential large scale spillage / explosion risk during transportation (-). This risk is mitigated by means of SANS codes of practice for transportation of hazardous substances (+). ■ Potential large scale spillage / explosion risk during processing (-). Facilities would be required to operate under stringent environmental and health and safety controls thereby minimising risk profile (+).	**-1**	
Economic	Cost and Affordability	■ Current option (existing facilities) requires no establishment cost. Additional facilities would be profit based off-setting establishment costs (+). ■ Generator paid for waste (+). ■ Recovery service profits through sale of recovered product) (+). ■ Limited recovery facility closure / decommissioning costs assuming correct management (+).	**1**	**2**
	Impact on Local Economy	■ Promotes local primary (e.g. new processing facilities) and secondary (e.g. transportation / maintenance companies) economic opportunities (+).	**1**	
Social	Employment	■ Transportation and processing provides additional local employment opportunities. This would not be at the expense of employment in the 'new products' industry (+).	**1**	**2**
	Perception	■ Concept of recycling / recovery is generally well received by society (+). ■ Perceived heath impacts associated with processing facilities (-). Mitigated through information sharing / responsible environmental planning (e.g. EIA process and environmental management) (+).	**0**	
	Equity	■ Recycling limits future environmental liability (e.g. Landfill sites) (+). ■ Application of sustainable development principles during planning prevents discriminatory siting of processing facilities (+).	**1**	
Practicality	Legal / policy	■ Existing environmental legislation does not preclude processing facilities for hazardous substances (+). ■ Waste management policy supports concepts of recycling and recovery (+).	**1**	**2**
	Processing capacity	■ Existing capacity exists (+). Additional facilities viable on demand. ■ Highly contaminated solvent waste streams cannot be processed (-).	**1**	
			Total (cumulative)	**5**

Landfilling with treatment

Parameter	Criteria	Pros and Cons / Comments	Criteria Score	Parameter Score (Total)
Environmental	Resource Depletion	■ Does not reduce raw material useage for production of new products (e.g. through recycling) (-). ■ Transportation to the landfill site contributes to depletion of fossil fuels (-).	**-1**	**-1**
	Air Quality	■ Contributes towards landfill gas generation (particularly VOCs) and associated airborne emissions (-). Gas management systems reduce airborne emissions (+).	**0**	
	Water Quality	■ Landfilled waste will decompose anaerobically and add residual leachate (-). Leachate management systems minimise surface and groundwater contamination (+).	**0**	
	Hazard	■ Potential large scale spillage / explosion risk during transportation (-). This risk is mitigated by means of SANS codes of practice for transportation of hazardous substances (+).	**0**	
Economic	Cost and Affordability	■ Current option (existing landfill facilities) requires no establishment cost. ■ Establishment cost for future landfill facilities (-). ■ Generator pays disposal costs (-). ■ Landfill operator profits through disposal fees (+). ■ Cost associated with closure / decommissioning (-).	**-1**	**-1**
	Impact on Local Economy	■ Inhibits economic opportunities in the secondary waste management services sector (e.g. recycling) (-). ■ Promotes secondary (e.g. transportation / maintenance companies) economic opportunities (+).	**0**	
Social	Employment	■ Transportation provides additional local employment opportunities. ■ Landfill sites provide limited employment opportunities (-).	**1**	**0**
	Perception	■ Concept of landfilling is increasingly being rejected by society (-) ■ Perceived heath impacts associated with landfill emissions (-). Mitigated through information sharing / responsible environmental control (+).	**-1**	
	Equity	■ Landfilling creates future environmental liability (e.g. closure management (-). ■ Application of sustainable development principles during planning prevents discriminatory siting of landfill sites (+).	**0**	
Practicality	Legal / policy	■ Existing environmental legislation does not prohibit landfilling of hazardous substances (+). ■ Waste management policy identifies landfilling as the least preferred waste management strategy (-).	**0**	**1**
	Processing capacity	■ Existing capacity exists (+).	**1**	
			Total (cumulative)	**-1**

Non-hazardous substitution

Parameter	Criteria	Pros and Cons / Comments	Criteria Score	Parameter Score (Total)
Environmental	Resource Depletion	▪ N/A assuming no recycling undertaken.	**0**	**3**
	Air Quality	▪ Airborne emissions eliminated as hazardous component removed (+).	**1**	
	Water Quality	▪ Reduced risk from potential spillage as hazardous component removed (+).	**1**	
	Hazard	▪ Reduced risk from potential hazard as hazardous component removed (+).	**1**	
Economic	Cost and Affordability	▪ Potential increase in cost for purchase of non-hazardous substitutes (-). ▪ Reduction in disposal costs as waste is regarded as non-hazardous (+). ▪ Non-hazardous substitution does not preclude potential recycling opportunities. (+)	**1**	**1**
	Impact on Local Economy	▪ N/A.	**0**	
Social	Employment	▪ N/A.	**0**	**1**
	Perception	▪ Concept of hazardous waste avoidance is generally well received by society (+).	**1**	
	Equity	▪ N/A – non hazardous.	**0**	
Practicality	Legal / policy	▪ Waste management policy supports concepts of waste avoidance (+).	**1**	**0**
	Processing capacity	▪ Practicality issue - product substitution technology still under development. Currently not possible to substitute wide range of products (-).	**-1**	
			Total (cumulative)	**5**

Waste Paint Recycling Programme

Parameter	Criteria	Pros and Cons / Comments	Criteria Score	Parameter Score (Total)
Environmental	Resource Depletion	▪ Re-use off-sets use of raw materials for production of new products (+).	**1**	**2**
	Air Quality	▪ N/A.	**0**	
	Water Quality	▪ Waste avoidance – Reduced potential surface water pollution risk (+).	**1**	
	Hazard	▪ Potential spillage / explosion risk during storage / transfer (-). Facilities would be required to operate under stringent environmental and health and safety controls thereby minimising risk (+).	**0**	
Economic	Cost and Affordability	▪ Potential collection, distribution and storage costs (-).	**-1**	**0**
	Impact on Local Economy	▪ Positive publicity to participating organisations (+).	**1**	
Social	Employment	▪ Limited employment opportunities (-).	**0**	**2**
	Perception	▪ Re-use / charity initiatives perceived as positive by society. Potential positive benefits to participating organisations (+)	**1**	
	Equity	▪ Re-use / waste avoidance limits future environmental liability (e.g. Landfill sites) (+) ▪ Benefits underprivileged recipients (+).	**1**	
Practicality	Legal / policy	▪ Waste management policy supports concept of re-use (+).	**1**	**1**
	Processing capacity	▪ Practicality – potential limited provincial / local government resources (-). Could be facilitated through private sector participation (+).	**0**	
			Total (cumulative)	**5**

On-site Recovery Technology

Parameter	Criteria	Pros and Cons / Comments	Criteria Score	Parameter Score (Total)
Environmental	Resource Depletion	▪ Recycling off-sets use of raw materials for production of new products (+).	**1**	**2**
	Air Quality	▪ Fugitive VOC emissions potentially limited as off-site transfer not required (+). Emissions would be controlled / regulated through application of relevant environmental laws (+).	**1**	
	Water Quality	▪ On-site recovery process could potentially generate effluent (e.g. from solvent washing) which is ultimately discharged to natural watercourses with or without treatment (-). Effluent quality is controlled (treated to acceptable standards) in terms of the National Water Act and relevant municipal bylaws (+).	**0**	
	Hazard	▪ Potential spillage / explosion risk associated with recovery process (-). Solvent is already present therefore increase in risk is likely to be negligible. Recovery facilities would be required to operate under stringent environmental and health and safety controls thereby minimising risk profile (+).	**0**	
Economic	Cost and Affordability	▪ Potential high cost for on-site recovery technology (-). Only warranted if technology costs sufficiently off-set by savings.	**-1**	**0**
	Impact on Local Economy	▪ N/A.	**1**	
Social	Employment	▪ Limited direct employment opportunities (e.g. additional process management staff) (+).	**0**	**2**
	Perception	▪ Concept of recycling / recovery is generally well received by society (+) ▪ Perceived heath impacts associated with processing facilities (-). Mitigated through information sharing / responsible environmental planning (e.g. EIA process and environmental management) (+).	**1**	
	Equity	▪ Recycling limits future environmental liability (e.g. Landfill sites) (+). ▪ Application of sustainable development principles during planning (e.g. EIA process) prevents uncontrolled implementation of processing facilities (+).	**1**	
Practicality	Legal / policy	▪ Existing environmental legislation does not preclude processing facilities for hazardous substances (+). ▪ Waste management policy supports concepts of recycling and recovery (+)	**1**	**0**
	Processing capacity	▪ Practicality issue – Option would only be available to large scale producers where 1) technology is available, and 2) fiscal benefits outweigh capital investment (-).	**-1**	
			Total (cumulative)	**4**