Landfill Closure and Rehabilitation Costing and a Closure Case Study

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ABSTRACT
The management of municipal solid waste is one of the most important challenges faced by our more-rural, urban and industrial societies, especially in so far as the environmental effects on surrounding areas are concerned. In recent years South Africa has experienced far reaching legislation regulating the rehabilitation of landfill sites with one of the main aims of minimising the potential impact of such sites on the environment. The rehabilitation of modern-day landfill sites is a highly capital intensive procedure and the cost estimates are highly dependent on the relevant market and economic parameters and site specific data. This paper presents project experience and insight into the costing and implementation of such final capping, closure and rehabilitation of some sites. Equally so, the paper provides feedback on research done regarding the vegetation (landscaping) of site(s) - successes and failures.
Keywords Landfill Closure, rehabilitation, costs, landscaping.

1. INTRODUCTION

In financial terms, a Waste Disposal Facility (WDF *aka* "landfill") is an asset to a landfill owner or license holder and capital and operating expenditure to maintain the Facility during its active life (i.e. while the site can offer "airspace") is a recoverable cost from the charges relating to those disposing of material. Once the Facility has reached its capacity, in terms of the License for the site, the closure needs to commence (or be finalised if progressive closure has been taking place) and the related infrastructure installed or modified, which can be a huge cost to the License holder. This work also comes at a stage where it is likely that no further income is likely to be generated to recover such costs. This said, the Waste Disposal Facility becomes a liability to the Landfill owner/ License holder.

Municipalities are required in terms of GRAP (Generally Recognised Accounting Principles) to perform a valuation for landfill sites for inclusion into financial year end statements and demonstrate that they have sufficient budget in place for the closure of their municipal owned landfill sites. These estimates are, in some cases, based on reports from independent experts (National Treasury SA. 2014). In recent years, it has become common practice for Civil Engineering Consultants to serve the role as "independent expert" and provide an assessment for the valuation for closure and rehabilitation of landfill sites. These assessments, although small in scale in comparison to typical civil engineering projects, present their own unique challenges in the form of data deficits, lack of defined methodologies and the difficulties in combining engineering principles with accounting philosophies. Jeffares & Green have undertaken costing analyses for numerous municipalities located throughout South Africa, and it has been experienced that as a result of such challenges, there is an increasing variance in assessment results year on year and with a change in consultant. This paper aims to identify and assess the methodology, experienced challenges and potential solutions in going forward with landfill closure assessments.

This paper also looks at a case study of landfill rehabilitation which provides an understanding of the extent of requirements for successful closure and rehabilitation of landfill sites. From 2012 to 2014 Jeffares & Green (Pty) Ltd was extensively involved in the extension of the Vissershok South and Vissershok North landfill sites. The civil engineering extensions were constructed concurrently with a landscaping and rehabilitation contract covering some 9.8 ha of lined airspace within the boundaries of the existing Vissershok South site and 7.5 ha at the adjacent Vissershok North landfill site (Jeffares & Green. 2012). A scientific experiment, referred to as Landscape Functional Analysis (LFA) was undertaken on the east slope of the Vissershok South Landfill, to determine the best mix of planting ratios for future rehabilitation work. This paper reflects on the philosophy behind the well planned

rehabilitation of the site, the success and failures of the experimental panels and the progress of works to date.

2. UNDERTAKING CLOSURE COST ASSESSMENTS

The Generally Recognised Accounting Practice (GRAP), also referred to as the accounting standards, state that "Provisions are measured as the amount (best estimate) that the entity would rationally pay to settle the obligation or to transfer it to a third party at the reporting date. Where the effect of time value of money is material, the provision should be the present value of the expenditures expected to be required to settle the obligation".

In layman's terms and in terms of landfill closure, a municipality has an obligation to rehabilitate a landfill site at its end life (full capacity). The engineering assessment must assess how much it would cost the municipality to close the landfill at its expected date of closure. The present value of the estimated future cost to rehabilitate the site at its end life must be calculated (using amortisation tables) and it is this present value that is reflected in the financial statements.

Jeffares & Green employs the following methodology in determining the cost for closure and rehabilitation:

1) Site Visit and Assessment
2) Literature and Legislative Review
3) Assessment of Closure and Rehabilitation Requirements
4) Design Review and Quantity Calculation
5) Costing Analysis

2.1. Site Visit and Assessment

In order to assess the requirements for the closure of a site, it is essential to gain perspective on the current status of the site. The following aspects are relevant and are noted during the site visit:

- Infrastructure on site (condition and effectiveness),
- the existence and condition of the fencing, diversion channels, ponds and roads,
- the availability of suitable capping materials on or near the site,
- in-situ soil conditions,
- any progressive capping undertaken to date,
- general operation of the site (daily cover, compaction, access control, etc.),
- groundwater monitoring infrastructure and
- gas monitoring infrastructure

a) Photograph taken during a WDF site visit (North West Province)

b) Photograph taken during a WDF site visit (Western Cape)

c) Photograph taken during a WDF site visit (Limpopo Province)

d) Photograph taken during a WDF site visit (Eastern Cape)

Figure 1: Photographs taken during site visits of waste disposal facilities located throughout South Africa.

2.2. Literature and Legislative Review

Municipalities are mandated to operate the landfills in compliance with current legislation, the conditions of the Waste Permits/Licences and respective Record of Decisions (ROD's). A waste Permit/Licence authorises (amongst other items) the decommissioning of a waste disposal facility and its associated infrastructure and rehabilitation thereof, subject to conditions specified in the Permit/Licence. These Permits/Licences state that, in addition to specified Licence conditions, the closure and rehabilitation of the sites must be in accordance with the Minimum Requirements for Waste Disposal by Landfill (DWAF. 1998) and any subsequent updated/more-recent legislation/ regulation(s).

Notwithstanding the release of the Waste Classification and Management Regulations (WCMR) in August 2013, the 1998 Minimum Requirements Trilogy documents nevertheless hold key design data and requirements with regards to landfill closure and rehabilitation which have not yet been superseded by the 2013 WCMR. New legislation specific to landfill closure is pending and expected to be released in the near future.

In addition to the legislative requirements, the waste License/s, RODs, end use plans, external audit compliance reports, integrated waste management plans, records of disposed waste volumes, airspace surveys, engineering designs (for closure or development) and future development plans are all requested from the client and reviewed to ensure that all requirements are considered.

2.3. Assessment of Closure and Rehabilitation Requirements

The legislative (and other documented) requirements are compared to the existing site conditions and a summary of the required measures for the closure of the sites tabulated. This summary table itemises the description of works to be undertaken for closure of the site.

2.4. Design Review and Quantity Calculation

The final design profile (as per the end use plan) of the landfill site determine the quantities of capping layer works, infrastructure and site area for clearing. Aerial images from Google Earth as well as the available design drawings are used to compile a bill of quantities. The quantities are relative to the items of works to be undertaken are determined in the rehabilitation requirements determined above.

The costing analysis calculates the cost for the closure of the landfill sites at its end life, at full cell capacity at current day rates and costs. The rates are on projects of a similar nature, undertaken recently within the nearby areas to the site under consideration and/or projects currently underway in South Africa. Any shortfall in priced data information is then replaced by suppliers in the Industry.

It is important to note that at this stage the cost analysis applies likely current-day construction rates to the estimated quantities.

2.5. Costing Analysis

In order to determine the final value of closure at a sites end life, one must inflate the cost (calculated at current rates) annually to the expected closure date.

The inflation rate (current at the time of reporting) is applied to the estimated cost to determine he closure cost at the date of expected expenditure based on annual inflation.

The client provides the latest comparative estimated interest rates. Amortisation tables are used to calculate the present value of the future cost (i.e. the required provision to be made for the current financial year). An amortisation table is a table detailing each periodic payment on an amortising loan. Amortisation refers to the process of paying off a debt over time through regular payments (Wikipedia. 2015).

3. CHALLENGES EXPERIENCED IN UNDERTAKING CLOSURE COST ASSESSMENTS

As is the case with most engineering projects, every project or site presents its own unique challenges. Jeffares & Green, have however, in its experience in compiling these assessment, noted the regular reoccurrence of numerous circumstances that pose difficulty in obtaining an accurate assessment.

It is the norm that as the number of assumptions made increases, the accuracy and reliability of a design decreases. In many instances, there are no end use plans, integrated waste management plans, records of disposed waste volumes, airspace surveys, engineering designs (for closure or development) and even in some cases, waste Licenses available for review. This is most often the cases in smaller, more rural municipalities where due to lack of budget, waste management is often neglected and the landfill sites are poorly managed. This lack of data critical to the assessment forces the engineer to make educated assumptions in terms of the closure design.

In addition to a lack of data, variation in methodologies and view point of consultants often lead to significant variances in the total cost estimate. This poses a problem for the municipal accountants who have to justify the sudden fluctuation in provision one year later. There are models being developed by consultants however, to date there has been no approved standardised methodology released for such cost assessment. Although most consultants will apply the same basic principles there is room for interpretation in the legislative requirements and the views on what is required versus what is a “nice to have” often differ. It has also been noted that as the degree of assumptions escalates the difference from consultant to another will fluctuate proportionality.

The assessment report is often requested and reviewed by the finance department of a municipality. Often there is very little understanding, by the accountant (or other such financial-minded person), of the engineering principles, assumptions or design principles applied. Equally so, there is often a lack of understanding of accounting principles possessed by the engineer, presenting difficulty in grasping accounting principles such as amortisation tables, inflation, discount rate and net present value. It is this “language barrier” between accountants and engineers that often poses a challenge in ensuring that the ultimate cost outcome has been correctly calculated.

4. POSITIVE OUTCOMES AND WAY FORWARD WITH CLOSURE COST ASSESSMENTS

The concept of the calculation of rehabilitation, capping and remediation cost at closure of landfill sites provision is a fairly new one in the engineering industry. With each passing year, the process becomes increasingly refined. There are many positive outcomes associated with these yearly assessments. “Models” are being developed to assist in standardising methodologies. One such model is the Municipal Landfill Closure Costing Model (MLCCM) developed by Environmental & Sustainability Solutions, in collaboration with Jones & Wagner. This model provides a framework for determining the financial provisions to be disclosed in the annual financial statements (Godschalk, et al. 2015). It is

anticipated that such a model will become a mandatory tool for all consultants undertaking these cost assessments, this standardisation of methodology will greatly reduce variations in results between consultants.

With each assessment completed, the understanding of the process becomes increasingly familiar to the consultants undertaking the assessment and the client requesting the assessment. The gained experience and knowledge allows the client and auditor to review the report with greater effectiveness and constructive criticism and the engineer to refine their process and consider any shortfalls noted in previous assessments.

These assessment, are bringing to the forefront, on a yearly basis, the issues and required upgrades experienced at landfill sites. Many of the sites in poorer, rural area are in desperate need of upgrade and these reports allow the municipality to be reminded of these poor conditions and to gain perspective of the potential upgrades and expected costs to improve the daily management and operations of the site. It has been noted by Jeffares & Green in doing site assessment in consecutive years that, in some instances, there are noticeable improvements to sites since previous assessments and that these improvements upgrades have been directly related to the recommend upgrades in the assessment report. These reports assist in prioritising waste management within local municipalities and ensuring that the need for effectively managed and operated landfill sites is a significant one.

5. ASSOCIATED AND APPLIED PROJECT EXPERIENCE

Closure costing described above needs to also be associated with actual practice and reality. Jeffares & Green undertook the Closure Costing for City of Cape Town's Vissershok Landfill South Site together with the actual implementation of the progressive closure of a portion of the site.

Jeffares & Green then compared and used such capital cost values for closure costing analysis and equally so identified technical shortfalls in the regulations where inexperienced closure-costing modelling would fail to account.

To further analyse technical considerations in closure and closure-costing, Jeffares & Green, with City of Cape Town, undertook onsite testing and research to further understand the technical demands of closing a site and thus have a more-accurate understanding of the related capex burden to a Landfill owner, when having to undertake this costly exercise.

Below outlines the undertaking.

5.1. Vissershok South Landfill- Progressive Closure

This Vissershok site is located off the N7 into Frankdale Road in the Western Cape. It is about 117 hectares in size (including the closed "Triangle" site between). The Vissershok Site is divided into two portions - Vissershok South (the original site) and Vissershok North (newer portion of the site). Vissershok South is licensed under permit number 16/2/7/G203/D29/Y1/P3001 (as amended) and is classified as a co-disposal site for hazardous and general waste. The classification is as a Hazardous (H: H, H: h) and General, Large, Leachate producing site (G: L: B+).

Figure 2: Aerial photo of the Vissershok South Waste Disposal Facility (Jeffares & Green. 2013)

From 2012 to 2014 extensive construction works were undertaken for the City of Cape Town at the Vissershok North and South landfill sites. The civil engineering works were constructed concurrently with the landscaping and rehabilitation contract.

Phase 1 of the works saw Vula Environmental Management Services appointed as the Landscape Sub-Contractor by Burger and Wallace on Contract No. 346Q/2009/10 to undertake work which included hydro seeding and planting Cell 0 and the Balefill after the area was capped by Burger & Wallace.

Figure 3: Cappped Portion of Cell 0 and Balefill (Hendrik van der Hoven & Jeffares & Green. 2014)

The parties involved in the Phase 2: The Provision of Landscaping Services for the Vissershok South and North Waste Disposal Sites are outlined below:

- Client: City of Cape Town
- Consultant: Jeffares & Green Engineering and Environmental Consulting
- Landscape Architects (Sub- Consultant to J&G): Hendrik van der Hoven
- Contractor: Vula Environmental Services

A Landscape Master Plan Proposal for Closure was compiled by Jeffares & Green and Hendrik van der Hoven in compliance with the Record of Decision (RoD), July 2007. The masterplan specified that areas to the south and east of the Vissershok South landfill were rehabilitated with appropriate hydro seeding and/or planting with nursery grown plants. The area to the east of Vissershok North was restored with hydro seeding and inter-planting with nursery grown plants. A scientific experiment referred to as the

Landscape Functional Analysis (LFA) was undertaken on the east slope of the Vissershok South Landfill, to determine the best mix of planting ratios for future rehabilitation work.

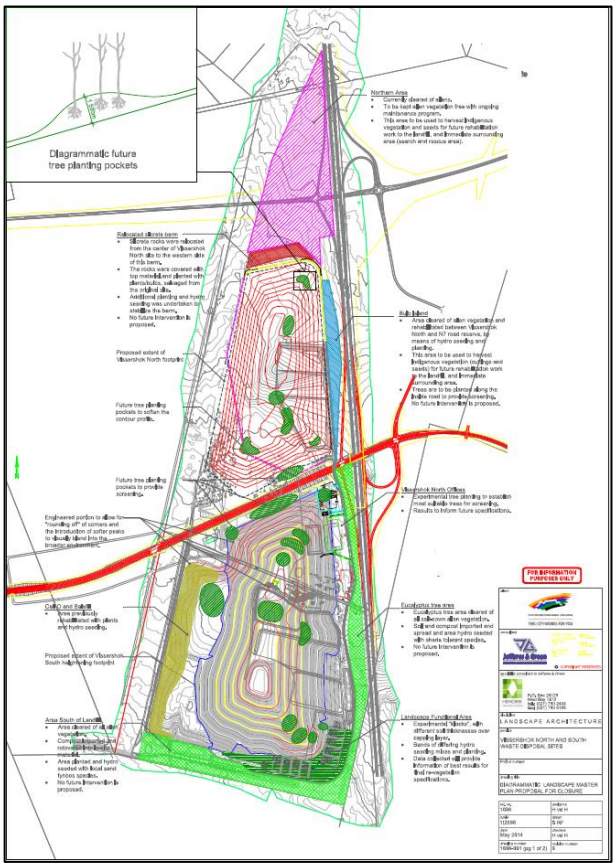

Figure 4: A Landscape Master Plan Proposal for Closure (Hendrik van der Hoven. 2014)

The LFA study area comprised eight experimental blocks (40m x 80m) planted with four varying soil thicknesses (0mm,150mm,300mm,450mm) of 1:2 clay to local sand mix over the compacted clay layer (CCL) capping layer. Four differing bands of hydro seeding mixes and planting and three planting options were planted over the experimental blocks.

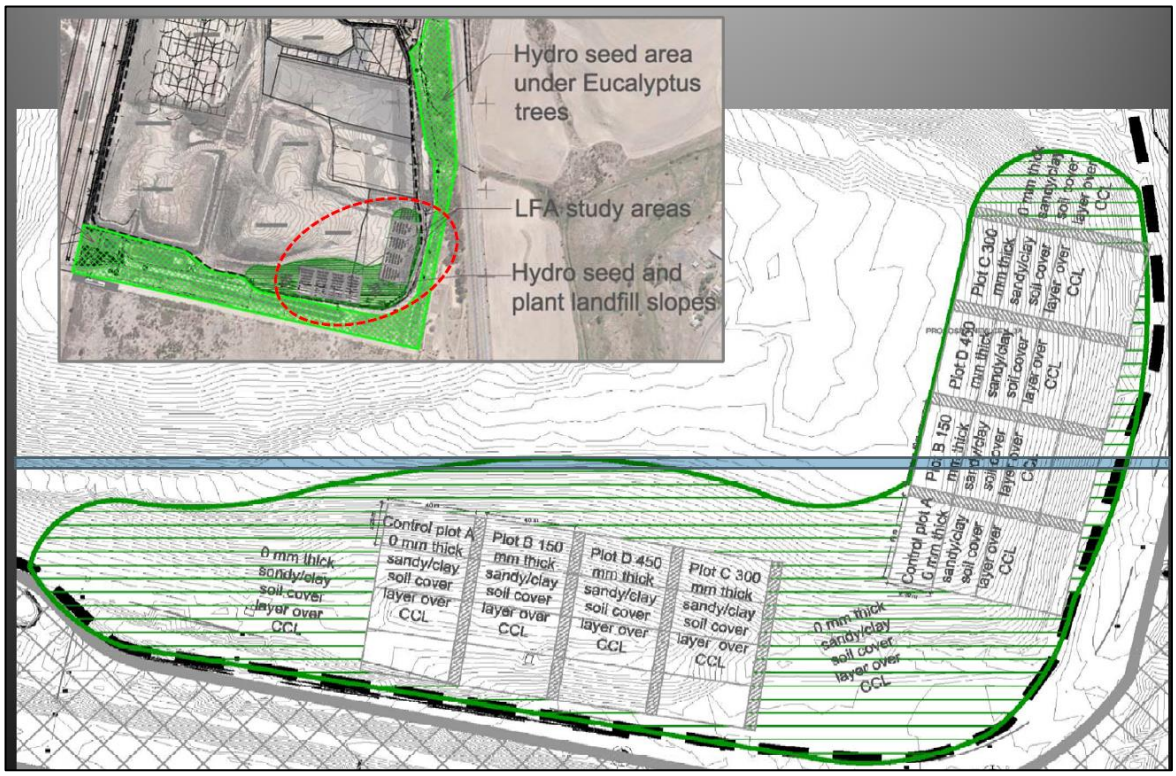

Figure 5: LFA Area- Diagrammatic Landscape Master Plan Proposal for Closure (Hendrik van der Hoven & Jeffares & Green. 2014)

The intention behind the experiments is that the data collected will provide information of the best results for final re-vegetation specifications. To date the trial vegetation panels have yet to yield any viable, usable results, however a second tender is in the process of being adjudicated to continue the monitoring of these panels as well as the tree planting that was undertaken at Vissershok landfill site and it is expected that the updated information will provide some clarity or a developing trend.

In recent visits to the site it is evident that the capping and hydro seeding undertaken has produced thriving vegetation of the slopes. The vegetation is dense and there is no visible exposed capping layers.

a):Vissershok Southern Slope before Capping (Jeffares & Green. 2008)

b)Vissershok Southern Slope Experimental Planting (Jeffares & Green. 2015)

Figure 6: Photographs taken of Vissershok Southern Slope before and after capping

6. CONCLUSION

Once a Waste Disposal Facility (*aka* "landfill") has reached full capacity, in terms of the License for the site, the closure needs to commence (or be finalised if progressive closure has been taking place) and the related infrastructure installed or modified, which can be a huge cost to the License holder. Municipalities, most often the license holder, are required in terms of GRAP to perform a valuation for landfill sites for inclusion into financial year end statements and demonstrate that they have sufficient budget in place for the closure of their municipal owned landfill sites. The rehabilitation of modern-day landfill sites is a highly capital intensive procedure and the cost estimates are highly dependent on the relevant market and economic parameters and site specific data.

Jeffares & Green, have undertaken many such assessments and developed a systematic methodology and approach. Through experience it has been noted that the regular reoccurrence of numerous circumstances pose difficulty in obtaining an accurate assessment, equally so there are also many positive outcomes associated with these yearly assessments which may produce positive outcomes for the solid waste sector of South Africa as a whole.

Closure costing also needs to be associated with actual practice and reality. Jeffares & Green undertook the Closure Costing for City of Cape Town's Vissershok Landfill South Site together with the actual implementation of the progressive closure of a portion of the site. The civil engineering works were constructed concurrently with the landscaping and rehabilitation contract. A scientific experiment referred to as the Landscape Functional Analysis (LFA) was undertaken on the eastern slope of the Vissershok South Landfill, to determine the best mix of planting ratios for future rehabilitation work. Although to date the trial vegetation panels have yet to yield any viable, usable results, a second tender is in the process of being adjudicated to continue the monitoring of these panels as well as the tree planting that was undertaken at Vissershok landfill site. It is expected that the updated information will provide some clarity or a developing trend. This expectation is supported by recent visits to the site, where it was clearly evident that vegetation on the capped slopes appears to be thriving and no evidence of capping material on these slopes are visible.

As the South Africa society moves up the waste hierarchy away from landfilling towards waste minimisation, the closure of waste disposal facilities remains an important one within the South African waste sector. The closure of these facilities presents its challenges, however with increasing experience in landfill closure assessments and actual implementation so are the methodologies and refined and the potential impacts on the environmental from these facilities reduced.

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