THE CLOSURE AND REMEDIATION OF THE CITY OF CAPE TOWN'S WASTE DISPOSAL LANDFILL SITES

LANDFILL INTEREST GROUP SEMINAR

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UNITED BY OUR DIFFERENCE

WSP

INTRODUCTION

Good afternoon and thank you for attending this Landfill Interest Group (LIG) event.

My name is Thorsten Aab and I am currently working for WSP SA Civil and Structural Engineers (Pty) Ltd – Bellville Office.

Previously I worked for Entech Consultants (Pty) Ltd in Stellenbosch and before that at the Department of Water Affairs and Forestry.

ACKNOWLEDGEMENTS

Please acknowledge the **City of Cape Town**, who appointed Entech and WSP to close and remediate five of their waste disposal sites. In particular I would like to thank the following employees of the CCT:

Colin Hall, Alan Lindgren and Peter Novella, who have been closely involved with the Project Management of the closure and remediation projects of the following of their waste disposal facilities:

- Brackenfell
- Faure
- Table View
- Gordon's Bay
- Swartklip.

These dedicated champions ensure that the CCT's waste management does not slide down the priority list, as is the case in so many local authorities in South Africa.

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I would like to thank the Contractors that were or are still involved in the construction of these projects:

Waltell Civils (Pty) Ltd, who have co-sponsored many of the past LIG events, including this one.

Amandla.

A special thanks also to the **Bracken Nature Reserve** Management team, who fall under the Biodiversity Management Branch of the City of Cape Town's Environmental Resource Management Department, for making their Reserve and the "Friends of Bracken" this venue available for this event.

Finally thanks to the rest of the **LIG Organising Committee** for making this event possible:

Peter Hardie (Chairman), Annette Naude, Chris Wiid, Craig Mitchell, Deon Stipp, Richard Emery, Wihan Visser.

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Why some waste disposal sites must be closed and remediated

- They have reached the end of their capacity i.t.o.: (a) slope stability; (b) final allowable height
- Pose unacceptable risk to ground and surface water resources
- Pose an unacceptable risk to the environment (includes humans)
- Are not operated properly
- Cause unacceptable nuisance conditions or compromise human health or wellbeing
- Become economically unviable
- Are replaced by waste transfer stations

Most older sites were established before the “Minimum Requirements” were published by the Department of Water Affairs and Forestry (DWAF) and hence were constructed without an engineered bottom liner. Often these sites were also not sited properly i.e. in close proximity to water resources or too close to residential areas. However, it also frequently happens that residential areas, both formal and informal, were allowed to encroach on to the disposal sites, thus not maintaining a proper buffer zone.

What does closure entail?

- No more waste may be disposed of on the site
- The site must be shaped to its pre-determined final shape, or where no permit or waste management licence was issued, shape it to suit its end-use
- The waste must be isolated from the environment as far as reasonably possible to prevent:
  - Wind-blown litter
  - Nuisance conditions such as odours, flies and vermin
  - Fires
  - Ingress of significant volumes of precipitation (rain) that can percolate through the waste, generating enough leachate to pollute the environment
  - Scavenging
  - Health risks and unacceptable aesthetics

What is remediation?

- Rehabilitation is returning something to its original state. In the case of landfills, this is not possible and therefore the term remediation is used, which means to change something from an altered state to a more acceptable state.

- Thus remediation could mean changing an unacceptable “rubbish dump” to a sanitary waste disposal landfill site or to remediate a sanitary landfill to a desired after-use, such as sport fields, parks or aesthetically pleasing open spaces or even nature reserves.

- This is normally accomplished by capping the site and placing a topsoil layer over this cap that can sustain vegetation. The vegetation protects the cap from erosion and is visually pleasing. Unfortunately livestock also seem to find the vegetation attractive, which could lead to erosion.

Possible risks posed by landfill sites

- Ground or surface water pollution (unacceptable contamination)
- Wind-blown litter
- Nuisance conditions
- Health and well being
- *Fauna* and *flora*
- Fire
- Eye-sore
- Attract scavengers
- Atmospheric pollution

Receptors

- Water users (ecology, human consumption, irrigation, industry)
- Residents (nuisance conditions i.e. odours, vectors and aesthetics)
- Atmosphere (dust, landfill gas and burning)
- Domestic and wild animals
- Workers on the waste disposal sites
- Scavengers

Environmental Risks

Risk is determined by the following factors:

- The likelihood of an occurrence
- The frequency of an occurrence
- The duration of the impact
- The sensitivity of the receptor (human, natural and agricultural *fauna* and *flora*, the atmosphere etc.)
- The exposure / contact time
- The exposure pathway
- The severity (toxicity, carcinogenicity, explosiveness, etc.) of the impact

Implementation of mitigating measures, such as capping, access control, security etc. could significantly lower the risk.

Capping design

The environmental risks of a specific waste disposal site is normally determined by an Environmental Impact Assessment (EIA) or Basic Assessment. To simplify the identification and quantification of mitigating measures to reduce these risks, the 'Minimum Requirements' grouped landfill sites according to:

- the type of waste it received (either hazardous or non-hazardous);
- the amount of waste that was disposed of (size of the landfill); and
- whether significant amounts of leachate could be generated (water or moisture balance).

Depending on this risk classification, various minimum requirements were developed for the capping design required. Obviously these are just minimum guidelines and other factors such as the following must also be considered:

- Whether the site is lined at the bottom
- The presence of sensitive water resources and other environmental receptors
- The potential of the landfill sites to generate significant amounts of landfill gas
- The prevailing meteorological conditions
- The intended after-use.

Thus the authorities responsible for approving the capping design will require a Risk Assessment and other investigations to enable them to accept or reject a proposed closure design.

Capping a landfill site limits the ingress of rainwater which percolates through the waste and creates leachates, which in turn could cause a hydraulic head in the waste body thereby causing potential slope instability and or could cause water pollution.

Generally the higher the risk of a waste disposal site to its surrounding environment, the less permeable the capping layer, according to the Minimum Requirements.

A cap also isolates the waste from wind, which could cause wind blown litter as well as from vectors such as flies and rodents that could breed in the waste.

A cap prevents fires by limiting the amount of oxygen.

Various materials are generally used to construct the different types of capping layers, either on their own, or in combination with other materials. These include the following:

Clay

- Clay has to be compacted in layers not exceeding 150mm, which must be regularly verified by Proctor density testing
- A optimum moisture content of the clay must be determined and prepared prior to compaction
- The physical properties of the clay must enable the barrier to attain a minimum hydraulic conductivity, which must be regularly verified by double ring infiltrometer testing
- As clay is prone to desiccation and cracking, multiple layers are normally required

- The clay layers must be covered with topsoil or another membrane as soon as possible after placing, to prevent desiccation and erosion
- The advantages of clay are that, depending on the proximity of its source, it could be cheaper than other alternatives, it could be relatively resistant to chemical degradation, it can create a fairly impermeable barrier to both liquids and gas and it can withstand mechanical abuse
- Disadvantages include that it takes up space, requires much haulage, and may be prone to cracking over uneven settlement or consolidation of the waste body.

Geosynthetic Clay Liner (GCL)

- Consists of a thin bentonite layer (10mm thick) sandwiched between two synthetic material mats
- The functionality may vary depending on the type of bentonite used, the type of carrier material (woven or non-woven) as well as the stitching techniques used in its manufacturing
- Advantages are that it takes up very little space is very impermeable relative to its thickness, can 'self-heal' when punctured, may be fairly resistant to chemical destruction, is relatively easy and quick to install and provides flexibility in case of uneven settlement or consolidation of the waste body
- Disadvantages include its need to be kept hydrated if it must function as a gas barrier, needs to have a minimum ballast on top for confinement, needs manufacturing, storage and installation specifications and testing and is susceptible to root ingress

High Density Polyethylene (HDPE) flexible geomembrane

- Usually used between other capping layers (composite capping)
- Advantages: very impermeable to both liquid and gas relative to its thickness, resistant to most chemicals, does not take up space and has good stretching ability
- Disadvantages: is easily punctured, cannot 'self-heal', is desirable as building material and therefore vulnerable to theft, prone to interface slippage, must be subjected to manufacturing quality control and installation must be done and tested by professional welders.

Topsoil

- Topsoil is essential to support vegetative cover
- Is vulnerable to erosion if not vegetated
- May need to be of a specific type to sustain certain vegetation
- May need to be ameliorated by adding compost and fertilizers

Leachate Management

In waste disposal sites with bottom liners, leachate is usually collected in a collection sump or pond and must be treated either locally or by a suitable sewage works that has the capacity to treat the leachate.

Such leachate management facilities can fail (pumps), block or exceed their capacity, which must be prevented by regular maintenance.

Depending on the waste disposal site, leachate quality and quantity can vary significantly. All leachate is considered hazardous until proven otherwise as leachate can be extremely reactive or toxic.

In unlined waste disposal sites, often the only practical way to manage leachate is to minimise its generation by placing a cap over the landfill, and diverting any stormwater away from the site.

Landfill gas management

Landfill gas is derived from the decomposition of waste, mainly by microorganisms. At first aerobic decomposition takes place, generating mainly carbon dioxide (acetogenic phase). Once no more oxygen is available, mainly methane gas is generated (anaerobic phase). Landfill gas may accumulate in voids between the waste, called residual gas. This gas will follow the path of least resistance and often ends up in the atmosphere. Both carbon dioxide and methane gas contribute to global warming and can be asphyxiating.

The migration and accumulation of landfill gas in confined areas such as buildings and sewers must be prevented. This could be achieved by constructing gas collection channels or layer under the cap and allowing the gas to passively vent into the atmosphere and / or by constructing cut-off barriers around the landfill site.

Because methane gas has a 20x bigger effect on global warming than carbon dioxide and is flammable and even explosive at certain concentrations, the oxidation of methane gas to carbon dioxide through natural degradation in the soil or combustion by flaring (burning) is recommended.

Even more preferable would be to harness the methane to generate electricity or substitute fossil fuels such as diesel and coal.

Normally this would require active gas extraction by vacuum pumping the gas out of a network of connected gas wells within the waste body.

As we heard all about this very fascinating subject of the utilisation of waste disposal landfill gas from our previous presenter, I shall not elaborate on this any further.

Stormwater Management

Stormwater must not be allowed to come into contact with the waste. Therefore stormwater originating from areas around the landfill must be deviated away from the waste body. If uncontaminated, it could be allowed into the environment without any treatment. Stormwater falling on the site must be allowed to run off without causing erosion to the capping layers. This is achieved by limiting the side slopes of the landfill site and breaking the speed of the run-off by various erosion control measures such as:

- Vegetation
- Silt fencing
- Biodegradable jute netting
- A gravel cover over the topsoil (especially sandy topsoil)
- Lined stormwater channels
- Stilling bays
- Retention ponds

Site maintenance

Most closure permits or waste management licences require the maintenance and responsibility of the waste disposal site for at least a period of 30 years after closure, unless a shorter period can be motivated.

Maintenance could include the following:

- Preventing and rectifying any erosion
- Preventing the formation of ponds and sinkholes on the waste disposal site
- Preventing fires by removing of dead vegetation where practically possible
- Removing alien vegetation
- Preventing the site being used for grazing and housing
- Maintain the functionality of leachate, landfill gas and stormwater management systems

Post closure monitoring

Monitoring of groundwater and surface water quality is very important, especially where the site is not lined at the bottom or where previous contamination has been caused. The efficacy of the cap can be measured by such monitoring. Strategically placed monitoring boreholes should be placed around the site and regularly monitored until trends prove that the monitoring frequency could be abated or even stopped.

Landfill gas monitoring is also important to determine how much landfill gas is being produced and whether any landfill gas is escaping laterally into the surrounding substrate, where it could pose a risk to the environment.

A post closure monitoring plan should be developed for each remediated landfill site and regular monitoring reports should be recorded and interpreted to inform auditors in order for the authorities to base further decisions on the outcomes, trends and recommendations.

CONCLUSION

This concludes my very general discussion on the closure and capping of waste disposal sites. Obviously this subject can be discussed at far greater depth and this presentation does not even scratch the surface, however there is simply not enough time to become more specific.

I have prepared a slide show with photos on the closure and remediation of the following waste disposal sites:

- Brackenfell
- Faure
- Table View
- Gordon's Bay
- Swartklip (construction has not yet started)

However, as we must allow for question time and we will take a walk over the Brackenfell site, there may not be sufficient time for all of them.

Therefore I shall just quickly rush through the photos and allow for questions later.

I thank you all for attending and your patient attention.