REHABILITATION OF DAGGAFONTEIN TAILINGS DAM TOWARDS LONG-TERM SUSTAINABILITY

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SOUTH AFRICAN INSTITUTE OF MINING AND METALLURGY COLLOQUIM ON MINE CLOSURE FOR SUSTAINABLE DEVELOPMENT

Rehabilitation of Daggafontein Tailings Dam Towards Long-term Sustainability

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1. INTRODUCTION

Daggafontein tailings dam has come to the end of its operational life and a strategy on how best to close-out the facility had to be defined. In particular, the strategy had to consider what must be done to create the best chance of achieving a successful closure. Hence, the creation of a situation that will demonstrate to the regulatory authorities the long-term sustainability of the closed facility.

The close-out strategy had to follow a structured process, aimed at binding the authorities and other affected parties into a long-term arrangement, thereby minimising the possibility or repeating closure related work and/or revisions of the closure plan.

The paper described the approach followed with the selection of final land use and the formulation of the cover and associated slope modification to sustain the selected final land use.

2. PROJECT OBJECTIVES AND APPROACH

The overall project objective could be defined as "obtaining the most appropriate closure strategy for Daggafontein tailings dam, following a structured and defensible process in the identification and evaluation of alternatives". Consultation with stakeholders had to be part and parcel of this process.

The work related to the development of a closure strategy for Daggafontein tailings dam was conducted in a staged manner, addressing the following:

- Data collection, problem definition and scoping
- Setting of objectives
- Screening of alternatives
- Strategic evaluation of alternatives
- Development and documentation of closure strategy.

This paper addresses the setting of objectives, screening of alternatives and the strategic evaluation of alternatives.

3. OVERALL RISK-BASED APPROACH

A risk-based approach was followed to devise the primary components of the closure strategy for Daggafontein tailings dam. The approach was applied specifically to the following:

- Final land use
- Slope modification and cover
- Care and maintenance
- Residual risks related to selected approaches.

The risk-based approach related to the above was applied at two levels:

- Screening of alternatives
- Quantitative assessment of candidate options.

4. FINAL LAND USE OPTIONS

Final land-use options were identified in brainstorming and consultation sessions. Associated performance criteria related to final land use were also established in this manner.

The specific physical features associated with Daggafontein tailings dam were key factors in guiding final land-use identification and selection. Specific features which were considered included the isolated nature of the tailings dam, its relative elevation, the workability of the outer slope material, pan (concave) shaped top surface topography and steep outer slopes. Moreover, once the tailings dam has been decommissioned, about three years would be required for the beach to settle. During this period a semi-dry to dry state of the tailings material could lead to wind and water erosion.

5. EVALUATION OF FINAL LAND USE OPTIONS

5.1 Screening

The identified land-use options were screened by means of a qualitative assessment, using a risk-ranking matrix. The risk-ranking matrix considered the following:

- Environmental performance
- Acceptability to stakeholders
- Sustainability.
- Cost related to implementation and maintenance
- Time for implementation and demonstration of success
- Resources required
- Safety, health and related environmental considerations
- Technical viability
- Post-closure transferability.

5.2 Quantitative analysis

The candidate land use options as depicted by the cluster matrix were subjected to a quantitative probabilistic risk assessment, using Goldsim.

For each of the candidate land use options flow sheets were developed. The flow sheets reflected requirements for the implementation, care and maintenance as well as closure. Each flow sheet item was costed by assigning minimum costs, most likely costs and maximum costs. Associated time for implementation was also assigned.

The information derived from the above was used as input data for Goldsim.

The wilderness option was selected as the most appropriate final land use.

6. TECHNOLOGY OPTIONS

The technology options identified were categorised as follows:

- Surface stabilisation
- Water management
- Outer slope amelioration.

6.1 Surface stabilisation

the surface stabilisation option could be viewed in terms of two broad categories, namely slope modification and slope stabilisation. In terms of slope modification the following were identified:

- Mechanical shaping
- Hydraulic shaping (water cannon)
- Buttressing with stable material
- Deposition of slimes to change outer slope.

In terms of outer slope stabilisation the following were identified:

- Rock cladding
- Vegetation
- Armouring and vegetation
- Vegetation and topsoil
- Stabilisation of in-situ tailings material
- Geosynthetics.

6.2 Water management

Water management related to the tailings dam involved the following:

- Benches coupled to stormwater chutes
- Benches with stormwater retention
- Retention on upper tailing dam surface.

6.3 Outer slope amelioration

In terms of amelioration of the tailings dam outer surface the following were considered:

- Chemical
- Organic
- Replacement
- Leaching.

The technology options identified to be relevant to Daggafontein tailings dam as outlined above, were subjected to a screening analysis (considering final land use) by applying risk-ranking matrices.

7. EVALUATION OF TECHNOLOGY OPTIONS

The technology options selected from the screening analysis were subjected to quantitative probabilistic risk assessment, using Goldsim:

- 300 mm thick topsoil and limited slope modification (side slopes about 27°)
- 300 mm thick armour cover and limited slope modification (side slopes about 22°). Vertical spacing between benches 30 to 40 m
- 300 mm thick armour cover at a side slope of 18°and vertical spacing between benches of about 9 m. Benches were assumed to be 7 m wide.
- 250 to 300 mm thick waste rock cover with no slope modification
- Application of care and maintenance to a situation with no slope modification and limited topsoil cover, varying between 75 to 150 mm.

The above analyses indicated that the armour cover on slope angles between 22 degrees and 18 degrees to be the most feasible. Hence, these options were subjected to detailed cost estimates. However, the option related to rock cladding was also included in the cost analysis for completeness.

8. CONCLUSION

A risk-based approach was followed to aid in the selection of the final land use and associated cover (including slope modification). Risk assessments were conducted at screening and quantitative levels.

It is believed that the information derived from the risk assessments facilitated informed decision-making. Regulatory buy-in was obtained for a closure strategy aimed at wilderness as final land use.

The wilderness land use will be supported by slope modifications at angles between 18 degrees to 20 degrees with an armour cover of 300 mm thickness. Benches will be 5 m wide at a vertical spacing of 13 m.