University of Pretoria etd – Ramabitsa-Siimane, T M (2006)

REFERENCES

Alphonse C. 1997. *Application of the Analytical Hierarchy Process for Agriculture in Developing countries*. Agricultural Systems. Volume 53, Issue 1. Pages 97-112. http://www.sciencedirect.com/

Asante-Duah K. 1993. *Hazardous Waste Risk Assessment.* Lewis Publishers.

Athey T. 1982.*Systematic Systems Approach. An Integrated Method for solving Systems Problems*. Prentice-Hall, Inc New Jersey.

Aull-Hyde R, Erdegon S and Duke M. 2004. *An experiment on the consistency of aggregated comparison matrices in AHP.* European Journal of Operational Research (Corrected proof in Press). http://www.sciencedirect.com/

Bana e Costa C and Vansnick J. 2001. *A fundamental criticism to Saaty's use of the eigenvalue procedure to derive priorities.* The London School of Economics and Political Science. London. [Online] Available at http://uts.cc.utexas.edu/~consbio/minireview.pdf

Barbalace, CR. (1999). *History of Waste: Do you want to be a Garbologist?* [Online]. Available at http://environmentalchemistry.com/yogi/environmental/wastehistory.html [Accesses 12th February 2005]

Beck L, 1973. *An Ode to Problem Solving Using the Systems Approach*.Contained in: The educational Technology Review Series. *Number three*. *Introduction to the Systems Approach*. (1973) educational Technology Publications, Inc. New Jersey.

Brody S,Gisselquist D, Potterat J, Drucker E. 2003. *Evidence of iatriogenic HIV transmission in children in South Africa.* International Journal of obstetrics and gynaecology. Volume 110, issue 5. Pages 450-452.

University of Pretoria etd – Ramabitsa-Siimane, T M (2006)

Brown D. 1999. *What is sustainable Integrated Waste Management?* Brock University. Environmental Policy Institute. [Online]. Available at http://www.brocku.ca/epi/ciet/whatis.htm Accessed on the 10th February 2005.

Bryce H. 1987. *Financial and Strategic Management for Nonprofit Organizations*. New Jersey. Prentice-Hall. Pages 1-6.

Chacko G. 1989. *The Systems Approach to Problem-Solving*. New York .Praeger. Page ix

Checkland P.1989. *Systems Thinking: Systems Practice*. New York. John Wiley & Sons

Connely J, Smith G. 2003. *Politics and the Environment from theory to practice*.2nd edition, .Routeledge, London.

Coxon AP.1982. *The user's guide to multidimensional scaling*. New Hampshire. Heinemann Educational Books.

Eldin H. 1988*. Problems of Technology Transfer to Developing Countries*. In: Khalil T, Bayraktar B and Edosomwan J (ed). Technology Management 1. Florida. Inderscience Enterprise Ltd.

Encyclopedia of Educational Technology. [Online]. Available at http://coe.sdsu.edu/eet/articles/gestalt/index.htm accessed 23rd September 2005

English MR, Dale VH, Van Ripeer-Geibig V, Ramsey WH. 1999. Tools to aid Environmental Decision Making. New York. Springer-Verlag New York. Pages 1-32.

Friend, F. 2001. *Possible solutions to the challenges facing environmental management in a First/Third World Developing Country*. A paper presented at the 6th world Congress of Chemical Engineering, Australia 2001.

University of Pretoria etd – Ramabitsa-Siimane, T M (2006)

Garbutt D. 1992. *Making budgets work: the Control and Use of Budgetary Control Process*. London. Chartered Institute of Management Accountants.

Graedel, TE. 1998. *Streamlined Life Cycle Assessment.* New Jersey. Prentice-Hall.

Hanks, J and Hobbs J. 1991. *Environment, Economics and Enterprise: A role for The Polluter Pays Principle*? Resource. September/October issue. Pages 6-8

Hickman L and Eldgedge R. (n.d.)**.** *A Brief History of Solid Waste Management in the US During the Last 50 Years Part 2*. [Online]**.** Available at http://www.forester.net/msw_9909_brief_history.html [accessed 1st March 2005].

Hill MK. 2004. *Understanding environmental pollution*. Cambridge. Cambridge University press.

Hirschhorn J, Jackson T and Baas L. 1993. Towards Prevention- the emerging environmental management paradigm. In: Jackson T (ed*) Clean Production strategies: Developing preventative environmental management in the industrial economy.* USA. Lewis Publishers

International Labour Organization. 2004. Global unemployment trends figure. [Online]. Available from http://www.ilo.org/public/english/employment/strat/kilm/trends.htm Accessed on 12th July 2005

International Solid Waste Association. 2002*. Industry as a partner for Sustainable Development- Waste Management.* United Kingdom. International Solid Waste Association and United Nations Environment Programme.

Jackson M. 2000. *Systems Approaches to Management*. Kluwer Academic/Plenum Publishers.

University of Pretoria etd – Ramabitsa-Siimane, T M (2006)

Jazairy I, Alamgir M and Panucio T. 1992. *The State of World Rural Poverty*. London. Intermediate Technology.

Kane A, Lloyd J, Zaffran M, Simonsen L, and Kane M .1999. *Transmission of hepatitis B, hepatitis C and Human Immunodeficiency Viruses through unsafe injections in the developing world: model-based regional estimates.* Bulletin of the World Health Organization (volume 77, issue 10). Pages 801-807.

Khalil T. 2000. *Management of Technology, The Key to Competitiveness and Wealth Creation.* Singapore. McGraw-Hill.

Kibwage, KJ. (2002). *Integrating the Informal Recycling Sector into Solid Waste Management Planning in Nairobi City.* PhD Thesis. Maseno University. Kenya

Kjaerheim G, 2003. *Cleaner Production and sustainability.* Journal of cleaner production, Volume 13, issue 4. Pages 329-339. http://www.sciencedirect.com/

Laininen P, and Hämäläinen R. 2002. *Analyzing AHP-Matrices by regression*. European Journal of Operational research. Volume 148. http://www.sciencedirect.com/

Lannon-Kim C. 1994. *The Vocabulary of Systems Thinking: A Pocket Guide*. Pegasus Communications, Inc.

Lassey W . 1977. *Planning in Rural Environments*. McGraw-Hill.

Lesotho Ministry of Development planning. 2000. Interim Poverty Reduction strategy Paper. Maseru. Ministry of Development planning.

Lesotho Ministry of Environment, Gender and Youth Affairs. 1998. National Environmental Policy. Maseru. Ministry of Environment, Gender and Youth Affairs

Lesotho Ministry of Health and Social Welfare. 2003. Statistical Tables. Maseru. Ministry of Health and Social welfare.

University of Pretoria etd – Ramabitsa-Siimane, T M (2006)

Lesotho Ministry of Health and Social Welfare. 2004. Health Facility List. Maseru. Ministry of Health and Social welfare.

Lesotho Ministry of Health and Social Welfare. 2005. National Healthcare Waste Management Plans, First Draft. . Maseru. Ministry of Health and Social welfare.

Mc Dougall R, Franke M, Hindle P. 2001. *Integrated Solid Waste Management: A Life Cycle Inventory* . (USA). Blackie Academic and Professional.

Mc Rae G and Agarwal R. 1999*. Clinical Waste in Developing Countries: An analysis with a case study of India, and A critique of the Basel - TWG guidelines*. [Online]. Available from www.noharm.org accessed on 5th January 2005.

Merkhofer MW. 1999. Assessment Refinement and Narrowing of Options. In Dale V and English M (ed) *Tools to Aid environmental Decision Making*. New York. Springer-Verlag New York. Pages 231-281.

Morrissey AJ and Browne J. 2003. Waste management models and their application to sustainable development. Waste management. Volume 24, issue 3. Pages 297-308. http://www.sciencedirect.com/

Mvuma GK. 2002. Urban poverty Reduction through Municipal Solid Waste Management: A Case Study of Maseru and Maputsoe in Lesotho. PhD Thesis. University of Durban-Westville. South Africa

Noble, BF. 2003. *Strategic Environmental Assessment quality: Evaluating and Improving the Consistency of Judgments in Assessment Panels*. Environmental Impact Assessment Review. 24 (2004). Pages 3-25. http://www.sciencedirect.com/

Ogawa H. 1996. *Sustainable Solid Waste Management in Developing countries*. A paper presented at the 7th International Solid Waste Association International congress and Exhibition proceedings in Japan.

University of Pretoria etd – Ramabitsa-Siimane, T M (2006)

Omachuno V and Khalil T. 1988. *Conceptual and Policy Framework for the Management of Technology in Developing Countries*. In: Khalil T, Bayraktar B and **Edosomwan J** (ed). Technology Management 1. Florida. Inderscience Enterprise Ltd. Pages 59-65

Palmer Development Group. 1996. *Evaluation of Solid Waste Practice in Developing Urban Areas of South Africa*. Pretoria. Water Research Commission (Report 629/1/96).

Phaladze NA, Human S, Dlamini SB, Hulela SB, Hadebe IM, Sukati NA, Makoae LN, Seboni MS, Moleko M, Holzemer WL. 2005. *Quality of Life and the Concept of ''Living Well" with HIV/AIDS in Sub-Saharan Africa*. Journal of Nursing Scholarship. Volume 37, Issue 12. Pages 120-127. http://www.sciencedirect.com/

Prüss A, Giroult E, Rushbrook P. 1999, *Safe Management of Wastes from Health-care Activities*. World Health Organization, Geneva.

Reige AM. 2003. *Validity and reliability tests in case study research: a literature review with" hands-on" applications for each research phase*. Qualitative Market Research: An International Journal. 6 (2) pp 75-86.

Rogers DEC, Brent AC, Rohwer MB, 2002. *Life Cycle check as a Decision Support tool for Medical Waste Management in Underdeveloped Areas of Africa*. International Waste Management Biennial Congress and Exhibition, Proceedings WasteCon 2002.

Rogers DEC, Cilliers K. 2004. *Generic Waste Minimization Principles and Initiatives for Healthcare Institutions and Facilities in the Western Cape*. Pretoria, CSIR.

Royal Society of Chemistry. 1995. *Waste Treatment and Disposa*l. United Kingdom. Royal Society of Chemistry.

Saaty T. 1980. *The Analytical Hierarchy Process*. McGraw-Hill Inc. USA

Saaty T. 1986. *Decision-Making for Leaders*. McGraw-Hill Inc. USA

Sewall K. 1990. *The Trade-off Between Cost and Risk in Hazardous Waste Managemen*t. New York. Garland Publishing.

Siimane T, Brent A, Rogers D. 2005. Establishing Weighting values for waste management options at primary health care facilities in under serviced areas of Lesotho: Workshop Report. Pretoria.

South African Bureau of Standards. 1993. Code of Practice: Handling and Disposal of Waste Materials within Health Care Facilities (SABS 0248). Pretoria. The Council of The South African Bureau of Standards.

South African Bureau of Standards. 1997. Code of Practice: Environmental Management-Life Cycle Assessment-principles and framework (ISO 14040). Pretoria. The Council of the South African Bureau of Standards.

South Africa Department of Environmental Affairs and Tourism . 1993. *Managing South Africa's environmental Resources: A Possible New Approach (*ISBN 0-621-15900-X). Pretoria: Government printer.

South Africa Department of Environmental Affairs and Tourism. 2002. *Stakeholder engagement, Integrated Environmental Management, Information Series 3*. Pretoria. Department of Environmental Affairs and Tourism.

Steyn A, Smit C, Du Toit S and Strasheim C. 1994. *Modern Statistics in Practice*. Pretoria. Van Schaik.

Tchobanoglous G, Theisen H and Aliassen R. 1977. *Solid Wastes: Engineering Principles and Management Issues*. USA. McGraw-Hill.

Tryfos P.1996. *Sampling Methods for Applied Research.* USA. John Wiley and Sons.

University of Pretoria etd – Ramabitsa-Siimane, T M (2006)

United Nations. 1992. [Online] Agenda 21. Available from http://www.un.org/esa/sustdev/documents/agenda21 accessed on the 8th February 2006.

UNEP International Environmental Technology Centre (IETC). 1996. *International Sourcebook on Environmentally Sound Technologies for Municipal solid Waste Management.* USA. UNEP IETC.

United States Environmental Protection Agency (USEPA). (n.d.). [Online] *Environmentally Preferable Purchasing*. Available from http://www.epa.gov/oppt/epp/ accessed on the 28th February 2005.

Wasserburg, S. (n.d.) [Online] . *Transition and Implementation of Waste Management Policies in Central and Eastern Europe***.** Available from http:// www.inece.org/2ndvol/WASSER2.html accessed on the 2nd February 2005

Woodside G. 1993. *Hazardous Materials and Hazardous Waste Management: A Technical Guide*. USA. John Wiley and Sons.

White PR, Franke M and Hindle P. 1995. *Integrated Solid Waste Management: A Life Cycle Inventory*. (USA). Blackie Academic and Professional.

Wilson, D. 1981. *Waste Management: Planning, Evaluation, Technologies*. Oxford. Clarendon Press.

Wilson R. 1974. *Financial control: A Systems Approach*. New York. Mc Graw-Hill Inc.

World Bank. 2000. *Entering the 21st century: world development report 1999/2000*. Washington. Oxford university press.

Yin RK. 1989. *Case Study Research Design and Methods*. 2nd ed. California. Sage Publications.

APPENDICES

APPENDIX 1: AHP RESULTS

Table 1: AHP results obtained from the workshop participants for the **waste generation** life cycle phase.

Options	Participants											Average weight
	1	2	3	4	5	6	7	8	9	10	11	
Level 2												
Container	0.413	0.333	0.333	0.333	0.333	0.333	0.333	0.778	0.279	0.243	0.455	**0.375**
Infrastructure	0.260	0.333	0.333	0.333	0.333	0.333	0.333	0.111	0.072	0.056	0.091	**0.235**
Procedures	0.327	0.333	0.333	0.333	0.333	0.333	0.333	0.111	0.649	0.701	0.455	**0.386**
Consistency	0.046	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.056	0.093	0.000	
Level 3												
EC	0.833	0.875	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.833	0.857	**0.882**
nEC	0.167	0.125	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.167	0.143	**0.118**
Consistency												
EL	0.875	0.875	0.900	0.900	0.900	0.900	0.900	0.875	0.900	0.750	0.800	**0.870**
nEL	0.125	0.125	0.100	0.100	0.100	0.100	0.100	0.125	0.100	0.250	0.200	**0.130**
Consistency												
DP	0.875	0.875	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.889	0.857	**0.891**
nP	0.125	0.125	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.111	0.143	**0.109**
Consistency	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	

Table2: Weighting results obtained from the workshop participants for the **collection and storage** life cycle phase.

Options	Participants											Average weight
	1	2	3	4	5	6	7	8	9	10	11	
Level 2												
Tech/Agg.	0.069	0.067	0.063	0.818	0.333	0.104	0.333	0.333	0.471	0.200	0.678	**0.315**
Inrastructure	0.244	0.467	0.458	0.091	0.333	0.127	0.333	0.333	0.059	0.200	0.142	**0.253**
Procedures	0.687	0.467	0.478	0.091	0.333	0.769	0.333	0.333	0.471	0.600	0.179	**0.431**
Consistency	0.107	0.000	0.002	0.000	0.000	0.033	0.000	0.000	0.000	0.000	0.046	
Aggregation	0.059	0.067	0.818	0.818	0.250	0.095	0.634	0.481	0.471	0.149	0.129	**0.391**
Transport	0.240	0.467	0.091	0.091	0.250	0.250	0.174	0.056	0.059	0.66	0.085	**0.159**
Container	0.701	0.467	0.091	0.091	0.500	0.655	0.192	0.463	0.471	0.785	0.785	**0.450**
Consistency	0.254	0.000	0.000	0.000	0.000	0.063	0.008	0.001	0.000	0.069	0.066	
Level 3												
EC>EC	0.293	0.377	0.377	0.207	0.207	0.2550	0.653	0.750	0.692	0.568	0.501	**0.467**
EC>nEC	0.293	0.072	0.073	0.207	0.207	0.250	0.228	0.083	0.140	0.313	0.251	**0.192**
nEC>EC	0.207	0.496	0.496	0.293	0.293	0.250	0.060	0.083	0.070	0.069	0.251	**0.223**
nEC>nEC	0.207	0.055	0.055	0.293	0.293	0.250	0.060	0.083	0.098	0.042	0.037	**0.118**
Consistency	0.045	0.045	0.057	0.091	0.091	0.155	0.091	0.000	0.091	0.063	0.068	
EW	0.731	0.735	0.743	0.582	0.751	0.743	0.796	0.102	0.205	0.731	0.798	**0.671**
EnW	0.188	0.207	0.194	0.367	0.178	0.194	0.125	0.726	0.722	0.188	0.138	**0.251**
nEnW	0.081	0.058	0.063	0.051	0.070	0.063	0.079	0.172	0.073	0.081	0.064	**0.251**
Consistency	0.056	0.100	0.061	0.046	0.025	0.061	0.046	0.025	0.107	0.056	0.093	
EC	0.875	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.875	0.857	**0.892**
nEC	0.125	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.125	0.143	**0.108**
Consistency	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
REF	0.731	0.773	0.818	0.672	0.627	0.582	0.663	0.725	0.635	0.649	0.655	**0.685**
nREF	0.188	0.139	0.091	0.265	0.256	0.367	0.278	0.207	0.287	0.279	0.290	**0.241**
nRnEF	0.081	0.046	0.091	0.065	0.063	0.051	0.058	0.058	0.078	0.072	0.055	**0.069**
Consistency	0.056	0.046	0.000	0.025	0.025	0.046	0.046	0.101	0.081	0.056	0.069	
DP	0.889	0.889	0.900	0.900	0.900	0.900	0.875	0.875	0.900	0.833	0.857	**0.883**
nP	0.111	0.111	0.100	0.100	0.100	0.100	0.125	0.125	0.100	0.167	0.143	**0.117**
Consistency	0.000	0.000	0.000	0.000	0.00	0.000	0.000	0.000	0.000	0.000	0.000	

Table 3: Weighting results obtained from the workshop participants for the **onsite waste treatment** life cycle phase.

Option	Participants											Average weight
	1	2	3	4	5	6	7	8	9	10	11	
Level 2												
Tech./Equip	0.416	0.413	0.413	0.333	0.333	0.413	0.333	0.413	0.444	0.462	0.773	**0.431**
Infrastructure	0.126	0.260	0.260	0.333	0.333	0.260	0.333	0.260	0.111	0.077	0.134	**0.226**
Procedures	0.458	0.327	0.327	0.333	0.333	0.327	0.333	0.327	0.444	0.462	0.093	**0.342**
Consistency	0.008	0.046	0.046	0.000	0.000	0.046	0.000	0.046	0.000	0.000	0.093	
Technology	0.687	0.659	0.550	0.250	0.250	0.515	0.429	0.785	0.333	0.714	0.482	**0.514**
Transport	0.069	0.185	0.210	0.250	0.250	0.097	0.143	0.149	0.333	0.143	0.091	**0.175**
Container	0.244	0.156	0.240	0.500	0.500	0.388	0.429	0.066	0.333	0.143	0.429	**0.311**
Consistency	0.107	0.025	0.016	0.000	0.000	0.069	0.000	0.046	0.000	0.000	0.013	
Level 3												
SASSI-E	0.641	0.655	0.655	0.717	0.735	0.606	0.735	0.763	0.733	0.644	0.648	**0.685**
SASSI-M	0.293	0.290	0.290	0.217	0.207	0.333	0.207	0.176	0.199	0.271	0.300	**0.253**
OAB	0.067	0.055	0.055	0.066	0.058	0.061	0.051	0.061	0.068	0.085	0.052	**0.062**
Consistency	0.086	0.069	0.069	0.032	0.101	0.008	0.101	0.093	0.081	0.046	0.093	
EWT	0.777	0.785	0.793	0.770	0.770	0.777	0.773	0.696	0.761	0.699	0.655	**0.751**
GT	0.153	0.149	0.131	0.162	0.162	0.153	0.139	0.229	0.166	0.237	0.290	**0.179**
IT	0.007	0.066	0.076	0.168	0.168	0.070	0.088	0.075	0.073	0.064	0.055	**0.088**
Consistency	0.090	0.069	0.019	0.046	0.046	0.090	0.046	0.066	0.063	0.081	0.069	
EC	0.889	0.875	0.900	0.900	0.900	0.900	0.875	0.889	0.900	0.833	0.875	**0.885**
nEC	0.111	0.125	0.100	0.100	0.100	0.100	0.125	0.111	0.100	0.167	0.125	**0.115**
Consistency	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
ES	0.857	0.875	0.875	0.900	0.900	0.900	0.875	0.889	0.900	0.750	0.889	**0.874**
nES	0.143	0.125	0.125	0.100	0.100	0.100	0.125	0.111	0.100	0.250	0.111	**0.126**
Consistency	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
DP	0.833	0.875	0.875	0.900	0.900	0.900	0.875	0.889	0.900	0.875	0.900	**0.884**
nP	0.167	0.125	0.125	0.100	0.100	0.100	0.125	0.111	0.100	0.125	0.100	**0.116**
Consistency												

Table 4: Weighting results obtained from the workshop participants for the **onsite waste disposal** life cycle phase.

Option	Participants											Average weight
	1	2	3	4	5	6	7	8	9	10	11	
Level 2												
Tech/Equip	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.883	0.800	**0.558**
Procedures	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.116	0.200	**0.442**
Consistency	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Technology	0.500	0.875	0.875	0.333	0.333	0.500	0.500	0.800	0.500	0.800	0.875	**0.626**
Container	0.500	0.125	0.125	0.667	0.667	0.500	0.500	0.200	0.500	0.200	0.128	**0.374**
Consistency	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Level 3												
EP	0.641	0.641	0.592	0.751	0.751	0.714	0.796	0.796	0.763	0.701	0.767	**0.719**
CD	0.293	0.297	0.333	0.178	0.178	0.143	0.079	0.079	0.176	0.243	0.176	**0.196**
OD	0.067	0.072	0.075	0.070	0.070	0.143	0.125	0.125	0.061	0.056	0.061	**0.084**
Consistency	0.086	0.086	0.012	0.025	0.025	0.000	0.046	0.046	0.093	0.093	0.093	
EC	0.889	0.875	0.875	0.0900	0.900	0.900	0.889	0.857	0.900	0.833	0.857	**0.880**
nEC	0.111	0.125	0.125	0.100	0.100	0.100	0.111	0.143	0.100	0.167	0.143	**0.120**
Consistency	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
DP	0.875	0.900	0.900	0.900	0.900	0.900	0.900	0.875	0.900	0.750	0.889	**0.881**
nP	0.125	0.100	0.100	0.100	0.100	0.100	0.100	0.125	0.100	0.250	0.111	**0.119**
Consistency	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	

Table 5: Weighting results obtained from the workshop participants for the offsite (**central) waste treatment** life cycle phase.

Option	Participants											Average weight
	1	2	3	4	5	6	7	8	9	10	11	
Level 2												
Tech/Equip	0.687	0.714	0.714	0.333	0.333	0.600	0.333	0.444	0.333	0.333	0.528	**0.487**
Infrastructure	0.186	0.143	0.143	0.333	0.333	0.200	0.333	0.084	0.333	0.333	0.091	**0.228**
Procedures	0.127	0.143	0.143	0.333	0.333	0.200	0.333	0.472	0.333	0.333	0.381	**0.285**
Consistency	0.081	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.000	0.000	0.093	
Technology	0.594	0.667	0.667	0.250	0.250	0.429	0.429	0.687	0.672	0.667	0.761	**0.552**
Transport	0.157	0.167	0.167	0.250	0.250	0.143	0.143	0.069	0.063	0.167	0.166	**0.158**
Container	0.249	0.167	0.167	0.500	0.500	0.429	0.429	0.244	0.265	0.167	0.073	**0.290**
Consistency	0.046	0.000	0.000	0.000	0.000	0.000	0.000	0.107	0.025	0.000	0.063	
Level 3												
MCI	0.833	0.833	0.833	0.875	0.875	0.857	0.857	0.889	0.875	0.857	0.833	**0.856**
SCI	0.167	0.167	0.167	0.125	0.125	0.143	0.143	0.111	0.125	0.143	0.167	**0.144**
Consistency	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
EWV	0.777	0.743	0.743	0.751	0.751	0.799	0.799	0.707	0.785	0.761	0.770	**0.762**
GV	0.153	0.194	0.194	0.178	0.178	0.105	0.105	0.223	0.149	0.166	0.162	**0.164**
IV	0.070	0.063	0.063	0.070	0.070	0.096	0.096	0.070	0.066	0.073	0.068	**0.164**
Consistency	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
EC	0.875	0.900	0.900	0.900	0.900	0.900	0.900	0.889	0.900	0.857	0.889	**0.892**
nEC	0.125	0.100	0.100	0.100	0.100	0.100	0.100	0.111	0.100	0.143	0.111	**0.118**
Consistency	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
ES	0.889	0.900	0.900	0.900	0.900	0.900	0.900	0.875	0..900	0.857	0.900	**0.893**
nES	0.111	0.100	0.100	0.100	0.100	0.100	0.100	0.125	0.100	0.143	0.100	**0.107**
Consistency	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
DP	0.875	0.900	0.900	0.900	0.900	0.900	0.900	0.889	0.900	0.889	0.889	**0.895**
nP	0.125	0.100	0.100	0.100	0.100	0.100	0.100	0.111	0.100	0.111	0.111	**0.105**
Consistency	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	

Table 6: Weighting results obtained from the workshop participants for offsite **central waste disposal.**

Option	Participants											Average weight
	1	2	3	4	5	6	7	8	9	10	11	
Level 2												
Tech/Equip	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.900	**0.890**
Procedures	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.100	**0.110**
Consistency	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Technology	0.761	0.800	0.509	0.250	0.250	0.458	0.429	0.333	0.333	0.714	0.766	**0.539**
Transport	0.073	0.100	0.097	0.250	0.250	0.063	0.143	0.333	0.333	0.143	0.125	**0.174**
Container	0.166	0.100	0.094	0.500	0.500	0.479	0.429	0.333	0.333	0.143	0.125	**0.287**
Consistency	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Level 3												
LF	0.467	0.750	0.750	0.735	0.735	0.804	0.592	0.722	0.722	0.763	0.481	**0.686**
CD	0.467	0.171	0.171	0.207	0.207	0.122	0.333	0.222	0.227	0.176	0.463	**0.248**
OD	0.067	0.078	0.078	0.058	0.058	0.074	0.075	0.051	0.051	0.061	0.056	**0.066**
Consistency												
EWV	0.777	0.798	0.798	0.761	0.761	0.818	0.777	0.798	0.663	0.763	0.751	**0.770**
GV	0.153	0.138	0.138	0.158	0.158	0.091	0.153	0.138	0.278	0.176	0.178	**0.160**
IV	0.070	0.064	0.064	0.082	0.082	0.091	0.070	0.064	0.058	0.061	0.070	**0.071**
Consistency	0.090	0.093	0.093	0.001	0.001	0.000	0.090	0.093	0.046	0.093	0.025	
EC	0.889	0.889	0.889	0.900	0.900	0.900	0.889	0.889	0.900	0.857	0.889	**0.890**
nEC	0.111	0.111	0.111	0.100	0.100	0.100	0.111	0.111	0.100	0.143	0.111	**0.110**
Consistency	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
DP	0.875	0.875	0.889	0.900	0.900	0.900	0.889	0.889	0.900	0.875	0.900	**0.890**
nP	0.125	0.125	0.111	0.100	0.100	0.100	0.111	0.111	0.100	0.125	0.100	**0.109**
Consistency	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	

APPENDIX 2: THE WORKSHOP REPORT

Establishing weighting values for waste management options at primary health care facilities in under serviced areas of Lesotho

A Workshop Held at Bambatha Ts'ita Arena on the 6th-7th April 2005

Report Prepared by
Ts'aletseng Siimane
Dr Alan Brent
Dr David Roger

LIST OF TABLES

LIST OF ACRONYMS

CHAL:	Christian Health Association of Lesotho
EST:	Environmentally Sound Technology
HCW:	Health Care Waste
HCWM:	Health Care Waste Management
MoHSW:	Ministry of Health and Social welfare
MoTEC:	Ministry of Tourism, Environment and Culture
NES:	National Environment Secretariat
NHCWMP:	National Healthcare Waste Management Plans
PHC:	Primary Health Care

1. INTRODUCTION

The two-day workshop was sponsored by the Development Corporation of Ireland (DCI) under the Health Planning unit of the Ministry of Health and Social Welfare. It was held as an aid for a postgraduate data-gathering exercise from experts in the field of healthcare waste management in Lesotho. DCI has supported the overall MSc programme since July 2003.

The participants of the workshop came from both district and national levels. An average of 14, highly engaged participants was registered per day for the two days.

The facilitators of the workshop were Drs Alan Brent, David Rogers and Godfrey Mvuma who came from the University of Pretoria, Council for Scientific and Industrial Research (CSIR) and Department of Environmental Affairs and Tourism in RSA, respectively.

To realise the objectives of the workshop, the following methods were used in the workshop:

- Presentations;
- Discussions, questions and positive criticism (Nominal Group Technique);
- Charts;
- Role cards;
- Worksheets.

2. RATIONALE FOR THE WORKSHOP

The choice of performing a workshop for gathering data was based on the following advantages:

- The participants work as a group and thus the advantage of pooled judgements is benefited upon;

- Improved communications between the participants lead to better understanding of their respective operations and responsibilities;
- There exists a vastness of ideas, which is not exhibited by other methods, e.g. questionnaires;
- Balancing of individual dominion is achieved; and
- Participants are encouraged to confront issues on a problem-solving basis.

3. OBJECTIVES OF THE WORKSHOP

The objectives of the workshop were to:

a. Establish weighting values for waste management options at primary health care facilities in Lesotho.

b. Establish the objectives of and the roles of each participant in the waste management system of Lesotho.

c. To reach a consensus regarding the definitions of HCW and a PHC facility.

4. WORKSHOP PROGRAMME

The workshop process is summarised in Tables 1 and 2.

Table 1: Programme for the 6th of April 2005

Time	Activity	Responsibility
08h30 – 09h00	Registration	Ts'aletseng Siimane
09h00 – 09h05	Welcome by chair and Prayer	Ts'aletseng Siimane
09h05 – 09h10	Opening speech	Mr Nkuebe Theko (apology)
09h10 – 09h15	Introduction of the project team	Ts'aletseng Siimane
09h15 -09h 25	Introduction of participants	Participants
09h25 – 09h	Presentation: Problem statement	Dr David Rogers
	Presentation: Procedures to obtain solutions to the problem	Dr Alan Brent and Ts'aletseng
	Presentation: The definition of the system, HCW, PHC	Ts'aletseng Siimane

	facility	
10h30 - 10h45	Tea Break	All
10h45 –	Worksheets: Generation on-site	Dr Brent
	Worksheets: collection & storage	Dr Brent
	Lunch	All
	Worksheets: Treatment on-site	Dr Brent
15h30 – 15h45	Tea Break	All
15h45 – 16h25	Worksheets: Disposal on-site	Dr Brent
16h25 – 16h30	Closing remarks	Ts'aletseng Siimane

Table 2: Programme for the 7th of April 2005

Time	Activity	Responsibility
08h45 – 09h00	Registration	Ts'aletseng Siimane
09h00 – 09h05	Welcome by chair and Prayer	Ts'aletseng Siimane
09h05 – 09h10	Recap of previous day's work	Ts'aletseng Siimane
09h10 – 10h30	Worksheets: Collection and storage (central location) + discussions	Dr David Rogers
10h30 -10h45	Tea Break	All
10h45 – 12h00	Worksheets: Treatment at central location + discussions	Dr David Rogers
12h00 – 13h00	Worksheets: Disposal at central location + Discussions	Dr David Rogers
13h00 – 14h00	Lunch	All
14h 00 - 15h30	Way forward: Plenary session	Dr David Rogers
15h30 - 15h40	Final Closing Remarks	Ts'aletseng Siimane

5. PROCEEDINGS FROM THE WORKSHOP

The following points emanated from the workshop participants and facilitators. They have been recorder under the presentations and discussions headings they emanated from.

5.1 Participants' expectations of the workshop

The participants hoped that the workshop would set the grounds for:

- Implementation of the outcomes of the MSc research;
- Deliberations that would help in the formulation of the National HCWM Plans (NHCWMP) of Lesotho;
- Information acquisition for personal enrichment and also to know what other countries like RSA are doing in terms of HCWM;
- The improvement of strategies and policies that need to be formulated; and
- Define the roles and responsibilities within the waste management system.

5.2 Statement of the Problem

Following Dr Rogers's presentation, discussions followed and a consensus was reached regarding what the problem is. The consensus was reached as follows:

- **Waste at clinics is highly infectious** due to its content of sharps, swabs and dressing, which can transmit diseases like HIV/AIDS and Hepatitis B.
- **Policies:**

a. There are no policies to guide responsible HCWM and many institutions hide behind that fact instead of pushing towards the formulation of such policies. Therefore a system can hardly be built at national level.

b. There exists a lack of alternatives (especially infrastructure and technologies) for proper HCWM.

c. A lack of responsibility occurs at remote clinics where sometimes resources are there but are not being used

- **Low awareness:**

a. At many clinics waste is not considered a problem, but has a high potential of affecting whole communities.

b. Most communities have low awareness on the risks of HCW, but yet have close proximity to waste facilities (even sharing of resources).

- **Resources:**

a. Clinics in remote rural areas are under resourced. There is limited funding and often skills.

b. There is an inadequacy of facilities e.g. equipment for the safe treatment of HCW

5.3 Solutions to the problem

The best solution was for waste managers to operate as and within an appropriate system.

The system would be characterised by being:

a. Safe;

b. Achievable; and

c. Easy to monitor for continual improvement and in support of Agenda 21, which advocates for sustainability of the environment, economy and society.

Under this topic, participants were also asked to write the roles they play within the following categories: Policy, Action Plan, Standards, Monitoring, Capacity-building and Tenders. The participants were given colour-coded paper to write on:

Pink: Name and Position

Green: The role that he/she plays in waste management

Yellow: The challenges that he/she faces in his/ her position.

The outcome of this exercise is shown in Table 3.

Table 3: Participants' roles in waste management

Name	Roles	Challenges	Categories of operation
Sebonoang Mots'oari	1. Ensure proper disposal of waste in wards. 2. Procure containers for other waste including general and body fluids. 3. Education of unit staff.	1. Lack of equipment e.g. containers and staff turnover. 2. Lack of guidelines and policy except for universal precautions	1. Waste generation
Tieho Chatsane	1. Training of waste collectors 2. Inspection of HCWM facilities	1. Lack of funds to train waste collectors 2. Lack of human resource to monitor activities of HCWM 3. Lack of equipment for disposal and treatment of HCW 4. Low commitment of administrators to fund HCWM activities	1. Capacity building 2. Monitoring 3. Full Life Cycle
Seipati Lekoeneha	1. Disease prevention and control through proper environmental management	1. Lack of storage, treatment and disposal facilities for HCW	1. Capacity building 2. Monitoring 3. Full Life Cycle
Mosepeli Ratikane	1. Protection of public health by implementing strategies and policies in disease control. 2. Promotion of good health practices/behaviours 3. Procurement of containers and proper storage for	1. Inadequacy of funds 2. Absence of legislation 3.Inadequacy of knowledge	1. Capacity building 2. Monitoring 3. Full Life Cycle

Name	Roles	Challenges	Categories of operation
	waste		
Thato Williams	1. Collaborates with MoLG and MoTEC for waste management 2. Training of Health workers in managing waste 3.Availing proper containers and protective clothing for health facilities and workers	1. Unavailability of a sound disposal area. 2. Lack of funds for training of health workers on waste management 3. Poor state of present incinerator	1. Capacity building 2. Monitoring 3. Full Life Cycle
Ntsoaki Zwane	1. Training of healthcare workers in waste management. 2. Collaboration with administrators and town clerk to ensure provision of waste handling equipment and disposal site availability. 3. Continuous inspection in the life cycle of the waste and advising on measures	1. Lack of transport to disposal site 2. Resistant to change by healthcare staff 3. Unavailability of proper containers and protective clothing for workers 4. Low awareness on healthcare workers regarding proper waste handling practices	1. Capacity building 2. Monitoring 3. Full Life Cycle
Motsamai Mahahabisa	1. Teaching Environmental Health Assistants on HCWM and other environmental Health issues	1. The deficit between actual practice and ideal theory that is taught to students	1. Capacity building 2. Full life cycle
Moqekele Mohale	1. Management of Junior staff activities in districts 2. Education of healthcare workers and the public on waste management. 3.Advising relevant	1.Changing the perception of the public on HCW 2.Acquisition of resources in the implementation of proper	1. Capacity building 2. Monitoring 3. Full Life Cycle

Name	Roles	Challenges	Categories of operation
	authorities at health care facilities on HCWM	HCWM 3.Formulation of strategies, and policies by relevant authorities 4. Training and monitoring HCW handlers including scavengers	
Mokitimi Thekiso	1.Coordination of HCWM activities within the MoHSW	1. Formulation of non-existent NHCWMP 2. Engaging all stakeholders in government and private sectors	1. Action Plan 2. Strategy 3. Full life cycle
Thabo Ts'asanyana	1. Coordination of environmental issues related to pollution. 2. Facilitating development of policies, strategies, standards and guidelines for pollution prevention	1. Absence of regulatory tools 2. Inadequate infrastructure to monitor pollution 3.Understaffing for timely response	1. Strategy 2. Policy
Leon Ramatekoa	1.Design programmes to curb pollution 2.Monitoring of activities likely to pollute 3. Create awareness on environmental pollution 4. Ensure compliance with standards	1.Lack of cooperation from line ministries 2. Lack of public awareness on environmental issues. 3. Lack of compliance due to the non-operational state of the environment Act 4. Lack of funds to implement planned activities.	1. Action Plan 2. Capacity building

Name	Roles	Challenges	Categories of operation
		5. Low staffing	
Jürg Oehninger	1. Coordination of infrastructure projects and maintenance in CHAL facilities 2.Planning and execution of renovations and repairs at health centres. 3.Buying equipment for health centres 4. Maintenance at health centres and network at CHAL	1.Waste management priorities keep changing 2. Little time to do many activities, some very urgent and overriding others. 3. Low collaboration with MoHSW. 4. Some of the authorities' opinion is unfounded and difficult to understand	1. Full life cycle of waste
Godfrey Mvuma	1. Formulation of strategies, guidelines, policies and standards in hazardous waste and HCWM in RSA	1. Lack of understanding by political leaders and top government officials on the importance of policy formulation on waste management issues 2. Roles and responsibilities replication among dept of health and environment.	1. Strategy 2. Full life cycle
Refiloe Sethathi	1.Raise awareness on EIA 2. Review EIA reports 3. Monitor compliance to management plan 4. Participate in developing tools related to EIA	1.Lack of operational legal framework 2. Lack of cooperation from line ministries 3. Lack of financial and human	1. Standards

Name	Roles	Challenges	Categories of operation
		resources 4. Lack of commitment to prioritise environmental issues 5. Lack of environmental awareness	

5.4 The definition of the waste management system

The aim of this presentation was to present the views of the team regarding three points and then lead the participants into reaching a consensus on each of the points. The points were:

- The objectives of Lesotho's waste management system;
- The definition of HCW in the Lesotho context; and
- The definition of a rural PHC facility.

The consensus is summarised in the following sub-sections.

5.4.1 The objectives of Lesotho's waste management system

a. Protection of public health with environmental health and occupational health tools.
b. Protection of the physical and socio-economic environment for better health of present and future generations.
c. Sustenance of a waste information system, especially for rural healthcare facilities.
d. Promulgate legislation and regulations and ensure enforcement of such frameworks.
e. Slot in policy for HCWM in rural clinics.

f. Encourage participation of the public and all other stakeholders in HCWM.

5.4.2 The definition of HCW in the Lesotho context

Healthcare waste includes the following categories at rural health facilities:

a. **Sharps:** which include needles, syringes, and blades and can infect through skin puncturing.
b. **Anatomical (placentas):** which are infectious by virtue of containing blood.
c. **Pharmaceuticals:** includes expired or contaminated drugs. These are chemicals and may be toxic.
d. **Packaging and general waste:** These are not risk waste if managed correctly.
e. **Heavy metals:** includes mercury from medical instruments. This is a minute quantity and is rare at rural clinics.

The inclusion of these categories into the definition of HCW at rural clinics required special consideration for their storage, treatment and disposal options.

5.4.3 The definition of a rural PHC facility

A rural PHC clinic has the following characteristics:

a. It is headed by a nursing sister or a nurse clinician.
b. It reports to a district or Health Service Area (HSA) hospital.
c. It provides basic curative and emergency services as well as immunizations and mother and child services.
d. It does not cater for in-patients

5.5 Comparison of options

Using the Analytical Hierarchy Process (AHP), the participants were requested to perform pair-wise comparisons of available/desired options for on site and off-site (central) locations.

- The AHP proved to be difficult to a certain degree for some of the participants who believed a single comparison of all options of a life cycle stage would have sufficed.
- Inconsistent judgements were identified in certain cases and attempts were made to improve the logical consistencies of these comparison sets.

Important points that were raised during the comparison sessions are summarised below:

- There is awareness that pit or open-air burning is not effective in treating HCW.
- Incinerators are required and should ideally be engineered units.
- Present incinerators fail because the operators do not know how to operate them; also maintenance is a big problem.
- Incinerators should reach temperatures of 1000^{o}C and beyond. Participants felt that it is vital to set the country's own standards and not just what organizations like WHO tolerate.
- Some of the technologies that were compared are not in use in Lesotho. However, they may be considered for use in Lesotho.
- National HCWM plans are being formulated and such technologies and the requirement for procedures need to be incorporated.
- Quality of technologies and procedures should not be compromised due to lack of available funding. Planning should be focused on systems that work and are sustainable, rather that on interim-strategies.
- It is advisable to always have a backup alternative at health facilities in case incinerators fail.
- Pit latrines, which are also used for disposal of HCW, are considered to be a controlled dump.

5.6 Way Forward: Plenary session

The group paved the way forward by specifying what they want to see happening to improve HCWM and what is needed to make it happen. Actions were identified as summarised in the following table.

Table 4: Planned goals and activities to improve HCWM in Lesotho

Goal	Main Activity
1. Identify gaps and collect data (or use existing one) to improve healthcare waste management	1.A centre of data excellence (expertise) should exist that will: a) Handle technical issues independently and rationally (meetings). b) Prioritise the components of the waste management system to tackle first. c) Identify training needs and packages. d) Integrate with the NHCWMP (meetings). 2. NES should cooperate with MoHSW, MoLG, MoNR and NGOs to coordinate the implementation of the MSc thesis findings. 3. Management personnel should acquire information and make other relevant persons e.g. maintenance aware of current situation and way forward
2. Assign responsibilities, budgets and commitment to policy for waste management	1. Prepare budgets to fund appropriate equipment
3. Formulate guidelines and procedures for appropriate alternatives.	1. Advocate for the formulation of guidelines and procedures for the diverse professionals that deal with HCWM. 2. Strengthen the capacity of operational staff and professionals by conducting on the job training 3. Discourage the use of open air

	burning to treat waste
4. Develop Job specifications for guideline and procedure formulation and implementation considering "tool box talks"	1. This will be done from recommendations of an advisory committee.
5. Adopt the MSc research into national HCWM plans via pilot project(s)	1. The outcome of the thesis should serve as a waste management survey, giving data of classes of waste and the quantities generated at PHC facilities as well as costs. 2. It is hoped the thesis will come up with options that emphasize risk but strike a balance between capital and operational cost of ESTs and the risk posed to HCW handlers 3. The thesis may also identify a general methodology, which can be used for other problems e.g. industrial waste. 4. Recommendations to be implemented to improve segregation and treatment of HCW
6. Form a committee that will monitor the implementation at healthcare facilities	1. Committee is to help in the formulation of guidelines and get commitment of healthcare facility managers or administrators
7. Promulgate and formulate regulations to control waste management (HCW)	1. Advocate for the promulgation of sound legislation to support NHCWMP
8. Implement inspection of premises	1. Premises to be inspected routinely to ensure application of guidelines and procedures
9. Devise a penalty system for trespassers	1. Penalties to be charged on facilities that still use methods that will be prohibited (open-air burning)
10. A monitoring system should be put in place	1. Monitoring results should be fed back as input to the system so that it can be continually improved.

Finally, it was agreed that the results of this study would be communicated to the participants of the workshop towards the end of 2005.

APPENDIX 3: MODIFIED WORLD HEALTH ORGANIZATION RAPID ASSESSMENT TOOL (TOOL D-1)

Health-care waste management • Rapid assessment tool			**(country)**
Tool D-1	**Interview**	**Manager or deputy of health care facility**	**Duration: 30"**

Health care facility:	Address:	District:
Name of interviewee:	Function:	Tel. n°:
Assessment made by:		Date of assessment:

c	n°	topic	question	type	data	comments / multiple choice
	2	**health care facility (HCF)**				
	200	HCF	Which category is it ?	C		[1] ambulant service; [2] (sub-)district hospital; [3] large hospital
	201	HCF	Which type is it ?	C		[1] public; [2] private
	203	services	which services do you have in your HCF	C		[1] medicine; [2] gynaecology; [3] surgery; [4] children services [5] emergencies; [6] radiology; [7] laboratory; [8] other (specify)
	204	bed capacity	How many beds do you have in total ?	N		
	3	**staff**				
	300	medical staff training	Is training of med. staff available regarding HCWM ?	B		
	301	medical staff training	If yes, what kind of training is given ?	T		
	302	staff for HCWM	Who is in charge of HCWM in your facility ?	T		
	303	training of responsible of HCWM	What kind of training has this person followed ?	T		
	306	medical staff numbers	Could I have a break down of the medical staff ?	B		
< >	**9**	**HCW off-site transport**				
< >	900	transport services	Are there any control measures ?	B		[0] none; [1] transport form; [2] other (specify)
< >	901	type of transport	Who does generally transport the HCW ?	C		[1] the HCF; [2] municipal service; [3] private company (name ?)
	1000	HCW treatment	Is it treated on-site or off-site ?	C		[1] on-site; [2] off-site

	10	**HCW treatment**	*Ask to be allowed to take photos of the system !*			
< >	1001	off-site HCW treatment	Who's in charge with the off-site treatment ?	T		
< >	1002	off-site HCW treatment	Does this organisation offer satisfactory options ?	B		
	12	**HCWM regulations (code of conduct; management plan, policy…)**				
	1203	HCF HCWM regulations	Can we have copies of existing (in preparation) doc. ?	B		
	13	**policy and budget**				
		Funds sustainability	Who is the source of your funds?	**C**		[1]Government; [2]Organization;[3]User-fees;
		Accessibility of funds	Is it easy to access funds from central level?	**B**		
		Signing powers	Who has signing powers over funds?	**C**		[1] District hospital; [2] Organization office;[3]Head nurse
		Budgeting type	What type of budgeting system do you use?	**C**		[1] Zero-based; [2]Incremental
	1301	budget allocation for HCWM	Do you think sufficient funds are allocated to HCWM ?	B		
	1303	budget allocation for HCWM	Which % of the HCF budget do you allocate ?	N		
		Overall spending	What mechanisms do you use to avoid over- and underspending?	T		
		Accountability	How do you account for spent funds?			[1]Audits; [2]Receipts; [3]Reports
		Balancing figures	Is there balancing of figures at the HCF?	B		
		Capital costs	What was the capital cost of current HCW technologies per unit waste?	N		
		Operating costs	What is the cost of running HCWM systems per unit waste	N		
		Cost-saving activities	Do you practice any cost-saving activities?	B		
		Targets for savings	Do you have targets for saving?	N		
	1308	annual report of activities	Could I obtain a copy of your annual report(s) ?	B		try to obtain copies of the last 2-3 years

APPENDIX 4: PILOT STUDY REPORT

MMAMETLHAKE HOSPITAL PILOT STUDY REPORT

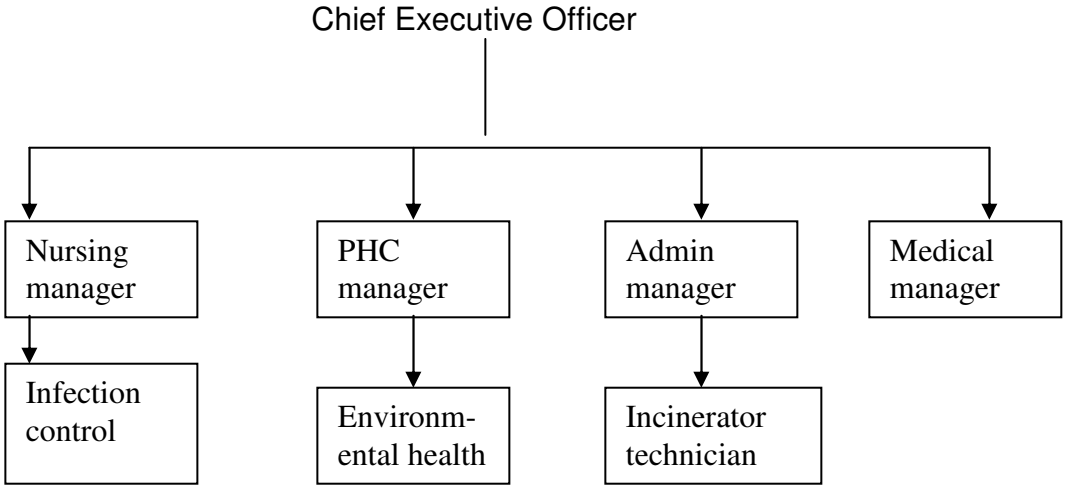
1. INTRODUCTION

Mmametlhake hospital is situated within the Mpumalanga province, within the district of the Nkangala district It is an ambulant and sub-district hospital with 50 beds (improvised to 56), which were fully occupied at the time of the study. The hospital sees between 60 and 70 outpatients per day. The highest level of decision-making lies with the Director General (DG) at national level. The hierarchical representation shows the following:

National level: Director General

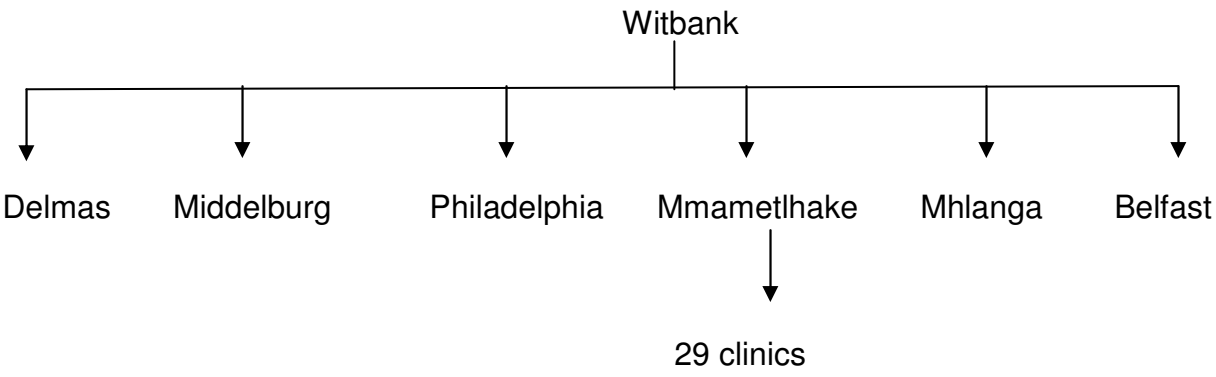
Provincial level: Chief Director

District level:



The CEO is the decision-maker in the hospitals. The district hospital is Witbank hospital and has six hospitals under it as shown below.

District hospital:



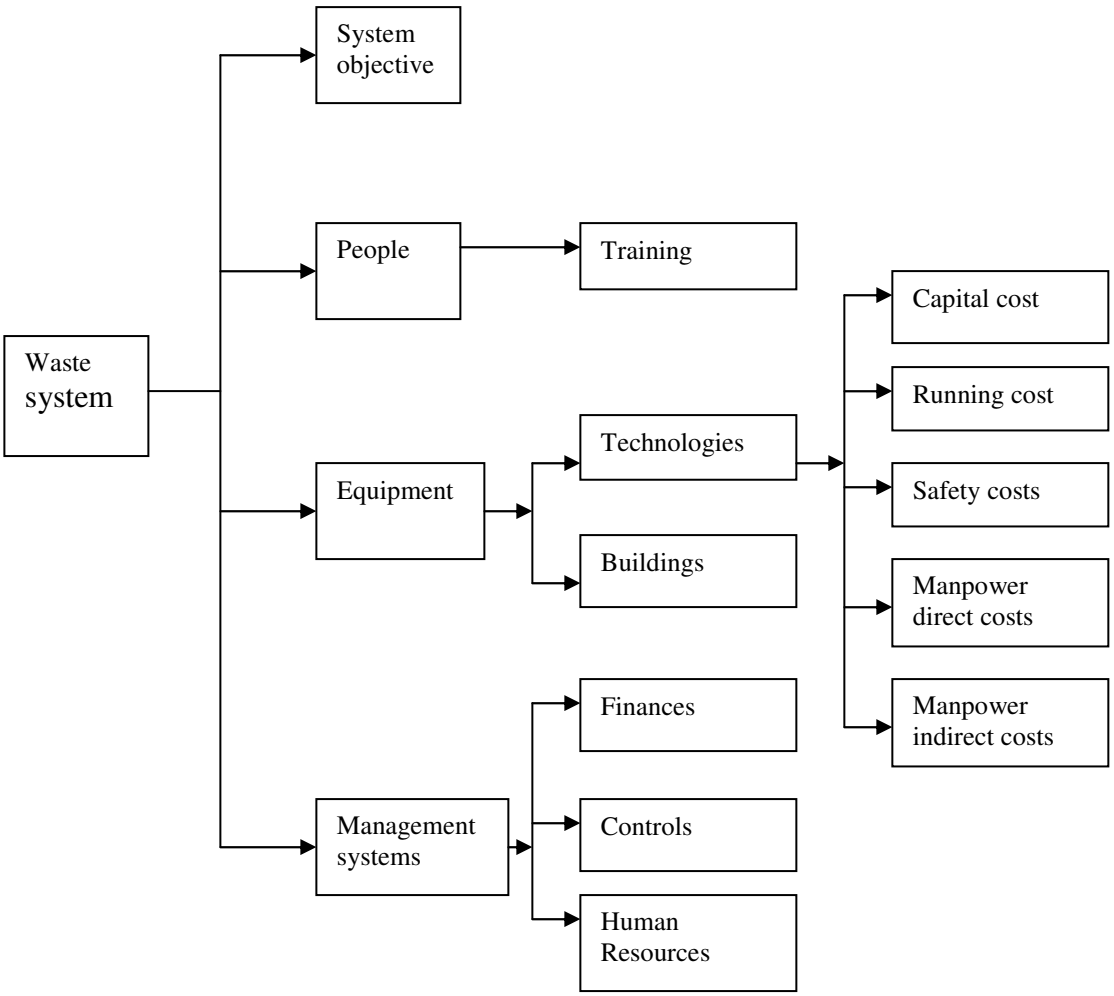
Mmamethlake hospital offers the following services:

Medicine	Gynaecology	Surgery	Children services
Emergencies	radiology	Laboratory	Dental
Maternity	Physiotherapy	HIV/AIDS	Antiretroviral clinic

1.1 The waste system

The systems approach to waste management is based on objectives of the system, people, Equipment and management systems as shown below.

Figure 2: The systems approach to waste management



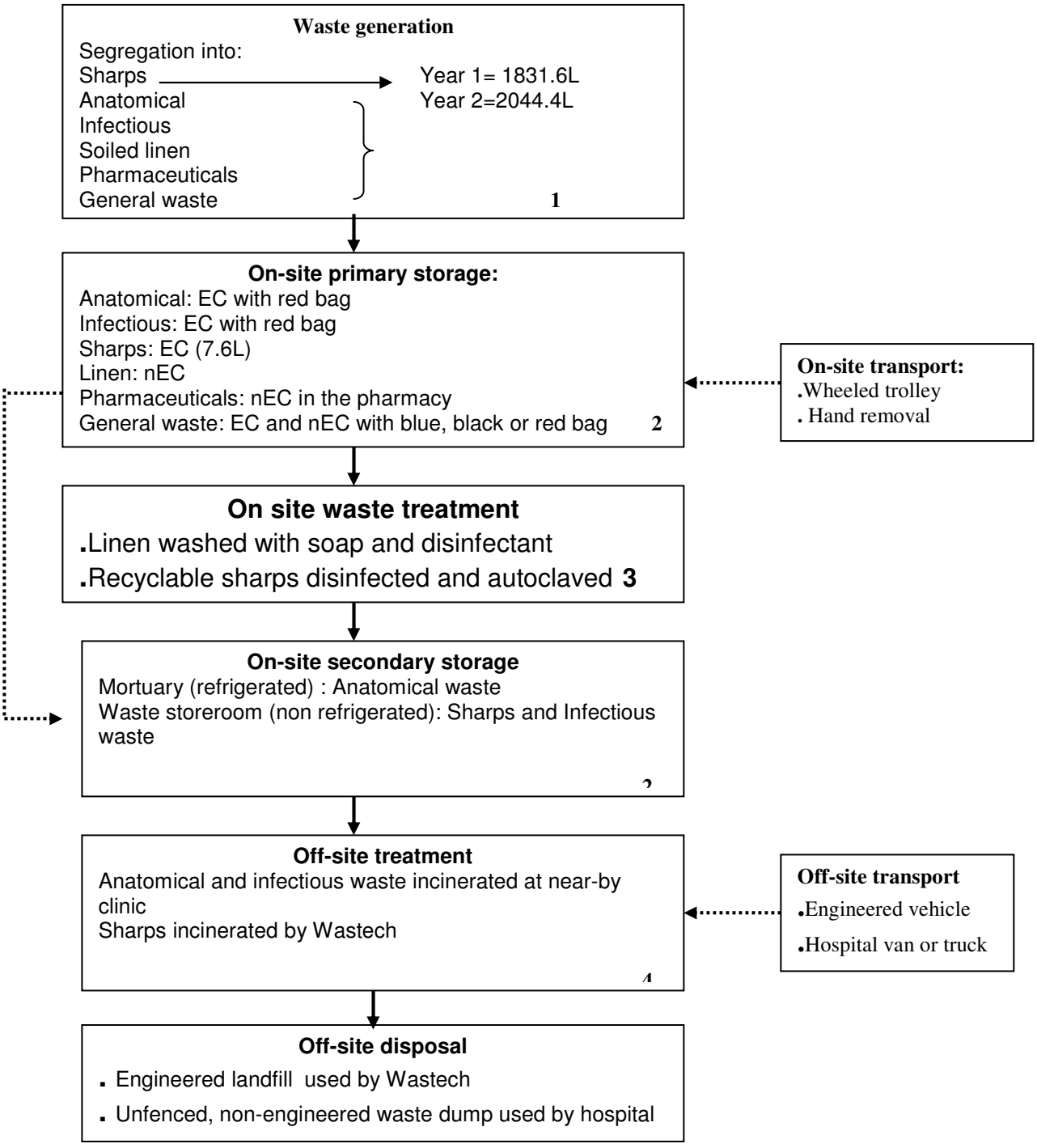
2. OBJECTIVES OF THE STUDY

The general aim of the project was addressed to the problem of providing resource poor decision-makers with a practical tool to identify and prioritise options to reduce impacts on the public and healthcare workers resulting from the management of hazardous waste generated at healthcare facilities. This would be realised by performing the following tasks:

- Qualify and quantify within each class the HCW generated by classification
- Device a mass flow of commodities and waste within the hospital system
- Analyse the waste system in place at the HC facility

3. FINDINGS AND OBSERVATIONS

3.1 Waste Flow Diagram (figure 3)



The flow chart above pertains to the responses given by health professionals at the hospital and have been presented in a life cycle approach. The life cycle is also

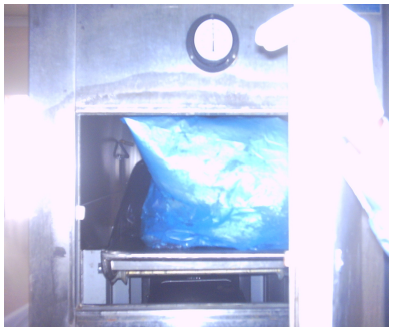
shown in pictures below Table 1 below shows figures of waste generated within the facility

1. Storage at generation point in ward

2. Storage at generation point

3.temporary storage

Trolley for primary transportation



Anatomical waste in mortuary

Sharps in storeroom

Out of order incinerator

Waste stored outside storeroom

Table 1: waste generation figures

Life cycle stage	Reference no.	Amounts of goods/waste
Goods supply for 1 month Swabs gauze (8ply x 100x100mm) Dressing gauze(100mmx7m) Alcohol swabs(24mmx30mm) Disposable hypodermic syringe Hypodermic needle Bandage cotton crepe(150mmx4.5) Bandage cotton crepe(100mmx4.5m)	Not within the waste flow diagram	 372 packs@100 units/pack 27 packs @1 unit/pack 129 units 5 Units 13 packs@ 100 units/pack 64 packs @12 units/pack 61 packs @ 12 units/pack
Waste Generation Sharps Anatomical Infectious Soiled linen Pharmaceuticals General waste	1	 Year 1=92 boxes x 7.6L =599.2L Year 2=119Boxes x 7.6L =904.4L 4 bags in 8 weeks No data No data No data No data
Waste storage	2	Non-quantified sharps stored for 1 year
On-site treatment	3	Recyclables not quantified
Off-site treatment	4	Contractor has not collected in one year. **No data**
Disposal	5	Contractor has not collected in one year. **No data**

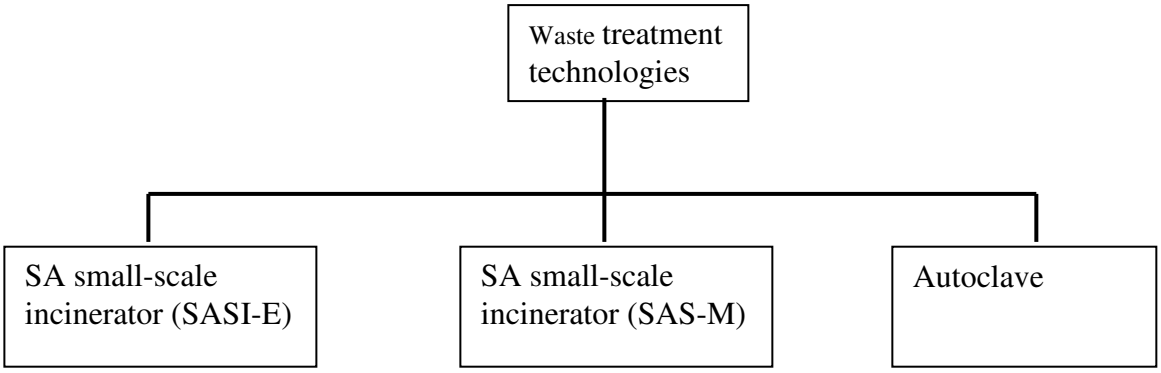
From the table above:

- Goods supply is for a single ward for one month. This can not be safely extrapolated to daily or annual amounts because of changes of disease patterns with season and differing bed occupancy.

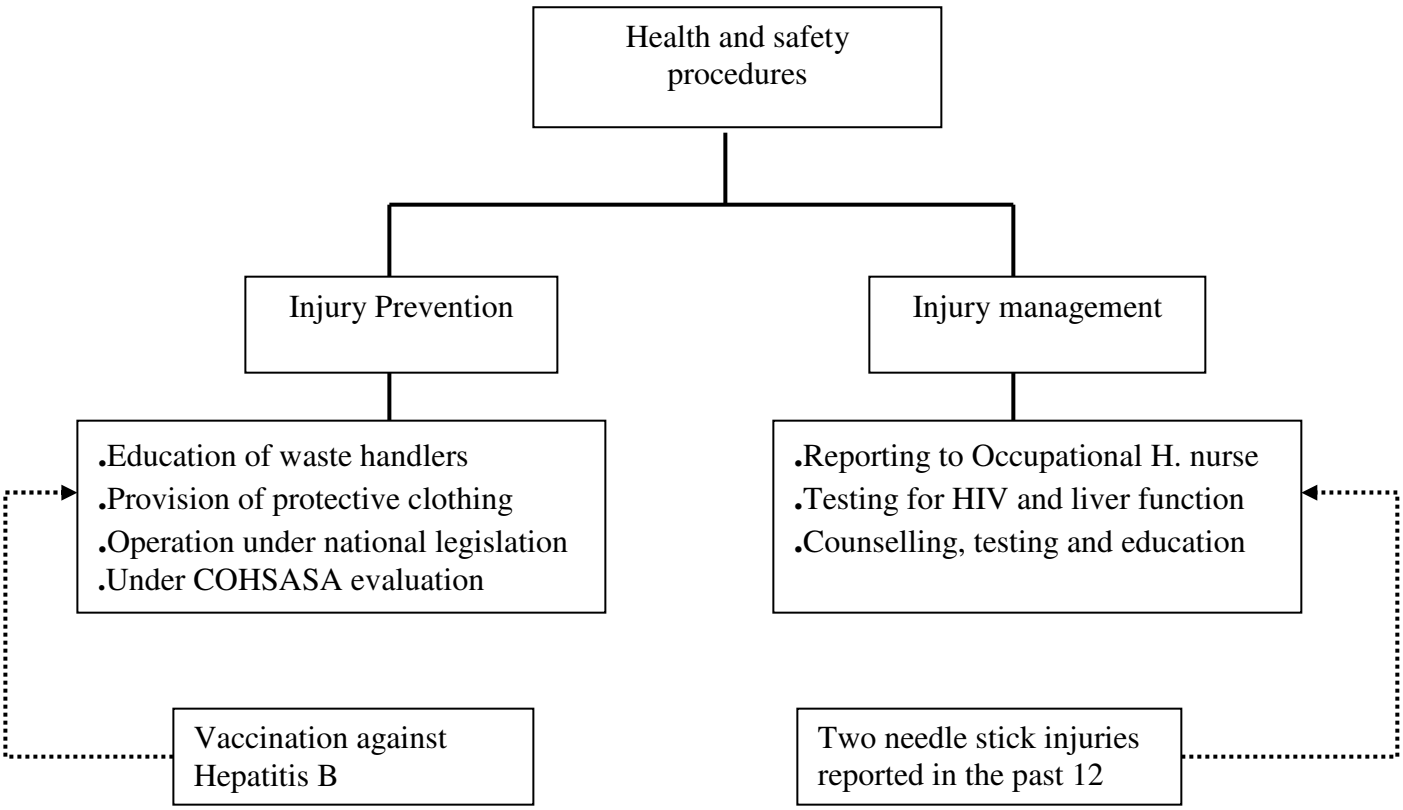
- Sharps stored were full in the storeroom and could not be counted. Records of up to September 2004 are present. Also sharps are collected from other clinics and their disposal is incurred by the hospital.

3.2 Technologies and procedures

Technologies



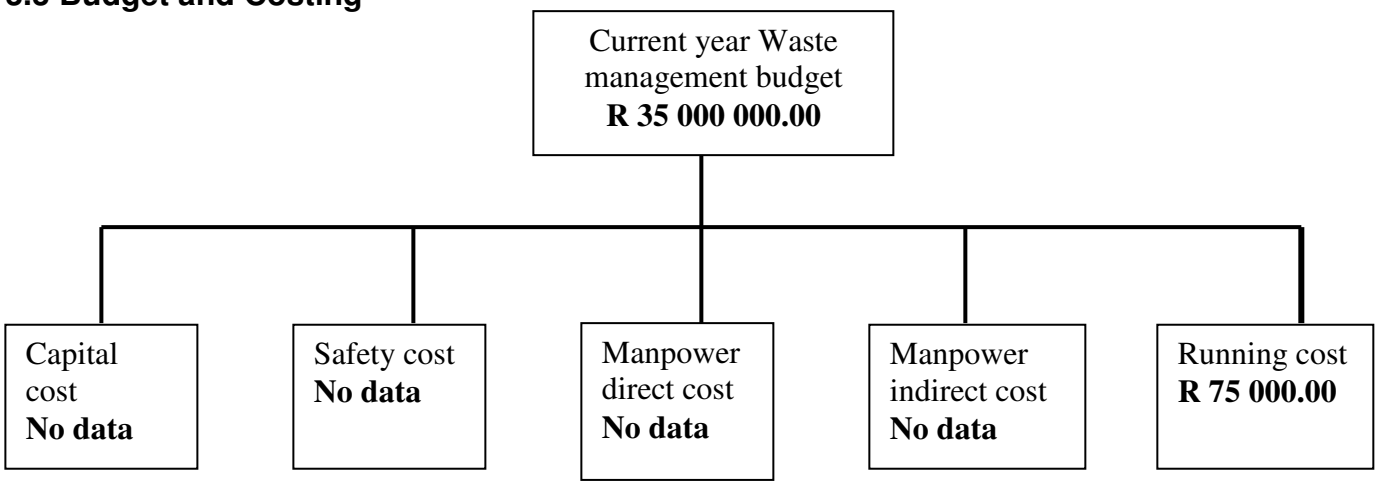
Procedures



The hospital also uses the following guidelines

- Guidelines for disposal of needles, syringes and sharps (provincial)
- Needle stick injury policy (July 2004)
- Waste management policy (August 2004)
- Colour coding of bags

3.3 Budget and Costing



- The amount of R35 000 000.00 is budgeted for packaging and this includes sharps containers purchasing, transportation and treatment and disposal by the private contracted company.
- Only R75 000.00 (0.21 %) had been used up to the time of the study for sharps emanating from the hospital and all the 29 clinics.

4. PROBLEMS ENCOUNTERED

- Mass of waste generated was not established due to the absence of a usable balance.
- Due to the rainy weather and absence of transport, waste flow was not followed up to the municipal waste dump.

5. INTEPRETATION

A life cycle approach to waste management ensures that all aspects of waste are taken care of since they are inter-related. Life cycle Assessment is however too

extensive a tool to use for WM in developing countries and is not appropriate to use at sub-national levels of operation. Wasteopt comes in as a tool that can be used from policy-making to implementation stages of waste management.

WasteOpt encourages:

- The use of life cycles of the waste management process such that waste is managed from "cradle-to grave". Mmametlhake hospital is aware of the life cycle management and environmental, top management, occupational health and infection control staff all work together to achieve proper waste management.
- The identification of options within each stage that can minimise risk at a reasonable cost. A good budget is in place for waste management in the hospital. It is however not easy to engage in waste management due to it being tied to packaging. It could benefit waste management if the budget could be separated in the future. This can then enable such needs as protective personal clothing and fixing or purchasing of an incinerator possible.
- It is also possible through WasteOpt, to assess the benefits of transportation to a central location for treatment and disposal compared to fixing old incinerators or buying a new one. This would need also the inputs of cost modelling and feasibility assessment.
- Hierarchical trees incorporate procedures and equipment, which make technologies environmentally sound. The hospital has written procedures on needle stick injury and colour coding of bags. Procedures should be present also regarding the sustainable use of human resources such that top management does not order untrained personnel to deal with waste management.
- Hospital personnel are aware that a risk exists when dealing with waste, although it is not quantified. The application of WasteOpt can give ranking of technologies and procedures in terms of risk.

The data that was compiled in this study can not facilitate the complete application of WasteOpt to this hospital.

6. RECOMMENDATIONS

6.1 Waste Storage

- The colour coding of bags should be strictly adhered to. This decreases the risk to handles and makes colour coding worthwhile.
- Sturdy engineered waste receptacles should be provided
- Waste storeroom must be lockable and is best refrigerated such that the mortuary is used for the intended purpose.

6.2 Waste Collection

- It could be ideal to contract a waste removal company that collects waste more frequently (as opposed to the current once in 13 months)
- Staff should be encouraged to use trolleys for on-site transport to decrease the risk of falling and or bag tearing with weight.

- The on-site SASI-E has been proven (CSIR and Mmametlhake hospital) to be very efficient in destroying pathogens and in fuel use. The hospital should consider fixing it to reduce cost of transporting to another clinic.

6.4 Waste Disposal

- The municipal dump personnel should not accept any untreated healthcare risk waste.
- The hospital should put pressure on the municipality to fence the dump.

6.5 Staff Issues

- All waste handling personnel without knowledge on waste management should be offered in-house training on HCWM.
- Appropriate personnel should be hired and trained on operating the incinerator such that the mortuary attendant can be efficient in his area of expertise.

6.7 Costing and Budget

Future budgeting for waste management should be separated from other aspects of spending so that management can improve and possible savings can be assessed.

APPENDIX 5: DEFINITIOION TO ABBREVIATIONS USED IN THE RESEARCH

GENERATION

- **Engineered Container (EC),** which is puncture-proof, spill-proof, stable, easy and fast to use, and of the appropriate size as stipulated by the WHO and UNICEF guidelines.
- **Non-Engineering Container (nEC),** which does not conform to any one of the technical specification for an Engineered Container.
- **Engineered Location (EL),** which renders the waste secure, but is in easy reach with safe access in terms of infection risks.
- **Non-Engineered Location (nEL),** which does not correspond to these technical specifications.

- **Detailed Procedures (DP),** e.g. sharps handling, etc.
- **No Procedures (nP),** i.e. no specific procedures in terms of best practices are stipulated at the primary health care facility.

COLLECTION AND STORAGE

- **Engineered Wheeled (EW),** i.e. a trolley, cart or wheeled container that is easy to load and is dedicated for waste collection inside the clinic, has no sharp edges, is easy to clean, and is impermeable to sharps.
- **Engineered non-Wheeled (EnW)**, i.e. a dedicated non-wheeled container that is easy to load, has no sharp edges, is easy to clean, and is impermeable to sharps.
- **Non-Engineered non-Wheeled (nEnW)**, which does not conform to any one of the abovementioned technical specifications.

- **EC>EC**: Transferring between Engineered Containers (as stipulated above).
- **EC>nEC:** Transferring from an Engineered Container to a non-Engineered Container, i.e. a container that does not meet any one of the EC specifications.
- **nEC>nEC:** Transferring between non-Engineered Containers.

- **nEC>EC:** Transferring from a non-Engineered Container to a dedicated Engineered Container that meets all of the technical specifications for handling health care waste.

- **Refrigerated Engineered Facility (REF**), where the floor is impermeable, has water supply for cleaning and good drainage, is easy to disinfect, is accessible for staff with good lighting, but lockable, with no direct sunlight, isolated from vermin with passive ventilation, and separated away from food handling areas and patients. Furthermore, the facility has access to Personal Protective Equipment (PPE) for the clinic staff and adequate waste containers.
- **Non-Refrigerated Engineered Facility (nREF**), which, except for refrigeration, has similar technical specifications to a REF, but with a waste turnaround of less than 24 hours in summer, and less that 48 hours in winter.
- **Non-Refrigerated non-Engineered Facility (nRnEF),** which does not meet any one of the above specifications.

ONSITE TREATMENT

- **South African small-scale incinerator, which is engineered (SASSI-E)** and corresponds with the following appropriate technical specifications: 10 kg/d waste-handling capacity, temperatures in excess of 650 ℃; single chamber with a chimney.
- **South African small-scale incinerator (SASSI-M),** which adheres to the minimum requirements as stipulated by the national Department of Environmental Affairs and Tourism (DEAT): temperatures between 300 and 400ºC with; static grate, single chamber (confined burning in a drum or brick structure), optional support fuel.
- **Open Air Burning (OAB),** i.e. the last resort in South Africa where no other treatment option is possible; preferably in a disposal pit (support firing not necessary).
- **Engineered Waste Transport (EWT**), i.e. a trolley, cart or similar dedicated wheeled container that is easy to load, has no sharp edges, is easy to clean, and is impermeable to sharps.

- **General Transport (GT),** i.e. another wheeled transport mechanism that is not dedicated for health care waste, e.g. a wheelbarrow.
- **Inappropriate Transport (IT):** i.e. which is not suitable for health care waste in terms of good Environmental, Health and Safety (EHS) practices, e.g. a general waste drum.

- **Engineered Storage (ES),** i.e. a designated storage area of appropriate size, which is secure, lockable, scavenger free, and cool or out of direct sunlight.
- **Non-Engineered Storage (nES),** e.g. inside a small-scale incinerator.

ONSITE DISPOSAL

Engineered pit: An all sides lined pit for disposal of waste.(Often used for sharps.

Controlled dump: A fenced and controlled non-engineered (not easy to access) area for waste disposal.

Open dump: An unfenced, uncontrolled area where waste is indiscriminately disposed

OFFSITE TREATMENT

- **Engineered wheeled vehicle (EWV):** a vehicle that is easy to load, has no sharp edges, is easy to clean, and is impermeable to sharps, dedicated to transport healthcare waste.
- **General vehicle (GV):** another wheeled transport mechanism that is not dedicated for health care waste
- **Inappropriate vehicle (IV):** which is not suitable for health care waste in terms of good Environmental, Health and Safety (EHS) practices

- **MCI (Multi Chamber Incinerator):** DEAT approved; 0.2 to 10 tons per day., 800 – 900 ℃ / 900 – 1200 ℃, gas cleaning for large facilities, water / dust / ash management
- **SCI (Single Chamber Incinerator):** DEAT approved; 0.2 – 1 tons per day. (WHO small) or 50 kg – 1 tons per day. (SA large), air / temp / loading control, 300 – 400 ℃.

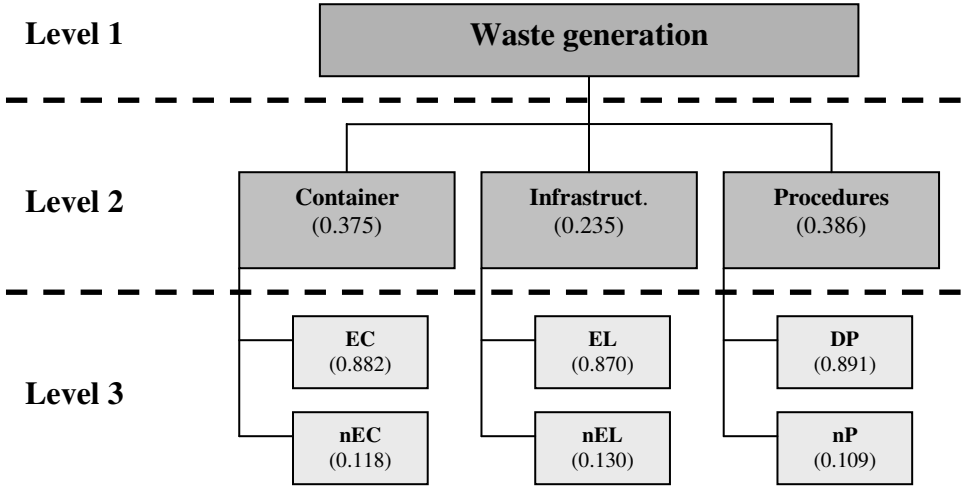
OFFSITE DISPOSAL

Landfill (LF): Operation where waste is compacted and covered with soil daily. Liners present at the bottom for leachate management. Gases emanating are also managed.

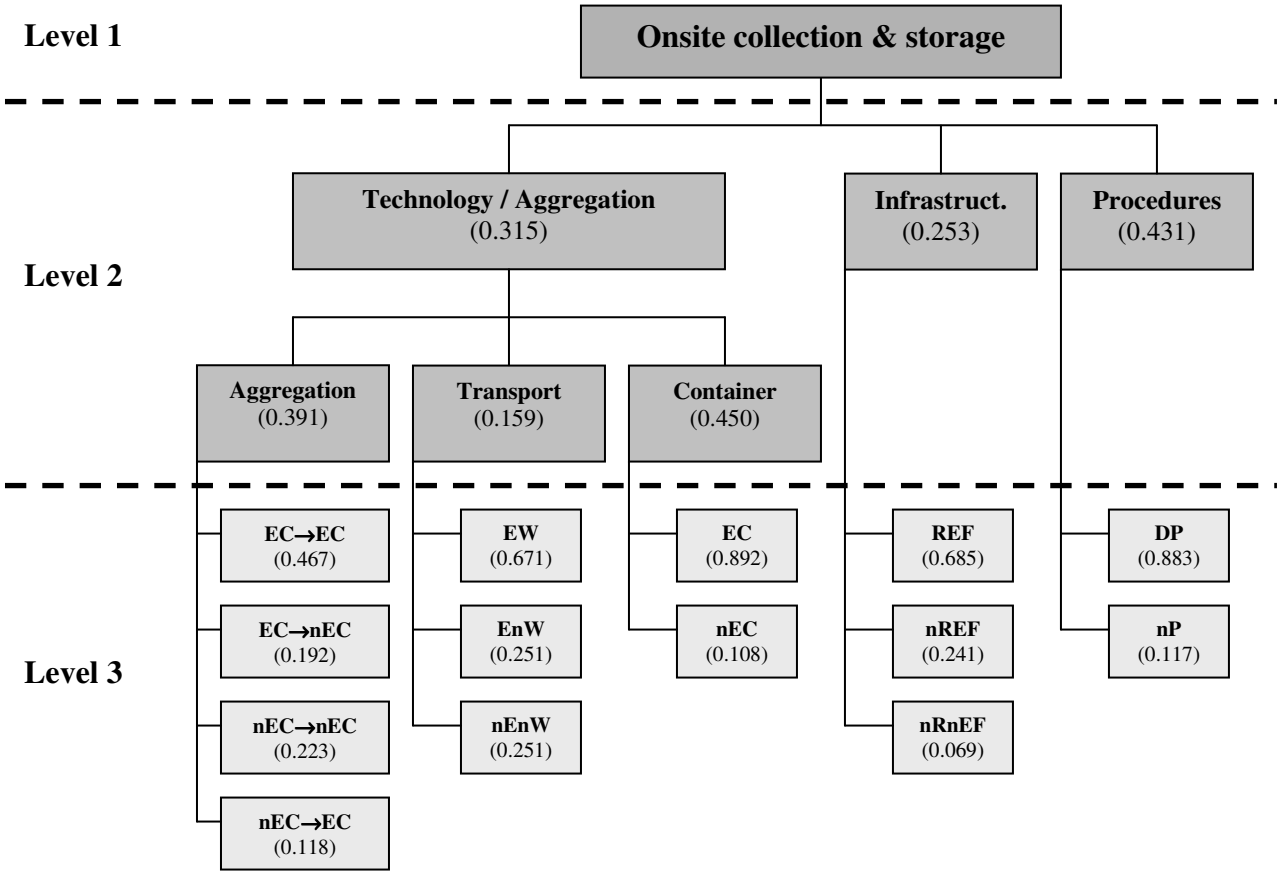
Controlled dump (CD): Authorized entry area with controlled tipping cells designated per period of operation. No compaction, soil and liners applied.

Open dump (OD): Uncontrolled disposal of waste in an open area accessible to anyone.

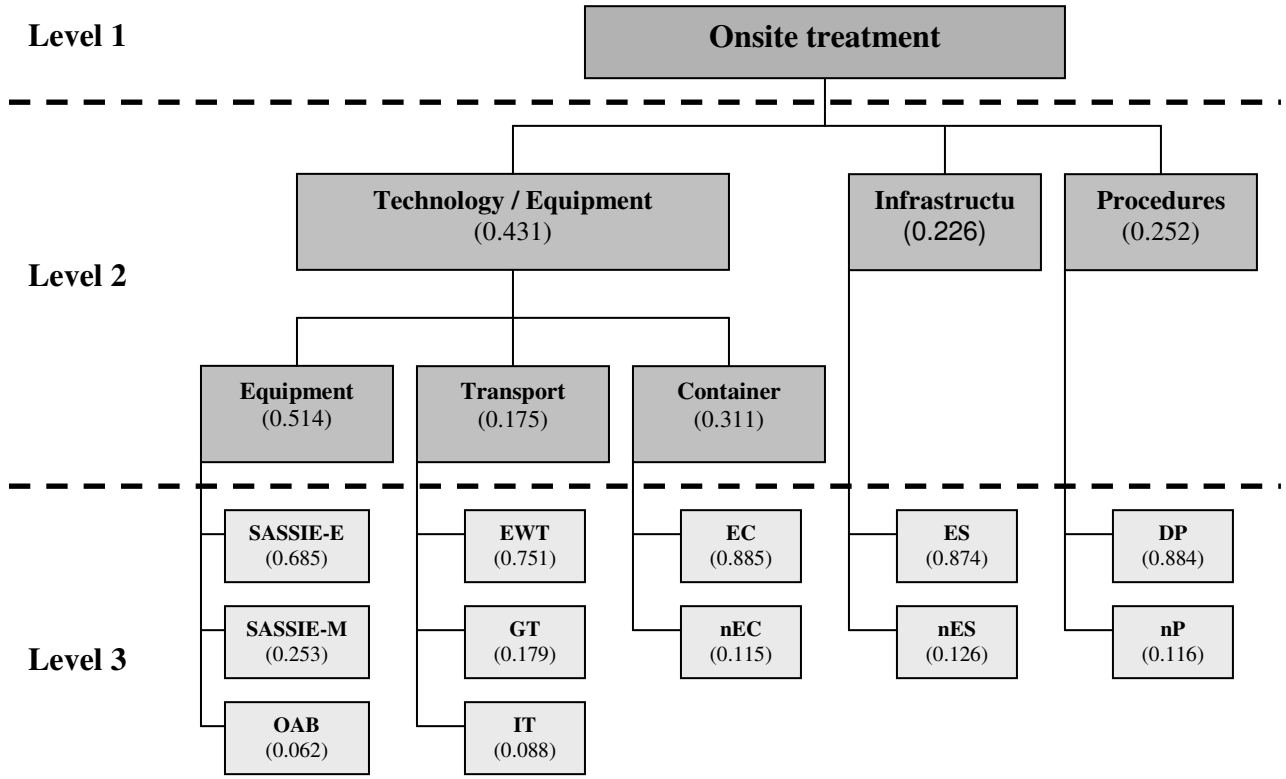
APPENDIX 6: HIERARCHICAL TREES FOR LIFE CYCLE PHASES



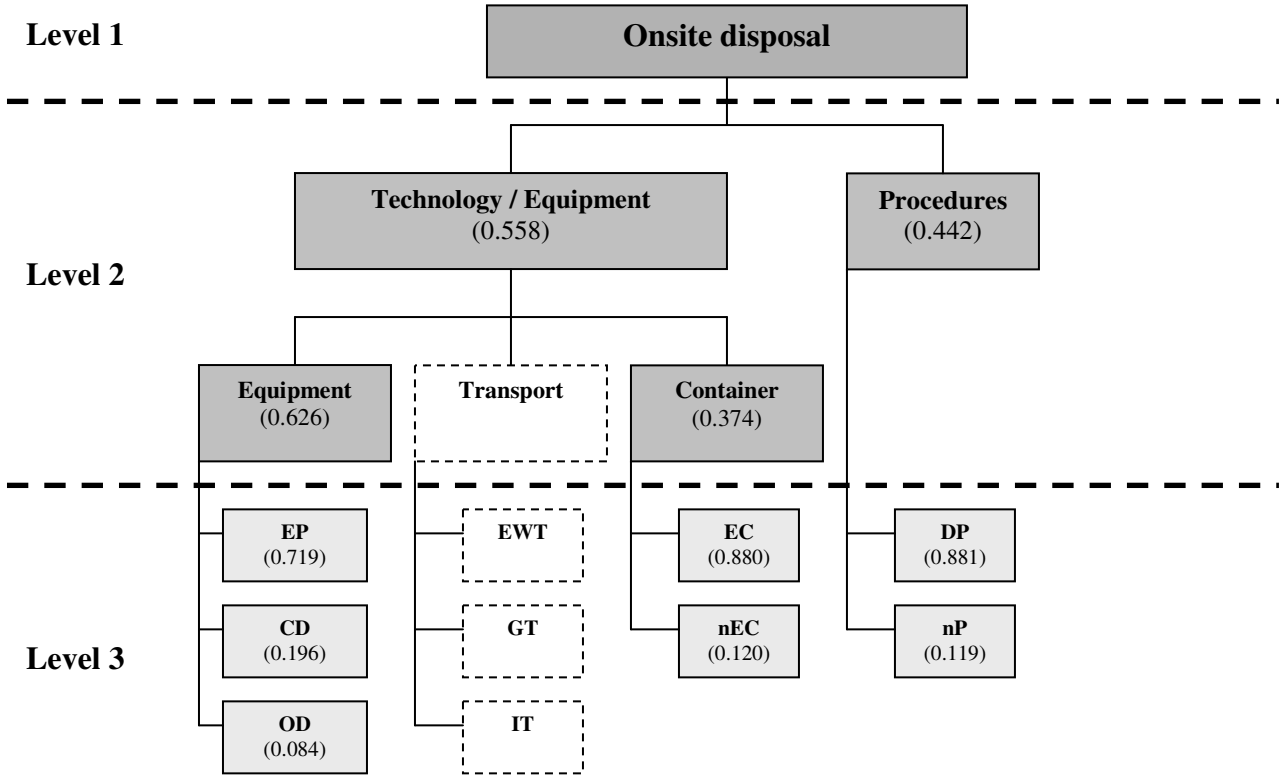
Options for the waste generation life cycle phase



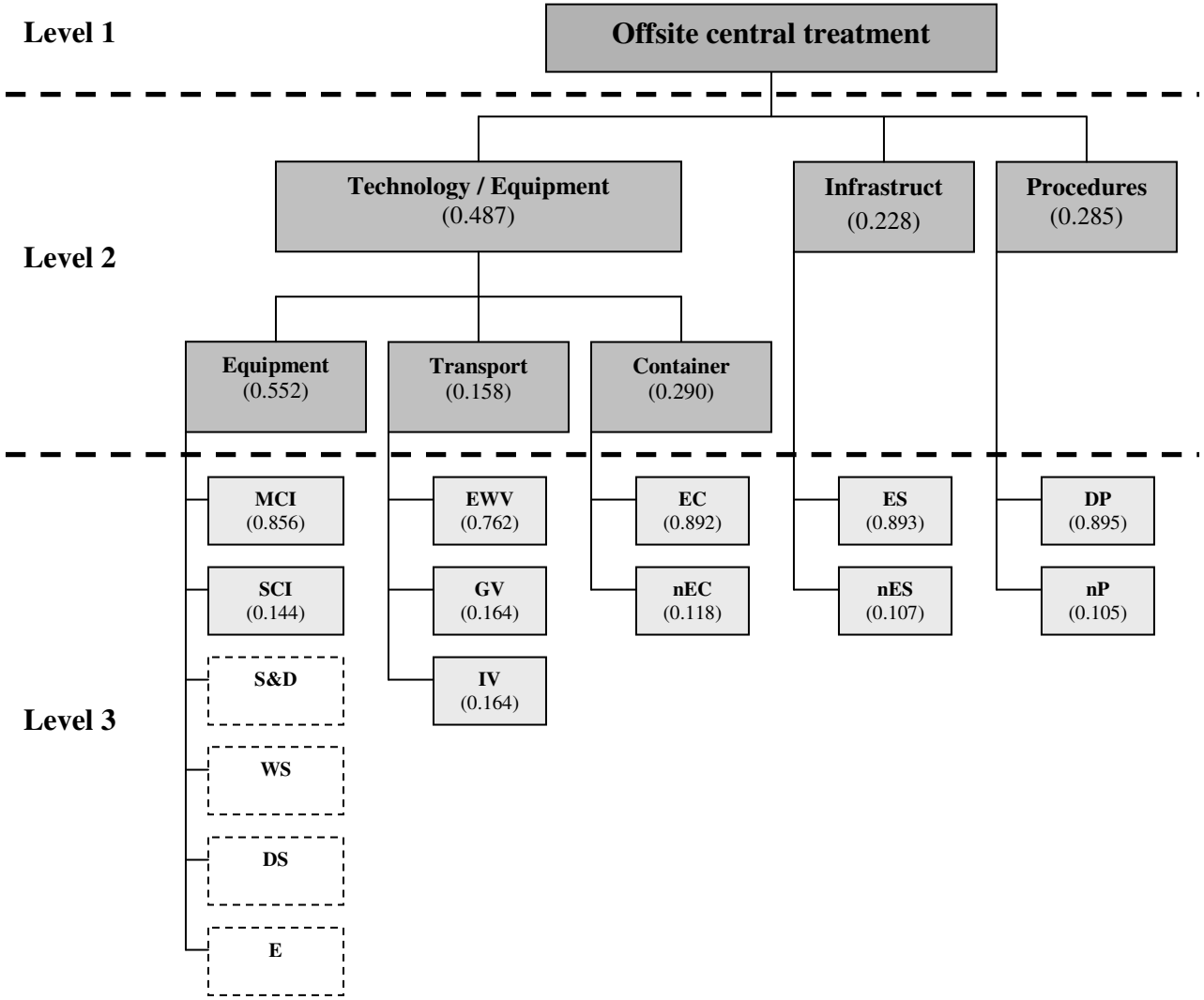
Options for the onsite collection and storage life cycle phase



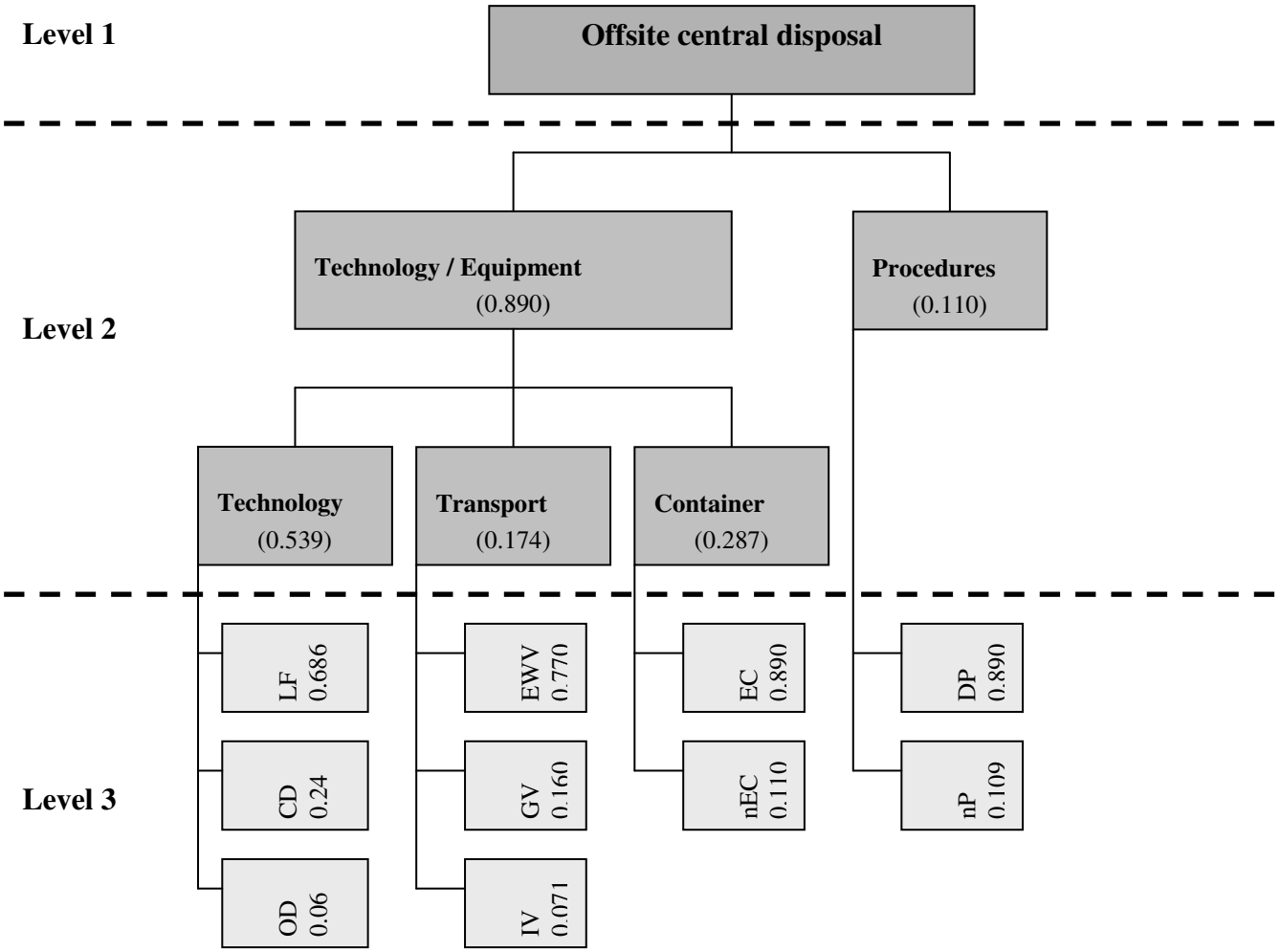
Options for the onsite treatment waste life cycle phase



Options for the onsite disposal waste life cycle phase



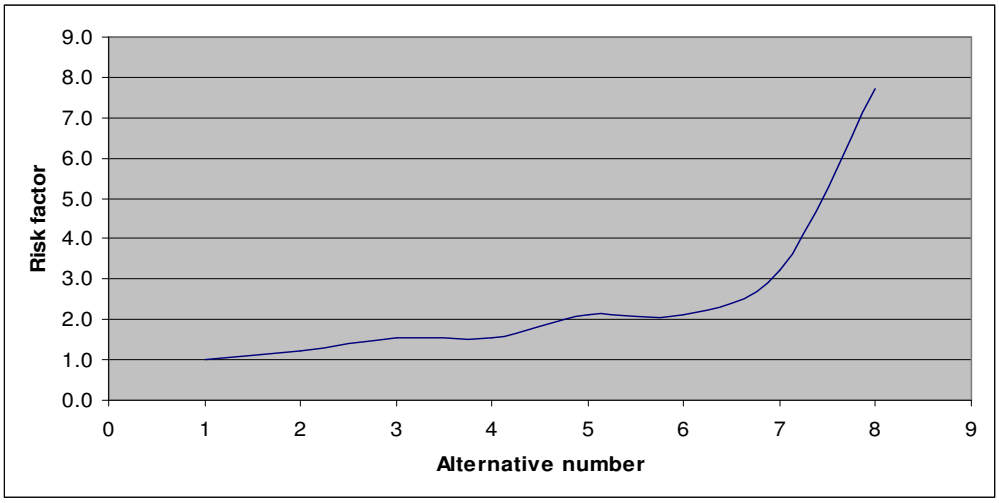
Options for the offsite central treatment waste life cycle phase



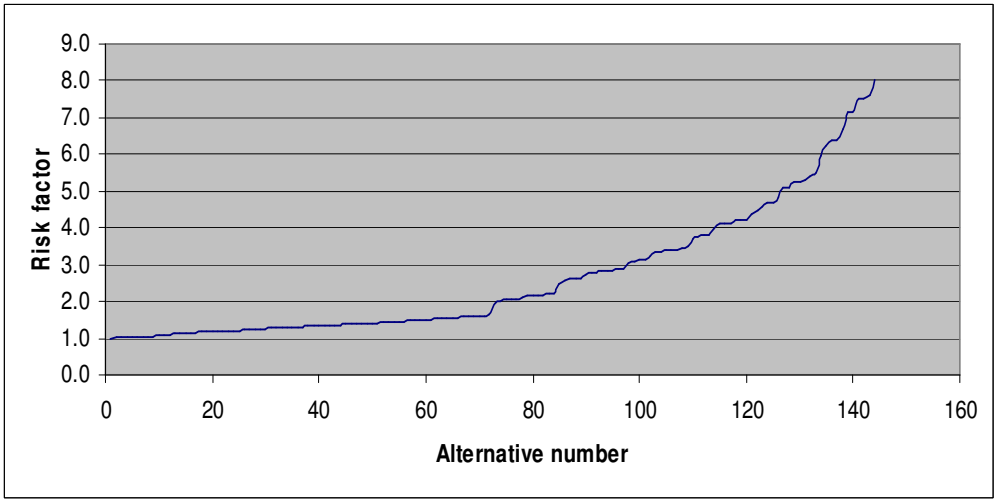
Options for the offsite central disposal waste life cycle phase

APPENDIX 7: MEAN VALUE PROFILES OF AHP RESULTS

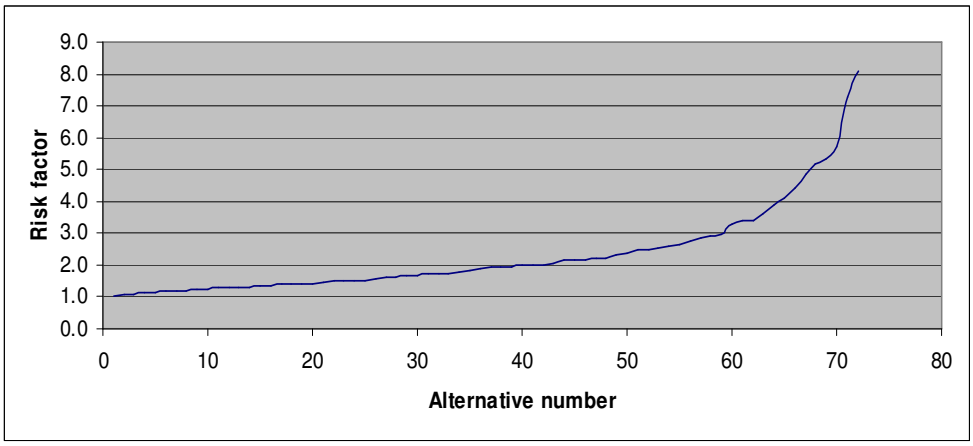
Generation



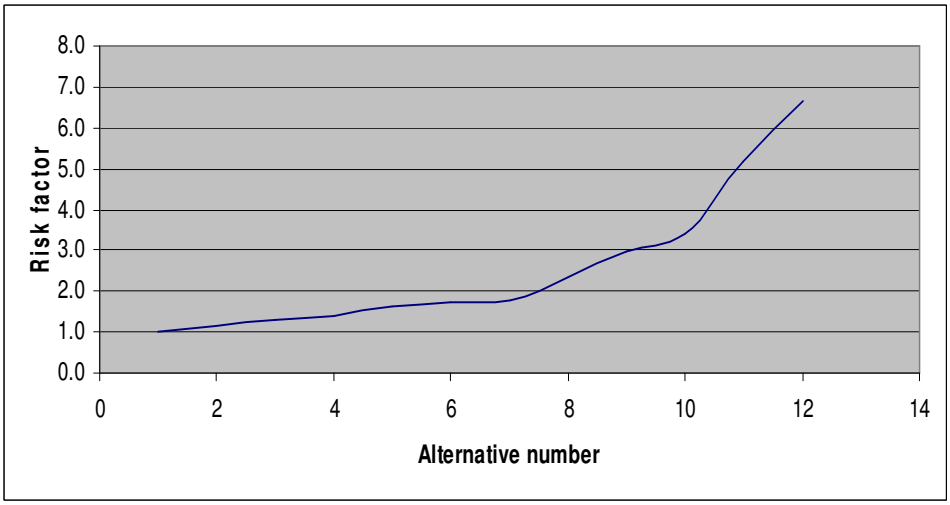
Collection and storage



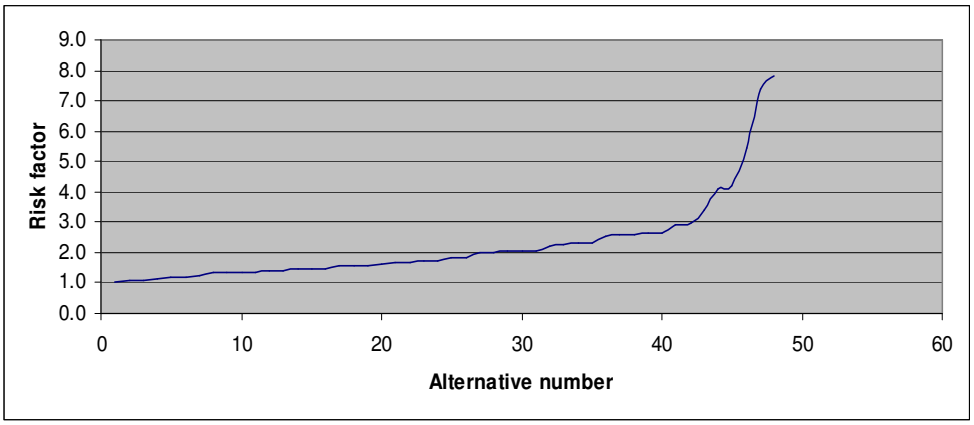
Onsite treatment



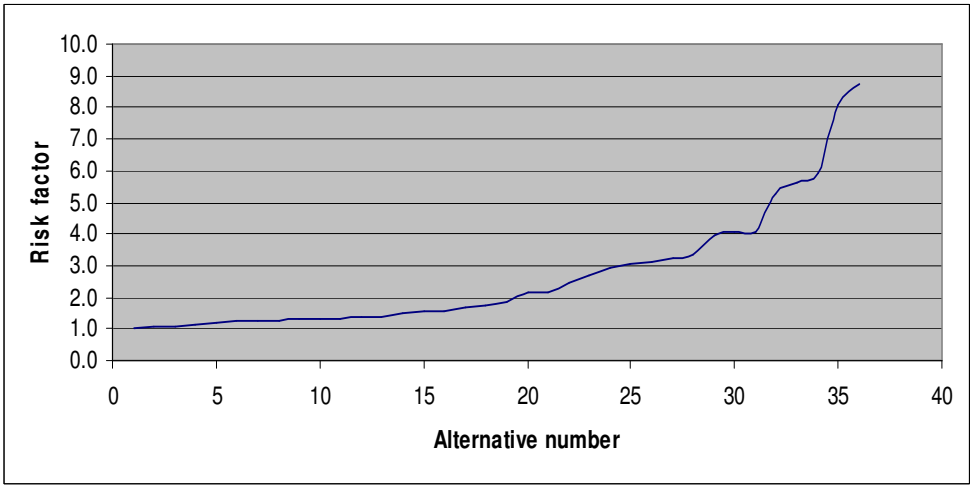
Onsite disposal



Offsite treatment



Offsite disposal



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APPENDIX 8: CONTACT DETAILS OF COMPANIES CONSULTED FOR COSTS

Reco
270 Soutter Street
Pretoria West
Tel: (012) 327 3186

Saubtech
Andrias Thieme
(011) 794 8798

The Waste group
P.O. Box 314
Bon accord 0009

http:// www.nwims.co.za

Lesotho National Healthcare Waste Management Plan