



KHUMANI PASTE DISPOSAL FACILITY



INDEPENDENT TAILINGS REVIEW REPORT No 3

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EXECUTIVE SUMMARY

The objectives of the review were to assess whether the Khumani PDF can be operated safely and effectively, have minimal risk to local communities and the environment, and meet applicable regulatory requirements, South African standards, and emerging international norms. Conformance to the Assmang management standard was also assessed.

This report builds on the review undertaken during 2021. A site visit was conducted, and key documents have been reviewed. The most recent investigations and conformance assessments were presented to the reviewer by the Engineer of Record and a 'reasonableness of results' check on key analyses, design values, and conclusions has been done. Independent calculations have not been done. Reliance has been placed on experience to confirm the "reasonability of results" or to question the results if a discrepancy has been detected.

The findings for the three objectives of the review are as follows:

Can the TSF be operated safely and effectively? The Khumani PDF as designed, can be operated safely and effectively for its remaining design life. The design has been optimized and is robust against reasonably expected deviations in environmental conditions, plant throughput and tailings properties. Monitoring and surveillance are done to a high standard and hence any deviation in performance from the design should be detected early enough to implement remedial action.

Does the TSF have minimal risk for communities and the environment? The design of the facility provides for adequate protection of present and potentially exposed communities and the environment.

Does the TSF design meet local and international standards? The design fully complies with South African regulations and standards. The design and operations comply with international norms and the Assmang Management Standard.

Recommendations for optimization, risk mitigation and governance improvements. Recommendations for improvement have been made in the body of the report. These recommendations would, if implemented, bring about improved consistency and reliability.

1.0 INTRODUCTION

This report presents the findings of the Independent Tailings Review Board (ITRB) review of the Tailings Storage Facilities (TSFs) at the Assmang Khumani Mine near Kathu in the Northern Cape. The members of the ITRB, John Wates and Danie Brink visited the mine on 28 November 2022. An inspection of the TSFs was carried out by the ITRB accompanied by Sindie Esterhuizen (RTFE) and Eli Visser of Assmang, and Thomas Abbott and Lenny Gregan of Stefanutti Stocks, the Operating Contractors. After the site inspection, presentations were made by the Mine and by the EoR, Guillaume De Swardt of Geotail assisted by Thomas O'Brien from ARQ, who will be taking over the role of EoR in two years' time.

The objectives of the review were to assess whether the TSFs:

- Are operated safely and effectively
- Have minimal risk to local communities and the environment
- Meet applicable local government and international standards, and
- Can be optimized in terms of better risk mitigation and/or governance improvements.

The review has been based on a benchmark that has been developed out of experience of the norms and standards that apply locally as well as those that are evolving across the globe.

2.0 BENCHMARK AND SCOPE OF REVIEW

While there is no one definitive standard for "good practice", in South Africa there is a South African National Standard (SANS 10286), regulations and learned publications that together establish a substantial body of knowledge that is applied in Southern Africa. The Assmang Management Standard has been published in the past year and this captures the essence of international "good practice".

The Assmang Management standard has been based on the Global Industry Standard for Tailings Management (GISTM) which was published in August 2020 and provides an important additional dimension to international standards going forward.

In the context of these benchmarks, the ITRB provides a high-level view on several aspects which included, but are not limited to:

- Implementation of the corporate tailings management standard
- internal and external appointments

- risk ranking and prioritize recommendations from the review
- operation specific documentation and requirements
- the design intent, as-built design, and operational requirements
- status of the TSF based on observations and inputs provided by the EoR and RTFE
- status of the design basis report, consequence classification and corresponding design criteria
- identification of deviances and risks posed

The work is carried out at a review level. As such the design reports, baseline and specialist studies and drawings are examined and 'reasonableness of results' checks done on key analyses, design values, and conclusions. The design is reviewed at a level sufficient to develop an independent opinion of the adequacy and efficiency of the design and life of facility plan. Reliance is placed on the documentation and representations made by the Mine personnel, the Contractor, and the Engineer of Record. This level of review is typical of what would be done by an Independent Tailings Review Board (ITRB). Such boards, serve the purpose of identifying particularly high consequence low probability risks (that is those that are not immediately obvious) and guide the mining operations to mitigate the risks identified.

3.0 2022 ITRB RECOMMENDATIONS

The 2022 ITRB recommendations have been assigned priorities P1 to P4 in accordance with the criteria set out in Table 4.1 below. Note that only the recommendations dealing with identified risks and governance issues have been assigned priorities. Recommendations related to good practice considerations are contained within the relevant sections of the report with the view of providing guidance to the EoR and the Mine and have not been assigned priorities.

PRIORITY	INTEGRITY	ACTIONS
1	A dam safety issue considered immediately dangerous to life, health or the environment, or a significant risk of regulatory enforcement.	Priority 1 recommendations requires immediate action. Action and time frames agreed with AE
2	If not corrected, a concern that could result in a dam safety issue leading to injury, health impact or discontinuity of operations	Priority 2 recommendations require immediate planning and completion by a date specified by operations
3	Single occurrence of deficiency or non-conformance that alone would not be expected to result in dam safety issues, discontinuity of operations or regulatory intervention.	Priority 3 recommendations require action by a date that would prevent escalation
4	A recommendation based on good practice improvement or risk reduction.	Priority 4 recommendations may be scheduled at the discretion of site operations considering its resources

4.0 GENERAL OBSERVATIONS FROM SITE INSPECTION

The observations that were made during the site inspection follow. These observations were not confirmed by consultation with documentation and should therefore be taken to be the as observed impression of the facility.

4.1. Safety

The safety standards were found to be high and were adhered to during the inspection.

4.2. General impression

The overall impression of the facility was that it was well managed and neat. Housekeeping was of a very high standard.

4.3. Operational conformance

The operations were observed to conform to the prescribed requirements.

4.4. Monitoring

Instrumentation and access have been well maintained.

4.5. Teamwork

The team was found to be motivated and combined well to provide open and transparent feedback to the ITRB.

5.0 SPECIFIC OBSERVATIONS FROM SITE INSPECTION

5.1. Water recovery

Water recovery from the active compartments, and specifically from Compartment 3B, does not appear to be optimal as beach formation is relatively flat, resulting in pools which are not consistently centered around the barge pump inlets. The following measures are proposed by the EoR and the Operating Contractor:

- Introduction of Turret intake devices which will allow the intake of water at shallow depth;
- Experimenting with spray-bar deposition in Compartment 3B to improve beach formation.

The ITRB supports the proposed measures.

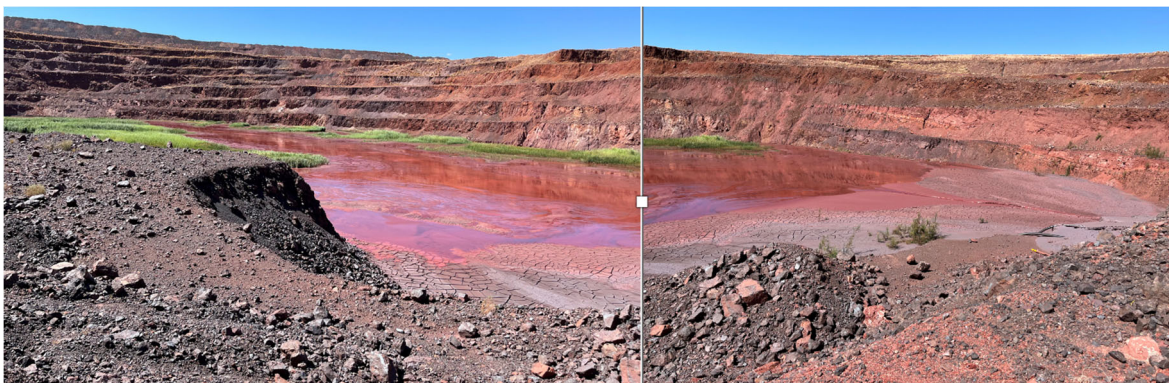


Photo 1: Deposition in Compartment 3B

5.2. Side-slope rehabilitation

It was noted that vegetation has established on the waste rock starter wall and no erosion is evident. It is understood that vegetation trials are planned for the rehabilitation of the paste side-slopes. The trials will include a section with topsoil and a section in which the vegetation will be established directly into the paste.

The ITRB recommends that consideration be given to mixing in waste rock into the topsoil or paste to provide a more erosion resistant surface, as it will be difficult to achieve a dense vegetation cover in such an arid climate area.



Photo 2: Vegetation cover on waste rock starter wall

5.3. Wall-building methodology

The Operating Contractor confirmed that the wall raises on the paste walls are carried out by scraping up a thin layer of tailings over a width of about 20m adjacent to the outer wall and that no trenching is done adjacent to the wall.

The ITRB supports this methodology.

5.4. Sinkhole formation

The sinkhole that formed in the south-east corner of Compartment 1, adjacent to Compartment 3A, was backfilled with gravelly material. No signs of subsidence of the backfill was noted and it was also noted that the basin of Compartment 1 was now covered with a layer of paste.



Photo 3: Backfilled sinkhole

The Mine appointed Jones and Wagener Consulting Engineers to prepare a Dolomite Risk Management Plan (DRMP) for the paste disposal facility. The Mine confirmed that they have implemented the maintenance and monitoring requirements as recommended in the DRMP.

The ITRB recommends that the possibility and consequence of reactivation of the sinkhole should be assessed with a view to reopening access to the division wall.

6.0 REVIEW FINDINGS: TECHNICAL

6.1. Classification

The TSF has been classified as “Very High” Hazard in terms of the Assmang Management standard and GISTM. A comprehensive and rigorous dam break analysis has been conducted to define the inundation zone.

The ITRB concurs with the classification.

6.2. Life of facility plan

The life of the facility has been well defined and quantified. The life of facility plan forms the basis for the operating, maintenance and surveillance manual and code of practice and conformance to the plan requirements is verified by the EoR on an annual basis.

The ITRB is satisfied that the life of facility plan is adequate.

6.3. Tailings characterisation

The tailings properties assumed for design have been documented. Subsequent testing has been conducted and the report on this testing confirms that that the tailings characteristics accord with the design assumptions. As part of the liquefaction study being carried out by ARQ, further sampling of the tailings has been carried out and laboratory testing is being carried out.

The ITRB is satisfied that the testing that has been carried out as well as the testing that is in progress will be adequate for the intended purpose.

6.4. Slope stability

The latest CPTu tests as well as the Vibrating Wire Piezometers that have been installed indicate no phreatic surface in the outer wall zone of the facility, although some of the CPTu tests showed a dynamic response in pore pressure, which could indicate a high degree of saturation.

The conventional limit equilibrium stability analyses carried out by the EoR indicate factors of safety for the facility at its current elevation that satisfy the current South African, the Assmang Management Standard and international standard of 1.5 for drained parameters.

ARQ has been appointed to carry out a liquefaction assessment for the facility. The work is well advanced, and it is understood that it is likely that the assessment will indicate that the required undrained factors of safety are met.

It is also understood that it is planned to install instrumentation to monitor the degree of saturation of the paste in the wall zone of the facility.

The ITRB recommends that future investigative work should focus on defining the desaturated prism and proving that it remains partially saturated and non-liquifiable – Priority 2.

6.5. Rate of rise

The maximum allowable rate of rise adopted for the design for raising Compartments 1 and 2 above 1228m is one meter per annum. This limit has been based on experience with the type of raising method and similar tailings. The current rates of rise for Compartments 1,2 and 3A are substantially below one meter per annum.

The ITRB is satisfied that the rate of rise is within acceptable limits.

6.6. Freeboard

The total minimum freeboard prescribed by South African regulations is being met and exceeded with ease. The facility has been shown to be capable of retaining the probable maximum precipitation (PMP).

The ITRB is satisfied that the freeboard is currently adequate. The risk of overtopping is very low.

6.7. Overall finding

In its current form the Khumani facility meets the highest standards of safety and if managed to maintain the safety limits that have been set will continue to remain safe. The mine operational personnel, the Engineer of Record and Operator's role in maintaining the standards is to be commended.

7.0 REVIEW FINDINGS: GOVERNANCE

7.1. Previous ITRB recommendations

Progress on 2021 ITRB recommendations was presented by the RTFE. Previous recommendations have been well addressed and progress is documented. Assurance needs to be provided to Assmang by the ITRB that recommendations have been adequately addressed and closed out.

ITRB close out on recommendations to be captured in data base – Priority 3

7.2. Operation

The operations appear to be run in conformance with the design requirements. The Operator demonstrated a good understanding of the requirements and documentation provided showed that there is high level of conformance. The mine personnel responsible

for oversight also demonstrated an effective working relationship with the Operator and provide the necessary resources and support for the operation.

Provided that the monitoring and risk management system is implemented consistently there is no reason to believe that an unwanted operational situation will develop without detection.

The ITRB is satisfied that the operations conform to the required standards of governance.

7.3. Management system

The management system implementation conforms to the Assmang Management standard and was found to be adequate. The following specific findings are highlighted:

- The OMS manual has been updated during 2022.
- The design that is on record is a concept design. It was reported that the EoR is currently compiling a Continuation Report that will document design criteria, a Construction vs Design Verification report, a Construction Records report and a Design Changes report.
- The RTFE reported that the Mine is in the process of setting up a formal Change Management system and that it will be implemented early in 2023.
- The management system is to be audited externally every 2nd year. The management system should be audited against the following key requirements:
 - Is the management system documented;
 - Is the scope and content of the management system adequate;
 - Is the management system implemented and functioning;
 - Are there any non-conformances.

The OMS manual to be reviewed by ITRB to assess conformance to International Best Practice – Priority 4

The management system to be reviewed for conformance to the key requirements – Priority 4:

7.4. Conformance Assessment and Review

The format of the 2022 Annual Performance review by the EoR has been expanded to cover a conformance assessment of Operational and Management systems. The July 2022 conformance assessment report was reviewed and was found to cover the required scope.

7.5. EoR Handover

Thomas O'Brien of ARQ will be replacing Guillaume de Swardt of GeoTail SA as the EoR. It was agreed with the Mine that it will be a phased transition with Guillaume remaining available to support the new EoR for a three year period. Thomas is currently responsible for the Liquefaction Study and stability assessment which is in progress which provides him with the ideal background to take over the role of EoR.

The ITRB is satisfied with the phased hand-over process.

7.6. Monitoring

The monitoring is done to the requisite standard. A number of VWP's are being installed to supplement the existing stand-pipe piezometers. It was also reported by the EoR that it is planned to install instrumentation to measure the degree of saturation in the upstream prism that provides support to the weak tailings.

The InSAR data and the interpretation of trends for tracking the subsidence was found to be of particular interest. The interpretation of deformation trends of the outer slopes is very useful.

The ITRB recommends that instrumentation be installed, or sampling and testing be carried out to monitor the degree of saturation in the upstream prism – Priority 2.

7.7. Risk Assessment

The GISTM requires the mine to address all potential failure modes of the TSF, its foundation, abutments, reservoir (tailings deposit and pond), reservoir rim and appurtenant structures. A comprehensive risk assessment supported by subject matter experts is required to inform design, demonstrate that the design achieves risk levels that are as low as reasonably practicable (ALARP) and defines the credible failure modes that inform the inundation study.

The EoR has documented a thorough risk assessment in the annual conformance assessment report (Annual Performance Review dated July 2022). The assessment covers

a description of credible failure modes, the likely consequence of each failure mode, the probability of each failure mode occurring and a semi-quantitative risk rating of each failure mode.

The ITRB recommends that the Risk Assessment be enhanced with the documentation of the justification of adopted consequences and probabilities – Priority 3

7.8. Reporting

Khumani has demonstrated through the documentation provided and representations that a high level of reporting governance is in place. The Khumani management was found to understand the nature of the risks and the importance of managing the risks.

The format of reporting to the Accountable Executive (AE) and the board was reviewed after the site visit and it was agreed that the dashboard should be revised to cover conformance to the six critical controls as set out in the Assmang Management standard.

The ITRB recommends re-structuring the format of the Executive dashboard to cover conformance to the six critical controls – Priority 3

The ITRB commends the presentation of the Annual Performance review to the AE by the EoR.

7.9. Road map to GISTM compliance

The Mine presented progress on compliance to GISTM which is due for August 2023. To achieve compliance by the due date will be challenging and will require focused attention by the Mine, the RTFE and the EoR. One of the outstanding actions is carrying out a Dam Safety Review (DSR). To achieve compliance, it will be required to have at least scheduled a DSR with a service provider by August 2023.

A DSR to be scheduled by August 2023 – Priority 3.

8.0 CONCLUSIONS

The review has confirmed that the Khumani PDF can be operated safely and effectively as designed. The design provides for an adequate level of reliability and robustness to protect present and potentially future exposed communities and the environment. The design and operation conform to local standards and laws.

Management of the facility is being done to a high standard and the level of conformance assessment and auditing is world class.

No significant risks were identified during the review.

The ITRB was impressed with the commitment and collaboration between team members. The appointment of a dedicated RTFE has contributed significantly to the successful implementation of the Assmang Management system.



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