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AN INVESTIGATION ON MANAGING THE RECOVERY OF HAZARDOUS HOUSEHOLD WASTE IN RUSTENBURG, SOUTH AFRICA

A Preliminary Operational Plan of Pilleri II

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Alustava toimintasuunnitelma ”Pilleri II”
jäteasemalle kotitalouksien vaarallisten
jätteiden osalta.

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TIIVISTELMÄ

Eteläafrikkalaisen Rustenburgin paikalliskunnan väkiluvun sekä elintason kasvaessa myös jätemäärien ennustetaan kasvavan huomattavasti lähitulevaisuudessa. Nykytilanteessa kaikki kotitalouksien vaarallinen jäte loppusijoitetaan suoraan kaatopaikoille yhdyskuntajätteen mukana ilman asianmukaista lajittelua. Loppuvuodesta 2011 lanseerattavien jätehuoltomääräyksiensä mukaan Rustenburgin paikalliskunta on velvollinen järjestämään asianmukaiset keräyspisteet kierrätettävillä jakeilla sekä vaaralliselle jätteelle. Vaarallisen jätteen tuottajat ovat myös velvoitettuja toimittamaan jätteensä kyseisiin paikkoihin.

Tämän opinnäytetyön tarkoituksena on tarkastella vaatimuksia suunnitellulle kotitalouksien jätejakeiden vastaanottoasemalle erityisesti vaarallisen jätteen osalta. Opinnäytetyössä käydään läpi Etelä-Afrikan lainsäädäntö vaarallisen jätteen osalta, sekä tarkastellaan Rustenburgin paikalliskunnan nykytilannetta että tulevaisuuden näkymiä. Työskentely- ja havainnointimenetelmät perustuivat omakohtaisiin kokemuksiin, kirjallisuuteen sekä avainhenkilöiden että kuntalaisten haastatteluihin.

Opinnäytetyön tuloksena on tiivis yhteenveto edellä mainituista asioista sekä alustava toimintasuunnitelma jäteasemalle. Toimintasuunnitelmassa esitetään tiiviisti tärkeimmät asiat, jotka tulee ottaa huomioon kokonaisuutta suunniteltaessa sekä rakennettaessa. Tarkastelujen perusteella mahdollisuudet toimivalle kokonaisuudelle ovat olemassa, kunhan kuntalaisia saadaan motivoitua käyttämään Pilleri II jäteaseman palveluita.

Avainsanat: jätehuolto, vaarallinen jäte, jätteen lajittelu, kierrätys, toimintasuunnitelma,

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ABSTRACT

Due to the growth of population and the standard of living in the Rustenburg Local Municipality, also the amount of waste is increasing rapidly. The current situation is that all the hazardous waste is disposed of with the general waste to the landfill sites without any separation. In the end of the year 2011, Rustenburg will promulgate a new by-law. It states that any person who generates hazardous waste is responsible to ensure that the waste is treated or disposed of at a waste disposal facility designated by the Municipality or at a waste disposal facility that is authorised to receive such waste.

The purpose of this study was to scrutinise the requirements for a planned waste sorting station regarding especially hazardous waste. The legislation of South Africa regarding hazardous waste and also the current situation and future prospects of Rustenburg are presented. Working and observing methods were based on individual experiences, literature and also on the interviews of the key-persons and the local community.

As a result of the study, an operational plan presents the most important issues which should be taken into account when planning and constructing the waste sorting station Pilleri II. The study indicates that the waste sorting station Pilleri II has all the possibilities to be efficient and functional if the local community and other stakeholders are involved in the system.

Keywords: waste management, hazardous waste, waste sorting, recycling, operational plan

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1 INTRODUCTION

1.1 North South Local Government Cooperation

The aim of The North South Local Government Cooperation Programme is to assist local governments in developing countries in getting long-lasting results on good governance, sustainable development and reduction of poverty. The program is coordinated by the Association of Finnish Local and Regional Authorities (AFLRA) and funded by the Ministry for Foreign Affairs of Finland. The city of Lahti has been involved in the program since 2002 with Bojanala Platinum District Municipality (BPDM), South Africa. The co-operation focuses especially on developing environmental administration. It is based on mutual learning and colleague-to-colleague interaction by exchanging expertise and ideas (Lahti-Bojanala 2011).

Starting from 2010, the Southern partners of the city of Lahti included also the Ho Municipality from Ghana and 3 local municipalities under the Bojanala Platinum District Municipality, namely Rustenburg LM, Madibeng LM and Moses Kotane LM. The local municipalities have signed a Declaration of Co-operation with the city of Lahti and take part in the planning, implementation and evaluation of the Lahti-BPDM co-operation activities.

1.2 The City of Lahti

The City of Lahti, located in southern Finland has over 100 000 inhabitants. It is not further than 100 kilometers from Helsinki, the capital of Finland. Therefore Lahti is considered to be a part of the Helsinki Metropolitan area. The location of the city of Lahti makes it easy to reach, the Helsinki-Vantaa international airport is only an hour away. Good train connections to Helsinki and St. Petersburg, Russia create good opportunities for economic development in an international world. (Lahti 2011). The City of Lahti is well-known for its environmental and design expertise. One of the aims of the Lahti Strategy 2025 is to promote sustainable

development. Lahti is number one in Finland, when it comes to separation at source, recycling and utilisation of waste. (GreenCity 2011).

1.3 Rustenburg Local Municipality

Rustenburg Local Municipality is located in the North West Province and Bojanala Platinum District Municipality. It is approximately 120 kilometers from the Johannesburg-Pretoria metropolitan area. It was established in the year 2000 (Rustenburg 2011). In 2010, population has been estimated to be almost 640 000 inhabitants (Jarrod Ball & Associates 2005). Characteristic for the landscape in the Rustenburg area are some of the biggest platinum mines in the world (Bojanala 2011). Majority of North West Province's platinum is mined in Rustenburg area and mining contributes 23.3 % of the economy of the North West Province (SouthAfrica.Info 2011). Rustenburg Local Municipality has its own Waste Unit, which is responsible of organising waste management.

1.4 Purpose of the Study and Research Questions

This study will be made for the North South Local Government co-operation project between the city of Lahti (coordinated by Lahti Science and Business Park) and Bojanala Platinum District Municipality. The study focuses especially on the recycling and collection possibilities of hazardous household waste in the Rustenburg Local Municipality (RLM).

R LM has included hazardous waste collection as one of the key development issues on waste management after exploring the source separation and collection models in Lahti. The project supports the implementation of this plan. Therefore, the goal of the study is to find solutions for organizing a hazardous household waste recovery facility in R LM, based on the proposed activities in the cooperation project and the plans of the R LM.

The aim of the study is to do research on the general requirements for a recovery system for hazardous household waste based on the involvement of the local community, and create an operational plan for the waste sorting station Pilleri II in Rustenburg. Information was gathered by studying the legislation of South Africa and interviewing the key-persons.

1.5 Scope and Limitations

Despite the fact that recycling centers and waste sorting stations will receive other fractions than hazardous waste, I will limit the study around hazardous waste and the general requirements of the storage for it. I am going to study hazardous waste in the South African context including legislative framework, hazardous waste treatment and problems caused by an unsafe disposal of hazardous waste. I am also representing a baseline review of the current situation and future prospects of hazardous waste management in the RLM. In chapter four I will create the baselines for establishing a waste sorting station to serve the local community. I will also review the possibilities to collect other fractions, but the main limitation remains in hazardous waste. To keep the scope of this study at a reasonable level, I will not discuss any further treatment possibilities for the collected hazardous and recyclable waste fractions.

1.6 Definitions

Because terms may be understood different way, in this thesis, unless the context shows otherwise,

Constitution means the Constitution of the Republic of South Africa, 1996 (Act No. 108 of 1996);

container means a disposable or reusable vessel in which waste is placed for storage accumulating, handling, transporting, treating or disposing of that waste and includes bins, bin liners, mass containers, skip containers and wrappers;

hazardous waste means any waste that contains organic or inorganic elements of compounds that owing to the inherent physical, chemical or toxicological characteristics of that waste, have a detrimental impact on health and the environment;

healthcare risk waste means waste potentially capable of producing a disease and includes laboratory waste, pathological waste, isolation waste, genotoxic waste, infectious liquids and infectious waste, sharps waste, chemical waste and pharmaceutical waste;

local community in relation to the Municipality means that body of persons comprising the residents in the municipal area; the ratepayers of the Municipality; any civic, non-governmental, private sector, or labour organisation or body or organ of state which is involved in local affairs within the municipal area; and visitors and other people residing outside of the municipal area who, because of their presence in that area make use of services or facilities by the Municipality;

Municipality means the Rustenburg Local Municipality established by Local Government: Municipal Structures Act, 1998 (Act No. 117 of 1998);

National Environmental Management Act means the National Environmental Management Act, 1998 (Act No. 107 of 1998) and any regulations or notices passed pursuant thereto;

nuisance means any injury, harm, damage, inconvenience or annoyance to any person which is caused in any way whatsoever by the improper handling or management of waste, including but not limited to, the storage, placement, collection, transport or disposal of waste, or by littering;

person has the meaning assigned to it in the Interpretation Act, 1957 (Act No 33 of 1957). and includes an organ of state;

pollution has the meaning assigned to it in section 1 of the National Environment Management Act;

recovery means the controlled extraction of a material or the retrieval of energy from waste produce a product

recycle means reclaiming waste for further use and includes the separation of waste from a waste stream for further use and processing of the separate material as a product or raw material;

storage means the accumulation of waste in a manner that does not constitute treatment or disposal of that waste;

waste includes any substance, whether solid, liquid or gaseous, which is - discharged, emitted or deposited in the environment in such volume, constituency or manner as to cause an alteration to the environment in, a surplus substance or which is discarded, rejected, unwanted or abandoned, re-used, recycled, reprocessed, recovered or purified by a separate operation from that which produced the substance or which may be or is intended to be re-used, recycled, reprocessed, recovered or purified, or identified as waste by prescribed regulation;

waste disposal facility means any site or premises used for accumulation of waste with the purpose of that waste at that site or on those premises;

waste handling facility means any facility on or in which waste is accepted, accumulated, handled, recycled, sorted, stored or treated prior to its transfer for treatment by way of incineration or for final disposal.

2 HAZARDOUS WASTE IN SOUTH AFRICAN CONTEXT

In this chapter, legislative framework for hazardous waste in the South African context will be evaluated shortly. Also, the problems caused by hazardous waste in terms of uncontrolled disposal at the landfill sites will be explored. Hazardous waste treatment and minimum requirements for it will also be reviewed.

The South African National Waste Management Strategy (DEAT, 1999), states that all provinces and municipalities are required to develop integrated waste management plans (Sawic 2011). Integrated Waste Management Plans and by-laws must be written in a manner that they do not conflict with the Constitution of Republic of South Africa, Acts and each other. Plans at the local level such as by-laws must provide more detailed and accurate information about regulations and implementations than district (regional), provincial and national plans and Acts. (Kanjee 2011).

2.1 South African Legislative Framework for Hazardous Waste

Waste can be categorised either into general waste or hazardous waste. The definition for hazardous waste can be very broad. In terms of The Waste Act (1998), hazardous waste "means any waste that contains organic or inorganic elements of compounds that may, owing to the inherent physical, chemical or toxicological characteristic of that waste, have a detrimental impact on health and the environment" (National Environmental Management: Waste Act 59/2008, 12). All the waste is considered to be hazardous unless it is proven otherwise.

Waste Act also defines that municipalities have the responsibility to provide services for the local community. Municipalities must provide containers or receptacles for the collection of recyclable waste that are accessible to the public (National Environmental Management: Waste Act 59/2008: Waste collection services, 23).

In terms of The Waste Act chapter 4 general duties, a holder of waste must, within the holder's power, take all reasonable measures to reduce, re-use, recycle and recover waste (National Environmental Management: Waste Act 59/2008, 32).

So basically the local community has the responsibility for disposing of their hazardous household waste into the containers that municipalities are responsible to provide and organise. These sections justifies and proves the aim of this study which is to find solution for hazardous household waste recovery based on the involvement of the local community in RLM.

2.2 Hazardous Waste Treatment and Disposal in South African Context

Minimum requirements for waste disposal by landfill define minimum requirements and classification for hazardous waste. Hazardous waste is classified into

Hazard Rating 1: Extreme Hazard

Hazard Rating 2: High Hazard

Hazard Rating 3: Moderate Hazard

Hazard Rating 4: Low Hazard

Landfills classified with H:H are allowed to accept all types of hazardous waste and landfills classified with H:h are allowed to accept only Hazard Rating 3 and 4 hazardous waste. If hazardous waste rated by Extreme or High Hazard has been delisted, it can be disposed to H:h landfill sites. (Minimum requirements for waste disposal by landfill 3.2 3-2,3-3). In some cases G:L:B+ landfill sites are allowed to accommodate delisted or low concentration hazardous waste (Minimum requirements for waste disposal by landfill 10.3.3, 10-8. Senne 2011). Hazardous waste landfill sites must be separated from the groundwater by a liner and leachate collection systems (Minimum requirements for waste disposal by landfill 3.5, 3-11).

Hazardous waste can be treated to a less harmful form. Purpose is to reduce the toxicity of the harmful components to minimise the impact of the waste on the environment. Available technologies for the treatment can be categorised for example to physical, biological and chemical treatments. (Minimum requirements for handling, classification and disposal of hazardous waste 7.1, 7.2).

2.3 Provincial Integrated Waste Management Plan: North West Province

North West Province has only one available hazardous waste treatment and disposal facility at the moment. It is located in Klerksdorp Landfill site. It has been classified with Class H:h permit. (Provincial Integrated Waste Management Plan: Status Quo Report, 78). Currently almost all the hazardous waste from Bojanala Platinum District Municipality is disposed of to Holfontein site in Gauteng province. Holfontein has been classified with Class H:H permit. Smaller amounts of hazardous waste are disposed of to Rosslyn H:h landfill site in Gauteng Province. (Mapholo 2011).

Provincial Integrated Waste Management Plan (PIWMP 2008) indicates four targets for Hazardous Waste Management. Establishment of a Hazardous Waste Landfill or Cell in North West Province and identifying Hazardous Waste hotspots are the most important targets in the future. All industrial hazardous waste and healthcare hazardous waste generators must be registered and approved by the provincial authority and they have to ensure that their waste is properly handled and disposed of.

So therefore the Provincial Integrated Waste Management Plan does not specify any targets for hazardous waste from households, which can be considered as a significant hotspot. Provincial Integrated Waste Management Plan mainly focuses on improving the overall hazardous waste management in North West Province. The biggest hazardous waste generator in North West Province is the mine industry.

2.4 Hazardous Waste Treatment and Disposal in North West Province

Only a small percentage of generated hazardous waste is treated and disposed of within North West Province (North West Province Hazardous Waste Management Plan Draft final report, 11). Existing treatments are done by private hazardous waste generators at their own sites. Basically North West Province does not have any kind of facilities for safe and efficient hazardous waste treatment and already existing treatment plants are managed and operated by mining companies and Local Authorities.

Overall situation is that the treatment of hazardous waste can be very expensive for generators and majority of hazardous waste is disposed of to landfill sites with general waste. (North West Province Hazardous Waste Management Plan Draft final report, 3.3.6). Bojanala Platinum District Municipality does not have own landfill site for hazardous waste, so therefore all the untreated hazardous substances are legally disposed of to the landfill sites of Holfontein and Rosslyn in Gauteng Province. They are charging per ton and transportation is expensive. Transportation must be organised by customer or generator of hazardous waste. (Mapholo 2011).

2.5 Problems Caused by Hazardous Waste

The disposal of hazardous waste with the general waste to the landfill sites is currently a serious problem in South Africa. When even a small quantity of hazardous waste is disposed of with general waste, the entire stream may have to be classified as a hazardous waste. (Minimum requirements for the Handling, Classification and Disposal of Hazardous Waste, 3.3.1). Indiscriminately disposed hazardous waste may have, even in low concentrations, significant negative impacts on public health and surrounding nature.

A pollution caused by hazardous leaks from the landfill sites can contaminate the groundwater. Once groundwater has been contaminated, it may cause major damages on the surrounding nature and wildlife. Groundwater and surface water are

also very difficult to purify after a contamination. At the same time surface water is a major source of drinking water in Rustenburg area. Therefore it may cause bigger damages on the health and well-being of the local community.

One challenge at the landfill sites is the hazardous waste from households. Smaller amounts of hazardous waste are disposed of with the general waste and it ends up at the landfill sites without any separation. It causes significant impacts on the surrounding environment. Impacts cannot be seen immediately, because concentrations are, at first, small. Healthcare risk waste such as used diabetes needles and other sharp items also causes dangerous circumstances for informal recyclers and employees. Needles may have been contaminated by HIV, AIDS or other diseases.

3 BASELINE REVIEW FOR HAZARDOUS WASTE IN RUSTENBURG LOCAL MUNICIPALITY

The current situation is that all the hazardous waste from households is disposed of to the landfill sites with the general waste without any separation. At the moment, Rustenburg Local Municipality does not have any services to provide for household hazardous waste collection. (Senne 2011). Townlands landfill site does not accept electronic waste or any other hazardous waste fractions from companies or individuals. Hazardous waste that has been brought to Townlands landfill site by the local community is disposed of to the landfill site of Holfontein in Gauteng Province. The expensive transportation is organised by the Municipality. (Mapholo 2011).

3.1 Background

3.1.1 Main Fractions

There are numerous waste fractions produced by households which can be considered as hazardous. The most common fractions from households are used oil, solvents, lighting waste such as incandescent bulbs, wet and dry cell batteries, electronic waste, chemical containers and healthcare risk waste. Other hazardous substances from households are asbestos, boiler ash, spent antifreeze, redundant pesticides, paint waste and empty paint containers and demolition and construction waste (Sevitz 2011).

3.1.2 Population

Majority of the population are Africans, approximately 87 % of total population. The second biggest population group is White, approximately 12 %. Other population groups are Coloured and Indians. In 2010, population has been estimated to be almost 640 000 inhabitants. In 2015, population is estimated to be over 800 000 inhabitants. 1 000 000 inhabitants boundary is going to brake in 2020, if the current trend continues. Estimated population growth percentage is 5.42 and Rustenburg is therefore one of the fastest growing cities in South Africa. The effects of HIV, AIDS and the issue of migration have not been taken into account (Jarrod Ball & Associates 2005). One challenge in terms of population growth is the population of townships and informal settlements near mines and around the city. Nobody really knows how many people lives there. In many cases, illegal immigrants do not have personal identification numbers or passports. It is impossible to even estimate the amount of people who are staying in Rustenburg illegally.

3.2 Household Hazardous Waste Collection Models in RLM

Based on interviews and research, Rustenburg does not have any customised collection models for hazardous waste at the moment by the Municipality. The new

by-law, which will be introduced at the beginning of the year 2012, defines that pharmacies are obligated to organise collection for expired medicines and used diabetes needles. Several stores, including Builders warehouse and Pick n Pay, collect used and empty batteries from households. Pick n Pay also collect bulbs and energy saving lamps. Data of these collected fractions neither does exist nor is available.

3.3 Future Prospects

In terms of Rustenburg by-law 2012, any person who generates hazardous waste is responsible to ensure that the waste is treated or disposed of at a waste disposal facility designated by the Municipality or at a waste disposal facility that is authorised to receive such waste (Rustenburg By-Law, 2011). Based on these terms, Rustenburg Waste Unit has decided to plan, organise and build waste recovery centers, transfer stations, recycling centers and waste sorting stations. One waste sorting station will be built on the property of the Waste Depot. Implementation of it will be on term 2013/14. Its operational principles regarding hazardous waste from household will be evaluated in chapter four (4). New Rustenburg by-law creates also possibilities to implement an action plan for a hazardous waste collection truck. The success of these plans depends on the involvement of the local community and therefore counseling and guidance are highly important.

New Wateval landfill site will start to operate at the end of the year 2011. Its operational time is estimated to be over 40 years. Also a material recovery center is planned to be placed on the area. It will also receive hazardous waste.

3.4 Challenges of Initiating Household Hazardous Waste Collection

One of the biggest challenges of initiating household hazardous waste collection system for the local community is to change the attitudes and mindsets more favorable for waste management and recycling. At the moment the Municipality

does not demand any extra efforts from the local community. The current waste collection system does not encourage the local community to separate their refuses in a proper way as the collected waste fee is not based on the amount of waste and all the waste is rated with the same amount of money. Changing these mindsets and old habits may take time. These challenges can be solved or at least mitigated by awareness-raising and motivating the local community to adapt to the new opportunities to dispose of their hazardous wastes safely.

The hazardous waste collection requires also qualified foremen and employees. The applying process can be long and finding available and qualified persons may take time. The employers must develop practices how to keep the employees motivated and focused on their areas of responsibility and to ensure that they are not neglecting their duties.

One challenge of initiating hazardous waste collection is the lack of facilities for further treatment for hazardous waste. Currently there are no recyclers to handle hazardous waste in RLM or North West Province. Collected hazardous waste and substances are transported to Gauteng Province to be disposed of to H:H landfill sites. H:H landfill sites can accommodate all types and concentrations of hazardous waste. New Waterval landfill site can accommodate delisted hazardous substances. This helps to reduce the transportation costs (Senne, Ntuane 2011).

The local community also uses so called garden sites and communal sites incorrectly. They are disposing all kind wastes over there, including hazardous waste and other hazardous substances. (Matsemela 2011).

4 FEASIBILITY OF IMPLEMENTING THE PILLERI II WASTE SORTING STATION MODEL IN RUSTENBURG

In this chapter the waste sorting station model Pilleri that is in use in Lahti will be presented and the possibilities to implement a similar model in Rustenburg Local Municipality will be evaluated by creating a preliminary operational plan for Pilleri II.

RLM has decided to create a collection model for hazardous waste based on the model Pilleri in the city of Lahti. At the same time it opens possibilities to collect other recyclable fractions as well. It can be considered as a kick-start to separation at source.

4.1 Model Pilleri in the City of Lahti

4.1.1 Päijät-Häme Waste Disposal Ltd

Päijät-Häme Waste Disposal Ltd (PHJ) was founded in 1993 and is owned by twelve (12) municipalities in Päijät-Häme Region. Päijät-Häme Waste Disposal Ltd is responsible for organising the mandatory waste management duties of the owner municipalities. PHJ is taking care of the handling and separation of waste. One of their main goals is to develop the current systems and increase waste counseling and awareness-raising. PHJ is responsible of the planning and implementation of an economically sustainable and effective waste collection system. The purpose is to prevent the creation of waste. In 2010, 95 % of waste produced in Päijät-Häme Region was utilised as material or energy.

Kujala Waste Center in the city of Lahti is managed by Päijät-Häme Waste Disposal Ltd. They are receiving and treating for example contaminated soils, managing a waste sorting terminal, composting center and waste sorting station Pilleri. It also operates the only landfill site of the Päijät-Häme Region (PHJ 2011).

4.1.2 Model Pilleri

Pilleri is a waste sorting station for waste from households and small companies. It is located in the Kujala Waste Center. Pilleri accepts general waste, metal, glass, energy waste which is mainly plastics, garden waste, building rubble, tyres, elec-

tronic waste and hazardous waste. Basically they are accepting all the waste fractions that households may generate.

All the hazardous waste is placed inside the Pilleri building. Customers are dropping of their hazardous waste in front of reception, where employees take them inside the facility. There the employees are sorting hazardous waste more carefully and prepare everything ready for the transportation to further treatment. These safety measures increase overall safety and create possibility to control the storage of the hazardous substances. Hazardous waste from households is received without any extra fees. Operation is partly covered by the eco-fee, which is collected from the local community. For steady residence eco-fee is 19€(approximately R190) per year and for part-time residence is 11€(approximately R110). Part of the operation is covered by profits from selling other recyclable fractions. So basically Pilleri is operating with a zero-profit principle. The owner municipalities do not pay any of the functions of PHJ. (PHJ 2011). Small companies are obligated to pay for the handling of their hazardous wastes.

PICTURE 1: Pilleri



4.2 Operational Plan of the Pilleri II

Pilleri II waste sorting station is planned to be built on the property of Rustenburg Waste Depot. It is located on Betlehem Drive, which makes the location optimal to operate waste sorting station. It is easy to reach from N4 freeway, Nelson Mandela Street and the taxi rank is nearby. There are also plans to build a rank for commuter busses at the same lot (Senne 2011). This opens opportunities for customers to use the services of the waste sorting station easily regardless of their level of income.

Pilleri II will provide services for the local community and tourists in RLM. One of its purposes is to promote and encourage the local community to start separating their wastes at source. Possible collected fractions will be cardboard, paper, metal, glass, e-waste, garden waste and hazardous waste. The area may be too small for larger general storage, but it can be put under consideration.

Pilleri II will provide, beside recycling opportunities, awareness-raising for the local community. Purpose is to encourage the local community to evaluate their consumption and make it more sustainable and environmentally friendly. Rustenburg Waste Depot has plans to promote sustainable development in everyday life with an educational eco-kitchen and awareness-raising exhibition area.

4.2.1 Argument for Pilleri II

The population of the R L is increasing rapidly. When the population increases, at the same time the amount of waste is increasing. Currently, the Townlands landfill site is overflowing and alongside of it all the communal sites are poorly managed as well. The new Waterval landfill site will provide safer final destination for general waste and delisted hazardous waste. Waste sorting and recycling are effective ways to decrease the amount of waste at the landfill sites. At the same it can save

significant amounts of raw materials and natural resources. Waste sorting stations and other waste collection points can be used to control and guide recyclable waste fractions for further processing or treatment. At the moment recycling activity is quite meager in RLM despite the fact that there are few entrepreneurs who are focusing on recycling. Only a waste collection is organised by the Municipality at the moment.

Rustenburg by-law states that the Municipality must provide services or designate a waste disposal facility that is authorised to receive hazardous substances (Rustenburg By-Law 2011). Rustenburg Waste Depot has all the possibilities to establish such a place. Qualified personnel and relations with the local community already exist. Waste Depot also has a perfect place for Pilleri II: circle shaped, fenced area provides great possibilities for effective and functional waste sorting station. It is easy to reach and it can be easily controlled by the management. The Municipality can also apply funding from district and national level to help implementation of the model.

PICTURE 2: Area for Pilleri II at Rustenburg Waste Depot



Pilleri II is based on the idea, that recycling and waste management is possible when counselors, politicians and the local community are involved. Co-operation between stakeholders, entrepreneurs and different departments is crucial to ensure continuance. It is recommended to establish relations with different municipalities

and companies who are dealing with recycling and waste. Ideal situation would be when municipalities, who are providing similar services, are exchanging experiences and information to improve each other's management, services and practical arrangements. The involvement of the local community cannot be highlighted enough. Especially hazardous waste collection requires the commitment of the local community.

4.2.2 Collection and Sorting

Waste sorting station Pilleri II is a supporting collection system beside the normal waste collection by the Municipality. Unlike normal waste collection by trucks which is obligatory, Pilleri II is for voluntary collection and recycling. Local community members who are willing and keen to expedite recycling can bring their wastes from metal, paper and glass to hazardous waste to the waste sorting station. Trained personnel will be there to help with sorting and giving practical information on organizing a functional waste sorting system starting from customers own households. Collection at Pilleri II will be organised in a way that it will be easy to just drop-off different fractions into different containers. The most common hazardous waste fractions are electronic waste, batteries, solvents and oils, bulbs and fluorescent lamps, medicines and pesticides. Personnel should advise the local community to bring their hazardous waste in its original package. Usually these packages have all the required information about the handling instruction and the toxicity of the product. Hazardous waste collection campaigns can be put under consideration. In Lahti Region such campaigns are done regularly twice in a year. These collection campaigns can be used also to promote the services of Pilleri II and waste management. Also more strict and detailed guidelines for the most common hazardous waste fractions are needed.

PICTURE 3: Preliminary Sorting



PICTURE 4: Preliminary Sorting



4.2.3 Storage of Hazardous Waste

According to the plans and the budget, the construction of Pilleri II will start in 2013/2014. Environmental Impact Assessment (EIA) has been done and it was part of the whole assessment of the Waste Depot property (Senne 2011). So therefore funding and permissions are under control and Pilleri II waits for operational plan and construction phase. There are several issues that should be taken into account when constructing a building that will accommodate and store hazardous substances and other waste fractions.

The general requirements for the storage of waste are that any person who stores waste must at least take steps to ensure that

- (a) the containers in which any waste is stored, are intact and not corroded or in any other way rendered unfit for the safe storage of waste;
- (b) adequate measures are taken to prevent accidental spillage or leaking;
- (c) the waste cannot be blown away;
- (d) nuisances such as odour, visual impacts and breeding of vectors do not arise; and
- (e) pollution of the environment and harm to health are prevented

(Department of Environmental Affairs 2010)

All the hazardous substances will be situated inside Pilleri II. All the floor spaces of the rooms must be built in a way that in case of possible leakage, the contents of containers must fit into that pool. It can be implemented either by making inclinations into the room or with higher thresholds. This precaution prevents surrounding rooms and areas from possible dangerous leakages.

All the wells and drains must be closed with valve to avoid spillage and leakages into the surrounding environment. When wells are closed, possible leakage is easier to clean up. All the waters from drains must be led into collecting pools. If there is a possibility that flammable liquids may end up into the collecting pools, it must not be built under the building or in any other places where it might cause danger for employees or customers. In any case, if it is possible, the collecting pools should be built somewhere else than under the building. It makes maintenance and monitoring easier.

Storm water management is highly important on a waste sorting center. Pouring rain can make significant damages if hazardous substances are mixed with storm waters.

Another very important part of storage is ventilation. Evaporative hazardous substances create gases that may create dangerous circumstances either by themselves or after reacting with each other or with the air. Gases can cause immediate damage and may suffocate personnel and customers. Air in the rooms should change completely at least once in an hour.

All the electronic installations should be as minimised as possible to avoid possible explosions. High temperatures especially in summers should be taken into account. (Tukes 2009).

A few aspects that should be highlighted when constructing Pilleri II.

- 1) To make sure that facilities and storage spaces are big enough.
- 2) Ventilations, enlightenments, drain systems and storm water management are on sufficient level.
- 3) There is enough space for working.
- 4) Assessment for plausible incoming hazardous waste fractions.
- 5) Assessment for the amounts of waste that will be collected and stored.
- 6) Different hazardous substances may react with each other and cause harm for employees, customers and environment.
- 7) Accept only those hazardous waste fractions which already have either safe final disposal or further treatment possibilities

PICTURE 5: Ventilation system and shower



PICTURE 6: Ventilation system for paints



4.2.4 Disposal of Hazardous Waste Fractions

When purchasing containers for hazardous substances, several issues must be taken into account; chemical and physical attributes of hazardous waste, its state of matter, the amount of that particular hazardous substance, the manageability of the container and transportation requirements (Ekokem 2011). When the hazardous waste is packed and stored correctly already at Pilleri II, the transportation to further treatment or final disposal is safe and effective. It helps to control and manage expenses, when hazardous waste is disposed of properly. For example delisted or low concentration hazardous waste can be disposed of at new Waterval landfill site instead of Holfontein H:H landfill site. Internationally UN-approved contain-

ers are safe and well-marked with germane labels. (Lassila&Tikanoja 2011). Containers should also fulfill all the requirements for the transportation.

4.2.5 Security

Crime rates in the Rustenburg are relatively high. Especially burglaries, thefts and property-related crimes rates are showing significant increase despite the fact that the overall current trend is descending (South African Police Service 2011). Because Pilleri II stores valuable fractions, security issues cannot be highlighted enough. Electronic waste, hazardous substances, metal and medicines can be potentially targets for criminals. Vandalism is one plausible option that should be taken into account.

Area is already fenced with fences and electric wires, but improvements to the security system might be needed. Pilleri II's entrances should be locked with metal cages and all the containers that contain hazardous substances should be locked and secured. If reception will collect money, internal threat must be taken into account. In case of an emergency, all the drains must be closed (if they are not closed already like they should be) and the area isolated. Security instruction should be placed in a way that all the employees and customers can see them. All the signs and guidelines must be written at least in Setswana, English and Afrikaans.

4.2.6 Personnel Safety Measures and Daily Functions

Personnel play an important role. Because operating Pilleri II is a customer service, employees must have basic knowledge about recycling and hazardous substances. Their role in awareness-raising can be put under consideration. Important thing is that they have direct contact with customers.

One option is to organise one day workshops of current topics that promotes recycling for employees and the local community. Rustenburg Waste Depot should also plan and create internal education program for employees to ensure their competency. This is mainly because environmental issues and recycling are relatively new concepts in South Africa. It makes availability of competent employees a challenge. It is also recommended to write detailed instructions about safety measures and handling of hazardous substances.

Reception must always have at least one employee whose responsibilities are bookkeeping and recording the waste flows. The reception finds out what substances are brought in and guides customers to the correct sorting place. Other employees' duties can be customer service, maintenance and cleansing of the area, assortment of received wastes, sellotaping batteries and combining for example paints into one container. Hazardous waste storage requires extra attention from the employees.

Opening hours for Pilleri II must be determined in a way that most of the possible customers can reach it. One possible scenario is to separate working day into two different shifts with same amount of employees, one in the morning and one in the afternoon. This creates opportunities to keep Pilleri II open from 07h00 am to 19h00 pm. This allows within the budget to employ more workers which is one way to decrease unemployment rates and poverty in Rustenburg LM area. Rush hours are predicted to be at seven (07h00) o'clock when the local community members starts their working days and between four (16h00) and six (18h00) when they are knocking off the day.

4.2.7 Economic Resources

Pilleri II is budgeted for term 2013/2014 and its preliminary budget is R8,000,000 (approximately 735,000€). (Senne 2011). Part of the funding for operating Pilleri II is going to be covered by waste fee which is collected from the local community. Basically this means that for example hazardous waste and other recyclable waste fractions are free of charge for private persons. The idea is to ensure this

way that the local community brings their hazardous household waste into recycling. One option is to charge from small companies who are delivering hazardous waste to Pilleri II. Otherwise amounts that they are delivering can be relatively big which can create challenges in storing. By pricing Pilleri II operators can steer the process so that all the waste is disposed of safely to the right places. Possible fractions that generate money for operator are glass, paper and cardboard, plastic and metal. General waste should be priced with certain amount per volume. It will steer customers first to separate their waste loads and then to dispose of their general waste either with organised waste collection or directly to the landfill site. Illegal dumping can still be a challenge, even though most of the fractions are free of charge for the customers.

One option in organising personnel and transportation is to outsource it. Then the main challenge is to find competent and reliable entrepreneurs or contractors to operate Pilleri II. Basically outsourcing shifts responsibilities to the service providers but monitoring is still needed to ensure that agreed duties take places. Contracts should also have a point which forces contractors to get an approval for subcontractors from the management of the Waste Unit. The contractors are also going to be able to benefit from the recyclable materials.

Estimated numbers of staff and container costs of Pilleri II are presented in the tables below. Numbers of the personnel cost are taken from the document “Financial Implications of the Waterval Landfill Site”.

TABLE 1: Personnel costs

Staff	Allocation	Unit cost R / month	Annual costs R
Site manager	1	25000	300000
Supervisor	1	15000	180000
Clerk	1	7500	90000
Operator	1	12000	144000
Drivers	1	10000	120000
Cleaners/workers	8	7500	720000
Security	1	7500	90000
Total numbers	14		1644000

TABLE 2: Container costs

Skip containers	7	8000
Chippers	1 -	
Hazardous waste containers		
Liquids	2	16870
Solids	1	13480
Storage container	1	73760
Container for batteries	1	4880
Container for fluorecent lamps	1	4990
Total numbers	14	186650

4.2.8 Marketing and Stakeholder Involvement

Marketing and awareness-raising is highly important when the local community needs to be involved. The demographic profile of Rustenburg area and very low socio-economic level creates major challenges. Majority of population is living with under R800 (80€) per month, totally the rate is 72.2% of population. (Jarrod Ball & Associates 2005). When incomes and monthly salary are on a very low level, recycling and sustainable consumption is not a priority number one. Nevertheless, mindsets need to be changed on every level. The location of Pilleri II and Waste Depot can be highlighted in the marketing. It is easy to reach by own car or

public transportation and when several fractions are free of charge, it might encourage the local community to separate their wastes into different fractions. When the local community realises that they can save money by doing separation, it will be easier to propose, implement and start a separation at source by collecting several fractions directly from households. This model is not viable with the current waste fee system though.

Marketing and awareness-raising can be done in different ways. The personnel and staff will be in an important position in any case. Internet and social media can be used to reach audience from higher socio-economic groups. Flyers and grapevine can be used in rural areas, informal settlements and marketplaces. Idea is to reach as many people as possible at the same time with relatively low costs. Calendars which are delivered to the households and advertisements in local magazines can also be effective way to reach the local community. Stands in possible campaigns, mass fairs and all the places where it is possible to reach a large number of people are good ways to promote Pilleri II's and Waste Depot's activities. Previously mentioned hazardous waste collection truck campaigns can also be used to promote awareness-raising in waste management and environmental issues.

4.3 Opportunities and Threats of Pilleri II

Due to the on-going situation, it is relatively difficult to name the strengths and weaknesses of Pilleri II. As a conclusion for Pilleri II, I will evaluate its opportunities and threats. The aim is to recognise possible pitfalls before the construction and operational phase. The opportunities and threats are presented in the table below.

TABLE 3: Opportunities and Threats

Operational area	Opportunities	Threats
Collection and sorting	*Different fractions can be sold to different recycling companies	*Lack of awareness *Requires extra-effort from the customers

	<ul style="list-style-type: none"> *Services mainly free of charge for the customers * E-Waste processing at Waste Depot *Kick start for separation at source 	<ul style="list-style-type: none"> * Lack of further treatment possibilities *Fluctuations in the markets for recyclable materials
Storage of hazardous waste fractions	<ul style="list-style-type: none"> *Keeps hazardous substances in a safe place * Possibility to gather larger quantities for transportation cuts costs 	<ul style="list-style-type: none"> *Chemical reactions between different substances *Maybe expensive to build *Availability of suitable containers in the markets
Disposal of hazardous waste fractions	<ul style="list-style-type: none"> *Controlled final disposal *Same containers for storage and transportation *Waterfall Landfill 	<ul style="list-style-type: none"> *Transportation and disposal is costly *Disposal into wrong classification landfill site
Personnel safety measures	<ul style="list-style-type: none"> *Clear guidelines with at least three different languages *Clear protocol for in case of emergency *Workshops for employees and customers 	<ul style="list-style-type: none"> *Do employees read or follow the guidelines? *Indifference
Security	<ul style="list-style-type: none"> *To prevent property theft 	<ul style="list-style-type: none"> *Crime rates in Rustenburg *Are fences and cages enough? *Inner security, especially if/when money is collected
Personnel resources	<ul style="list-style-type: none"> *Outsourcing *Small enterprise development; training for local unemployed people to start 	<ul style="list-style-type: none"> *Internal security *Lack of competent workforce

	their own recycling companies	
Economic resources	*Clear budget to follow	*Continuity of funding; covering the operational costs needs to be secured in long-term *Security issues, corruption *Service usage needs to be high to recover costs; lack of community involvement
Stakeholder/local community involvement	*Direct contact helps to improve services *Workshops *Environmental Counseling center at Waste Depot	*Attitudes and mindsets *Lack of participation *Lack of it may slow down development in terms of recycling
Marketing	*Stands *Promotion *Workshops *Cleaning up -campaigns *Internet and social media	*Lack of co-operation between the administrative units, e.g. the waste unit and the environmental unit

5 CONCLUSION AND SUGGESTIONS FOR FURTHER RESEARCH

This study included the most important pieces of the legislation for hazardous waste treatment and final disposal in the South African context. It is crucial to dispose of hazardous waste reasonably and in a safe way. This requires extra attention by the Municipality and other stakeholders including the local community who are involved in the process. Co-operation between the stakeholders, the local community, other municipalities and entrepreneurs is crucial. Information and means should be shared to improve already existing systems and functions. The role of raising awareness cannot be highlighted enough.

The operational plan is meant to guide the project of constructing the waste sorting station Pilleri II. The purpose of the study was to give perspectives and ideas on what should be taken into account when establishing and introducing such a facility, whose concept and functions are related to a new issue for the local community. After all recycling is, or should be, a growing field of business as the availability of natural resources is decreasing in the future. Recycling also assists with the challenges in final disposal. It decreases the challenges at the landfill sites by reducing waste quantities and uncontrolled disposal of hazardous substances.

When storing and handling hazardous substances, it is necessary to follow all the safety rules. Clear guidelines help employees and customers to avoid and to be prepared for a possible or potential dangerous situation. Services are mainly free of charge and easy to use. Pilleri II waste sorting station is easy to reach by using one's vehicle or the public transportation system.

Highly important issues are to reach all possible customers from the local community and to promote the services of Pilleri II equally to everybody. This can be done by organising workshops, campaigns and other events where the local community and other stakeholders can be involved. Once the local community can adapt to the services of the waste sorting station and the Waste Depot, it will be

easier to launch other activities around waste management and recycling. Well-organised services can be a good kick-start to present model of source separation.

This study raised a few questions and possible topics for further research. Further treatment for the fractions of recyclable waste is still a question mark. Co-operation with private companies and entrepreneurs should be considered when it comes to, for example, transportation and other business opportunities. A research concerning other fractions of collected recyclable waste is therefore important. The feasibility of a buyback center operation model could be studied as well. The idea is to give small refunds for customers who bring recyclables, and to sell them to recycling companies with zero-profit.

Economic incentive is an important motivation method in encouraging the local community to recycle. Otherwise it is unlikely that the majority would take part in the recycling activity. When Pilleri II operates with a zero-profit principle, the local community might adopt its services easier because the purpose is not to gain revenue. At the moment, the fee is paid for waste collection and it is constant even if the household would minimise their waste flows by separating and recycling. It does not encourage the local community to use the recycling services. The collected waste fee could be bind into the state of recycling. The fees could be modified to reflect the amount of collected waste. The idea is to use converse economic benefiting by recycling and minimising the waste streams from the households. Less collected general waste, less fees.

When the local community has some motivation to come to Pilleri II to bring their recyclables, they can easily also drop off their hazardous waste fractions at the same time. Customers will also get information about the dangers of hazardous household waste. Employees can guide customers to visit the Waste Depot's environmental counseling exhibition areas to get more information about recycling, sustainability and environmental issues. It should also be used to educate the local community about damages that an unsafe disposal of hazardous household waste can cause.

One option is to research opportunities to establish, for example, a sorting center for collected electronic waste that could operate at the Waste Depot site. Its value comes when the hazardous parts can be separated from plastics and various metal components. It can reduce the costs of the final disposal of e-waste and create employment. This type of manual disassembling and separating of e-waste is also practiced by private recycling companies in the Lahti Region.

Future prospects for Pilleri II and recycling in Rustenburg LM will be successful if mindsets and attitudes can be changed to favor recycling. Sorting at source did not happen overnight in Lahti. A lot of work has been done in awareness-raising and promoting recycling activities. Success has been possible by cooperation within the municipality, between the municipalities and by establishing private-public partnerships in recycling.

Bojanala Platinum District Municipality and Rustenburg Local Municipality have all the possibilities to succeed. Lack of waste management activities is only a challenge that can be solved. If there are possibilities to implement them, then it is an opportunity.

REFERENCES

ELECTRONIC REFERENCES:

Bojanala Platinum District Municipality. 2011. Tourism. Bojanala Platinum District Municipality. [referred 10.11.2011]. Access:

http://www.bojanala.gov.za/index.php?option=com_content&view=article&id=6&Itemid=30

City of Lahti. 2011. Lahti in brief. City of Lahti. [referred 18.10.2011]. Access:

<http://www.lahti.fi/www/cms.nsf/pages/67301723715716F4C225714C0042ECEB>

Crime Research and Statistics – South African Police Service. 2011. Crime in Rustenburg (NW) for April to March 2003/2004 – 2010/2011. South African Police Service. [referred 27.10.2011]. Access:

http://www.saps.gov.za/statistics/reports/crimestats/2011/provinces/n_west/pdf/rustenburg.pdf

Department of Environmental Affairs. 2011. Storage, collection and transportation of waste. Department: Environmental Affairs. [referred 17.11.2011]. Access:

http://www.wastepolicy.co.za/home/nwms_v1/3/8

Ekokem. 2011. Oikeat astiat turvalliseen pakkaamiseen. Esite. [referred 17.11.2011]. Access:

http://www.ekokem.fi/files/attachments/yhtioiden_esitemateriaali/Ekokem_astiaesite_2011.pdf

GreenCity. 2011. GreenCity vastaa ympäristökaupungin kasvun haasteisiin. [referred 20.10.2011]. Access: <http://www.greencity.fi/>

Päijät-Hämeen Jätehuolto Oy. 2011. Ekomaksu. Päijät-Hämeen Jätehuolto Oy. [referred 1.11.2011]. Access: <http://www.phj.fi/isannoitsijat/ekomaksu>

Päijät-Hämeen Jätehuolto Oy. 2011. Päijät-Hämeen Jätehuolto Oy (PHJ). [referred 20.10.2011]. Access: <http://www.phj.fi/yhtio>

Rustenburg Local Municipality. 2011. Rustenburg Local Municipality. Rustenburg Local Municipality. [referred 10.11.2011]. Access:

http://www.rustenburg.gov.za/index.php?option=com_content&view=article&id=6&Itemid=16

Sawic. 2011. Department Environmental Affairs Republic of South Africa. Access: <http://www.sawic.org.za/>

SouthAfrica.Info. 2011. North West Province, South Africa. Big Media Publishers. [referred 10.11.2011]. Access:

<http://www.southafrica.info/about/geography/north-west.htm>

Turvatekniikan keskus. 2009. Vaarallisten kemikaalien varastointi. Turvatekniikan keskus. [referred 25.10.2011]. Access:

http://www.tukes.fi/Tiedostot/julkaisut/Vaarallisten_kemikaalien_varastointi_2009.pdf

INTERVIEWS

Helenius, K. 2011. Manager of Services. Päijät-Häme Waste Disposal Ltd. Interview 07.10.2011.

Kanjee, B. 2011. Technical support. Bojanala Platinum District Municipality. Interview 15.08.2011.

Kantele, M. 2011. Service Point Foremen. Päijät-Häme Waste Disposal Ltd. Interview 07.10.2011.

Mapholo, D. 2011. Manager Landfill Site. Rustenburg Local Municipality. Interview 18.8.2011.

Matsemela, K. 2011. Supervisor of Garden Sites. Rustenburg Local Municipality. Interview 26.8.2011.

Ntuane K. 2011. Manager Refuse Removal. Rustenburg Local Municipality. Interview 18.08.2011.

Senne, W. 2011. Head of Waste Unit. Rustenburg Local Municipality. Interview 24.08.2011.

LITERATURE REFERENCES:

Department of Water Affairs & Forestry Republic of South Africa. 1998. Minimum requirements for the handling, classification and disposal of hazardous waste. Second edition. Cape Town. CTP Book Printers.

Department of Water Affairs & Forestry Republic of South Africa. 1998. Minimum requirements for waste disposal by landfill. Second edition. Cape Town. CTP Book Printers.

Draft Waste Management By-law for Rustenburg Local Municipality. 2011.

Jarod Ball & Associates cc. 2005. Status Quo Analysis Report on Waste Management. Report.

National Environmental Management: Waste Act 59/2008.

Sevitz, J. Hazardous Waste. PowerPoint -presentation.

APPENDICES

APPENDIX 1. Table of Compatibility of Chemicals

