Appendix C
Site Selection Report

GCS
Water & Environmental
Consultants

November 2016

Draft

REPORT

ANGLOGOLD ASHANTI LTD. - VAAL RIVER OPERATIONS

Project Charter for the Expansion of the Kareerand Tailings Storage Facility

Submitted to:
PO Box 8044
Western Levels
Gauteng
2501

Report Number: 1535687-308423-1

Distribution:

1 x copy to AngloGold Ashanti Ltd.
1 x electronic copy to ProjectReports@golder.co.za

Golder Associates

Record of Issue

Company	Client Contact	Version	Date Issued	Method of Delivery
AngloGold Ashanti	Duncan McArthur Charl Human	Draft	16 November 2016	Electronic and hard copy

Executive Summary

The sustainability of the Mine Waste Solutions (MWS) operations in the Klerksdorp area depend on having access a tailings storage facility (TSF) that can accommodate the tailings derived from re-mining of the full reserve of 566 Mt. The operations are currently served by the Kareerand TSF where the capacity is limited to 352 Mt. This capacity is expected to be depleted by 2025 at the current processing rate of 28,47 Mt per annum. A new TSF is therefore required for the balance of the reserve. The start date for deposition of one (10.7 m tons per year) of the three tailings streams onto the Kareerand TSF expansion is February 2021. The other two tailings streams would then continue to be deposited on the current Kareerand TSF until April 2025 at which time the full tonnage will be deposited onto Kareerand Expansion. This proposed approach will allow AGA to have a staged approach to expansion to spread out capital cash flow.

The most significant cost element for a new TSF is the lining that has been prescribed by the 2013 regulations published in terms of the National Environmental Management: Waste Act, notably GN R. 634 to GN R. 636 relevant to *Waste Classification and Management, National Norms and Standards for the Assessment of Waste for Landfill Disposal and National Norms and Standards for Disposal of Waste to Landfill*.

The cost of lining depends on the waste assessment and classification but is expected to be R1M/hectare for the assumed type of waste. The area required for a new facility could as large as 800 hectares. Golder has been advised that the additional cost of R800M required for lining will impact negatively on the feasibility of extending the life of the current re-mining operations and could lead to postponement or abandonment of the operations. AngloGold Ashanti have therefore requested Golder to assess whether a liner is technically justified and, if not, to propose a way forward to motivate an alternative to lining to the regulatory authority

This report examines alternative sites that might be viable and narrows the selection down to the two most favourable options. These two most viable options are as follows:

Option 3: North of the existing MWS tailings facilities and located on dolomites; and

Option 4/7: West of and adjacent to the current Kareerand TSF and located off the dolomites.

The above options were selected since they rated best and both have the potential to be technically feasible without liners. They are however quite different insofar as the seepage interception measures that would be required to mitigate groundwater impacts. Option 3 will rely on the assumption that all seepage will gravitate downward into the dolomites and will be intercepted by dewatering from Margaret Shaft. No known sources of current groundwater use will thus be affected and expressions of seepage on surface will be prevented. Option 4/7 will rely on the assumption that a seepage interception curtain down gradient from the facility will effectively intercept most of the seepage. No ground water users will be impacted and the seepage will be intercepted before reaching the Vaal River.

Under the current regulatory regime there are challenges associated with licensing and developing new tailings storage facilities without liners since the mine must demonstrate to the regulator that the proposed alternative is as effective if not more effective than a liner (Class C barrier). This can only be done if the justification is based on credible knowledge of the groundwater regime and must be supported by modelling to demonstrate that an adequate level of protection can be achieved with the proposed mitigation measures in place. It is also necessary to present DWS with a lined base case (Class C barrier) against which the alternatives can be compared.

This report maps out the following process in order to justify an alternative:

- Carry out baseline hydrogeological and geotechnical investigations on the two candidate sites;
- Prepare prefeasibility level designs for the base case on site 4/7 (with a liner), for site 3 without a liner and for site 4/7 without a liner;
- Model the groundwater impacts for all three cases;

- Confirm the preferred option;
- Present the options and justification to the regulators; and
- Proceed to feasibility with the alternative options.

The Department of Environmental Affairs has recently indicated to the Chamber of mines that mining waste is to be excluded from the definition of waste in terms of the National Environmental Management: Waste Act and its regulations. The legal prescription of liners for mine tailings facilities would therefore fall away. Although this may take place shortly it will not necessarily mean that the competent authority will approve of an unlined site without justification. The seepage that is currently arising from the existing Kareerand TSF will provide the basis for the argument that a liner is required and that without one, the ground and surface water will be further threatened by an extended footprint. An alternative will therefore still need to be strongly motivated. It is therefore prudent to proceed as proposed above irrespective of what the outcome of the change to the Act or applicable regulations may be.

Golder has developed a roadmap for the implementation of the Kareerand TSF Expansion. It is proposed that further technical investigations be conducted on the preferred alternative options and that regulatory consultation takes place to confirm that the alternatives are viable. Further engineering, specialist investigation and integrated regulatory processes can be initiated to develop the Kareerand TSF expansion.

Table of Contents

TABLES

FIGURES

APPENDICES

APPENDIX A
Site selection process maps

APPENDIX B
CONCEPTUAL LAYOUTS OF OPTIONAL SCHEMES

APPENDIX C
SCHEDULES OF QUANTITES OF OPTIONAL SCHEMES

APPENDIX D

Document Limitations

1.0 INTRODUCTION AND BACKGROUND

Gold mining with associated uranium mining has been carried out in the Klerksdorp, Orkney, Stilfontein, Hartebeestfontein (KOSH) area for many decades. The original gold mining operations were mainly conducted as underground mining operations. This has resulted in the development of large surface tailings residue deposits.

AngloGold Ashanti (AGA), as part of the long term business plan has developed a strategy for the re-mining and reclamation of surface tailings resources and processing through the Mine Waste Solutions (MWS) gold plant. Tailings and residues would continue to be disposed to the Kareerand Tailings Storage Facility (TSF).

The combination of AGA, Buffelsfontein and MWS re-mining and reclamation surface tailings resources opened the opportunity to also develop integrated water supply, reclaimed tailings conveyance, processing plant and tailings dam infrastructure.

AngloGold Ashanti (AGA) will continue with the underground mining operations, especially to the south of the Vaal River. To the north of the Vaal River, Mine Waste Solutions (now owned by AGA) will continue to re-mine substantial dormant tailings deposits.

At present all reclamation operations delivers tailings to three separate gold plants located in the north at the site of the original Mine Waste Solutions plant. Water is distributed from Midway sump to three separate reclamation operations. Each delivering to a dedicated gold plant at Mine Waste Solutions. Mine Waste Solutions gold plant #1 (MWS 1) receives slurried tailings from the Hartebeesfontein Complex. Mine Waste Solutions gold plant # 2 (MWS 2) receives slurried tailings from Buffelsfontein Compartment #4. Slurried tailings from the reclamation operation at sulphur pay dam is currently pumped to the tailings sump at Buffelsfontein Compartment 2, from where it is pumped to Mine Waste Solutions gold plant # 3 (MWS 3).

Tailings from the Mine Waste Solutions gold plant are conveyed through a pumping scheme to the Kareerand TSF and the TSF return water system allows for collection, conveyance and storage to a central facility (Midway Dam) and distribution back to the re-mining sites.

The Kareerand TSF is currently authorised by Water Use Licence (number 27087241) dated 11 June 2010 (hereafter referred to as the WUL). The licence was issued by the Department of Water and Sanitation (DWS) to Chemwes (Pty) Ltd in terms of Chapter 4 of the National Water Act, 1998. AGA currently produces 28,47 Mt per annum and the expected life of mine for the remaining reclamation process is until 2045.

The existing Kareerand TSF has a remaining storage capacity to accommodate the full tonnage profile until February 2021 and thereafter tailings depositioning will have to be decreased and ultimately ceased during 2025. AGA has to ensure that the operation of the Kareerand TSF does not to exceed the allowable rate-of-rise and further meet the closure design requirements.

The management of AGA and Mine Waste Solutions (MWS) decided during 2016 to initiate the planning for the expansion of the current Kareerand TSF and proactively launched the development of a Project Charter, which includes a pre-feasibility step, due to challenging timeline requirements to permit, design and implement the planned expansion project.

Golder Associates Africa (Pty.) Ltd. has been appointed by AGA to develop a Project Charter for the expansion of the current Kareerand TSF, which includes assistance with an Integrated Regulatory Process (IRP) and the Engineering Concept Development (ECD) for the planned new facility.

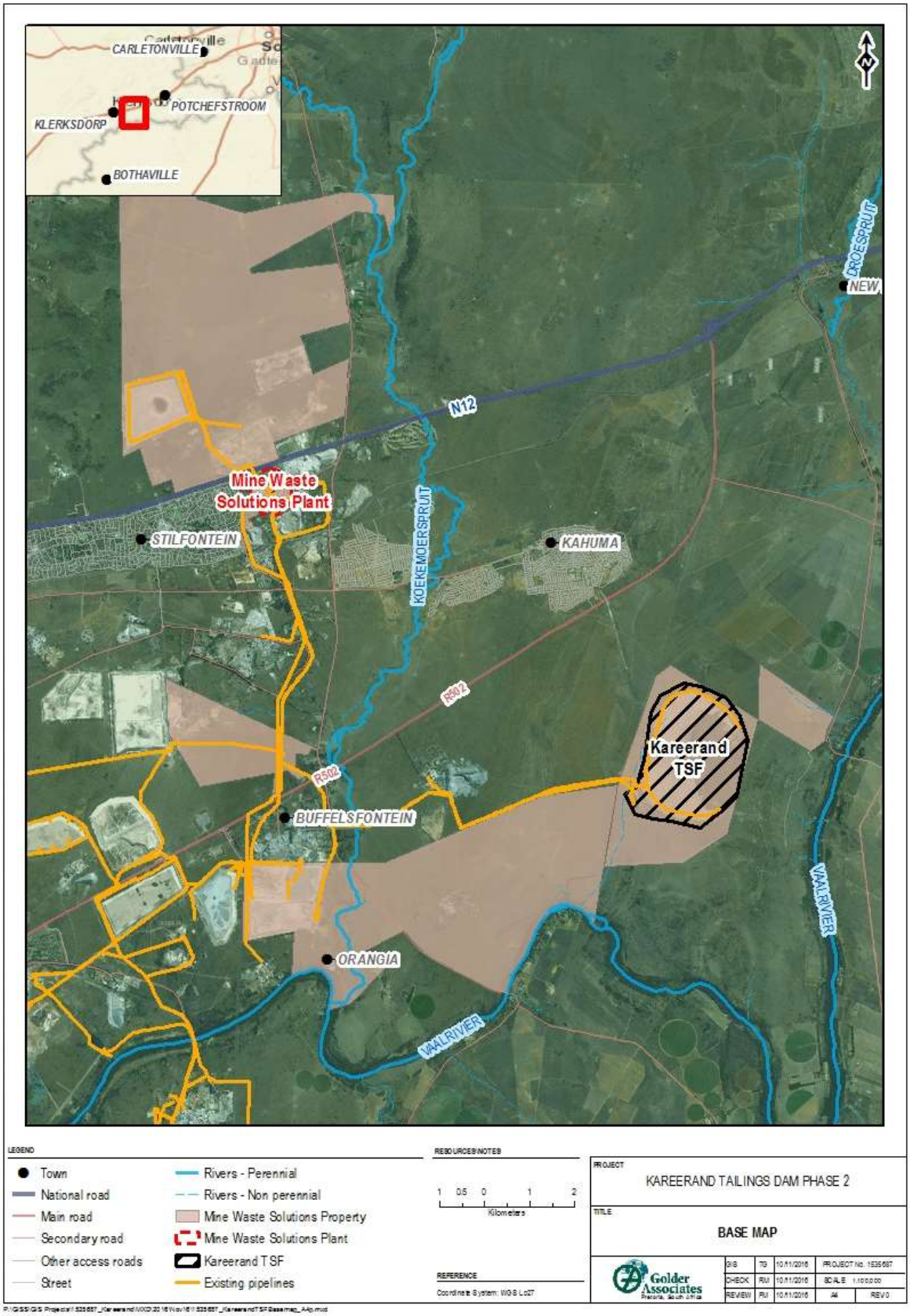


Figure 1: Location of MWS plant, re-mining operational infrastructure and current Kareerand TSF

2.0 PURPOSE OF THE PROJECT AND KEY STUDY OBJECTIVES

During June 2016 Golder submitted a proposal to position the AGA Vaal River Operations for the implementation of a large new TSF facility based on developing a second phase to the existing Kareerand TSF. This requires upfront consideration of technical, engineering, financial and regulatory approval aspects at a strategic level. The proposed development of a Project Charter included the following aspects related to the expansion of the Kareerand TSF:

- Develop an Integrated Regulatory Process (IRP) approach and road map for the new TSF outlining the regulatory process;
- Determine the scope of work for any technical and specialist investigations needed to inform the IRP, site selection, Engineering Concept Design and any follow-up/future feasibility process; and
- Develop a conceptual engineering approach for the TSF through a concept engineering design. A pre-feasibility step of preferred options and alternative implementation models for the TSF and a high level (order of magnitude) costing for the facility.

3.0 SCOPE OF WORK AND OVERALL PROJECT SCHEDULE REQUIREMENTS

The scope of work to develop a Project Charter for the Kareerand TSF Expansion project entailed the following:

Project initiation workshop and site visit

This involved a project initiation meeting and workshop between environmental and engineering teams of AGA and the Golder. During this workshop the environmental and engineering requirements and project scope was defined in order to inform the engineering design, site selection and regulatory approval and technical assessment process. Aspects such as the planned life of the project, engineering concepts for alternative tailings dam construction, footprint area, waste characterisation of tailings and liner requirements were discussed. The workshop was concluded with a site reconnaissance to familiarise all team members with the project area. This workshop also facilitated information gathering of available information which informed the project.

Site selection

The process to conduct a site selection for the Kareerand TSF Expansion was not included in the original scope of work, but it was necessary to conduct a high level site selection process prior to development of the conceptual engineering design for the TSF.

Document review and gap analysis of available information

Golder reviewed existing technical and environmental baseline reports to determine the quality and extent of available information related to the project area. Technical and environmental baseline information relevant to the proposed project site was used for the development of the Integrated Regulatory Process and the identification of potential TSF sites. The outcome of the gap analysis on the technical and environmental baseline information defines the magnitude and extent of specialist work required during the IRP.

Develop project specific Integrated Regulatory Process

It was proposed that a site-specific Integrated Regulatory Process (IRP) be developed taking into consideration various environmental Acts and Regulations applicable to the proposed TSF project and the authorisations required.

Engineering and technical approach

It was proposed that the concept engineering designs would utilise the recently completed waste assessment and characterisation of the waste streams as a critical parameter impacting on engineering design and regulatory approval.

The concept engineering design would be informed by the outcomes of the project initiation workshop, on aspects such as the tailings processing capacity of MWS, engineering concepts for alternative tailings dam construction and operation; footprint area and liner requirements.

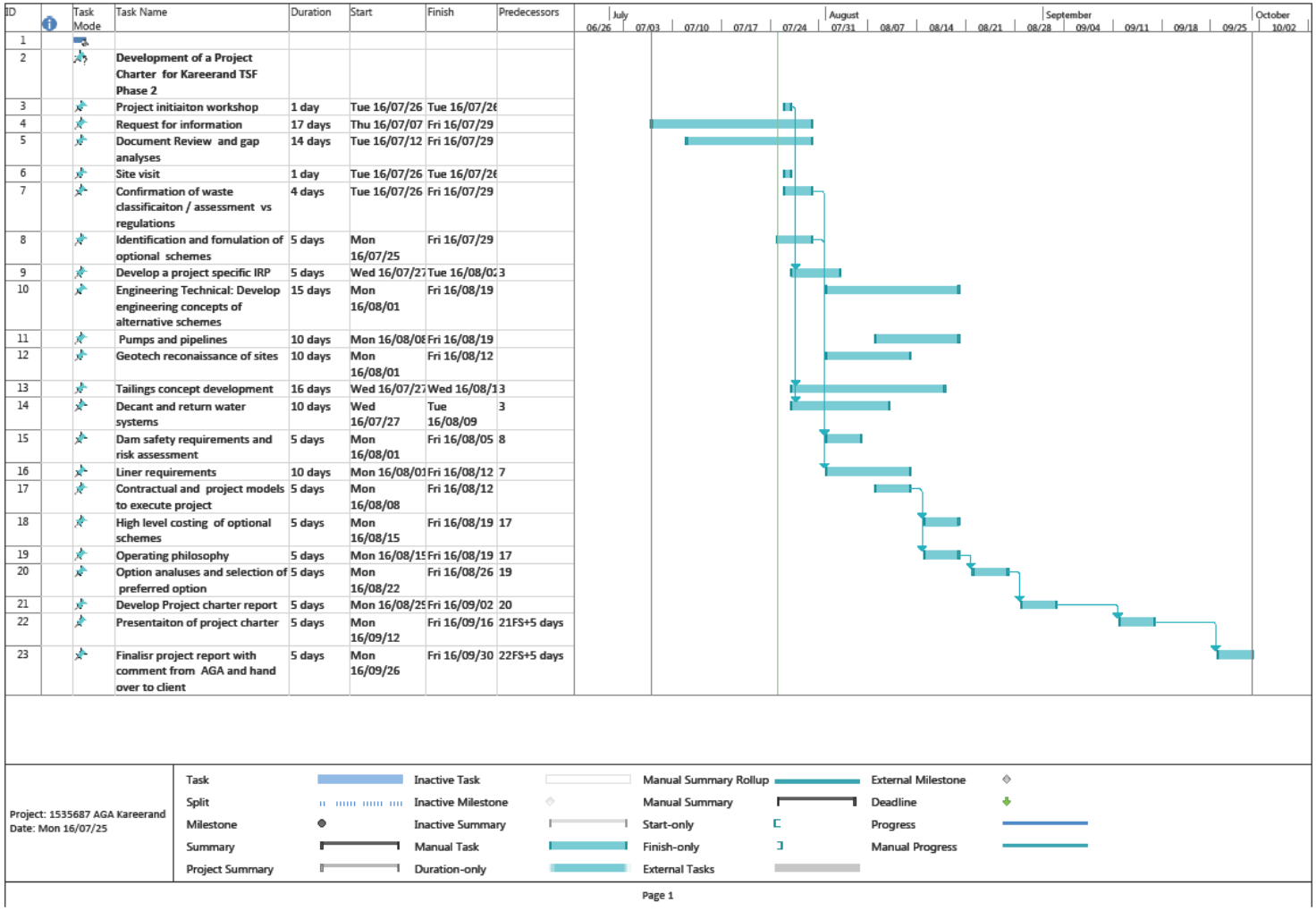
The following key items form the basis of a conceptual engineering/technical development scope of work;

- Pumps and pipelines (Tailings delivery system) from Midway Dam (Project battery limit);
- Geotechnical reconnaissance to confirm site for TSF;
- Tailings concept development taking key engineering and operational aspects into account i.e. Rate of rise, deposition rates, Outer side slopes, stability aspect, water management, leachate management and a stage capacity analysis to analyse the footprint size and storage capacity of the facility;
- Return water system and decant system on the new TSF, including the sizing of the return water pump pipelines;
- Dam safety requirements will include a professional opinion from a registered Dam Safety Engineer within Golder will be sourced to confirm the concept development and water management strategy, due to water needing to be stored on the Kareerand TSF Expansion project;
- Evaluate the existing TSF deposition / operations methodology and record lessons learnt and modification requirements which would be applicable for the new TSF;
- Liner requirements evaluated in terms of regulatory requirements, focusing on the findings of the waste assessment of the tailings, evaluation of the natural barrier system, ground water flow pathways, sensitivity of receptors, introduction of an engineered barrier system and a trade-off applying a risk based approach;
- Contractual / project models to implement the scheme will be proposed;
- Operating philosophy for Kareerand TSF Expansion project, which will include the roles and responsibilities of the operator, contractor and owner; and
- High level cost estimates.

It was proposed that the deliverable for this project would be a Project Charter which would include the IRP map, scope of work for environmental specialist studies to inform the authorisation process and concept engineering design process, conceptual engineering design and alternative implementation models for the TSF and a pre-feasibility level, to Order of Magnitude level of accuracy) costing for the facility.

No project schedule was included in the proposal. The schedule, as indicated in Figure 1, was drafted upon appointment and presented to AGA during the project initiation workshop on 26 July 2016. It was agreed during the workshop that the due date for submission could be adjusted to 30 October 2016.

This extension of time was required and approved due to the fact that Golder investigated more than one preferred option.



ID	Task Mode	Task Name	Duration	Start	Finish	Predecessors
1						
2		**Development of a Project Charter for Kareerand TSF Phase 2**				
3		Project initiaiton workshop	1 day	Tue 16/07/26	Tue 16/07/26	
4		Request for information	17 days	Thu 16/07/07	Fri 16/07/29	
5		Document Review and gap analyses	14 days	Tue 16/07/12	Fri 16/07/29	
6		Site visit	1 day	Tue 16/07/26	Tue 16/07/26	
7		Confirmation of waste classificaiton / assessment vs regulations	4 days	Tue 16/07/26	Fri 16/07/29	
8		Identification and fomulation of optional schemes	5 days	Mon 16/07/25	Fri 16/07/29	
9		Develop a project specific IRP	5 days	Wed 16/07/27	Tue 16/08/02	3
10		Engineering Technical: Develop engineering concepts of alternative schemes	15 days	Mon 16/08/01	Fri 16/08/19	
11		Pumps and pipelines	10 days	Mon 16/08/08	Fri 16/08/19	
12		Geotech reconaissance of sites	10 days	Mon 16/08/01	Fri 16/08/12	
13		Tailings concept development	16 days	Wed 16/07/27	Wed 16/08/13	
14		Decant and return water systems	10 days	Wed 16/07/27	Tue 16/08/09	3
15		Dam safety requirements and risk assessment	5 days	Mon 16/08/01	Fri 16/08/05	8
16		Liner requirements	10 days	Mon 16/08/01	Fri 16/08/12	7
17		Contractual and project models to execute project	5 days	Mon 16/08/08	Fri 16/08/12	
18		High level costing of optional schemes	5 days	Mon 16/08/15	Fri 16/08/19	17
19		Operating philosophy	5 days	Mon 16/08/15	Fri 16/08/19	17
20		Option analuses and selection of preferred option	5 days	Mon 16/08/22	Fri 16/08/26	19
21		Develop Project charter report	5 days	Mon 16/08/29	Fri 16/09/02	20
22		Presentaiton of project charter	5 days	Mon 16/09/12	Fri 16/09/16	21FS+5 days
23		Finalisr project report with comment from AGA and hand over to client	5 days	Mon 16/09/26	Fri 16/09/30	22FS+5 days

Figure 2: Kareerand TSF Expansion Project Schedule

4.0 PRE-AWARD MEETING WITH AGA TO AGREE TERMS OF REFERENCE

On 27 June 2016 a high level meeting was held between AGA and Golder, prior to the formal project initiation meeting, in order to ensure that the project deliverables meet client expectations.

The following key aspects were discussed during the meeting:

- AGA has not constructed a new TSF in recent years and the existing Kareerand TSF was an “inherited” facility, purchased as part of the MWS agreement;
- The current Kareerand TSF is under pressure due to increased deposition rates and the timing of the project for the TSF expansion is of the utmost importance;
- AGA was part of the discussions held between the Chamber of Mines (CoM) and the Director General of the Department of Water and Sanitation (DWS) during June 2016 during which an in principle agreement was reached for following a risk based approach for lining of mine residue disposal facilities;
- AGA has experience with a lined mega tailing facility where the reverse filter system blocked within 24 months of commissioning of the facility;
- AGA has reviewed their project standards and expects the project to align to AGA stage gates;
- AGA has a structured review process and a team of people will review the Project Charter. It was stated that AGA would make available their draft improved guideline;
- AGA tabled their request for Golder to not only develop an engineering concept but to take the process to a pre-feasibility level. AGA stated that they would like to have a fully implementable design at the end of the pre-feasibility stage. This requirement was re-visited again during follow up discussions and AGA agreed to a high level pre-feasibility study with order of magnitude costing;
- Associated with this request is the requirement to also prove site selection at the end of the pre-feasibility level. Golder was therefore tasked to also include the site selection process into the project charter development;
- The due date for commissioning of the new TSF was set as February 2021. At that stage one of the three waste streams deposited onto the current Kareerand TSF could be split off to the Kareerand TSF expansion;
- AGA committed to supply all the required background information to inform the project;
- AGA clearly articulated the requirement to design the TSF for closure;
- Borrowed material will be assessed for use either during operational and/or closure phase;
- The battery limit specified for the TSF return water system was set as the MWS plant;
- AGA stated that high level order of magnitude costing with an accuracy of $\pm$25% would be acceptable; and
- A trade-off between the existing pipeline and new pipeline should be included.

During the meeting the client’s brief emphasized recent discussions with the Regulator related to the mine waste regulations; and the implication thereof for the lining of mine residue disposal facilities, the need to include a trade-off and pre-feasibility step within the project charter and the road map to implement the entire project.

Golder committed to identify, formulate and compare other engineering barrier systems versus the compliant design which could be used by AGA for motivation to the Minister for the Kareerand TSF expansion. After this meeting Golder re-submitted a final proposal and project budget, including a project timeline.

5.0 INFORMATION REQUIREMENTS AND REVIEW THEREOF WITHIN THE PROJECT STUDY AREA

In order to facilitate the effective execution of the project, an introductory meeting was held on 27 June 2016 at AGA West Wits Operations. During this meeting a decision was made that Golder would compile a request for information which will inform the scope of work and the effective execution of the project. The request was sent to AGA on 7 July 2016 and a memorandum is compiled to reflect the status of the information as received from AGA.

Based upon initial discussion and the scope of work outlined in the proposal the following information was requested and subsequently provided by AGA.

Table 1: Information required and provided to inform the Project Charter development.

Required information:	Status of information received
1) Survey data, 0.5 m to 1.0 m contours of the Kareerand TSF area and areas adjacent, where the new TSF is proposed;	Survey data was received.
2) Maps of the possible brown field areas where TSF developments could be pursued as alternatives to a green field site;	Map of Chemwes properties and GCS report on preliminary site selection provided.
3) AGA mine lease areas and legal boundaries within the: • Kareerand TSF and adjacent areas; and • Mine lease areas within the available brown fields areas, where brown field TSF's could be considered;	Map provided of Vaal River Operations and Mine Waste Solutions.
4) Underground mining layouts indicating historical mining area and depth of mining (< 500 m will be essential);	No information provided.
5) Dolomitic / no dolomite areas;	Files were provided.
6) Flood lines (1: 100 and 1: 50 year) of the rivers: Vaal River and Koekemoer Spruit;	There is a gap for Kareerand TSF.
7) Existing and future residential expansion areas, especially in the Karee Rand Phase 2 area;	No information provided, although reference was made to the fact that it may be obtained from local government.
8) The Local authority's Land Development Objectives (LDO's) and spatial framework, indicting local authority expansions;	No information provided, although reference was made to the fact that it may be obtained from local government.
9) Areas within the study area, earmarked for future high intensity agricultural development;	No information was provided.
10) Tonnage profiles for re-mining and plant through-put;	Spreadsheet provided with deposition tons, the re-mining plan, and plant throughput.
11) Confirmation that February 2021 is the start date for the new TSF;	Start date for deposition of one (10.7 m tons per year) of the three tailings streams onto Phase 2 is February 2021. The other two tailings stream would then continue to be deposited on Phase 1 until April 2025 at which time the full tonnage will be deposited on Phase 2. Note that this will allow AGA to have a staged approach to Phase 2 which we would like to follow to spread out capital cash flow.

12) Waste streams generated by the process plant: Confirmation of whether it is limited to ONE stream or are THREE streams generated and then mixed into ONE;	Three streams are pumped from the MWS plant in three separate pipelines plus a stream in a fourth line from a plant run by Village Mine. They are combined at the TSF pump station so that the tailings deposited on the dam is in the form of a combined stream.
13) Was a waste classification done for one or three streams (already in Golder possession);	Golder did waste assessment on final deposition site. Additional work on the three streams deposited on the TSF and the sources would be a recommendation.
14) Water balance of the current scheme;	Water balance provided.
15) Confirmation of any buffer storage for water at the process plant;	No information provided.
16) Decant and RWD facility requirements? Barge or Gravity penstock? AGA preferences?	AGA has done studies for Kareerand Phase 1 to compare barge vs penstock for the ongoing operation. This has shown that there is no operational technical reason to select one over the other. AGA will be staying with the barge system as this is what AGA already has and the difficulty in constructing a penstock on the dam. However, AGA will be doing a study to look at installing a syphon system. Due to operational problems with the barge system on current TSF, AGA's preferred option for the expansion would be start off with a penstock and then change to a syphon system once there is sufficient height to drive it, AGA expect about 40 m.
17) Tailings characteristics: Physical (PSD) and geochemistry for the existing and new TSF;	PSDs for the typical material deposited on Kareerand Phase 1 was provided. AGA expects material deposited on Kareerand Expansion in future to be similar. Geochemical assessment was provided.
18) % solids in tailings stream;	Spreadsheets provided gave the relative densities for the streams as received at the cyclones on the dam.
19) Is cyanide destruction done at the plant or is it a future consideration?	There is a process circuit for destruction of cyanide in the MWS plant tailings. This circuit has not yet been commissioned. The current plan is to commission during 2017 as excess barren solution from the uranium plant becomes available. (Golder to assume for the project charter that cyanide will be removed. Impact on waste assessment to be confirmed.)
20) Groundwater work: Baseline information / monitoring information in the area of Kareerand TSF and adjacent areas?	GCS, Kareerand Hydrogeological Discussion Document Report, Version – 01 DRAFT for Discussion, 23 July 2015 provided. Groundwater data and monitoring locations provided.
21) Tailings profile planned for the new TSF: 2021 and beyond on an annual basis (t / annum);	Spreadsheet provided the deposition tonnages, as well as the tons to be deposited on Phase 2 annually and for the life of TSF.

22) % cyclone split for tailings: coarse to fines;	Spreadsheets provided gave the splits from the cyclones.
23) Could tonnage profile be split into two streams: X % to a new TSF and y to an existing upgraded / piggy back footprint? What is that spilt?	There is currently no facility for depositing the plant residue anywhere except Kareerand Phase 1. By 2021 there will be two current TSF footprints from which the tailings will have been reclaimed and one possibly redundant existing TSF which could be used for MWS tailings deposition. This is something AGA would only do if for some reason Phase 2 cannot be commissioned in time. AGA would have to do a trade-off of the costs of creating (and in future reclaiming) a temporary TSF against the costs of temporarily stopping one of the three plant streams. As above AGA needs to take one of the three tailings streams off of Phase 1 by early 2021 so the tonnage to be split to a temporary TSF would be 10.7 m tons per year.
24) Geotechnical report for Kareerand TSF 1, which could inform the study for Kareerand TSF 2;	Geotechnical report provided.
25) Environmental baseline reports for Kareerand TSF 1 area;	GCS, Mine Waste Solutions: Reworking of TSFs Environmental Impact Assessment Report Version – 1 dated November 2008. Project Number: SJM.B.06.272. DME Reference Number: NW 30/5/1/2/2/378 MR provided.
26) Pipeline requirements (minimum specifications for tailings delivery and return water pipelines; lining requirements, AGA paint specs, etc.);	No specific information provided.
27) Availability of power for the return water at Kareerand TSF 1 and would additional power be required for TSF 2;	There is spare capacity on the overhead line to Phase 1; assuming any additional return water pumping capacity has similar installed power as existing (1.5 M) AGA can accommodate. Would need transformers/switchgear. For Phase 2 there is power available at the ESKOM sub where AGA draws power for Phase 1, AGA could draw double the amount of power AGA is using for Phase1. Will need to look at loads for the staging of Phase 2 to determine whether AGA would need to pull in an additional overhead line from the ESKOM sub.
28) Will TSF 1 be kept dormant as redundancy when TSF 2 is commissioned?	The current plan is to use the full design capacity of Kareerand Phase 1 by early 2025 and then close the dam.
29) Critical crossings to be taken into account with new pipeline routing: national roads, provincial and local roads, streams, servitudes, etc.;	Only WUL for existing crossing provided.
30) Copies of previous permits for Kareerand TSF	NEMA authorisation, Dam safety permit, WUL, and Environmental Authorisation provided
31) Process flow diagrams for the plant (high level if available rather than detailed)	MDM Engineering, First Uranium, Phase 1B Chemwes Plant Process Design Criteria November 2008, and the MDM Engineering, First Uranium, Chemwes Uranium Plant Process Design Criteria supplied.

32) Closure philosophy for existing Karee Rand TSF 1	No information provided.

6.0 AGA KEY REQUIREMENTS FOR PRE-FEASIBILITY STUDIES

According to the AGA Capital Investment standard the main objective of a Pre-feasibility Study is to make a decision on the most attractive technical option to follow to feasibility stage if viable.

This is achieved by means of the following:

- Evaluating all realistic options for developing the investment opportunity and establish a single base case and preferred option for moving forward. The preferred option is to be fully optimised as part of the subsequent Feasibility Study phase;
- Ensuring the commercial viability of the opportunity and demonstrating the justification for continued investigation and development of the opportunity;
- Ensuring that key stakeholder requirements have been adequately captured;
- Re-confirming that the investment opportunity remains aligned with the strategic and business objectives of the company;
- Ensuring that the project scope, cost estimate (+25% to –15%) and schedules are sufficiently developed in order to enable the selection of the preferred option thus providing the basis for conducting the Feasibility Study;
- Ensuring that major risks have been identified with mitigation and scenario plans in place;
- An appropriate plan has been completed with re-sourcing requirements, costs and forecast schedules for completing the subsequent Feasibility Study;
- Based on the level of assessment carried out to date, ensuring that no legal impediments exist with the potential to materially impact on the investment;
- Ensuring that sufficient technical work has been undertaken in order to demonstrate the technical viability of the opportunity, and to support the selection of the preferred option for moving forward; and
- Ensuring that technical issues requiring further investigation such as geological drilling, geo-technical assessments or pilot plant testing have been identified.

However, during subsequent discussions with AGA on 23 August 2016 regarding the fact that the TSF project will most likely end-up with more than two preferred options, and it was agreed to include a trade-off step to compare these options/ schemes first. The engineering related to the trade-off study's outcome will result into a lower level certainty than the pre-feasibility study requirements approximately conceptual level, Class 0 study outcome.

6.1 Other requirements related to the development of the Kareerand TSF Expansion

In a project meeting between AGA and Golder, held on 30 August 2016 the learnings from the current TSF facility were discussed. The Project Charter development must incorporate these fundamental requirements and document it as such.

Design Phase of TSF

- The gap between pre-feasibility, feasibility, conceptual design and final design in terms of specialist input was too big during the development of the current Kareerand TSF. The Hydrogeologist was not included from the feasibility onwards. Only baseline hydrogeology was done at an early stage and then

the area was changed and most of the geophysical survey was conducted at a different site location. Develop a very clear understanding of the geology underneath the site;

- Allowance must be made for a proper hydrogeological assessment and for close corporation between the design engineer and the geotechnical engineer;
- Allowance must be made for a proper vadose zone seepage analyses;
- Conduct detailed footprint geophysical survey at site selection phase;
- Determine the expected deposition rate and the MWS plant's maximum production rate and design the facility for the maximum tonnage profile plus and additional safety factor;
- Establish the physical properties of the material that will be reclaimed, re-processed and deposited, i.e. particular splits, chemistry etc. to select the correct deposition methodology;
- Compile a management plan for the storm water generated from the top and the side slopes of the TSF and design accordingly. The volume of storm water from the side slopes of the TSF must be incorporated in the water management system;
- Determine the volume of shallow seepage and develop a management plan for the seepage based upon the outcome of the geotechnical assessment;
- It is recommended that the seepage intervention mechanisms be installed prior to the development of the TSF;
- Align the environmental authorisations with the actual facilities which will be constructed on site;
- Ensure that the return water system and dams are adequately sized and designed correctly to allow for maximum deposition and an additional safety margin;
- Provide for a sufficient buffer zone around the TSF and ensure that access can be obtained to neighbouring properties for monitoring or other management measures;
- Make allowance for backup power supply system to continue deposition during unplanned power failures. This will prevent uncontrolled spillages of residue and water;
- Set out of the closure objectives for the dam to ensure the design of the final cover can support the final end land use;
- Make sufficient financial provision for closure based on a well-designed closure plan at the planning phase Make a decision regarding closure construction and end rehabilitation of the TSF expansion at the planning phase;
- Use the rehabilitation requirements to inform the site selection process;
- Utilise the same cover design planning process that AGA conducted for the current TSF to ensure a sustainable closure cover;
- The planning and availability of water for irrigation should also be considered and quantified;
- Use the trails planned on current dam to set the rehabilitation specifications. It is important to ensure the rehabilitation specification and the outer slope design of the dams are aligned; and
- Develop a surface water, groundwater and dust management plan.

Construction phase

- Collect sufficient and accurate baseline information before deposition commences. (i.e. surrounding groundwater levels and qualities);
- Ensure that the concept and final design are aligned and that it include the hydrogeology of the site;

- Implement a proper topsoil management and stockpiling plan to prevent problems with rehabilitation and to prevent sterilising good material. The stripping and stockpiling of topsoil should be in line with the planned closure cover and method;
- Install the seepage management measure before deposition commences;
- Install automatic level loggers in boreholes from the start to pick up sudden movement of water table at an early stage as not enough monitoring took place in first 6 months of the current facility; and
- Properly document the deep earth works for foundation construction to address uncertainty about the development of preferred pathways which may develop if excavations penetrate into the weathered diabase.

Deposition phase

- Implement the design philosophy and deviate as little as possible;
- Develop a management plan to deal with water losses during the initial deposition because very little water will be recycled;
- Ensure that the concurrent rehabilitation is aligned with the TSF design and deposition schedule;
- Establish rehabilitation trail sites as soon as possible to monitor planned rehabilitation performance;
- Manage the storm water on the TSF side slopes. Don't allow water and tailings material to spill into the solution trench and surrounding environment;
- Develop a management plan for the shallow seepage;
- Implement a dust management plan (dust suppression system i.e. watering canons);
- Implement a ground and surface water monitoring plan to ensure early detection of water quality issues; and
- Provide for seepage losses which could resulted in as much as 10m groundwater level increase. The water balance only suggested about 4000 to 6000 m^3/day loss to seepage.

7.0 TSF CANDIDATE SITE IDENTIFICATION PROCESS

The key objective of the site selection process was:

To identify a suitable TSF site that will pose minimal risk to the environment, public health and safety and private properties. The preferred site would be associated with acceptable cost of development, operation and closure and would comply with legal and regulatory requirements.

7.1 Methodology and Approach

The Kareerand TSF expansion to be designed will consist of a mega tailings storage facility with associated water management infrastructure. A suitable location for the TSF had to be found. The methodology that was followed to find the preferred TSF site is summarised in Figure 3.

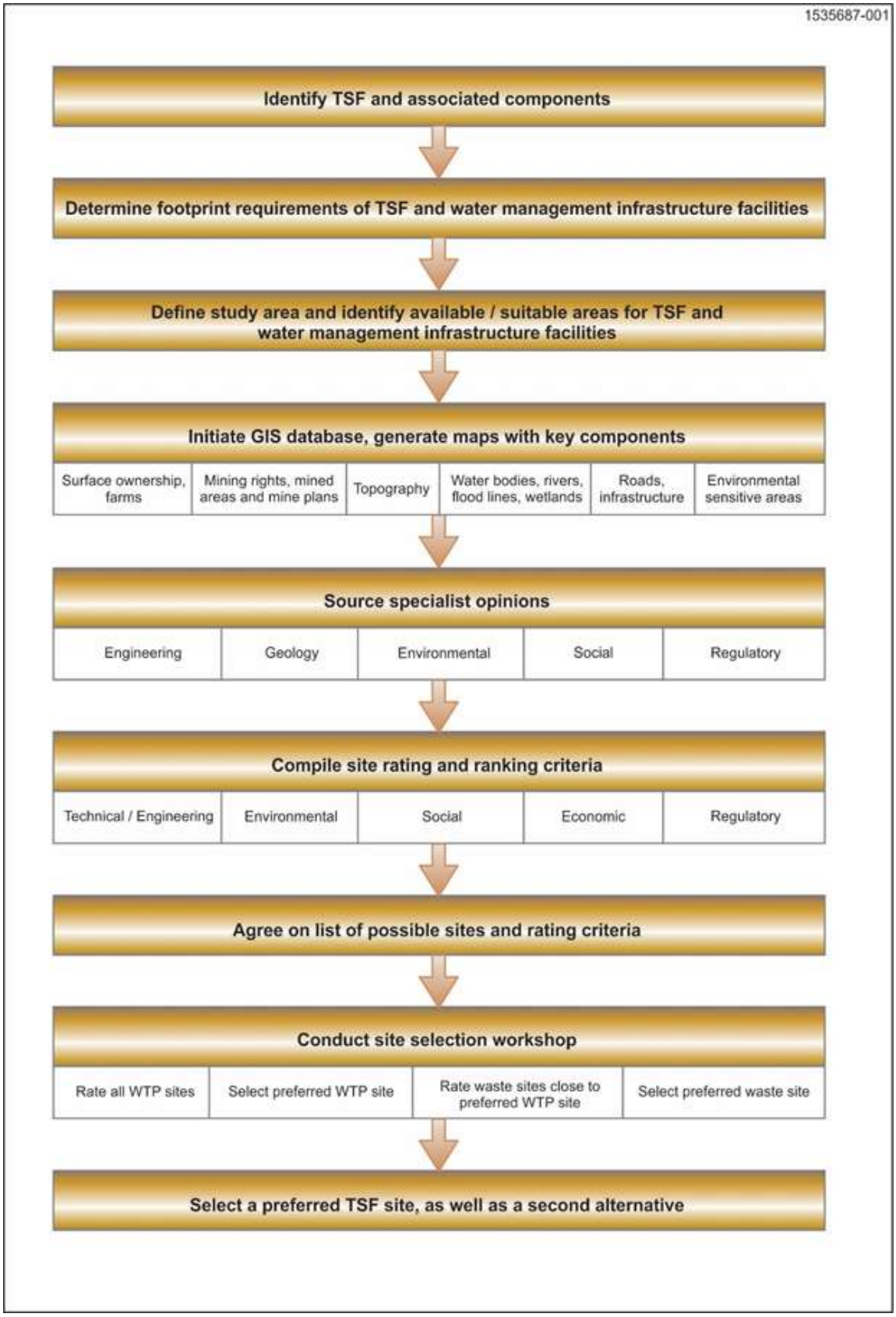


Figure 3: Kareerand Site selection process

7.2 Candidate sites

During the site identification process candidate sites for the Kareerand TSF expansion outlined in Table 2 and depicted in Figure 4 were identified.

In order to identify the candidate sites for the proposed Kareerand TSF expansion the following aspects were taken into consideration to identify potential sites:

- Location of sites both “of the dolomites” and “on dolomites”;
- Land available for further development for the TSF;
- Current and potential future land use;
- Greenfields and brown fields sites; and
- Airspace requirement for LOM tonnage (566 Mt) and associate footprint requirement of approximately 610 Ha.

Table 2: Alternative sites for Kareerand Tailings Expansion Project

Name	Site description
Option 1	Site located on Existing Buffelsfontein TSF footprint. Site area is 300 ha, can accommodate 230Mt, 70 m high at a deposition rate of 10Mt /a. Located on dolomite. Area required for expansion incorporate the current Buffelsfontein Gold Plant which does not belong to AGA.
Option 2	Site is located directly north of the existing MWS plant, on a TSF footprint area. Consist of 4 cells 2a, b, c, and d, of which 2b is a greenfields site, and 2c has an existing TSF, still to be reclaimed. The entire footprint area can accommodate 560Mt at 70m high at a deposition rate of 30 Mt/a. Located on dolomite. Land mostly owned by MWS.
Option 3	Site is located north of the existing MWS plant, on a greenfields area. The entire footprint area can accommodate 560 Mt at 70m high at a deposition rate of 30 Mt/a. Located on dolomite. Land mostly owned by MWS.
Option 4	Site is a greenfields site located directly to the west of the current Kareerand TSF. An area of 615 Ha is available, which caters for 456 – 584 Mt at a deposition rate of >30 Mt/a. The land is owned by and leased from the community. Site is not located on dolomite.
Option 5	Site is a greenfields site located directly to the north of the current Kareerand TSF. An area of 560 Ha is available. The land belongs to a private land owner. Site is not located on dolomite.
Option 6	Site is a greenfields site located directly to the south of the current Kareerand TSF. An area of 730 Ha is available. The land belongs to a private land owner. Site is not located on dolomite. The TSF footprint is located within the 500m buffer zone of the Vaal River.
Option 7	Site is a greenfields site located southwest of the current Kareerand TSF. An area of >510 Ha is available. The land belongs to MWS. Site is not located on dolomite. The TSF footprint is located within the 500m buffer zone of the Vaal River.

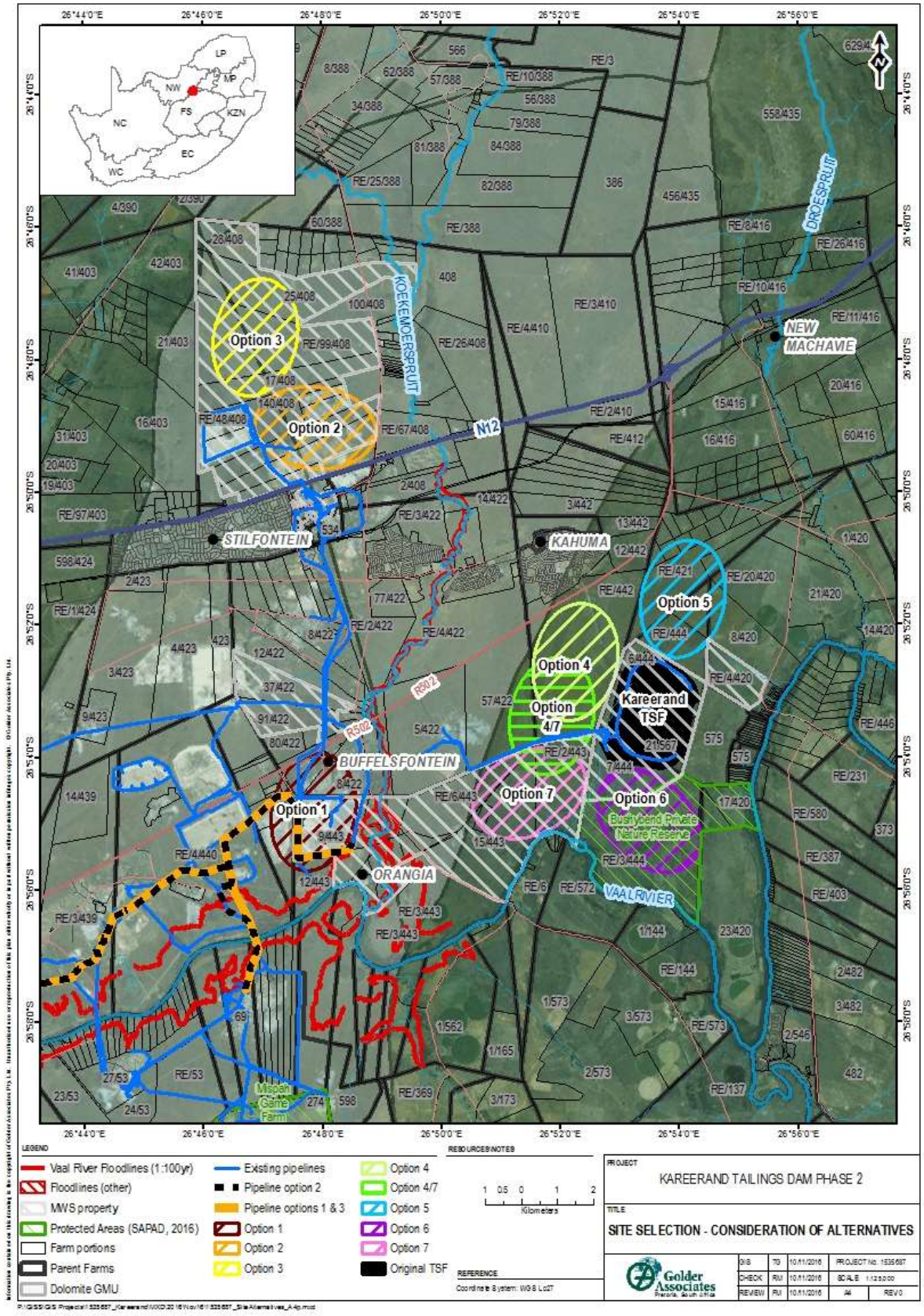


Figure 4: Alternative sites identified for the Kareerand TSF expansion

The candidate sites were visited after the project initiation workshop on 26 July 2016 and the following specific observations were made:

Name	Site observations
Kareerand Tailings Expansion Option 2	  Stilfontein located directly adjacent to Option 2. Lack of topsoil due to rehabilitation and clean-up of a portion of the footprint of the former MWS TSF 2. 
Kareerand Tailings Expansion Option 3	 Greenfields site located to the north of the MWS TSF 4 and 5.

Name	Site observations
Kareerand Tailings Expansion Option 4	 Site located on Hartebeesfontein, adjacent to existing Kareerand and Buffelsfontein Gold Mine. No communities in the area.
Kareerand Tailings Expansion Option 7	 Site located on land owned by MWS, north of the Vaal River. Currently a game farm. No community or residential settlement in the area.

7.3 Site selection process

Site Selection Criteria

The main site selection criteria were identified according to which the identified candidate sites was evaluated. The criteria were grouped in the following categories:

- Technical/engineering
- Environmental and Social;
- Economical
- Constructability; and
- Operability.

The procedure that was followed for the rating and ranking of candidate sites in terms of the main criteria included the following:

- Assigning a relative weight to the main categories of criteria;
- Identification of various sub-criteria under the main categories of criteria;
- Defining the sub-criteria; and
- Rating and ranking based on the sub-criteria.

Weighting of the Main Criteria

Based on professional collective views, opinions and consensus of the site selection specialist team present at the workshop, the following weights (refer to Table 3: Weighting allocated to main criteria for site selection below) were given to the main categories:

Table 3: Weighting allocated to main criteria for site selection

Criterion category	Weighting (%)
Economical	33
Technical/engineering	13
Constructability	10
Operability	10
Environmental and Social	34

Identification of Sub-Criteria

Economical

Economic criteria relate to the cost of purchasing, developing and operating the site and its associated infrastructure. Among others, they include the following considerations:

- Capital cost:
  - The distance of the site from the MWS plant, length of supply and return water pipelines;
  - Cost of ground preparation and infrastructure establishment; and
  - Purchase of private property.
- Operational cost:
  - Cost of operating and maintaining the TSF and water management infrastructure, including the tailings supply and return water system.
- Closure cost:
  - Cost of rehabilitation and capping of the TSF at closure and removal of infrastructure
- The possibility of motivating to the regulator for an alternative barrier design for the TSF was regarded as the most significant economic criteria as the cost of a lined facility will far outweighs the cost of conveyance infrastructure.

Technical/Engineering

The following technical/engineering sub-criteria were used to identify suitable criteria to conduct the rating and ranking assessment:

- Ease of engineering
  - Proximity to bulk services access (road, electricity, telephone);
  - The need for relocating of bulk services;
  - How accessible the site is for vehicles during construction, operation, etc.;
  - Consider length of pipes to the site, whether existing pipes be used, etc.
  - Flexibility to expand or maximise tailings storage

- Geotechnical stability of underlying geological strata
  - The suitability of the geotechnical conditions for cut to fill operation;
  - Excavation difficulty; and
  - Suitability of the founding conditions.

Constructability

The following constructability sub-criteria were used to identify suitable criteria to conduct the rating and ranking assessment:

- Availability of borrow material to construct starter walls and use as cover on closure;
- Availability of topsoil for cover during rehabilitation and closure; and
- Ease of stages construction of TSF.

Operability

The following operability sub-criteria were used to identify suitable criteria to conduct the rating and ranking assessment:

- Deposition of tailings, formation and pool control;
- Adequacy of storage capacity; and
- Public safety as presented by Dam safety risks and the zone of influence of the facility.

Environmental Criteria

Environmental criteria relate to the potential threat to the ecosystem and the geophysical environment. They include the following considerations:

- Geological regime;
  - The presence of local water bearing aquifers; and
  - Presence of dolomite in the underlying geology.
- Groundwater management / interception;
  - The incremental impact of the facility on the groundwater resource;
  - Short medium and long term liability for groundwater management; and
  - Interception and change in water quality (treatment).
- Proximity to the water resource;
  - Presence of fountains, wetlands and heir buffer zones; and
  - Floodlines.
- Visual Exposure:
  - Sensitive viewers (proximity to communities / households/ buildings / roads).
- Heritage;
  - Presence of cultural heritage sites, graves, etc.
- Social Acceptance;

- Proximity of the TSF and associated infrastructure to residential development; and
- Potential impact on the value of neighbouring property.

- Land ownership:
  - The need for land acquisition.
- Air Quality:
  - Prevailing wind direction and dust impact of the facilities;
  - Potential dust generation from the project facilities that may impact the adjacent residents;
  - Prevalent wind direction; and
  - Proximity to communities / households/ buildings.

Site Selection Matrix

A project specific site selection matrix was developed to assist with qualitative rating and ranking of the identified candidate sites.

The rating of the candidate sites was based on the values given in Table 4.

Table 4: Site selection rating value

Rating:	
Excellent	5
Above average	4
Below average	2
Very poor	1
Fatal Flaw	**F**

Where different rating values were used, the values were scaled to a value between 1 and 5 before using them to calculate the total rating of each site. The site selection categories were weighted according to pre-determined weighting values as indicated in Table 4. The individual criteria within each category were not weighted, thus each criteria within a specific category carried the same weight. The score of the selection categories were normalized.

Site Selection Workshop

The rating and ranking of the candidate sites was carried out in a workshop held at the offices of Golder Associates in Midrand on 15 August 2016, with contributions from the people listed in Table 5.

Table 5: Site selection workshop participants

Name	Role / discipline description
Riana Munnik	Project Manager
Francois Marais	Civil Engineer
Graham Hubert	Geohydrologist
David Love	Geochemist
Brent Baxter	Environmental Specialist
Theunis Duminy	Process Engineer
John Wates	Civil Engineer

During the process of considering the alternative sites the details of the scheme and alternative technologies were not considered, but a focus was placed on the area and site specific aspects such as:

- The broader engineering / technical criteria (the flexibility to accommodate a possible relaxation of a prescriptive engineering barrier system were taken into account);
- Environmental and social criteria; and
- Constructability and operability criteria.

It was decided that the economic criteria would be applied once a preferred scheme / next best option have been selected. The maps which informed the site selection workshop are attached in APPENDIX A.

Golder then presented the outcomes of the site selection to AGA in a meeting held on 23 August 2016.

The rating and ranking of the sites are depicted in below in Figure 5.

It must be noted that the rating and ranking of the alternatives were based upon qualitative evaluation of available information, professional knowledge and judgement. No detailed site specific investigation were conducted on all of the candidate sites.

		Evaluation criteria	Economical				Normalised Subtotal	Engineering/Technical			Normalised Subtotal	Constructability			Normalised Subtotal	Operability		Public Safety	Normalised Subtotal	Environmental and Social								Normalised Subtotal	Total Normalised score per option	Ranking	COMMENTS
		Sub-criteria	CAPEX	OPEX	CLOSURE	Possibility of motivating for alertantive design		Ease of engineering	Flexibility to expand/Max. Storage	Geotechnical stability		Availability of borrow material	Availabilty of topsoil	Ease of Staged construction		Deposition, Beach Formation and Pool Control	Capacity	Dam failure risks		Geological regime	Groundwater management / interception	Priximity to water reource	Visual exposure	Heritage sensitivity	Social Acceptance	Land ownership	Air quality				
		Comments	Pre Deposition Construction	Operating Capital + Ops	Cost of rehabilitation and liability											Rate of rise		Zone of influence and public safety .		Presence of dolomite	Short medium and long term liabiltiy Interception and change to water quality	Floodlines, fountains, wetlands and buffer zones	Exposure to settlement	To be confirmed	Proximity to people	Land owned or not	Dust impact				
		Weighting	33%					13%				10%				10%				34%									100%		
No.		OPTION DESCRIPTION																													
1	MWS Tailings Expansion Option 1	Site on Existing Buffelsfontein TSF footprint. 300 ha, 230Mt, 70 m high at a deposition rate of 10Mt /a. Located on dolomite.				2	47.14	2	0	4	10.68	1	1	1	6.82	4	0	1	6.41	1	1	2	2	4	4	5	2	47.60	118.66	6	
2	MWS Tailings Expansion Option 2	Site north of the existing MWS plant, on a TSF footprint area. Consist of 4 cells 2a, b, c, and d. 560Mt at 70m high at a deposition rate of 30 Mt/a. Located on dolomite. Land mostly owned by MWS.				4	94.29	2	5	2	16.03	1	1	2	9.09	2	5	1	10.26	1	1	4	1	4	1	5	1	40.80	170.46	2	Potential Radon build up on site. High public resistance to proximity to residential area.
3	MWS Tailings Expansion Option 3	Site north of the existing MWS plant, on a greenfields area. 560Mt at 70m high at a deposition rate of 30 Mt/a.				4	94.29	2	5	1	14.25	2	1	2	11.36	5	5	4	17.95	1	1	5	2	1	2	5	4	47.60	185.44	1	
4	MWS Tailings Expansion Option 4	Greenfields site located directly to the west of the current Kareerand TSF. 615 Ha, which caters for 456 – 584 Mt at a deposition rate of >30 Mt/a. Compliant design proposed for this option.				1	23.57	4	4	5	23.15	4	2	2	18.18	5	5	4	17.95	4	4	4	1	1	2	2	4	49.87	132.72	4	
5	MWS Tailings Expansion Option 5	Greenfields site located directly to the north of the current Kareerand TSF. 560 Ha is available. Private land owner. Not located on dolomite. Compliant design.				1	23.57	4	4	5	23.15	4	2	2	18.18	5	5	4	17.95	5	4	5	1	1	2	2	2	49.87	132.72	4	High risk of not abtaining land and landowner consent (Private and state owned land)
6	MWS Tailings Expansion Option 6	Greenfields site located south of the current Kareerand TSF. 730 Ha is available. Land belongs to a private land owner. Not located on dolomite. Within the 500m buffer zone of the Vaal River. Compliant design.				1	23.57	4	2	5	19.59	4	2	2	18.18	5	5	2	15.38	5	4	4	2	1	2	2	2	49.87	126.59	5	High risk of not abtaining land and landowner consent (privately owned)
7	MWS Tailings Expansion Option 7	Greenfields site located southwest of the current Kareerand TSF. >510 Ha is available. The land belongs to MWS. Site is not located on dolomite. Within the 500m buffer zone of the Vaal River. Compliant design.				1	23.57	4	4	5	23.15	4	2	2	18.18	5	4	2	14.10	4	4	4	2	1	2	5	2	54.40	133.41	3	

Figure 5: Site selection rating and ranking table for the Kareerand TSF Expansion project

The outcome of the site selection process is summarised in Table 6.

Table 6: Outcome of site selection process for Kareerand TSF Expansion

Name	Ranking	Comments on site selection
Option 1	**6**	Site is only 300 ha and cannot accommodate the required tonnage profile. Fatally flawed.
Option 2	**2**	Option 2 is located in close proximity to the residential area of Stilfontein and the risk of exposure to Radon were deemed to be a fatal flaw. Site 2 also had limited topsoil for rehabilitation. The site directly adjacent to the residential area of Stilfontein. The site will not be feasible from a social acceptance point of view.
Option 3	**1**	Feasible site, but located on dolomite. Land mostly owned by MWS.
Option 4	**4**	The land is owned by and leased from the community. Site is not located on dolomite. Feasible for development
Option 5	**5**	Option 5 is located on privately- and government owned land and land acquisition was not regarded as feasible. Site development regarded as having a very low potential.
Option 6	**5**	Option 6 is located on privately owned land and a very low probability of obtaining landowner consent for the proposed scheme development and the option was not feasible.
Option 7	**3**	Feasible site. The land belongs to MWS. Site is not located on dolomite. The TSF footprint is located within the 500m buffer zone of the Vaal River.

The outcome of the TSF site selection showed that Option 3 and 7 was deemed the most feasible sites for the location of the Kareerand TSF expansion, as Option 2 was deemed fatally flawed.

However Option 7 is located closest to the Vaal River and upstream of the Midvaal abstraction point. Due to the potential risk it was proposed that Option 7 be moved further away from the Vaal River and combined with the next best alternative, namely Option 4. Thus an Option 4/7 was created as a result of the site selection process. The footprint of Option 4/7 is further away from the Vaal River and was subject to further investigation and scheme development.

The project charter was developed for Option 4/7 and Option 3.

For Option 4/7 consideration was given to both a lined facility, deemed a legally complaint design and an unlined facility.

Figure 6: Site 4/7 located south east of the current Kareerand regarded as a preferred site for the TSF Expansion

8.0 KEY REGULATORY CRITERIA AND REGULATIONS RELATED TO MINE WASTE

The regulatory regime governing the management of mine residue facilities such as the Kareerand TSF expansion, are guided by the classification and characterisation of mine waste streams, which needs to be conducted according to the appropriate regulations and Norms and Standards, including the following:

- Classification of waste according to SANS 10234 as per *Waste Classification and Management Regulations* (GN R.634 of 23 August 2013);
- Waste Assessment as *per the National Norms and Standards for the Assessment of Waste for Landfill Disposal (*GN R.635 of 23 August 2013);
- Identification of the barrier design as per the *National Norms and Standards for Disposal of Waste to Landfill* (GN R.636 of 23 August 2013); and
- Characterisation of residue stockpiles and deposits as per the *Regulations regarding the planning and management of Residue Stockpiles and Residue Deposits from prospecting, mining, exploration or production operation* (GN R.632 of 24 July 2015).

Waste Classification

According to section 4(2) of GN R.634 of 2013, all waste generators must ensure that their waste is classified in accordance with SANS 10234 within 180 days of generation, except if it is listed in Annexure 1 of the GN R.634. Furthermore, waste must be re-classified every 5 years.

Waste classification according to SANS 10234 (based on the Global Harmonised System) indicates physical, health and environmental hazards. The SANS 10234 covers the harmonised criteria for classification of potentially hazardous substances and mixtures, including wastes, in terms of its intrinsic properties/hazards.

The chemical test results as well as intrinsic properties of the waste streams were used for the SANS 10234 classification. Constituents present in concentrations exceeding 1% are used for classification in terms of health hazards, except when the constituent is known to be toxic at lower concentrations (carcinogens etc.) (Table 7).

Environmental hazard is based on toxicity to the aquatic ecosystem and distinguish between acute and chronic toxicity, bioaccumulation and biodegradation.

Table 7: Cut-off values/concentration limits for hazard classes

Hazard class	Cut-off value (concentration limit) %
Acute toxicity	> 1.0
Skin corrosion	> 1.0
Skin irritation	> 1.0
Serious damage to eyes	> 1.0
Eye irritation	> 1.0
Respiratory sensitisation	> 1.0
Skin sensitisation	> 1.0
Mutagenicity: Category 1 Category 2	 > 0.1 > 1.0
Carcinogenicity	> 0.1
Reproductive toxicity	> 0.1
Target organ systemic toxicity	> 1.0
Hazardous to the aquatic environment	> 1.0

Waste Assessment

A GN R. 635 waste assessment is performed to determine the Type of waste and based here on the correct barrier design requirements for disposal. The assessment of waste must be done in terms of the procedures stipulated in GN R. 635 of 23 August 2013.

In terms of the *National Norms and Standards for the Assessment of Waste for Landfill Disposal (*GN R.635 of 23 August 2013), the potential level of risk associated with disposal of materials/wastes can be determined by following the prescribed and appropriate leach test protocols. The results must be assessed against the four levels of thresholds for leachable and total concentrations, which in combination, determines the waste type and associated barrier design / liner requirements. The relevant terminology is as follows:

- LC = means the leachable concentration of a particular contaminant in a waste, expressed as mg/l;
- TC = means the total concentration of a particular contaminant in a waste, expressed as mg/kg;
- LCT= means the leachable concentration thresholds for particular contaminants in a waste (LCT0, LCT1, LCT2, LCT3); and
- TCT= means the total concentration thresholds for particular contaminants in a waste (TCT0, TCT1, TCT2).

Figure 7 shows the flow diagram of the process to be followed to determine the waste type for correct disposal. According to this process, the waste needs to be analysed to determine total and leachable concentrations of potential Constituents of Concern (CoCs). The results are then compared to the threshold values to determine the waste type.

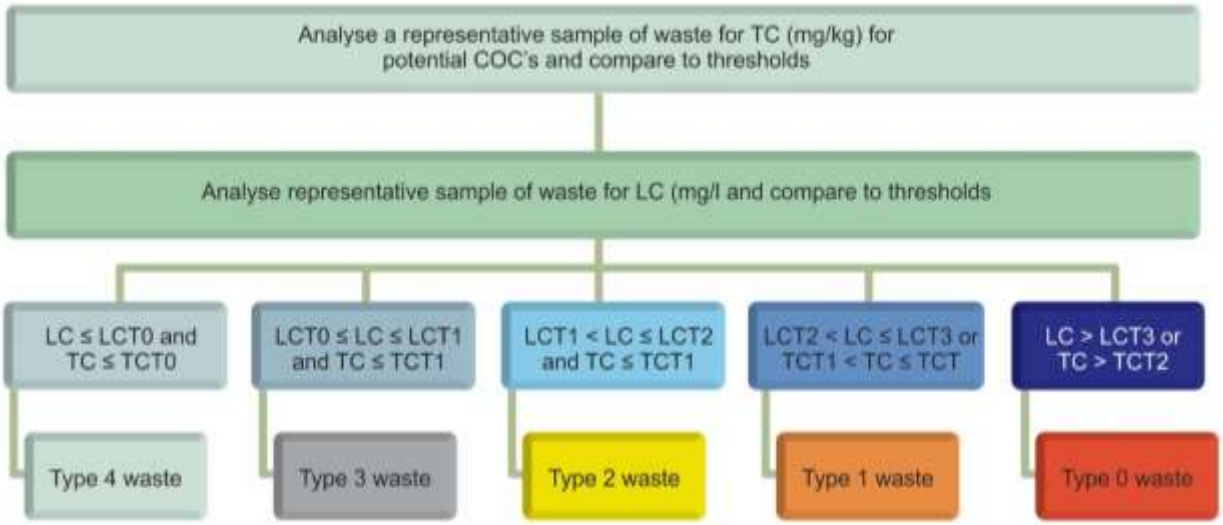


Figure 7: Flow diagram for waste assessment according to the GN R. 635

Barrier design requirements

The liner requirements/barrier design requirements, based on the type of waste, as detailed in GN R.636 are presented in Table 8.

Table 8: Landfill disposal requirements detailed in the GN R. 636 of 2013

Waste Type	Landfill Disposal Requirements
Type 0 Waste	The disposal of Type 0 waste to landfill is **not allowed**. The waste must be treated and re-assessed in terms of the *Standard for Assessment of Waste for Landfill Disposal*
Type 1 Waste	Type 1 waste may only be disposed of at a **Class A** landfill designed in accordance with Section 3(1) and 3(2), or, subject to Section 3(4), may be disposed of at a landfill site designed and operated in accordance with the requirements for a **Hh / HH landfill** as specified in the Minimum Requirements for Waste Disposal by Landfill (2nd Ed., DWAF, 1998).
Type 2 Waste	Type 2 waste may only be disposed of at a **Class B** landfill designed in accordance with Section 3(1) and 3(2), or, subject to Section 3(4), may be disposed of at a landfill site designed and operated in accordance with the requirements for a **GLB+ landfill** as specified in the Minimum Requirements for Waste Disposal by Landfill (2nd Ed., DWAF, 1998).
Type 3 Waste	Type 3 waste may only be disposed of at a **Class C** landfill designed in accordance with Section 3(1) and 3(2), or, subject to Section 3(4), may be disposed of at a landfill site designed and operated in accordance with the requirements for a **GLB+ landfill** as specified in the Minimum Requirements for Waste Disposal by Landfill (2nd Ed., DWAF, 1998).
Type 4 Waste	Disposal allowed at a landfill with a **Class D** landfill designed in accordance with Section 3(1) and 3(2), or, subject to Section 3(4), may be disposed of at a landfill site designed and operated in accordance with the requirements for a **GLB- landfill** as specified in the Minimum Requirements for Waste Disposal by Landfill (2nd Ed., DWAF, 1998).

Mining Residue Risk Assessment

GN R.632 of 2015 sets out the framework for assessing the risk posed by a mining residue deposit

1) Characterisation of the mining residues (understood to include stockpiles, waste rock dumps (WRDs), tailings storage facilities (TSFs) and similar mining residue facilities or MRFs) in terms of:

   a) Geochemical characteristics,

   b) Physical characteristics, and

c) Toxicity;

2) Classification of the mining residues in terms of physical, health and environmental hazards (SANS10234);

3) Assessment of the mining residues in terms of total and leachable concentrations (National Norms and Standards for the Assessment of Waste for Landfill Disposal);

4) Aggregation and integration of the mining residue assessments into the profile of the completed MRFs;

5) Determination of the impact on the receiving groundwater and surface water environment, considering:

   a) The characterisation, classification and assessment of the mining residues,

   b) The vulnerability of the local aquifer(s), and

   c) The predicted runoff and seepage chemistry, with classification of the predicted mine water in terms of baseline water quality, DWAF (1996) water use guidelines and applicable receiving water quality guideline;

6) Determination of the impact on biodiversity based upon the impact on groundwater and surface water; and

7) Prevention of pollution in order to satisfactorily mitigate the impact on groundwater and surface water and on biodiversity, such prevention measure to potentially include:

   a) The minimisation of runoff and seepage,

   b) The interception of runoff and seepage, and

   c) The reuse or treatment and release of intercepted mine waters.

9.0 DEVELOPMENT OF THE SHORT LISTED OPTIONS

The initial site selection process eliminated a number of options as discussed earlier in this report. Option 3 and Option 4-7 were selected from the site selection process for further development. Option 4-7 is a hybrid option combining features of Option 4 and Option 7. Option 4-7 is further sub-divided into an “a” and a “b” option (refer section 9.1.1).

This report sets forward information on the three options for consideration. The aim is to present information on the possible development of the short-listed options which will facilitate a discussion based on high level **concept development** and indicative **capital** costs associated with the options. The outcome of the discussion would be to decide upon an agreed options for taking forward to pre-feasibility design stage.

This report is not aimed at presenting such a discussion, and it is proposed that a workgroup be convened to discuss the alternate options selected and to ensure that the proposed alternatives are viable. The workgroup could consist of a Client team (sponsor, engineers, specialists and operational team) and the consultant.

9.1 Engineering attributes

The layout drawings in APPENDIX B have reference to this section.

9.1.1 TSF Expansion: - Option 4-7a and Option 4-7b

Option 4-7 is located approximately 440 m west of Kareerand TSF. The minimum distance to the Vaal River at the southern extremity of the proposed Phase 2 TSF is 640 m. The minimum ground elevation in the south is 1,293.40 m.a.m.s.l, and the maximum at its north-west corner is 1,337.20 m.a.m.s.l i.e. a fall of about 43.8 m across the TSF footprint over a distance of 3,980 m.

The sub-options are defined as follows:

a) Option 4-7a - lined with a Class C liner in alignment with the National Environmental Management : Waste Act, 2008 (Act No. 59 of 2008) Regulation 636 National Norms and Standards for Disposal of Waste to Landfill, promulgated 23 August 2013, and

b) Option 4-7b - unlined

Consideration was given to a location further north in order to avoid the existing pipeline corridor – however, the TSF air space requirement and the proximity to the nearby settlements necessitated the location currently shown in APPENDIX B.

Moreover, refinements to the currently proposed layout could see it constructed up against Kareerand Phase 1 in order to effect savings by sharing infrastructure such as the starter wall and seepage collection drains. These design optimisation steps could be pursued during the feasibility phase of the project.

The in-situ density of the re-claimed/retreated tailings is assumed to be 1.45 t.m^3. The following geometric parameters apply to the design of the proposed Phase 2 Kareerand expansion Option 4-7:

Table 9: Option 4-7 selected geometrical attributes

PARAMETER	VALUE
Footprint area (m^2)	8,896,806
Starter wall maximum height (m)	23
Kicker wall height (m)	6
Starter and kicker wall top width (m)	8
Starter and kicker wall side slopes (V:H)	1:2.5
Starter and kicker wall total volume (m^3) above existing ground	2,738,687
Tailings lift slope (V:H)	1:5
Tailings bench width (m)	7
Tailings average slope (V:H)	1:7.7
Tailings beach slope (V:H)	1:250
Tailings volume (Mm^3)	388.2
Tailings tonnage @ 1.45 t.m^3 (Mt)	563.0
Tailings maximum height above minimum elevation (m)	85.5

Pipelines

The proposed TSF footprint will engulf approximately 2,650 m of the existing pipeline route. Therefore the three 500 mm diameter mild steel tailings delivery pipelines and the 800 mm diameter mild steel return water pipelines will have to be re-routed. It is estimated that 50% of the existing tailings pipelines, and 80% of the existing return water pipeline, will be utilised in the re-routing of the pipelines. Quantities involved in the works are reflected in the schedule of quantities in APPENDIX C.

An improvement of the pipe crossing at Koekemoerspruit is allowed for. A provisional sum has been provided in the schedule of quantities for this work, which could involve:

- Creating an underground siphon in the stream which would extend from a predetermined distance upstream to a predetermined distance downstream. The pipes could then be wrapped in Denso-tape or similar and covered in a prism of dump rock for given distances on either side of the crossing, in order to discourage vandalism; and
- Creating a cradle and roof for the pipes with reinforced and precast concrete work.

In both the above (or other) schemes, reinstatement/improvement of the emergency berms must be considered.

Return Water Dams

Provision is made for new lined return water dams (RWD), dual compartments. This includes silt traps. The facilities will be sized during subsequent studies to comply with GN 704 requirements.

Pump Stations

Provision is made for a new return water pump station. It is proposed that the existing Kareerand pressure break station and tailings pump station be retained and used for tailings deposition to the TSF extension. A return water pump station mounted on a floating barge will discharge water from the pool to the solution trench which will in turn drain into the return water dam. A pool wall will be constructed by dry stacking and cyclone, followed by a length of floating walkway to the barge. Submersible pumps will be suspended from the barge into the pool.

Solution Trench

The TSF extension will operate on the same basis as the current facility, with a ring trench along the starter wall toe to collect seepage and return water and convey these streams to the return water dam.

Drainage

A clean water cut-off trench and berm (cut-to-fill) will be constructed to the north of Kareerand and the extension in order to intercept and discharge clean storm water runoff approaching the TSF's and discharge the water away from the affected footprints into the receiving environment. A non-perennial drainage line exists between Kareerand and the proposed extension in its current configuration. It is proposed that this drainage line be retained as-is if the TSF's are constructed as separate compartments.

TSF Underdrainage

A toe-drain and a blanket-drain, hydraulically linked by link-drains, will be provided to draw down the phreatic surface which develops in the TSF and thereby increase stability. The tow drain will be provided with outlet pipes into the solution trench. The underdrains will consist of HDPE pipes with drilled round openings, encapsulated in washed stone and covered with sequential filter layers to prevent blockage by fines material.

9.1.2 TSF Expansion: - Option 3

Option 3 is located approximately 3.5 km North-Northwest of the Mine Waste Services plant area. The minimum ground elevation in the southeast is 1,344.70 m.a.m.s.l, and the maximum at its Northwest corner is 1,387.60 m.a.m.s.l i.e. a fall of about 42.9 m across the TSF footprint over a distance of 4,095 m.

The in-situ density of the re-worked tailings is assumed to be 1.45 $t.m^3$. The following geometric parameters apply to the design of the proposed Phase 2 Kareerand expansion Option 3:

Table 10: Option 3 selected geometrical attributes

PARAMETER	VALUE
Footprint area (m^2)	9,881,305
Starter wall maximum height (m)	15.6
Kicker wall height (m)	6
Starter and kicker wall top width (m)	8
Starter and kicker wall side slopes (V:H)	1:2.5
Starter and kicker wall total volume (m^3) above existing ground	2,305,549
Tailings lift slope (V:H)	1:5
Tailings bench width (m)	7
Tailings average slope (V:H)	1:7.7
Tailings beach slope (V:H)	1:250
Tailings volume (Mm^3)	387
Tailings tonnage @ 1.45 $t.m^3$ (Mt)	561
Tailings maximum height above minimum elevation (m)	72.2

Pipelines

New pipelines will be required for this option, since the current lines will need to remain operational in the interim. The proposed pipe location of the MWS plant and the candidate site necessitates a crossing of the N12 national route. It is proposed that the pipes be stacked on supports in a square configuration for this section in order to minimise the size of precast conduit to be jacked across the highway. Quantities involved in the works are reflected in the schedule of quantities in APPENDIX C.

Return Water Dams

Provision is made for new lined return water dams (RWD), dual compartments and silt traps. The facilities will be sized during subsequent studies to be compliant with GN 704.

Pump Stations

Provision is made for a new return water pump station. The relatively short distance from the MWS plant to the proposed site negates the need for a pressure break station and tailings pump station for tailings deposition to the TSF extension. A return water pump station mounted on a floating barge will discharge water from the pool to the solution trench which will in turn drain into the return water dam. A pool wall will be constructed by dry stacking and cyclone, followed by a length of floating walkway to the barge. Submersible pumps will be suspended from the barge into the pool.

Solution Trench

The TSF extension will operate on the same basis as the current facility, with a ring trench along the starter wall toe to collect seepage and return water and convey these streams to the return water dam.

Drainage

A clean water cut-off trench and berm (cut-to-fill) will be constructed to the north of the extension in order to intercept and discharge clean storm water runoff approaching the TSF and discharge the water away from the affected footprint into the receiving environment.

TSF Underdrainage

A toe-drain and a blanket-drain, hydraulically linked by link-drains, will be provided to draw down the phreatic surface which develops in the TSF and thereby increase stability. The toe drain will be provided with outlet pipes into the solution trench. The underdrains will consist of HDPE pipes with drilled round openings, encapsulated in washed stone and covered with sequential filter layers to prevent blockage by fines material.

9.2 Environmental attributes of preferred alternatives

9.2.1 Option 3

Conceptual Site Model

The conceptual hydrogeological model for the Tailings locality Option 3 is detailed in the section below. The conceptual hydrogeological model has been developed based on hydrogeological studies and environmental engineering project completed between 2008 -2016 (GCS, 2008, 2014, 2015 and 2016 and Golder 2014, 2015 and 2016).

Location

The Option 3 site is located 3.8 km north of Stilfontein.

Topography and drainage

The site is located in quaternary catchment C24A which forms part of the Vaal Water Management Area. The regionally topography slopes from the north toward the Vaal in south. The Koekemoer Spruit drains the quaternary catchment and as such surface water flows in an easterly direction relation to the Option 3 position. The southern portion of the quaternary catchment has been extensively mined.

Rainfall

The site is characterised by summer rainfall conditions. The mean annual precipitation (MAP) is in the order of 556 mm/a.

Land use and dewatering history

The Klerksdorp, Orkney, Stilfontein and Hartbeesfontein (KOSH) mining complex has been the site of deep underground mining and more recently surface re-mining operations for many decades. The KOSH area was mined as a number of distinct underground operations, with many connections between adjacent mine workings. Each active mining operation managed underground dewatering individually to provide safe access to the ore resources. However, as these mining operations are discontinued, active mine lease areas now receive water from the various up dip mine lease areas, where operations have ceased (Golder, 2016).

The gold ore body dips in a southerly direction with the deeper AGA operations south of the Vaal River dependant on up-dip mines to maintain dewatering operations. Thus even following cessation of mining at Stilfontein Mine in 2002, groundwater abstraction at Margret shaft continued.

Groundwater abstraction in the order of 25 000 m^3/d is pumped from the Margret shaft and discharge to the nearby Koekemoer Spruit.

The area is characterised by numerous tailings storage facilities, many of which are being re-worked.

Geology

The Option 3 tailings site is underlain by Malmani dolomites which dip gently in a south easterly direction. The dolomites are in turn underlain by the Witwatersrand fractured quartzite, shales and Golder bearing conglomerates.

Hydrogeology

Hydrogeological zones

The most significant aquifers in the region comprise the Malmani dolomites. The primary permeability of the dolomites is low, however where the dolomites are chert rich and karst features have developed the

permeability significantly increases. The main hydrogeological zones identified in previous studies are summarised below;

- Eastern shallow dolomite aquifer zone;

  The shallow dolomites were inferred to extend to a maximum thickness of 30 mbgl. The weathered dolomites are in turn underlain by solid and fractured dolomites which extend to a depth of 60 mbgl. Site investigations found an increase in chert rubble toward the southern area of the footprint indicating the contact of the Oaktree (chert poor dolomites) and the Monte Christo (chert rich dolomites). It is estimated that approximately 70% of the site is underlain by the chert poor dolomites.

- Fractured quartzite/conglomerate and shale aquifer;

  The fractured rock aquifer underlies the dolomitic aquifer. The permeability of the aquifer is controlled by the dense network of fractures which characterise this aquifer zone.

- Dyke and fault zone;

  A dyke/fault zone with a north-south strike traverses the footprint of the Option 3 site. The weathered and fractured margins of dolerite dykes emplaced in the Malmani dolomites are well known to act as preferential flow pathways for groundwater flow and contaminant migration.

Aquifer parameters

The aquifer parameters interpreted by GCS (2008) found that;

- Solid dolomites have low conductivity values in the order of 0.0014 m/d;
- Weathered dolomites have a mean conductivity in the order of 0.25 m//d; and
- Karst and dyke structures are estimated to have conductivity values in the order of 6.6 m/d.

Recharge

Recharge to the Malmani dolomites is estimated to be in the order of 6% - 12% of MAP which equates to 33 mm/a - 66 mm/a (GCS, 2008).

Water levels and flow directions and groundwater velocity

As part of the study undertaken by GCS (2008), 16 shallow characterisation boreholes were drilled and tested. Water levels were all shallower than 11 mbgl.

A significant correlation was observed between hydraulic head and topography which indicates groundwater flow in the shallow aquifer zone is expected to mimic surface topography. In relation to the Option 3 tailings site, this indicates that groundwater will flow toward the Koekemoer Spruit, east of the site. Pretorius (2004) found that water levels in the shallow aquifer zone in this area do not reflect the extensive dewatering of the underground shafts and as such the deeper fractured aquifer zone is inferred to be confined to semi-confined. Deep and shallow borehole pairs are required in order to confirm this inference.

In conceptualisation of Option 3 as a potential site for the TSF, it was envisioned that dewatering of the Margret shaft is resulting in dewatering of the shallow aquifer beneath the tailings. However based on the water levels and hydraulic head contours, flow toward the Margaret Shaft is not supported. As such should an unlined facility be placed on the dolomites it is not expected for seepage to migrate to the Margret Shaft but rather it is expected that seepage will migrate toward the Koekemoer Spruit.

Based on the parameters indicated below the seepage velocity is in the order of 25 m per year. However, should the TSF be constructed without a liner it is probable that the resulting mounding could enhance the head gradient between the Koekemoer Spruit and the TSF resulting in an increased seepage velocity.

Table 11: Seepage Velocity – Option 3 - based on field data collected by GCS (2008)

Parameter	Value
Head at BH 4 (mamsl)	1369.98
Head at BH 2 (mamsl)	1336.57
Length (m)	4400
Porosity (n) (%)	3%
Hydraulic conductivity (m/d)	0.25
Vs (m/year)	25m per year

Potential receptors

The primary receptor in the vicinity of the proposed tailings site is the Koekemoer Spruit which is located 2 km east of the proposed TSF. Based on the groundwater flow contours, contamination migration could be expected to impact on the river over time.

Groundwater quality and expected seepage qualities

The water quality in proximity of the Option 3 site has been significantly impacted by the historical tailings storage facilities immediately south of Option 3. Updated sampling is required to confirm if the contamination generated from these facilities is migrating toward the Margret shaft or easterly toward the Koekemoer Spruit.

Based on the information obtained from the Kareerand tailings, seepage water quality from the existing tailings displays sulphate concentrations in the order of 1500 mg/l. As such seepage from the tailings will have an impact on background groundwater concentrations and may therefore potentially impact on the water quality of the Koekemoer Spruit.

Contamination migration from the TSF is expected to occur primarily in the upper weathered aquifer zone, i.e. shallower than 30 mbgl. In addition to contaminant flow in the shallow aquifer zone a component of contaminated seepage is expected to move vertical along the fracture zones associated with the fractured quartzite's and conglomerates.

Schematic conceptual hydrogeological model

The conceptual hydrogeological model described above is presented schematically in Figure 9 and Figure 11. The schematic depicts the conditions likely to prevail where (i) no mitigation is considered, where (ii) a liner is installed and (iii) where other mitigation options are considered.

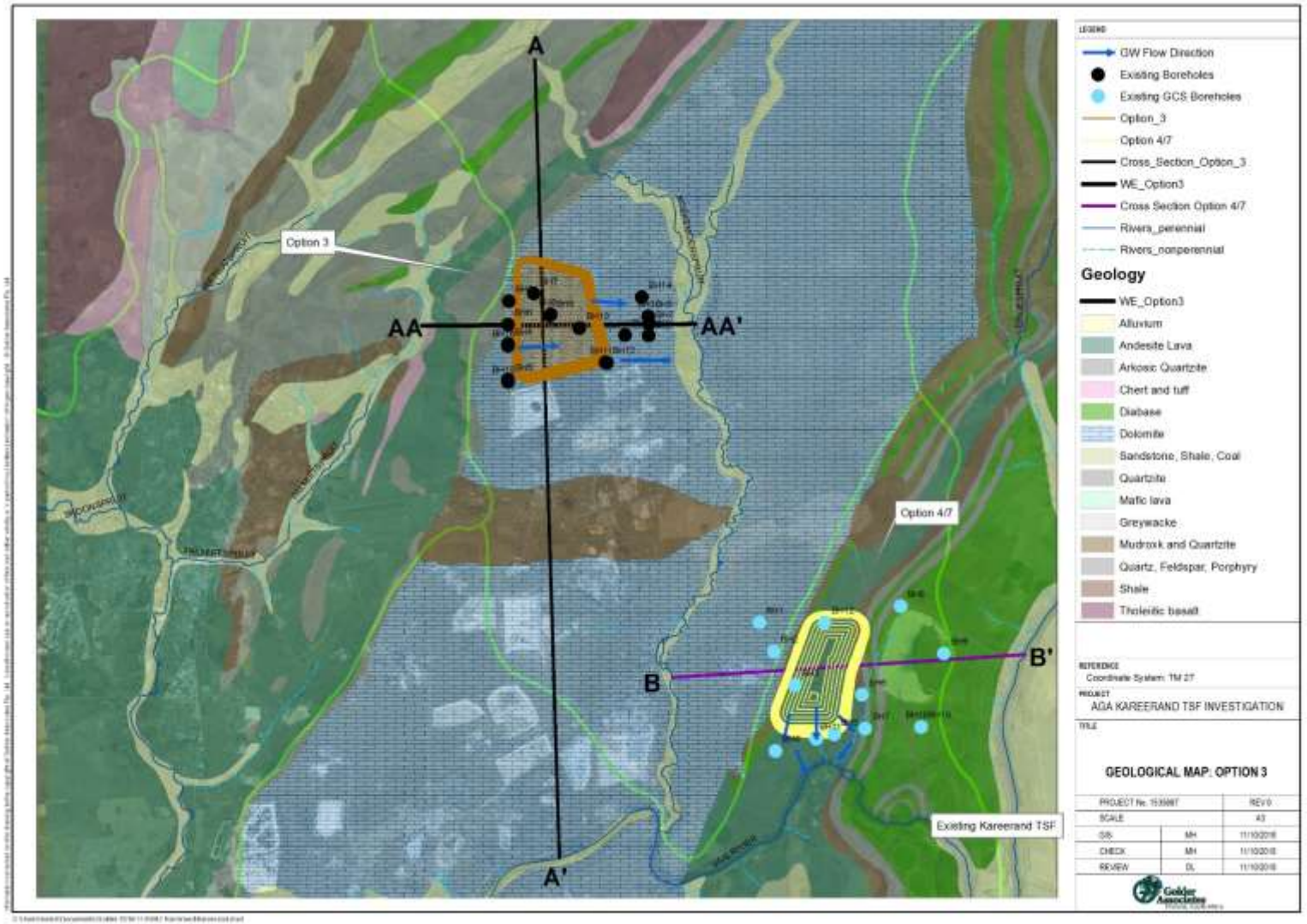
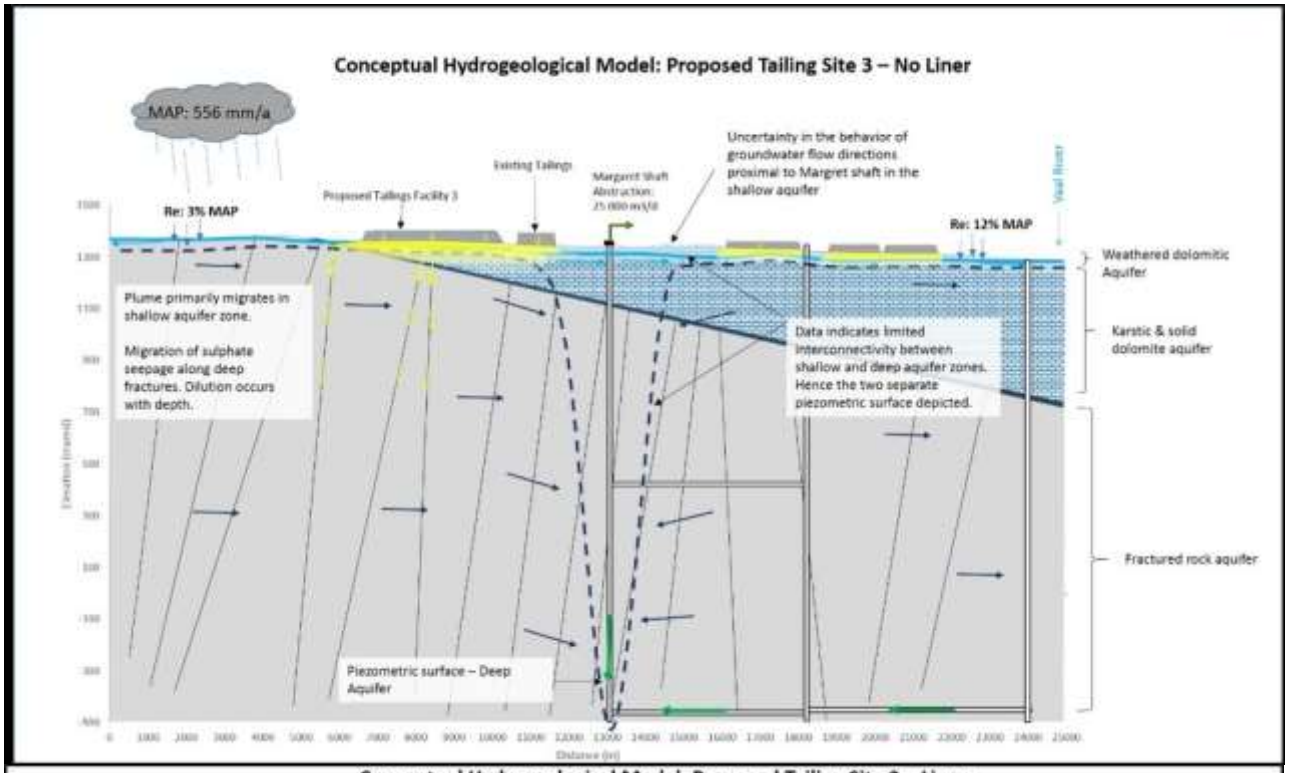
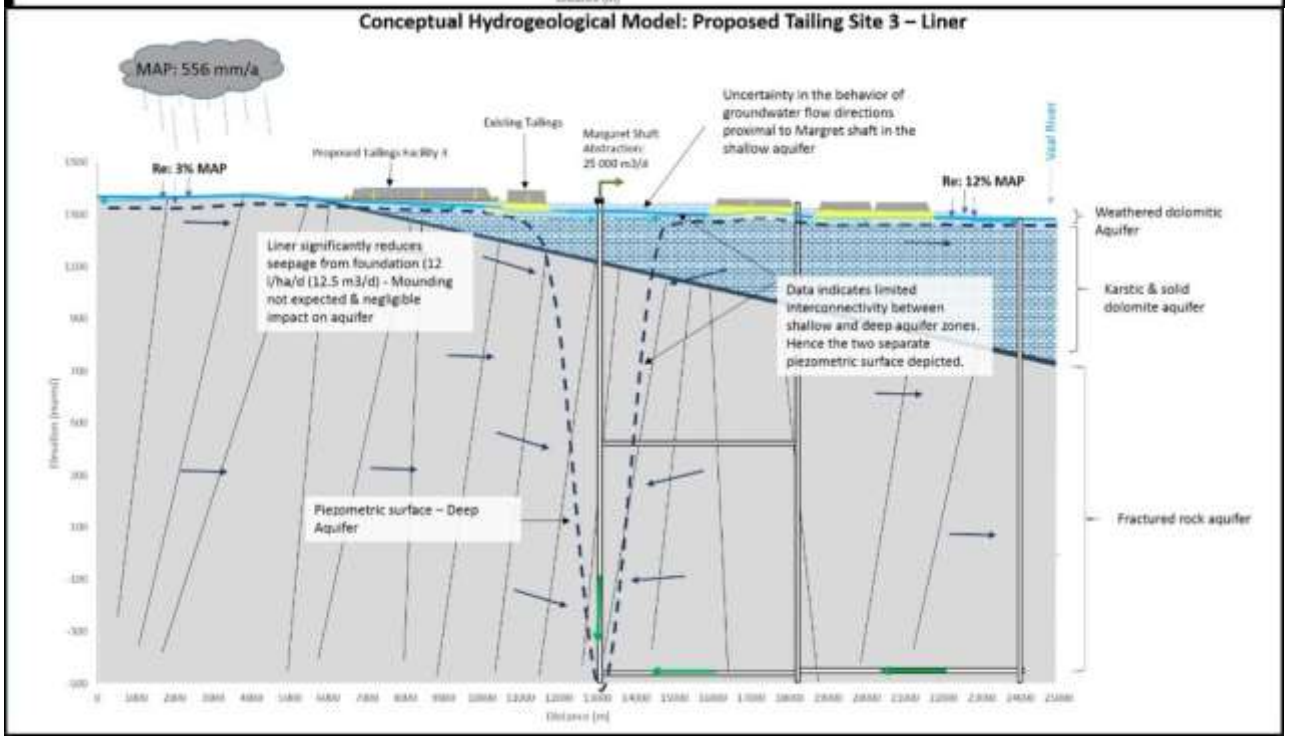


Figure 8: Geological Map of the study area - Option 3


Conceptual Hydrogeological Model: Proposed Tailing Site 3 – No Liner
MAP: 556 mm/a
Re: 3% MAP
Re: 12% MAP
Uncertainty in the behavior of groundwater flow directions proximal to Margret shaft in the shallow aquifer
Plume primarily migrates in shallow aquifer zone.
Migration of sulphate seepage along deep fractures. Dilution occurs with depth.
Data indicates limited interconnectivity between shallow and deep aquifer zones. Hence the two separate piezometric surface depicted.
Weathered dolomitic Aquifer
Karstic & solid dolomite aquifer
Fractured rock aquifer
Piezometric surface – Deep Aquifer


Conceptual Hydrogeological Model: Proposed Tailing Site 3 – Liner
MAP: 556 mm/a
Re: 3% MAP
Re: 12% MAP
Uncertainty in the behavior of groundwater flow directions proximal to Margret shaft in the shallow aquifer
Liner significantly reduces seepage from foundation (12 l/ha/d (12.5 m3/d) - Mounding not expected & negligible impact on aquifer
Data indicates limited interconnectivity between shallow and deep aquifer zones. Hence the two separate piezometric surface depicted.
Weathered dolomitic Aquifer
Karstic & solid dolomite aquifer
Fractured rock aquifer
Piezometric surface – Deep Aquifer

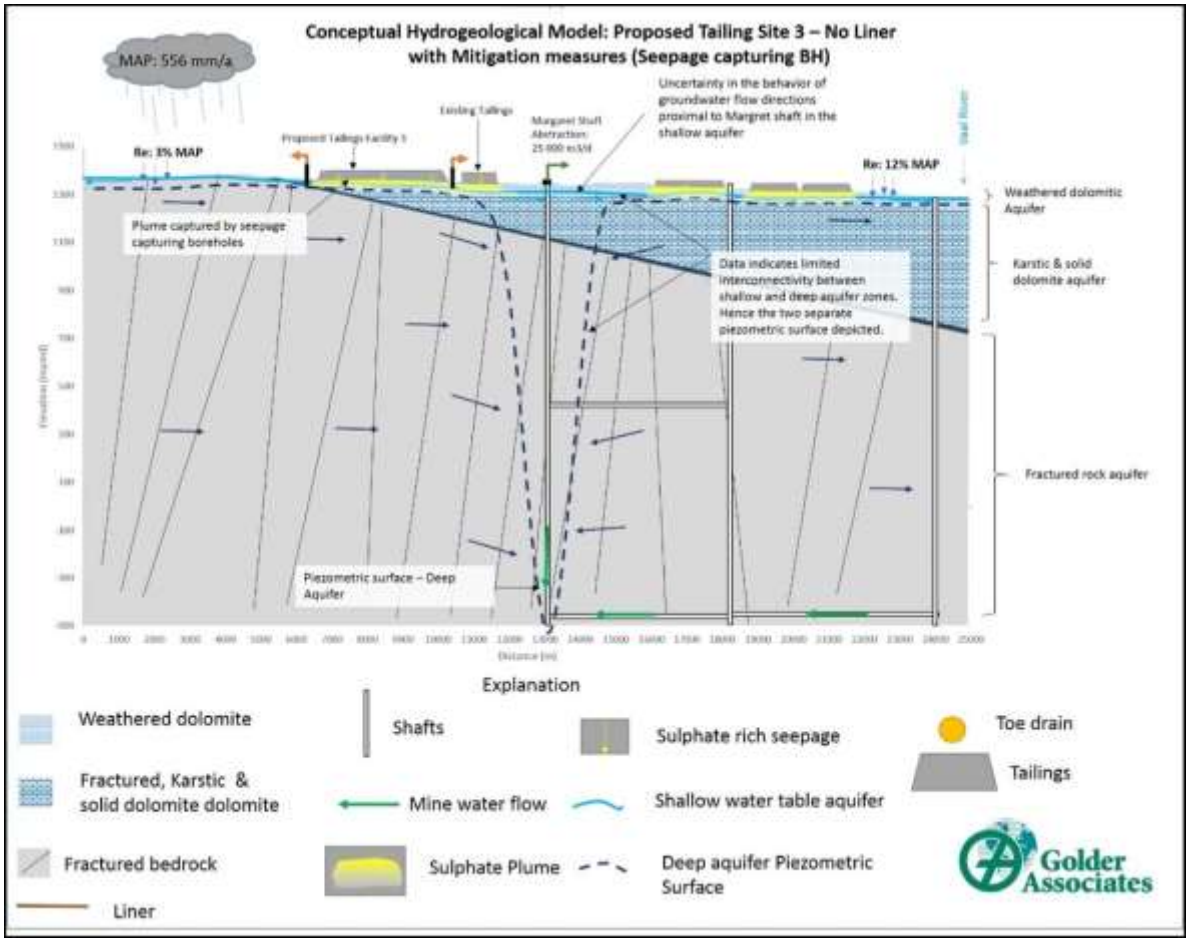
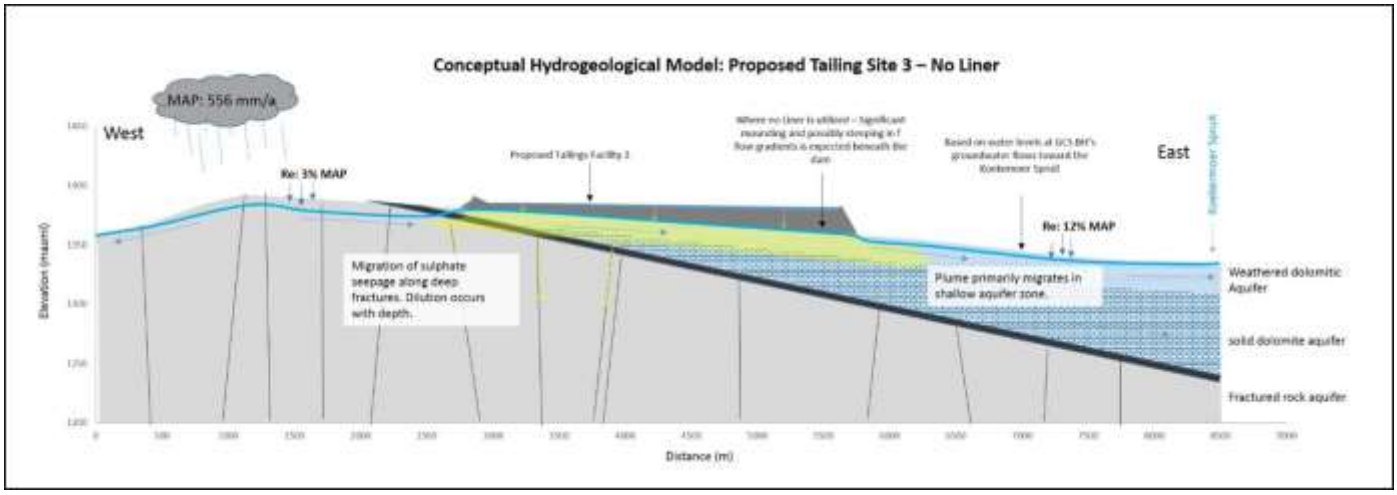
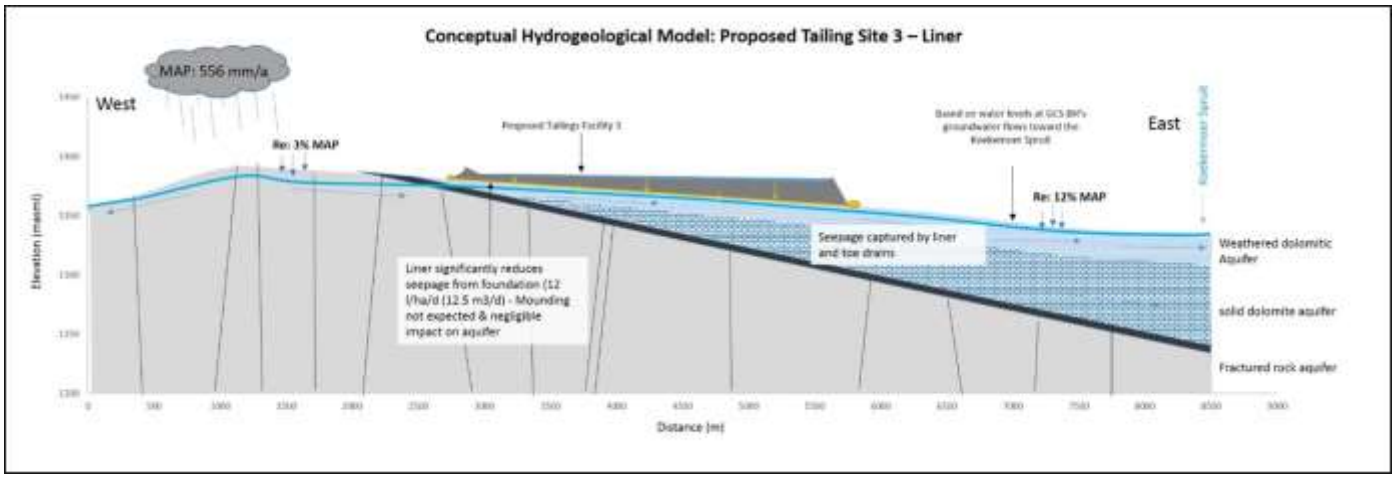


Figure 9: Conceptual Hydrogeological Model – Proposed Tailings: Option 3 (North – South (A-A')





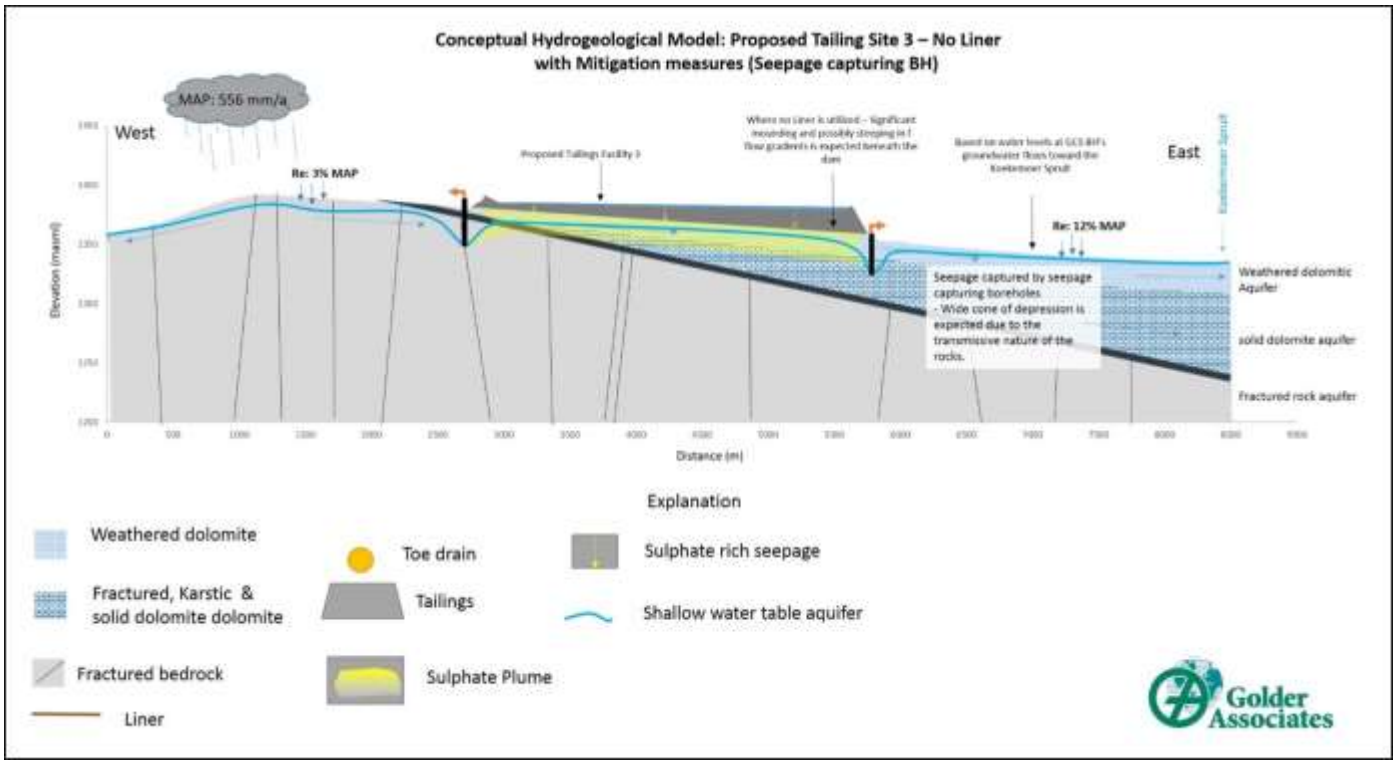


Figure 10: Conceptual Hydrogeological Model – Proposed Tailings: Option 3 (West -East (AA-AA')

Interception of Contaminated Seepage

Interception of contaminated seepage water options include the following;

- Compliant: Class C barrier system.

Alternative interception techniques may include:

- Interception by Margaret # pump and treat station;
- Based on review of the data, there is a risk that complete interception of contaminated seepage water by the Margret shaft pumping may not occur due to the current groundwater flow in the shallow weathered horizon towards the Koekemoer Spruit. However, an updated hydrocensus must be undertaken to confirm this finding;
- Seepage capture boreholes;

  Aquifer testing of boreholes located on the proposed foot print of option 3 and representing the weathered dolomites (< 15 mbgl) indicates that the aquifer has a high permeability and as such seepage capturing via boreholes is deemed a plausible method for capturing a plume associated with the proposed tailings.
- Interception trench;

  The drilled boreholes indicate a weathering depth of approximately 15 m, thus it is unlikely that a cut-off trench will prove to be effective in containing contamination associated with the tailings. In addition the deeper aquifer zone is envisioned to be highly fractured and thus deep vertical migration of contamination is expected thus rendering the cut-off trench ineffective.

Further Investigations Required

Should this option be investigated further the recommended follow up confirmatory work is outlined below;

- Hydrocensus;

  A detailed hydrocensus is required in order to confirm the flow directions of groundwater in the shallow aquifer zone.
- Geophysical survey;

  It is necessary to undertake a high resolution gravity survey over the Footprint of Option 3 in order to confirm the sinkhole risk status.
- Drilling program and aquifer testing;

  Extensive drilling was undertaken in the preceding study undertaken for the site. However, information on the water levels and groundwater flow direction behaviour for the deep fractured aquifer (underlying the dolomites) is required to be understood in order to definitively establish whether or not seepage from the tailings will flow toward the Margaret shaft or the Koekemoer Spruit.
- Source-Pathway-receptor modelling;
- Speciation modelling of seepage + deep groundwater;
- Seepage modelling;

  Seepage modelling in order to estimate the flow through the tailings impoundment. This is necessary information to guide the numerical flow model which in turn will guide, for example, the number and position of boreholes required for seepage capture.
- Groundwater flow and contaminant transport model to demonstrate plume capture by alternative options;

As described above, a detailed groundwater flow model is required in order to determine the effectiveness of the possible mitigation strategies conceptualised.

- Design of monitoring system;

  On completion of modelling a detailed water management plan is required to be developed for the operational phase of the TSF.

9.2.2 Option 4/7

Conceptual Site Model

The conceptual hydrogeological model for the tailings locality option 4/7 is detailed in the section below. The conceptual hydrogeological model has been developed based on hydrogeological studies and environmental engineering project completed between 2008 -2016 (GCS, 2008, 2014, 2015 and 2016 and Golder 2014, 2015 and 2016).

Location

Tailings option 4/7 is located 2.5 km south of the Khuma settlement and 9.5 km south east of Stilfontein. The tailings option is positioned ~700 m west of the existing Kareerand Tailings impoundment which was constructed in 2008.

Topography and drainage

The proposed tailings is located in quaternary catchment C24B which forms part of the Vaal Water Management Area. The Vaal River is located approximately 900 m south of the proposed TSF site and 4.6 km east of Option 4/7. The southerly flowing Koekemoer Spruit is located 3 km west of the proposed tailings position.

The local topography slopes in a southerly direction. A non-perennial drainage line runs between the existing tailings and the proposed TSF site.

Rainfall

The site is characterised by summer rainfall conditions. The Mean annual precipitation (MAP) is in the order of 556 mm/a.

Land use

The land use proximal to the proposed tailings option is dominated by gold mining activities. South of the Vaal River, the land is extensively utilised for agriculture. North of the proposed TSF the Khuma settlement has been developed.

Geology

Geological units significant to the investigation area include;

- Malmani dolomites which outcrop west of the proposed tailings and which are documented to dip at 50^0 toward the east;
- Andesite lava of the Hekpoort formation which underlies Option 4/7 TSF site;
- Shale and quartzite strata of the Strubenkop and Daspoort formations; and
- Diabase located east of the proposed tailings and which underlays the existing Kareerand TSF.

Hydrogeology

The GCS (2008) study documented the drilling and pumping tests results of boreholes located proximal to Option 4/7. The majority of boreholes were drilled to intersect the andesite underlying the proposed footprint and the diabase east of the proposed footprint. The andesite typically showed higher blow yields and higher estimated hydraulic conductivity relative to the adjacent diabase strata in which boreholes were typically dry. Weathering is present to depths of 20 - 30 m below surface level.

Hydrogeological zones

As such the geology was subdivided into three main hydrogeological zones (GCS, 2008);

- Dolomites (Upper weathered and deeper fractured and karstic) –(Major to moderate aquifer zone):

  The estimated hydraulic conductivity values for the dolomites based on pumping tests conducted are 0.25 m/d for the shallow weathered zone and 0.001 m/d where the dolomites are solid. Where cavities occur the dolomites were estimated to have hydraulic conductivities of 6.6 m/d.

- Andesite lava – (Moderate to minor aquifer zone):

  The estimated hydraulic conductivity for the Andesite lavas is in the order of 0.09 m/d. While not apparent from the hydraulic conductivity values relative to those presented for the diabase, the Andesite is viewed to be a more transmissive aquifer than the Diabase based on the number of boreholes with moderate blow yields during drilling compared with the number of dry boreholes drilled in the Diabase.

- Diabase, shale and Quartzite (Minor aquifer zone):

  The geometric mean of the data reflecting the diabase strata was in the order of 0.09 m/d. This is likely over estimated due to the fact that only boreholes with sufficient water could be tested, many boreholes drilled in the Diabase were dry.

Recharge

The major source of recharge to the aquifers in the area is rainfall the estimates of recharge on the various hydrogeological units are provided below as a percentage of MAP (Golder, 2016).

- Dolomite: 12% of MAP;
- Andesite lava: 4.5% of MAP; and
- Diabase: 2% of MAP.

Water levels and flow directions and groundwater velocity

The GCS (2008) study found there to be suitable correlation between topography and the hydraulic head elevation of the shallow aquifer zone to infer that groundwater flow directions are expected to mimic surface topography and hence groundwater from the proposed tailings areas is expected to flow toward the Vaal River.

The average water levels in the andesitic lava is 15 mbgl, while the average water level depths for the diabase are 23.79 mbgl. The latter deeper water levels are inferred to be a consequence of reduced hydraulic characteristics of the diabase (GCS, 2008).

The groundwater flow velocity is estimated to be in the order of 2m per year based on the parameters outlined below.

Table 12: Seepage velocity based on field data collected by GCS (2008)

Parameter	Value
Head at BH 12 (mamsl)	1302.88
Head at BH 11 (mamsl)	1294.88
Length (m)	3700
Porosity (n) (%)	3%
Hydraulic conductivity (m/d)	0.09
Vs (m/year)	2.3 m per year

The flow velocity may increase substantially due to a steeper flow gradient imparted on the system by the head on the tailings once operational, i.e. if the head at the tailings increases by 15 m, the expected flow velocity could increase up to 75 m per year. With no liner this type of condition is realistic as it was seen at the Kareerand TSF that water levels increased from 10 mbgl to <1 mbgl since initiation of the operation.

In addition, preferential flow pathways may not have been determined and as such fluid flow may be faster than anticipated above. This data gap needs to be closed through detailed resistivity surveying of the footprint of the TSF site.

Potential receptors

There are no current groundwater users between the proposed tailings and the Vaal River. The major receptors (hydrological and dependent biological receptors) are inferred to be the non-perennial drainage line that runs between the existing and proposed tailings and the Vaal River downgradient of the TSF site.

Salts associated with TSF seepage which may accumulate in the drainage line during low rainfall periods are expected to be mobilised during wet periods and flow into the Vaal system. In addition the shallow groundwater is inferred to leave the aquifer zone as base flow contribution to the Vaal approximately 900 m south of the tailings.

Groundwater quality and expected seepage qualities

Water quality of boreholes proximal to the proposed tailings facility was found to be of pristine water quality relative to the recommended limits for stock watering and domestic supply. Sulphate is a key parameter in identifying seepage associated with oxidation of sulphide minerals in mine waste. The geometric mean of sulphate based on the available 2008 dataset is <7 mg/l.

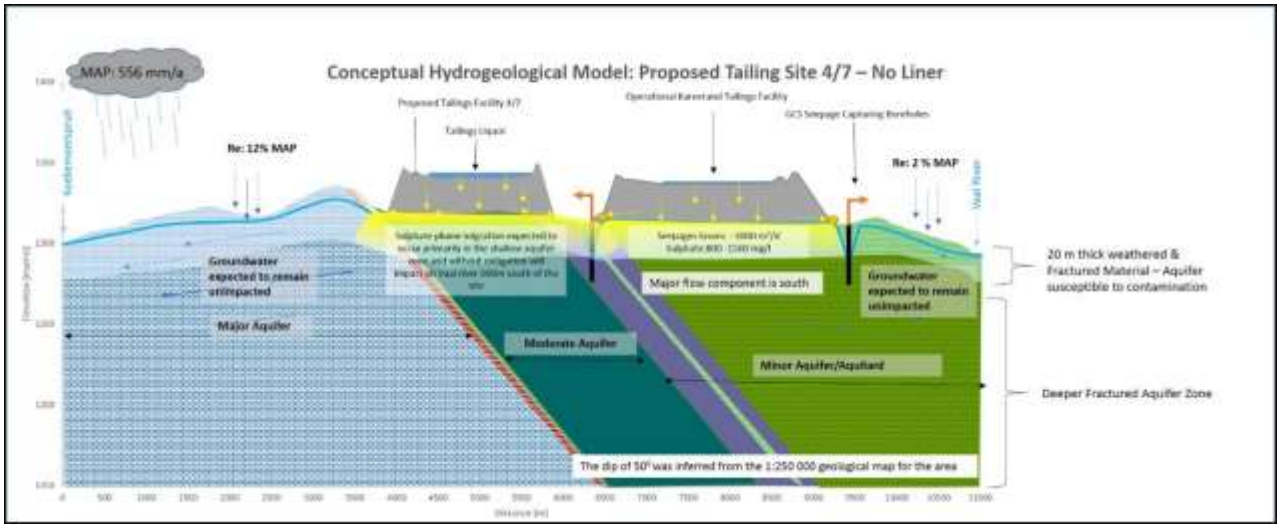
Seepage water quality from the existing tailings displayed sulphate concentrations in the order of 1500 mg/l. As such seepage from the tailings will have an impact on background groundwater concentrations and may potentially impact on concentrations of the surface streams.

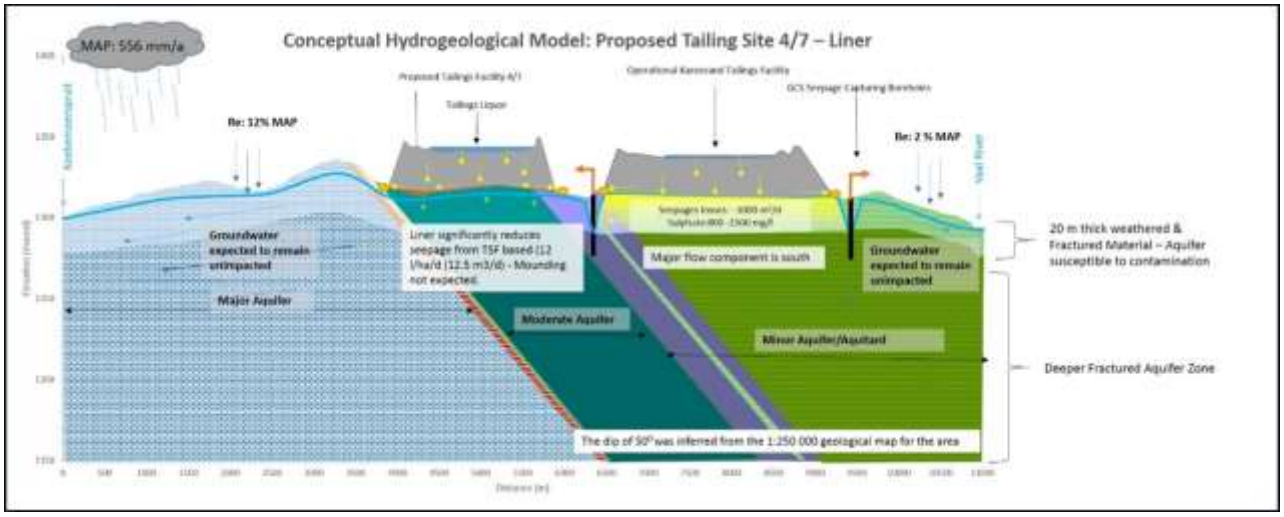
Contamination migration is expected to occur primarily in the upper weathered aquifer zone, i.e. shallower than 20 mbgl.

Schematic conceptual hydrogeological model

The conceptual hydrogeological model described above is presented schematically in Figure 12. The schematic depicts the conditions likely to prevail where (i) no mitigation is considered, where (ii) a liner is installed and (iii) where other mitigation options are considered.

Figure 11: Geological Map: Option 4/7


Conceptual Hydrogeological Model: Proposed Tailing Site 4/7 – No Liner
MAP: 556 mm/a
Re: 12% MAP
Re: 2 % MAP
Groundwater expected to remain unimpacted
Major Aquifer
Major flow component is south
Moderate Aquifer
Minor Aquifer/Aquitard
Groundwater expected to remain unimpacted
20 m thick weathered & Fractured Material – Aquifer susceptible to contamination
Deeper Fractured Aquifer Zone
The dip of 50° was inferred from the 1:250 000 geological map for the area


Conceptual Hydrogeological Model: Proposed Tailing Site 4/7 – Liner
MAP: 556 mm/a
Re: 12% MAP
Re: 2 % MAP
Groundwater expected to remain unimpacted
Liner significantly reduces seepage from TSF based (12 l/ha/d (12.5 m3/d) - Mounding not expected.
Major Aquifer
Major flow component is south
Moderate Aquifer
Minor Aquifer/Aquitard
Groundwater expected to remain unimpacted
20 m thick weathered & Fractured Material – Aquifer susceptible to contamination
Deeper Fractured Aquifer Zone
The dip of 50° was inferred from the 1:250 000 geological map for the area

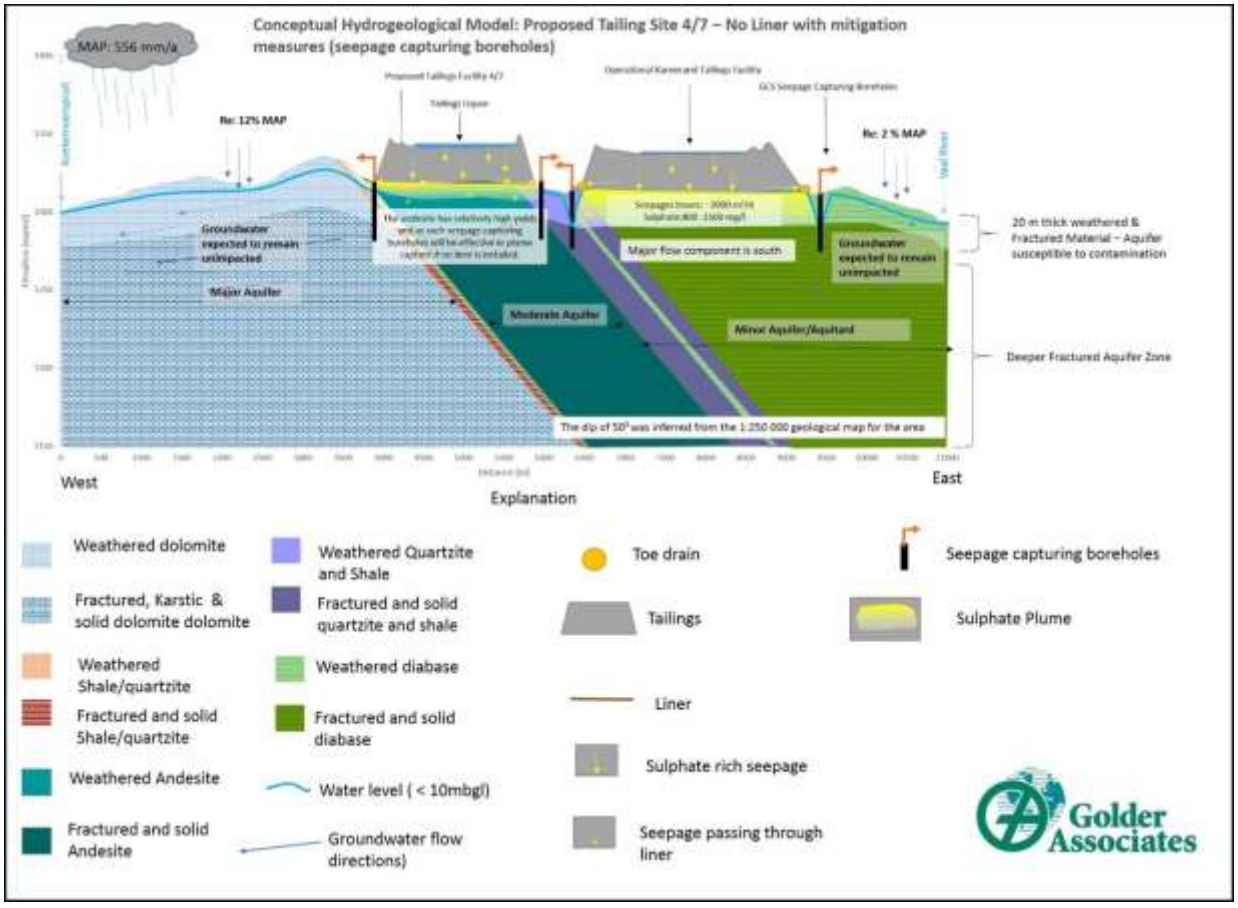


Figure 12: Conceptual Hydrogeological Model – Proposed Tailings: site 4/7 (West – East B-B')

Interception of Contaminated Seepage

Interception of contaminated seepage options include the following;

- Compliant: Class C barrier system

Alternative interception techniques may include;

- Seepage capture boreholes:

  The data review indicated that the andesite which underlies the proposed facility had relatively high blow yields during drilling and moderate hydraulic conductivity values confirmed by pump testing. As a result it is concluded that seepage capturing boreholes will be effective in this strata as a significant radius of influence can be developed around abstraction boreholes.

  Due to the proximity of the Vaal River, the seepage capturing boreholes and monitoring boreholes will be required to be located close to the footprint of the TSF to ensure early detection of seepage and prompt action to avoid impact on the receptor.

- Interception trench:

  The drilled boreholes indicate a weathering depth of approximately 20 m. Due to the potential depth of contaminated seepage, the installation of a trench is not deemed a viable option.

- Pre-split (preferential pathway to interception point):

  A pre-split with an interception point is viewed to be a potentially feasible strategy. The method relies upon developing a preferential flow zone along which the contaminated seepage associated with the tailings will be directed and abstracted via interception points (pump out boreholes drilled into the pre-split ground).

- Sub-surface funnel and gate system:

  The method relies upon developing an impermeable trench (bentonite/cement) functioning as funnel along which contaminated seepage will be constrained to flow. Contaminated seepage can then be intersected at a gate in the funnel.

  Similarly to the construction of a trench, the funnel and gate system is not viewed to be a viable option due to the potential depth of the seepage.

Reuse of Captured Seepage

Contaminated seepage collected via any of the above listed methods can likely be re-used as plant make-up water.

Further Investigations Required

Confirm sinkhole risk status, especially on western side of site where the dolomite sub-outcrop will be relatively shallow.

Source-Pathway-receptor modelling:

- Hydrogeological field study:

Geophysics

As outlined in the preceding sections, significant work has been undertaken on and proximal to the Option 4/7 footprint. However, the following gaps and associated field work requirements include;

A magnetic survey was previously conducted in vicinity of the Option 4/7 footprint in order to site characterisation boreholes.

It is recommended that a detailed resistivity survey be undertaken over the footprint to support the magnetic survey and confirm the absence (or presence) of any large fault structures beneath the footprint.

- This is necessary due to the potential risk associated with any as yet unknown potential preferential flow zone beneath the facility.

Drilling and aquifer testing

The existing drilling and aquifer testing is deemed suitable for characterisation of the aquifer. However, should the geophysical survey identify any preferential flow zones or possibly sinkholes (particularly on the western extent of the proposed TSF), additional drilling and testing will be required.

Hydrocensus

An update of groundwater water levels and water quality data is required in order to develop a model representative of present conditions.

- Seepage modelling:

  Seepage modelling in order to estimate the flow through the tailings impoundment. This is necessary information to guide the numerical flow model which in turn will guide, for example, the number and position of boreholes required for seepage capture.

- Groundwater flow and contaminant transport model to demonstrate plume capture by alternative options:

  As described above, a detailed groundwater flow model is required in order to determine the effectiveness of the possible mitigation strategies conceptualised.

- Development and implementation of a system-wide groundwater management plan in collaboration with GCS work on Kareerand;

- Design of monitoring system, including rapid early warning system:

  The monitoring system will be developed on completion of the recommended field work and modelling.

10.0 TSF OPTION COMPARISON AND CAPITAL COSTS

The Options Analysis Matrix, now updated to include Option 4-7, is attached in APPENDIX D. The options analysis process found Options 3 and 4-7 to be the most favourable candidates to take forward to feasibility evaluation.

Table 13 below provides capital costs (refer APPENDIX C for details) for the options, as well as various geometric features:

Table 13: Comparison: - Option 3 and Option 4-7 a, b

Parameter	Option 3 Unlined on Dolomite	Option 4-7a Lined	Option 4-7b Unlined
Capital Cost (ZAR) excl. fixed cost and time related P & G items, contingencies, VAT	537,404,758.00	1,348,646,579.00	535,865,546.00
Footprint Area Required (m^2)	9,881,305.00	8,896,806.00	8,896,806.00
Tailings Tonnage Available (t)	561,000,000.00	563,000,000.00	563,000,000.00
Height Required (m)	72.2	85.5	85.5

Parameter	Option 3 Unlined on Dolomite	Option 4-7a Lined	Option 4-7b Unlined
Pumping Distance (tailings) – 3 x 500 mm diameter steel pipes (m)	4,542.00	18,706.00	18,706.00
New steel pipe tailings pipe (m) – 500 mm diameter	13,626.00	6,759.00	6,759.00
Pumping Distance (water) – 800 mm diameter steel pipe (m)	5,576.00	16,036.00	16,036.00
New steel water pipe (m) – 800 mm diameter	5,576.00	302.00	302.00
Tonnage per m^2 (t/m^2)	56.80	63.30	63.30
Capital per m^2 (ZAR excl. fixed cost and time related P & G items, contingencies, VAT	54.40	151.60	60.20
Capital per t (ZAR excl. fixed cost and time related P & G items, contingencies, VAT **(baselined to 560 Mt)**	0.96	2.41	0.96

Note: - cost ratios shown reflect total capital costs for all works per option as per Schedule of Quantities.

The following observations are pertinent:

- Option 4-7 provides more tonnage per m^2 of footprint. This is because the narrower shapes results in shorter beaches and hence a shallower depression. The larger and “squarer” option 3 footprint offers more scope for increasing height;
- Comparing the two unlined options i.e. Option 3 and Option 4-7b, capital outlay per tonnage are similar although Option 4-7b requires substantially less purchase of new pipe;
- A saving in operational costs can be achieved with Option 3 due to the shorter pumping distances and the omission of a tailings pump station at the TSF; and
- The capital costs per m^2 are more favourable in the case of Option 3 which reflects that its footprint size and location, as well as its geometry, offer a more favourable capital prospect, especially if raising is considered. Moreover operational costs in terms of power consumption and maintenance will be lower.

11.0 SUSTAINABLE DEVELOPMENT CONSIDERATIONS

Sustainability of tailings deposition can be seen in two contexts by MWS. The first of these is the sustainability of the MWS operations so as to facilitate optimum exploitation of the minerals resources available to the company. From this perspective an affordable disposal site needs to found that can provide for the full mining reserve of 566 million tons of tailings. A site that will have excessive capital and operating costs will therefore render the operation unsustainable. Reserves that might otherwise be exploited will be left in place and will need to be rehabilitated in situ.

The second perspective is from the vantage point of the community. The local environment is already associated with mining and tailings in particular that will continue to impact on the environment for a long time to come. These impacts may never be mitigated given the practical limitations to what can be done. A new mega tailings facility therefore represents an opportunity for the region to bring about a significant

improvement by removing all the current diffuse sources of potential contamination and consolidating them into a single facility capable of storing the orphan tailings facilities dotted around the area.

The latter perspective is one that provides a context for this project. It is not so much about whether a new tailings dam can be established but whether the project will bring about a significant net positive impact on the social, economic and physical environment. This objective can be achieved simply by bringing economic and social benefit by continuing to provide employment in the region. Furthermore a net positive impact can be created by removing most of the tailings facilities in the close proximity of some communities and replacing them with one facility suitably located to minimise impact on community quality of life.

It is therefore important to approach the project with a positive net impact in mind as well as a commitment to engineer a new facility that will perform better than the past tailings facilities have done.

12.0 REGULATORY PROCESS

A site-specific Integrated Regulatory Process (IRP) is proposed for the Kareerand TSF taking into consideration the below-listed key environmental legislation applicable to the proposed TSF.

Triggered activities requiring authorisation(s) in terms of relevant environmental legislation

National Environmental Management Act (NEMA)

Should an activity listed in the EIA Regulations 983, 984 and/or 985 (of December 2014) be triggered, then an application for Environmental Authorisation is required, supported by either a Basic Assessment or Environmental Impact Assessment (EIA) process, outlined in the EIA Regulation 982 (of December 2014). A preliminary list of activities that could be triggered by the proposed TSF is provided in Table 14 below.

Table 14: Preliminary list of activities triggered in terms of the EIA Regulations

Listed Activity	Relevance to proposed TSF
GN R.983, Listed Activity 10 (alternatively, Listed Activity 46 for expansion[1] of existing pipe network): The development[2] and related operation of infrastructure exceeding 1000 metres in length for the bulk transportation of sewage, effluent, process water, waste water, return water, industrial discharge or slimes (i) with an internal diameter of 0,36 metres or more; or (ii) with a peak throughput of 120 litres per second or more; excluding where- (a) such infrastructure is for bulk transportation of sewage, effluent, process water, waste water, return water, industrial discharge or slimes inside a road reserve; or (b) where such development will occur within an urban area.	Should new slurry/return water pipelines exceeding the trigger thresholds need to be installed beyond the existing pipeline servitude, outside a road reserve, then an application for Environmental Authorisation, supported by a Basic Assessment, will be required for this Listed Activity.
GN R.983, Listed Activity 11 (alternatively, Listed Activity 47 for expansion/extension of existing electrical infrastructure): The development of facilities or infrastructure for the transmission and distribution of electricity- (i) outside urban areas or industrial complexes with a capacity of more than 33 but less than 275 kilovolts.	Should electrical infrastructure exceeding the trigger thresholds need to be installed to provide power for, e.g. pump systems, then an application for Environmental Authorisation, supported by a Basic Assessment, will be required for this Listed Activity.
GN R.983, Listed Activity 13: The development of facilities or infrastructure for the off-stream storage of water, including dams and reservoirs, with a combined capacity of 50000 cubic metres or more, unless such storage falls within the ambit of activity 16 in Listing Notice 2 of 2014.	Should the return water dam associated with the TSF exceed a capacity of 50000 cubic metres, then an application for Environmental Authorisation, supported by a Basic Assessment, will be required.
GN R.983, Listed Activity 24 (alternatively Listed Activity 54 for lengthening of existing roads): The development of- (ii) a road with a reserve wider than 13, 5 meters, or where no reserve exists where the road is wider than 8 metres.	Should a road wider exceeding the listed trigger thresholds need to be constructed to access the proposed TSF, then an application for Environmental Authorisation, supported by a Basic Assessment, will be required for this Listed Activity.
GN R.983, Listed Activity 46: The expansion and related operation of infrastructure for the bulk transportation of sewage, effluent, process water, waste water, return water, industrial discharge or slimes where the existing infrastructure- (i) has an internal diameter of 0,36 metres or more; or (ii) has a peak throughput of 120 litres per second or more; and (a) where the facility or infrastructure is expanded by more than 1000 metres in length; or (b) where the throughput capacity of the facility or infrastructure will be increased by 10% or more; excluding where such expansion- (aa) relates to transportation of sewage, effluent, process water, waste water, return water, industrial discharge or slimes within a road reserve.	In the event that existing slurry/return water pipelines are expanded outside a road reserve resulting in exceedances of the mentioned trigger thresholds, then an application for Environmental Authorisation, supported by a Basic Assessment, will be required for this Listed Activity.
GN R.983, Listed Activity 47: The expansion of facilities or infrastructure for the transmission and distribution of electricity where the expanded capacity will exceed 275 kilovolts and the development footprint will increase.	Should existing electrical infrastructure be expanded beyond the trigger thresholds to supply power to the proposed TSF operation, then an application for Environmental Authorisation, supported by a Basic Assessment, will be required.
GN R.983, Listed Activity 54: The widening of a road by more than	Where existing roads will be lengthened

[1] "expansion" means the modification, extension, alteration or upgrading of a facility, structure or infrastructure at which an activity takes place in such a manner that the capacity of the facility or the footprint of the activity is increased

[2] "development" means the building, erection, construction or establishment of a facility, structure or infrastructure, including associated earthworks or borrow pits, that is necessary for the undertaking of a listed or specified activity, including any associated post development monitoring, but excludes any modification, alteration or expansion of such a facility, structure or infrastructure, including associated earthworks or borrow pits, and excluding the redevelopment of the same facility in the same location, with the same capacity and footprint

Listed Activity	Relevance to proposed TSF
6 metres, or the lengthening of a road by more than 1 kilometre- (i) where the existing reserve is wider than 13,5 meters; or (ii) where no reserve exists, where the existing road is wider than 8 metres.	by more than 1 km to provide access to the proposed TSF, then an application for Environmental Authorisation, supported by a Basic Assessment, will be required for this Listed Activity.
GN R.984, Listed Activity 15: The clearance of an area of 20 hectares or more of indigenous vegetation[3].	In all likelihood indigenous vegetation will be cleared over an area in excess of 20 ha, during preparation of the TSF footprint, and hence an application for Environmental Authorisation, supported by a full EIA, will be required.
GN R.985, Listed Activity 12: The clearance of an area of 300 square metres or more of indigenous vegetation except (a) In Eastern Cape, Free State, Gauteng, Limpopo, North West and Western Cape provinces…iv. On land, where, at the time of the coming into effect of this Notice or thereafter such land was zoned open space, conservation or had an equivalent zoning.	The current zoning of the land associated with TSF Options 3 and 4/7 needs to be confirmed to determine whether this Listed Activity is triggered or not

Since an activity listed in GN R.984 is likely to be triggered, a full EIA process in terms of GN R.982 will need to be conducted, in support of an application for Environmental Authorisation in terms of the NEMA.

National Environmental Management Waste Act (NEMWA)

The proposed TSF will trigger the following Waste Management Activity listed in GN R.921 of November 2013, as amended by GN R.633 of July 2015:

- GN R.921, Category B, Activity 4(11): The establishment or reclamation of a residue stockpile or residue deposit resulting from activities which require a mining right, exploration right or production right in terms of the Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002).

Since a Category B activity is triggered, a full EIA process in terms of GN R.982 will need to be conducted, in support of an application for a Waste Management Licence in terms of the NEMWA.

In support of the application for a Waste Management Licence, it will need to be ensured that the requirements of the Regulations regarding the Planning and Management of Residue Stockpiles and Reside Deposits from a Prospecting, Mining, Exploration or Production Operation (GN R.632 of July 2015) are adhered to. These Regulations have detailed provisions on the management of residue stockpiles and deposits, including:

- Assessment of impacts;
- Analysis of the risks relating to the management thereof;
- Characterisation and classification of the waste material to identify any potential risks to health, safety and the environment;
- Site selection and designs; and
- Duties of Mining Rights holders regarding construction and operation; designs; water monitoring; preventative or remedial environmental measures; dust pollution and erosion; rehabilitation; maintenance and repair; monitoring and reporting; and decommissioning, closure and post closure management.

[3] "indigenous vegetation" refers to vegetation consisting of indigenous plant species occurring naturally in an area, regardless of the level of alien infestation and where the topsoil has not been lawfully disturbed during the preceding ten years

National Water Act (NWA), (Act 36 of 1998)

The NWA lists the following eleven water uses in Section 21 of the Act:

a) Taking water from a water resource;

b) Storing water;

c) Impeding or diverting the flow of water in a watercourse;

d) Engaging in a stream flow reduction activity contemplated in Section 36;

e) Engaging in a controlled activity identified as such in Section 37(1) or declared under Section 38(1);

f) Discharging waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or other conduit;

g) Disposing of waste in a manner which may detrimentally impact on a water resource;

h) Disposing in any manner of water which contains waste from, or which has been heated in, any industrial or power generation process;

i) Altering the bed, banks, course or characteristics of a watercourse;

j) Removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people; and

k) Using water for recreational purposes.

The proposed TSF will trigger a number of water uses in terms of Section 21 of the NWA: The application for a Water Use Licence in terms of the NWA would need to include, along with the relevant application forms, a technical supporting document, containing the relevant information required by the Department of Water and Sanitation (DWS) to inform the decision-making process. Such information would be similar to that listed in GN R.632 of July 2015.

Furthermore, the technical supporting document and especially the design of the facility would need to address the requirements of the Regulations on Use of Water for Mining and Related Activities aimed at the Protection of Water Resources (GN R.704 of June 1999), published under the NWA.

The TSF will in all likelihood need to be licensed as a dam with a safety risk in terms of Section 117 of the NWA, i.e. a dam which can contain, store or dam more than 50 000 cubic metres of water, whether that water contains any substance or not, and which has a wall of a vertical height of more than five metres, measured as the vertical difference between the lowest downstream ground elevation on the outside of the dam wall and the non-overspill crest level or the general top level of the dam wall.

National Nuclear Regulatory Act (NNRA)

Since the tailings contain radioactive elements, it is likely that the facility will be deemed to be a controlled area in terms of the NNRA; a Certificate of Registration (CoR) for the proposed TSF will therefore need to be obtained from the National Nuclear Regulator (NNR). As part of this process, a risk assessment will need to be conducted by a suitably qualified person.

National Heritage Resources Act (NHRA)

A Phase 1 heritage impact assessment (HIA) will need to be conducted on the footprint of the proposed TSF and related infrastructure (e.g. pipeline / road servitudes), to confirm if any heritage resources stand to be affected.

12.1.1 Recommended process to be followed

It is recommended that an integrated application for Environmental Authorisation and Waste Management Licence be applied for; one and the same EIA process could be used to support the integrated application. Furthermore, it is recommended that one public consultation process be followed for both the integrated

application for Environmental Authorisation and Waste Management Licence, and the application for a Water Use Licence. The radiation risk assessment and Phase 1 HIA can be conducted as part of the specialist studies during the EIA process.

The EIA and public consultation process will therefore be the key regulatory vehicle that will be used to meet the various legislative requirements.

The EIA process must comply with the requirements of Appendix 3 of GN R.982; the independent Environmental Assessment Practitioner (EAP) should pay particular attention to:

- Consideration of alternatives; which is a detailed assessment that requires application of full EIA assessment methodology;
- Rigour of scientific information required to inform planning and understanding of whether proposed mitigation measures are sustainable;
- Requirement for cumulative assessment of impact; and
- Obligation to provide a reasoned opinion on authorisation and conditions which should be attached to the authorisation.

All specialist reports need to comply with Appendix 6 of GN R.982. In the event that specialists belong to the same company as the EAP, it could be a requirement of the competent authority for the applicant to make provision for external review of such specialist reports.

The public consultation process should be aligned with the requirements of Chapter 6 of GN R.982, and as a minimum should consist of the following tasks:

- Consultation with:
  - Competent Authorities;
  - State departments that administer a law relating to a matter affecting the environment relevant to the application;
  - Organs of state which have jurisdiction in respect of the activity to which the application relates; and
  - Interested and Affected Parties (I&APs).
- Opening and maintaining a register of I&APs;
- Placing site notices at the preferred and alternative sites;
- Giving written notice to:
  - The occupiers of the site and, where AGA is not the owner or person in control of the site on which the activity is to be undertaken, the owner or person in control of the site where the activity is to be undertaken or alternative sites;
  - Owners, persons in control of, and occupiers of land adjacent to the site where the activity is or is to be undertaken or to any alternative site where the activity is to be undertaken;
  - The municipal councillor of the ward in which the site or alternative site is situated and any organisation of ratepayers that represent the community in the area;
  - The municipality which has jurisdiction in the area; and
  - Any organ of state having jurisdiction in respect of any aspect of the activity.
- Placing an advertisement in one local newspaper;
- Placing draft reports in the public domain for 30 day comment periods;

- Conducting at least one public meeting; and
- Compiling a comment and response report, which records all comments made by I&APs during the process, including responses to such comments and records of meetings.

In accordance with the aims of the recent legislative changes, implementation of the "one environmental system", should enable all authorisations to be granted within a period of 300 days.

12.1.2 Competent Authorities

It is Golder's understanding that MWS has acquired Mining Rights to undertake tailings reclamation. Therefore, it is argued that the proposed TSF is directly related to the extraction and processing of a mineral resource. Based hereon and the provisions of Section 24C[4] of NEMA, as amended, we believe that the relevant Competent Authority for the Environmental Authorisation and the Waste Management Licence will be the Department of Mineral Resources (DMR). However, based on Golder's recent experience, the DMR may not agree with this interpretation, especially if the land on which the proposed TSF will be developed is not covered by a Mining Right. If this is the case, the DMR may insist that the relevant applications be submitted to the Department of Environmental Affairs (DEA). This aspect will need to be confirmed with the authorities, prior to submission of the relevant application forms.

The Competent Authority for the Water Use Licence Application (WULA) is the Department of Water and Sanitation (DWS). As part of both the WULA and Waste Management Licence Application (WMLA), the design of the proposed TSF will need to be reviewed by the DWS. It is therefore recommended that one and the same design review meeting be requested for both applications. Furthermore, in the event that AGA proposes to construct a barrier design alternative to the requirements of the waste regulations, it is recommended that an upfront meeting be held with the DWS engineering department.

With regard to the applications for the NNRA CoR, the relevant Competent Authority will be the National Nuclear Regulator (NNR).

The Phase 1 HIA (heritage impact assessment) will be submitted to the North West Provincial Heritage Resources Authority.

12.1.3 Other

Major hazard installation

It will need to be determined if the proposed TSF is deemed as a major hazard installation in terms of the Major Hazard Installation Regulations (MHI Regulations) published in terms of the Occupational Health and Safety Act.

According to the document titled "*Explanatory Notes on the Major Hazard Installation Regulations*", dated April 2005, issued by the Department of Labour, there are two reasons that can determine when an installation is a major hazard installation (MHI). The first reason is when there is more than the prescribed quantity of a substance. The quantities and type of substances are prescribed in the General Machinery Regulation 8 and its Schedule A, on notifiable substances. The second reason is where substances are produced, used, handled or stored in such a form and quantity that it has the potential to cause a major incident. The important issue is the potential of an incident and not whether the incident is a major incident or not. The potential will be determined by the risk assessment.

Furthermore, in terms of the Regulations, a "major incident" means an occurrence of catastrophic proportions, resulting from the use of plant or machinery, or from activities at a workplace. The Department's explanatory document indicates that it is impossible to put a specific value to "catastrophic" because it will

[4] "…the Minister responsible for mineral resources must be identified as the competent authority in terms of subsection (1) where the listed or specified activity is directly related to— *(a)* prospecting or exploration of a mineral or petroleum resource; or *(b)* extraction and primary processing of a mineral or petroleum resource."

always differ from person to person and from place to place; however, when the outcome of a risk assessment indicates that there is a possibility that the public will be involved in an incident, then the incident can be seen as catastrophic.

Based on the above, it is recommended that a risk assessment be conducted by a suitably qualified person to determine whether the proposed TSF (at the selected site – option 3 or 4/7) qualifies as a MHI or not.

Servitude rights registration

Should additional pipeline or access road servitudes be required, over and above those associated with the existing pipe and road network, servitude rights will need to be registered at the Deeds Office.

Land rezoning

The current land zoning of the site options 3 and 4/7 will need to be confirmed through consultation with the Municipality. It is only at this stage that the need for rezoning for the TSF footprint can be confirmed.

The proposed IRP process for Kareerand TSF Expansion is outlined in Figure 13.

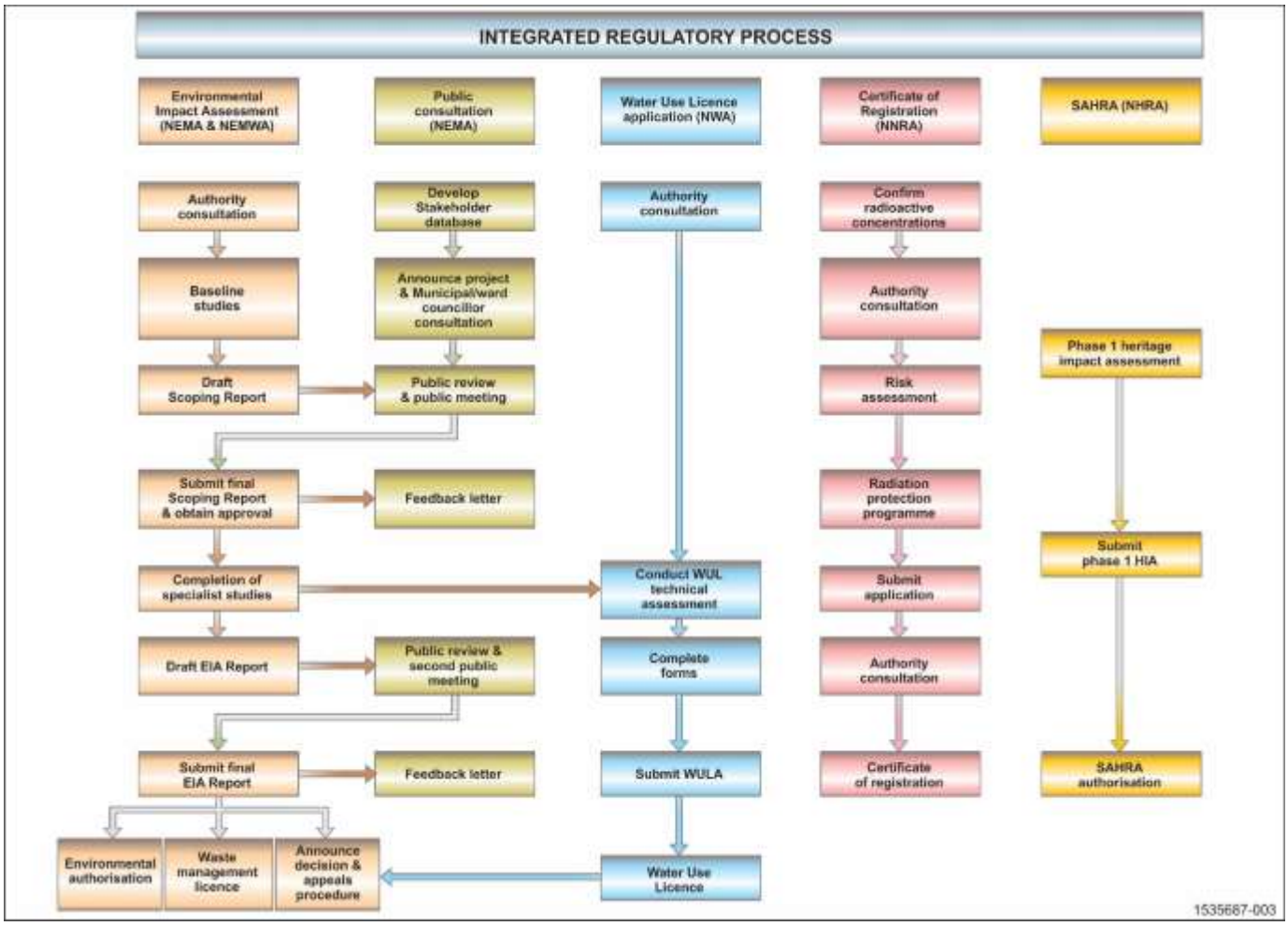


Figure 13: Proposed integrated regulatory Process for Kareerand TSF expansion project

12.1.4 Gap analysis of existing environmental baseline information

Based on a review of the existing baseline information generated for the MWS TSF reworking project and contained within the final EIA report, dated November 2008, and supporting specialist studies, the following data gaps exists.

It is important to note that site option 1 assessed in the 2008 studies is the same as site option 3 for the new TSF, and that site option 2 (i.e. the current Kareerand TSF locality) in the 2008 study is adjacent to the current site option 4/7 (see Figure 4).

Surface water

A hydrological assessment was done in 2008 for the MWS TSF reworking project. The purpose of the assessment was to indicate the catchments characteristics as well as to recommend the preferred site for the location of the Kareerand TSF. A risk assessment of the water resources that may be impacted by the proposed activities was also conducted.

In going forward, the catchment characteristics associated with site options 3 and 4/7 will need to be updated with the latest available information, and an impact assessment conducted and mitigation measures proposed, based on the proposed locality and design of the TSF, for the different site options. Statements will also need to be made on the ability of the TSF to comply with the requirements of Regulations GN R.704, especially with regard to design capacity. Furthermore, the assessment needs to make provision for recommended storm water management measures to be implemented at the proposed TSF as well as any recommendations on updates to the current monitoring programme, so as to ensure that performance of the implementation of the relevant mitigation measures can be measured. It is not foreseen that a floodline determination will be needed for either of the sites.

Groundwater

Already discussed in section 9.2 Environmental attributes of preferred alternatives.

Soils, land capability and land use

A soils, land capability and land use investigation was conducted in 2008, covering the area associated with site option 3. As minimum, it is suggested that a suitably qualified specialist reviews the previous study report, conducts a site visit, and based thereon, compile a professional opinion on the adequacy of the baseline information already collated for this site, for the purposes of the permitting of the new TSF.

A new soils, land capability and land use investigation for site option 4/7 will however need to be conducted by a suitably qualified specialist, as this area was not covered in the previous investigation. The study will need to cover any other Greenfield footprints associated with the proposed development, such as new pipeline routes (and servitudes), powerlines, access roads, etc.

Terrestrial ecology

A flora sensitivity analysis and faunal assessment were conducted in 2008, covering the area associated with site option 3. A site investigation was conducted for the flora sensitivity assessment; however, the season in which the study was undertaken is not stipulated in the report. The faunal assessment focussed on the availability of potential habitat for the red data species likely to occur in the study area. As a result of the timing of the site visit (29-30 September 2008), no trapping or active collecting of any animal group was done during this survey. Animals observed were noted, and investigations focused on habitat assessment.

As with the soils, land capability and land use investigation, it is recommended that a suitably qualified specialist reviews the previous study reports, conducts a site visit, and based thereon, compile a professional opinion on the adequacy of the baseline information already collated for this site, for the purposes of the permitting of the new TSF. Furthermore, any updates to existing literature relevant to the study area must be taken into account.

A new flora and fauna survey for site option 4/7 must be conducted by a suitably qualified specialist, as this area was not covered in the previous investigation. The study will need to cover any other Greenfield footprints associated with the proposed development, such as new pipeline routes (and servitudes), powerlines, access roads, etc. It is recommended that both a dry season and wet season survey be carried, if possible.

Wetlands

A wetland investigation was undertaken for the 2008 EIA for the initial Kareerand TSF. Detailed field investigations were undertaken on the wetlands associated with site option 1 and site option 2, as well as along the proposed pipeline routes. Since the study area for this investigation includes both site options under consideration for the new TSF (i.e. site options 3 and 4/7), it is recommended that only a specialist opinion on the adequacy of the existing information is required for the permitting of the new facility.

Air quality

An air quality study was conducted in 2008 for the TSF reworking project. The study focussed on the impacts associated with the sulphination plant and Kareerand TSF. As part of this study, air dispersion modelling was done for site option 1 (i.e. current site option 3); however, the model will need to be updated to take into consideration current baseline concentrations as well as the design of the new TSF. Furthermore, air dispersion modelling will need to be undertaken for site option 4/7. Based on the results of the modelling, mitigation measures will need to made and the existing air quality management plan (AQMP) for the MWS reworking project updated.

Cultural and heritage resources

A phase 1 heritage impact assessment was conducted for site option 3. The existing information generated in this study can be used for the purposes of the proposed TSF permitting process. However, a phase 1 HIA will need to be conducted for site option 4/7, as the previous study did not cover this area.

Socio-economic

A social impact assessment (SIA) was not conducted for the initial Kareerand TSF. Since a portion of site option 4/7 for the new TSF is located on community-owned land and the establishment of a new TSF in the Stilfontein area has the potential to impact on the local community, specifically with regard to dust, and the establishment of the facility will lead to permanent sterilisation of land, it is recommended that a project-specific SIA be conducted.

Noise and vibration

A noise survey was carried out at site option 1 and site option 2 in 2008. The existing information generated in this study can be used for the purposes of the proposed TSF permitting process.

Visual

A visual assessment was conducted for both site options 1 and 2 in 2008. The existing information generated in this study can be used for the purposes of the proposed TSF permitting process.

Closure and rehabilitation

Closure objectives and measures will need to be compiled for inclusion into the EMPr for the new TSF. Furthermore, the existing closure plan and costing for the MWS tailings reworking project will need to be updated to include the new TSF.

Other

A project-specific integrated regulatory process was compiled for the project. Based on the IRP, the following additional specialist studies will be required for the project:

- A risk assessment in terms of the National Nuclear Regulator Act; and
- A risk assessment in terms of the Major Hazard Installation Regulations published in terms of the Occupational Health and Safety Act.

It is suggested that the risk assessments be conducted on the preferred site only, unless such information is considered as critical inputs into the site selection process.

13.0 PROJECT IMPLEMENTATION ROAD MAP, CONCLUSIONS AND RECOMMENDATIONS

Golder has developed a roadmap for the implementation of the Kareerand TSF Expansion. It is proposed that further technical investigations be conducted on the preferred alternative options and that regulatory consultation takes place to confirm that the alternatives are viable. Further engineering, specialist investigation and integrated regulatory processes can be initiated to develop the Kareerand TSF expansion. The process is highlighted in Figure 14.

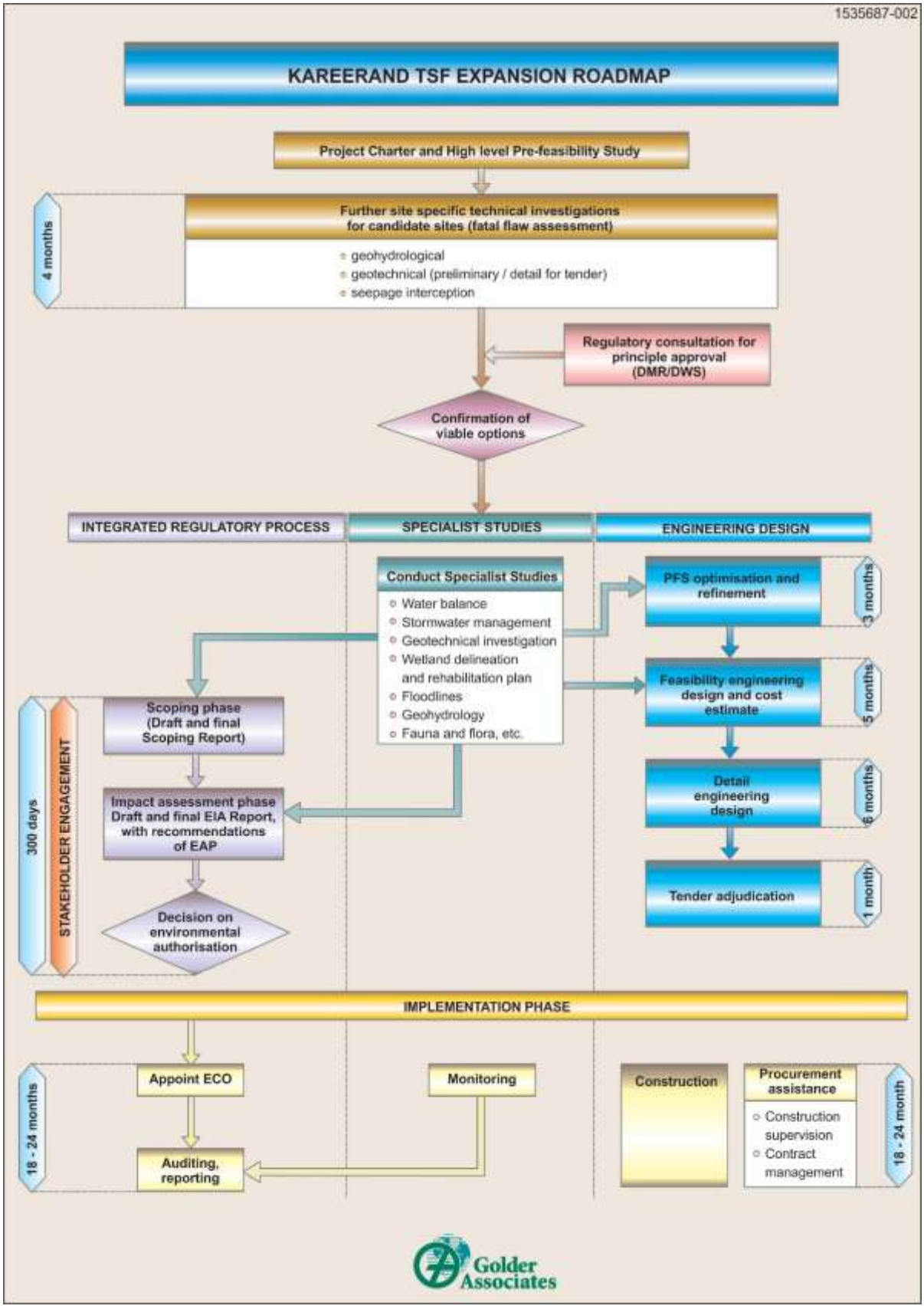


Figure 14: Kareerand TSF expansion roadmap

The following specialist studies will be required for the permitting process of the proposed TSF:

- Surface water assessment, which addresses:
  - Catchment characteristics;
  - Compliance with the requirements of Regulations GN R.704;
  - Storm water management; and
  - Recommendations on updates to the current monitoring programme.
- Groundwater assessment:
- Specialist opinions on the adequacy of existing baseline information for the purposes of permitting the new TSF, for:
  - Soils, land capability and land use for site option 3;
  - Flora and fauna for site option 3; and
  - Wetlands for site option 3 and site option 4/7.
- Soils, land capability and land use investigation for site option 4/7, including any other greenfield footprints associated with the proposed development, such as new pipeline routes (and servitudes), powerlines, access roads, etc.;
- Flora and fauna assessment for site option 4/7, including any other greenfield footprints associated with the proposed development, such as new pipeline routes (and servitudes), powerlines, access roads, etc.;
- Air quality impact assessment, which includes:
  - Updating the air dispersion model for site option 3, to take into consideration current baseline concentrations as well as the design of the new TSF;
  - Conduct air dispersion modelling for site option 4/7; and
  - Recommended mitigation measures, based on the results of the modelling.
- Phase 1 heritage impact assessment for site option 4/7;
- Social impact assessment;
- Updates to the MWS closure plan and costing;
- A risk assessment in terms of the National Nuclear Regulator Act; and
- A risk assessment in terms of the Major Hazard Installation Regulations published in terms of the Occupational Health and Safety Act (for site options 3 and 4/7).

It is important to note that all specialist reports need to comply with Appendix 6 of GN R.982, and must contain:

- Details of-the specialist who prepared the report; and the expertise of that specialist to compile a specialist report including a curriculum vitae;
- A declaration that the specialist is independent in a form as may be specified by the competent authority;
- An indication of the scope of, and the purpose for which, the report was prepared;

- The date and season of the site investigation and the relevance of the season to the outcome of the assessment;
- A description of the methodology adopted in preparing the report or carrying out the specialised process;
- The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure;
- An identification of any areas to be avoided, including buffers;
- A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;
- A description of any assumptions made and any uncertainties or gaps in knowledge;
- A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives on the environment;
- Any mitigation measures for inclusion in the EMPr;
- Any conditions for inclusion in the environmental authorisation;
- Any monitoring requirements for inclusion in the EMPr or environmental authorisation;
- A reasoned opinion as to whether the proposed activity or portions thereof should be authorised; and if the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;
- A description of any consultation process that was undertaken during the course of preparing the specialist report;
- A summary and copies of any comments received during any consultation process and where applicable all responses thereto; and
- Any other information requested by the competent authority.

In the event that specialists belong to the same company as the EAP conducting the EIA, it could be a requirement of the competent authority for AGA to make provision for external review of specialist reports.

GOLDER ASSOCIATES AFRICA (PTY) LTD.

R Munnik
Associate

F Marais
Principal

RM/FM/mc

g:\projects\1535687 - aga kareerandtsfphase2 northwest\6.1 deliverables\drafts and reviews\1535687-308423-1_kareerand_report_draft_15nov2016 v2.docx

APPENDIX A

Site selection process maps

APPENDIX B

Conceptual layouts of optional schemes

APPENDIX C

Schedules of quantities of optional schemes

APPENDIX D

Document Limitations

As a global, employee-owned organisation with over 50 years of experience, Golder Associates is driven by our purpose to engineer earth's development while preserving earth's integrity. We deliver solutions that help our clients achieve their sustainable development goals by providing a wide range of independent consulting, design and construction services in our specialist areas of earth, environment and energy.

For more information, visit golder.com

Africa	+ 27 11 254 4800
Asia	+ 86 21 6258 5522
Australasia	+ 61 3 8862 3500
Europe	+ 44 1628 851851
North America	+ 1 800 275 3281
South America	+ 56 2 2616 2000

solutions@golder.com
www.golder.com

Golder Associates Africa (Pty) Ltd.
P O Box 6001
Halfway House, 1685
Podium at Menlyn, Second Floor
43 Ingersol Road
Menlyn
Pretoria, 0181
South Africa
T: [+27] (11) 254 4800

Golder Associates