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ENVASS REF: 145-12_13
DMR REF: NC 30/5/1/2/2/ 10031 MR

15 April 2014

Directorate Mineral Regulation: Northern Cape
Sub Directorate: Mine Environmental Management
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8300

Tel: (053) 807 1700
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Attention: Ms NP Shandukani

Dear Madam,

RE: REQUEST FOR ADDITIONAL INFORMATION IN TERMS OF SECTION 39 (5) OF THE MINERAL AND PETROLEUM RESOURCES DEVELOPMENT ACT, 2002 (ACT 28 OF 2002) AS AMENDED REGARDING THE ENVIRONMENTAL MANAGEMENT PROGRAMME (EMP) SUBMITTED IN SUPPORT OF A MINING RIGHT FOR MANGANESE ORE IN RESPECT OF THE REMAINING EXTENT, THE REMAINING EXTENT OF PORTION 3 AND PORTION 8 AND PORTION 18 OF THE FARM MAMATWAN NO.331, KURUMAN, NORTHERN CAPE PROVINCE BY MAMATWAN MANGANESE (PTY) LTD

1. We refer to correspondence dated 9 April 2014 received from the Department regarding the above mentioned matter.

2. The Department requested that the following information be submitted as an addendum to the EMP on or before the 17^{TH} of April 2014:

   2.1 Clear description of the operational and decommissioning phase as required on the EMP – refer to ***Appendix A*** of this letter.

   2.2 A comprehensive rehabilitation plan/strategy ***(refer to Appendix B of this letter)*** which embraces the principles of sustainable development as requested by the National Environmental Management Act. 1998 (Act 107 of 1998) and amongst other things it must include the following:

      2.2.1 The manner in which the underground infrastructures will be rehabilitated – refer to ***Section 4.2.2 page 30 of Appendix B*** attached to this letter.

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2.2.2 Clear description on the rehabilitation of overburden/ dumps which will remain on the surface and their acceptable slope angle after rehabilitation which must also conform to the end land use of the area – refer to ***Section 4.1 page 28 of Appendix B*** attached to this letter.

2.3 The description of the main mining activities including the proposed number of excavations and trenches to be opened on the mine and their dimension - refer to ***Appendix C*** attached to this letter.

3. Financial Provision Quantum unacceptable ***(refer to Appendix B of this letter)***:

3.1 Financial Provision to include:

3.1.1 The sealing of the shaft
3.1.2 Rehabilitation of trenches and excavations
3.1.3 Rehabilitation of underground infrastructure such as service bay
3.1.4 General surface rehabilitation

3.2 A detailed itemisation of financial provision quantum using the current master rates that is required for the rehabilitation and/or management of negative environmental impacts.

Further information requested will be submitted on or before the 24th of April 2014 as requested by the Department.

We trust the attached information is sufficient to meet the minimum standards laid down for the compilation of the EMP.

Kind regards,

Monica Niehof
Environmental Consultant

APPENDIX A

Clear description of the operational and decommissioning phases

APPENDIX A

MINING RIGHT APPLICATION FOR MANGANESE ORE IN RESPECT OF THE REMAINING EXTENT, THE REMAIING EXTENT OF PORTION 3, PORTION 8 AND PORTION 18 OF THE FARM MAMATWAN NO. 331

REF: NC 30/5/1/2/2/ 10031 MR

Table 1: Summary of the operational and decommissioning phase:

Phases and Activities, Actions and Processes:	Time frame:
Operational Phase:	
(The operational phase will commence after completion of the boxcut, the life of mine is estimated to be 9 years)	**Month 4 to Year 9**
Primary Access: Two declines (6 m x 6m in section) will be developed through the over burden. (Average advance rate of 40 m per month)	**17 Months**
Secondary Access: On-reef development access concurrently with the development of two ore declines and two ledging drives, one on either side of the ore declines. All development ends will be 5 m in width and 5.3 m in height. It is assumed that these ends will advance together at 40 m per month. At the 40 m per month development rate, the reef access declines and ledging development will open up the first production section in approximately 4 months.	**Month 21 to 24**
Full production: The mine will attain its full production capacity during this phase. The subsequent two ore production sections will be available to produce by production month ten.	**Month 25 – Year 9**
Decommissioning Phase:	
Ramp down and closure	**From year 9** (Rehabilitation will run concurrently with the mining programme, however filling of the final void, reinstatement of dams and roads will commence towards the end of the life of mine).
Rehabilitation Phase:	**From year 9**

1. Description of the Operational Phase

The operational phase will commence after completion of the boxcut, the life of mine is estimated to be 9 years.

Life of Mine Schedule (Primary and Secondary Access)

Primary: A single box cut to access both declines will take approximately 3 months to establish. The two declines (6 m by 6 m in section) will be developed through the over burden. This will take approximately 17 months, at an average advance rate of 40 m per month to access the ore body. A maximum advance rate of 80 m per month through good ground conditions is anticipated whilst a minimum advance rate of 20 m per month through the poor ground conditions (clay) has been factored into the development schedule .The necessary surface infrastructure will be established in conjunction with the sinking of the declines. This includes a blind sink ventilation shaft which will be required for mine ventilation requirements.

Secondary: On completion of the two declines through the waste material, the on-reef development access will begin in month 21 with the concurrent development of two ore declines and two ledging drives, one on either side of the ore declines. All four development ends will be 5 m in width and 5.3 m in height. It is assumed that these ends will advance together at 40 m per month. The processing plant will take approximately 12 months to construct. This construction will take place in parallel with the build-up of ore production. The processing plant will be completed prior to the mining operation achieving its full production rate.

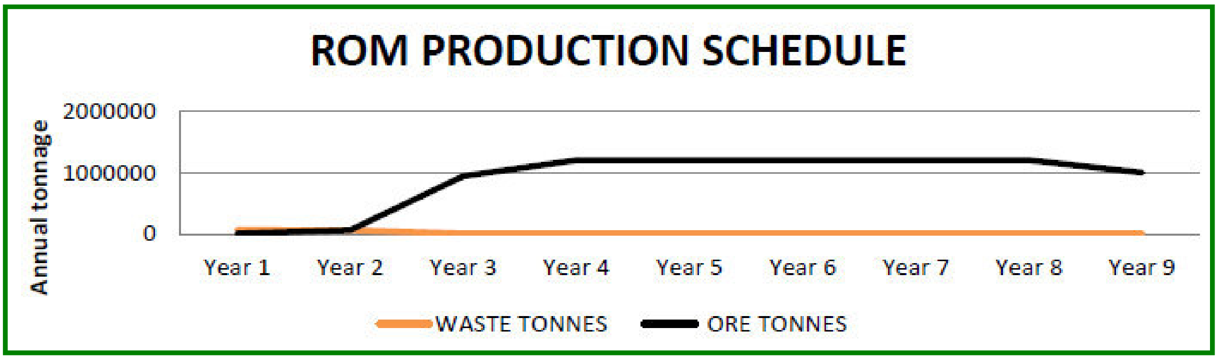

Figure 1: Run of mine production schedule

Production build-up

At the 40 m per month development rate, the reef access declines and ledging development will open up the first production section in approximately four months. The subsequent two ore production sections will be available to produce by production month ten. The combination of three sections and the reef access development will produce 100 000 tonnes per month. In summary, it will take 20 months to develop declines through the waste material underground to get to the manganese reef, and a further 10 months to get up to full production of 100 000 tonnes per month (see Figure 1 above).

Logistics

All men, material and rock transport will be handled via the twin ramp system. The twin ramp system will be equipped with the appropriate electrical and water handling and pumping services. The dirty water pumping facility is based on the use of relay pump stations which are constructed as the ramp system is developed. Vehicle passing bays and truck loading bays have also been provided to expedite the overall development and to ensure that the truck hoisting capability is achieved by preventing congestion in the decline.

Service water

Mining service water is to be fed from a reservoir on surface, situated adjacent to the portal, and will be piped to the various working faces in a 150 NB steel column, fitted with pressure reducers where required. Spent service water, together with groundwater inflow will be picked up from the footwalls with submersible pumps, which will pump it to a nearby sump equipped with a vertical spindle pump, which in turn will deliver this dirty water to a main pump station. Four main pump stations are proposed throughout the life of the mine. Two settling ponds will be excavated on surface, so that duties can be alternated between them, to facilitate regular cleaning out of mud. Clarified water will be pumped back into the service water reservoir. Any excess of water from underground will be pumped to the process plant for make-up there. Should there however be a short fall, it would have to be made up from an external source such as the Vaal Gamagarra Water Scheme.

Potable water

Potable water lines will be installed from the reservoir on surface to the portal, and also to the underground area. There will be a main potable water column in the decline with branches and small diameter gate valves / tee pieces at regular intervals to provide drinking water and fire protection to each refuge bay.

Underground workshops

Underground service bays have been provided for, for daily servicing, maintenance and repairs of LHD's drill rigs and roof bolters. Articulated dump trucks will be serviced on surface. One of the bays will have an elevated ramp and another, a pit to access vehicles from underneath. A separate store, hydraulic service area, and tyre store has been provided.

A wash bay has been included, with oil trap, to meet the ISO 14001 requirements. All the necessary tools and equipment required for cleaning, lubricating, maintaining, servicing and minor repairs have been provided for, but no provision has been made for major overhauls since it is planned that these are to be carried out by the OEM. Diesel shall be delivered to the underground workings by fuel cassettes initially. In the pre-feasibility study, consideration should be given to pie fuel underground.

Process Plant and Tailings

The ore to be processed is from the Lower Manganese Ore body (LMO). The Upper and Middle Manganese Ore bodies in the lease area are not sufficiently well mineralized to be considered for exploitation. The sub-divisions of the LMO are divided into Z, M, C and N zones. Ore to be obtained from the Z, M, C and N zones are considered to be of sufficient manganese grade to be direct shipping ore, without any upgrading being required.

Low phosphorus lump manganese ore will be stockpiled for sale to the market or it will be fed into a sinter plant. The generally required product is a lump with the size range of -75+6mm. The fraction finer than 6mm is generally screened at 1mm, with the -1 being discarded to a tailings dam and the -6+1 mm being stockpiled either for sale or as feed to a sinter plant.

A crushing and screening plant will be required to produce the -75+6mm product. The -6+1 mm product will be stockpiled. The screening plant could either make use of wet screening or dry screening.

Run-of-Mine ore will be delivered from underground and either fed directly onto the grizzly feeder ahead of the primary jaw crusher, or dumped onto the ROM stockpile ahead of the jaw crusher. During the times that ROM ore is not available from underground, ore can be reclaimed from the crusher stockpile with a front-end-loader and fed to the jaw crusher. Grizzly feeder oversize will be crushed by the jaw crusher. The grizzly feeder undersize will join the product from the jaw crusher and will be conveyed onto the secondary ore stockpile. This stockpile will have a live capacity equivalent to 12 hours of secondary crushing plant throughput, to take account of routine maintenance periods on the jaw crusher.

Ore will be withdrawn from the secondary crusher feed stockpile via vibrating feeders onto a conveyor and fed to the secondary screen feed bin. Ore will be withdrawn from the bin with a vibrating feeder and fed to a grizzly screen with a cut-point of 75 mm. Screen undersize will be conveyed to the product sizing screen feed bin and the oversize to the secondary crusher feed bin. Ore will be withdrawn from the secondary crusher feed bin with a vibrating feeder and fed to the secondary crusher. Secondary crusher product will be returned to the secondary screen feed bin.

Ore with a nominal top size of 75 mm will be withdrawn from the product sizing screen feed bin and fed to the product sizing screen. This double-deck screen has decks cutting at 6 mm and 1.5 mm. The screen will be operated as a washing screen to remove adhering fines from the product particles. The top-deck product will be the lump product, with a size range of -75 + 6 mm. The bottom deck oversize will be -6 + 1.5 mm and will be conveyed to the fines stockpile for either future sale or as possible sinter plant feed. Fines would be reclaimed from the fines stockpile with a front-end loader and loaded into road trucks for shipment.

The lump product will be conveyed to the lump product stockpile. Lump product will be withdrawn from this stockpile with vibrating feeders and fed to the rail load-out bin. Product from the load-out bin discharges into rail trucks underneath the bin. Should the lump product stockpile reach its maximum capacity, lump can be moved out to the side of the stockpile with a front-end loader. This material would then be reclaimed with a front-end loader and fed back onto the load-out bin feed conveyor as and when required.

The bottom screen deck undersize (- 1.5 mm) is tailings. This stream will be cycloned in a dewatering cyclone, to ensure that coarse material does not enter the thickener. The cyclone overflow will gravitate to a high density thickener. It will be necessary to add flocculent to the thickener feed to assist in settling of the slimes particles. Thickener overflow will be returned to the plant water tank. The thickener underflow will join the cyclone underflow and be pumped to the tailings dam. The cyclone underflow could alternatively be deposited onto the fines stockpile, depending upon its manganese content.

It is not expected that any water will be recovered from the tailings dam penstock, except possibly during an exceptionally heavy rainstorm. Any penstock water recovered will pass to the return water dam and be pumped to the plant water tank at the beneficiation plant.

The plant is required to produce 1,000,000 tonnes per annum of lump product. The screening plant will also produce a -6+1 mm fines product and a -1 mm slimes fraction. Based on operating data from other plants the percentage of fines produced is expected to be between 14 and 21% of the ROM feed, with the higher numbers coming from an open pit operation in which the ore contains a significant quantity of clay minerals. A figure of 16% -6 mm material after crushing has been assumed. The ROM plant feed will therefore be 1,000,000 / (1 – 0.16) = 1,200,000 tonnes per annum. The slimes fraction reporting to the tailings dam will comprise 4% of the ROM feed and the fines fraction 12%. The water consumption in the plant will be minimal, apart from the water required for wet screening. It is expected that the slimes fraction of the ore will comprise 4% of the ROM plant feed. Based on a ROM plant feed rate of 1,200,000 mtpa, the tailings dam capacity will be required to be 48,000 tonnes per annum. It has been assumed that due to the low quantity of water associated with the tailings that is pumped in the tailings dam, that no water will be recovered from the tailings dam, except after heavy rainstorms. As no chemicals are being used in the processing plant, and no deleterious minerals are expected to dissolve into the plant water, a lining will not be required underneath the tailings dam.

Product Logistics

- **Rail facilities and operations**

For the purposes of this concept study, trade off options have not been considered. It is assumed that the mine will have its own dedicated rail siding for the purposes of loading manganese ore to transport to port for export.

The rail option considered for the study consists of a line that takes off the Middelplaats siding which is currently connected to Mamatwan mine. The siding goes over the farm Shirley 367 to enter the property of the mine in the southwest corner. This is the shortest option considered and was chosen to avoid the need to cross over any existing provincial roads. A loading loop will be provided with a rapid loading station on the north western side of the loop. A shunting locomotive will also not be required. The length of the rail loop will be approximately 9.7 km.

- **Rapid loading station**

The rapid loading station consists of a feed conveyor from the product stockpile which feeds product into the silo, which in turn can load both train and road trucks. The silo capacity is 2,000 tonnes of manganese product. The silo discharges product into a loading flask designed to load rail trucks with a capacity of 63 tonnes each. The rapid loading station proposed will be able to load a train of 104 trucks in less than 3 hours. Alternatively 30 tonne road trucks can be loaded via a radial door controlled chute from the bottom of the silo. Since this operation is manually controlled, the loading rate will obviously be a lot slower.

The discharging of the ore from the loading flask to the rail/road truck will be performed either automatically with sensors detecting the presence of the rail/road truck, or manually via the MMI screen.

A PLC control system will be installed at the loading point to provide monitoring and control of the loading. Silo level detection will be installed to prevent overfilling and emptying of the silo. Two loading flasks complete with load cells will be installed to accurately weigh and dispense the correct mass of product into the carriages and trucks. One flask will be for the train loading and the other will be for the truck loading. The desired load per carriage or truck will be controlled with the PLC via a user inputted value on the MMI. The control system will operate the loading and unloading of the load flask.

2. Description of the Decommissioning Phase

This section includes activities during the decommissioning and closure phase of the project.

Ramp down and closure

Rehabilitation will run concurrently with the mining programme, however filling of the final void, reinstatement of dams and roads will commence towards the end of the life of mine.

The removal, decommissioning and disposal of all mining infrastructure, will comply with all conditions contained in the MPRDA. To this end, decommissioning and rehabilitation of all infrastructure areas will follow the following principles:

- Dismantle project related infrastructure. Load and remove from site for re-sale or disposal at an approved waste site.
- Any item that has no salvage value to the mine but could be of value to individuals will be treated as waste.
- Demolish and remove concrete foundations and slabs to an approved waste disposal facility, also to opencast voids and adits.
- Inert ceramics such as bricks, concrete, gravel will be used as backfill or disposed of in a permitted waste disposal site.
- Inert waste, which is more than 500 mm underground, such as pipes will be left in place.
- Dismantle and remove redundant fence for salvage.
- Cover the fence line with topsoil.
- The company contracted to supply fuel will be requested to remove all fuel storage and reticulation facilities.
- All structures will be demolished and terracing and foundations removed to the lesser of 500 mm below the original ground level.

- Rip and grade the above areas for placement of topsoil.
- Rip and grade mine roads for placement of topsoil.
- Maintenance of roads required for maintenance and monitoring.
- Load from stockpile, haul, and place and spread a layer of topsoil on all areas on which vegetation will be established.
- Establish vegetation on top soiled surfaces, including analysis of topsoil, application of fertilisers, application of seed and hand planting as necessary.
- Active maintenance of planted areas for a period of at least a year, including re-seeding and replanting, weed and alien vegetation control as required.
- Passive maintenance of planted areas, including re-seeding and re-planting, weed and alien vegetation control as required.
- Undertake complete groundwater quality and water level monitoring in order to establish long-term groundwater levels and quality trends.
- Haul roads will have consolidated basement materials lifted and disposed in to pit. Footprint of haul roads will be ripped to a depth of 1.0 meters. Topsoil will be spread over the ripped haul road footprint to a depth of 300 mm and reseeded.
- Piping and water treatment infrastructure will be maintained on site until water quality monitoring data proves that the water quality is acceptable for direct release to the receiving environment. The detailed closure plan that will be developed at end of mine life will address Long water monitoring and maintenance requirements.

Shafts and Mine access areas

- The proposed shafts will be sealed, fenced off and shaped to prevent runoff from draining inwards.
- A certain amount of the tailings produced will be pumped underground as backfill.
- No rehabilitation will be done underground as all materials, equipment and bet works will be withdrawn in terms of the relevant health and safety legislation.
- Final site inspections (underground) will ensure that no latent and or potential environmental risk is left, particular hydrocarbon storages.

Mine Residue Deposits

- Mine residue deposit will be capped where necessary and vegetated with a seed mix which will be determined during the closure specialist assessments and studies. Stoloneferous grasses are included to bind the tailings and soils and prevent erosion.

APPENDIX B

Mine Closure Strategy

MAMATWAN MANGANESE (PTY) LTD

MAMATWAN MINE CLOSURE STRATEGY AND INTERIM REHABILITATION PLAN

Submitted to:
Mamatwan Manganese (Pty) Ltd
Postnet Suite X11
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Johannesburg
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REPORT

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Signature:			
Date:	2014/04/14	2014/04/14	2014/04/14

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GLOSSARY AND KEY WORDS

- **Abandonment:** the act of abandoning and relinquishment of a mining claim or intention to mine; a voluntary surrender of the claim or mine to the next party.
- **Appropriately qualified:** A person who has training in the skills appropriate to the type of work to be done; and experience of the type of mine shaft and of the size, complexity and safety classification of the deposit or the environmental conditions (or both) pertaining to the specific project.
- **Closure:** the act of sealing a redundant mine opening which is acceptable for final mine closure
- **Context of an environmental impact:** The overall environmental setting in which an environmental impact occurs. It includes all "natural" components and characteristics (or both) and all "human and social" components and characteristics (or both). It has both spatial and time dimensions.
- **Continual improvement:** The process of enhancing a mine closure deposit management system, to achieve ongoing improvement in overall performance.
- **Design:** The documented result of a systematic process during which all relevant factors and criteria are taken into account. The design includes the design report, the working drawings and the operations manual.
- **Environmental impact:** Any change in the state of a component of the environment, whether adverse or beneficial, that wholly or partially results from activities, projects or developments.
- **Environmental integrity:** The reliability of performance of the environmental impact management measures associated with the facility, with respect to the environmental performance objectives.
- **Environmental management programme:** A programme contemplated in section 39 of the Minerals Act, submitted to and approved by the Director: Mineral Development, and detailing the plan to be adopted and implemented by a mine for managing the environmental effects of the operations of the mine.
- **Environmental objectives:** Those objectives that represent the desired state of environmental components that have been adopted for the mine shaft deposit facility.
- **Hazard:** The potential of a mine abandoned deposit to cause harm as a consequence of failure.
- **Intensity of an environmental impact:** The severity of the consequences of an environmental impact, as judged by suitably qualified persons.
- **Manager of a mine (general manager):** Any competent person appointed in terms of the Mine Health and Safety Act, 1996 (Act 29 of 1996), to be responsible for the control, management and direction of a mine.
- **Mine sealing:** the closing of openings into a mine in such a manner as to minimize or stop the pollution of the waters of the commonwealth by mine water and to prevent access to the mine by persons or animals.
- **Scheduled Closure:** Planned closure of the mine

- **Sealing:** the securing of mine entries, drifts, adits, slopes, shafts and boreholes with suitable materials to protect against fires, gas and water emissions and for the safety of the public.
- **Mine shaft and adit closing:** Closure of underground mine openings by filling, plugging, capping, installing barriers, gating or fencing.
- **Mine shaft management system:** That section of the overall mine management system that concerns itself, inter alia, with organizational structure, planning activities, responsibilities, practices, procedures, processes and resources for developing, implementing, achieving, reviewing and maintaining the closing and sealing of mine shaft system.
- **Mine shaft management system audit:** A systematic and documented verification process to objectively evaluate evidence to determine whether an organization's mine shaft management system conforms to the management system and whether the performance of the mine shaft complies with prescribed performance criteria.
- **Mine openings:** man-made mining excavation exiting on surface or near surface which results in surface instability
- **Non beneficial:** Not beneficial to the closure objective of the mine
- **Redundant:** permanently no longer required for mining operation
- **Reliability:** The probability that a specified event will not occur in a specified time (usually expressed as a ratio, when measured in quantitative terms).
- **Risk:** The probability that a specified event, such as failure, will occur in a specified time.
- **Significant environmental impact:** An impact in respect of which consultation (with the relevant authorities and other interested and affected parties) on the context and intensity of its effects provides reasonable grounds for mitigating measures to be included in the environmental management programme. Significance is determined by the integration of the context and intensity of the effects of the impact, and the likelihood that the impact will occur.
- **Un Scheduled Closure:** The closure cost associated with immediate closure and provision.
- **Annual Inflation:** Change in the CPI for all items month on month or year on year

1. BACKGROUND TO MINE CLOSURE

"Mine closure has increasingly become the focus of mining companies, governments, non-governmental organizations and other stakeholders and is destined to be the big mining issue of the new millennium. The issues involved in mine closure are usually complex and the risks significant," (Laurence, 2001:315).

Early legislation focused on 'surface rehabilitation' and the primary emphasis of mining was on its economic gains. With regard to environmental management and rehabilitation, mining companies therefore complied with the absolute minimum requirements and also followed a reactive approach.

Formal mine closure only became legislative requirement in 1956 with the promulgation of the Mines and Works Act, and the regulation of environmental management of the mining sites only came to being with the promulgation of the Minerals Act of 1991 and the Minerals and Petroleum Resources Development of 2002 (The National Strategy for the Management of Derelict and Ownerless Mines in South Africa, DMR).

Prior to the enactment of the Minerals Act,1991 (Act 50 of 1991), mining companies used irresponsible mining methods with no regard for protecting the environment and often shirked their responsibility towards environmental rehabilitation by leaving and area unrehabiltated prior to their being liquidated or leaving the country. This negative legacy also relates to the long-term residual effects on the social, health and environmental well-being of communities residing in the vicinity of these unrehabiltated mining areas.

A further critical complicating factor is that the availability of Government funding to address the magnitude of the mine legacy left behind is very limited. Particular reference is given to the so called derelict and ownerless mines (D&O mines). Furthermore, according to Swart. E, is government also forced to respond to issues enjoying media attention and these may not be the most important problems. (Swart, E., October 2003, The South African legislative framework for mine closure The Journal of The South African Institute of Mining and Metallurgy).

Section 41 of the most recent Mineral and Petroleum Resource Development Act (MPRDA) incorporates the polluter pays principle which is a move towards ensuring that mining operations consider ways of reinstating a functional end land use that can positively contribute towards the future biophysical and societal demands of the people and the animals living in proximity to a disturbed environment. The MPRDA in no uncertain terms requires that applicants of prospecting or mining rights to make financial provisions for the rehabilitation or management of negative environmental impacts.

The MRDA in terms of section 56, requires that the holder of a prospecting right, mining right, retention permit or mining permit must ensure that the closure of the prospecting or mining operation incorporates a process which must start at the commencement of the operation and continue throughout the life of the operation. The section further requires that the risks pertaining to the specific environmental impacts must be quantified and managed proactively, which includes the gathering of relevant information throughout the life of a prospecting or mining operation. Of importance does this section of the MPRDA also require that residual and possible latent environmental impacts also be identified and quantified and that the land is rehabilitated, as far as is practicable, to its natural state, or to a predetermined and agreed standard or land use which conforms with the concept of sustainable development.

Section 56 of the MPRDA goes further and states that any prospecting or mining operation must be closed efficiently and cost effectively and that in terms of section 57 of the MPRDA a particular prescribed process needs to be followed to secure closure which in effect incorporates a closure plan, an environmental risk report and a financial performance assessment report.

Mining companies are required under section 39 of the MPRDA to draw up an Environmental Management Plan (EMP), the EMP must include a rehabilitation and closure plan which predicts actual and or potential environmental impacts, prescribes required management and mitigation actions, and also should describe how the costs to achieve the actions will be internalized. The estimation of financial provisions as provided for in section 41 of the MPRDA should be in sync with the EMP and may be based either on rehabilitation and closure cost estimation models developed by the mining company or project concerned or in line with the DMR guidelines developed in 2005.

1.1 Governance and best practice guidelines

Even though significant improvement to mine closure planning has taken place over the last decade in South Africa, particular since the promulgation of the Mineral and Petroleum Resources Development Act (MPRDA), are there still very little evidence that the South African mining fraternity and it associated administrative authorities have actually reached an effective model to secure closure.

This is evident as the industry is not earmarked by definitive, repeatable mine closure processes. The latter which would be associated with successful mine closure applications or definitive rulings and guidelines available as case law. It is expected that in a country where mining has been formally applied for more than 100 years that this particular phase of the proverbial product life would be well defined, applied and used toward progression of the industry.

It is expected that open ended specialist studies and assessments during initial planning and prefeasibility assessments is of great value toward finalizing the rehabilitation and closure strategy.

Notions to save cost initially and therefore potentially produce substandard environmental studies and results, will certainly lead to exponential increases should any re-active actions need to be taken. These studies are crucially important for developing those much needed broad methods for closing a mine and for pinpointing and prioritizing potential and actual issues at the early stage of the mining cycle. Concurrently also consider that mining in South Africa has reached a very prominent level of maturity, particular as it relates to scenario planning and repetitive events analysis allowing for benchmarking and use case studies to assist with predictive modelling, supporting those specialist assessments.

1.1.1 Research and academic references

Research on mine closure evidently dates back as far as the 1990's where various papers were produced more specifically on the inability of the legislation and guidelines of the time to fulfil the requirements of a typical mine closure project.

Particular reference is made to research done by Julie L McCourt, Chamber of mines of South Africa in 1999, wherefrom the inadequacies of the Minerals Act, Act 50 of 1991 is scrutinized and reported on. This paper is foundational in that it identifies the needs of the various stakeholders. Including government. Also making the point that the minerals act of the time granted closure without specific reference to the compliance requirements of the other relevant acts. The paper finally makes reference to the importance of financial provision and explains the various methods and means through which mining house and or applicant can make the provision. (Environmental Legislation and water management issues during mine closure in South Africa, Julie L McCourt, Chamber of mines of South Africa).

E. Swart, published a research article, The South African legislative framework for mine closure by The Journal of The South African Institute of Mining and Metallurgy October 2003 489. This paper provided further insights into the roles and expectation of the various stakeholders but pertinently lifted out mine management as a responsible party. The paper eludes in certain terms to the inconsistencies of mine closure events / approvals of the time and highlights the confusion created by the various inconsistent manners within which and how closure was obtained. Mentioned to this effect was made to scenarios such as temporary closure, closure in terms of section 12 of the Minerals Act of 1991, abandoned and derelict mines, selling off of environmental liabilities, partial closure and even closure under any other form of legislation. The paper further endeavours to bring about a contextual understanding of the closure requirements under The Constitution of the Republic of South Africa, 1996 (The Constitution); the National Environmental Management Act 107 of 1998 (NEMA), as well as mention to the other relevant acts such as the National Water Act 36 of 1998, the now repealed Atmospheric Pollution Prevention Act, 1965 as well as the Nuclear Energy Act of 1999. The paper in its conclusion highlights the Minerals and Petroleum resources Development Act of

2002, earmarking the act as the first progressive act toward the transformation of the mining industry in all aspects. Particular sighting of the cradle to grave approach underpinned by NEMA section 2.

More recent research includes a paper done by Milaras M (Miltiadies) in 2012 which was an assessment of the judicious use of environmental indicators in support of sustainable mine closure in South Africa. This paper holds a direct relevance to the work done by Groenewald RH in 2004 which presented the question as to whether the new Mineral and Petroleum Resources Development Act 28 of 2002 provide for mine closure in a sustainable manner.

As Hewitson, SB (2012) conducted a research paper on the impact of a Monte Carlo analysis on the closure cost assessment of several mines. The research in particular focused on determining the distribution of closure cost whilst applying variations to the quantities and master rates associated with rehabilitation work. Secondary focus areas included the evaluation of escalation factors and the impact thereof on the same distributions of closure cost. A risk based decision making process, typically that of a Monte Carlo simulation might potentially provide the solution to the above mentioned problem. However is it also understood that it is not just financial provision which might influence the successful effort of a mine closure project, but also other peripheral matters and issues currently not attested to in the mine closure planning process prescribed by the DMR. This paper attempts to build on studies like those by Hewitson (2012) by critically evaluating those criterion which in addition to inaccurate financial provision and applied escalation rates will influence the success of mine closure applications in South Africa. In addition does this paper aim to contribute to the body of research on mine closure planning, particular to present a high level methodology against which mine closure planning as well as mine closure evaluations can be based from.

1.1.2 Governmental publications

a. Quantum of closure related financial provision provided by a mine (January 2005)

The guideline document for the evaluation of the quantum of closure related financial provision provided by a mine (January 2005), is the only official mine closure guideline as contemplated in Regulation 54(1) to the Mineral and Petroleum Resources Development Act, 2002 (Act 28 of 2002).

This guideline document mine governs the closure cost assessment process in South Africa and is applied by the DMR through its respective regional managers as the only guideline upon which a closure cost liability is calculated from. It is a quantifiable assessment of physical closure components and associated closure objectives and activities. It involves a process of chronologically classifying both component and cost of component closure, ultimately resulting in a sum of activities and cost for which legal provisions are made. The referred to process is well documented and applied in various manners locally in South Africa. Arguably could the process applied most cases be referred to as theoretical and simplistically assumptive, reasoning for inaccurate estimations and subsequent provisions, particular when primary and general (P&G's) costs are calculated and when the specialist assessments and aftercare calculation are done for the final mine closure applications and maintenance stages.

b. National Strategy for the Management of Derelict and Ownerless Mines in South Africa

The Department of Mineral Resources in 2009 published the National Strategy for the Management of Derelict and Ownerless Mines in South Africa. The overall purpose of the strategy is to provide a framework within which the state can implement management measures, including undertaking the rehabilitation of derelict and ownerless mines. It also aims to propose an action plan for a programme to address challenges related to these mines. A two pronged strategy is proposed for the management of derelict and ownerless mines. For purposes of this strategy, two clusters of sites have been identified. A two pronged strategy is proposed for the management of derelict and ownerless mines. For purposes of this strategy, two clusters of sites were identified.

The first cluster is of those which should be rehabilitated completely in localised projects.
The second cluster has larger or more regional impacts and will require larger scale, longer term programmes to mitigate their impacts.

The involvement of local communities in the implementation of solutions is critical. In many cases, this will require a concerted programme of training and skills development to empower community groups and local small and medium contractors to undertake rehabilitation and mitigation activities. It is also likely that many of the skills transferred to communities may be applicable in or convertible to other fields, stimulating local economic development after the rehabilitation programme has been completed.

Mining and Biodiversity Guideline, mainstreaming biodiversity into the mining sector. Department of environmental Affairs and the Department of mineral resources: 2013

1.1.3 Industry specific

Notable contributions to the research field are paper presented by mining firm De Beers. These research papers focused largely on closure processes as followed by de Beers on its own Diamond mines in Limpopo province. (A critical analysis of the mine closure process as followed by the De Beers Oaks Diamond Mine, Limpopo Province, South Africa Authors: Botham ND (Nicole Dawn): 2012.

Strategic mine closure planning – taming liability. Michael Cramer (Director) Accent Environmental Environment and Communities Seminar MCA Victorian Division 31 July 2013
An investigation of mine closure: gold mine case studies on the East Rand in South Africa. J.H Nel

1.1.4 Non-governmental

The World Wildlife Fund (WWF) in 2012 published a discussion document named the "Financial provision for the rehabilitation and closure in South African Mining: Discussion Document on Challenges and recommended improvements". The document focusses in on the adequacy of financial provisions and pulls a very strong link between insufficient financial allocations and that of derelict and abandoned mines in South Africa. The document further emphasizes the importance of establishing a dependency between the EMP (Environmental management plans or programmes) and financial provision which is updated and adequate. The discussion document strongly implies that the current method of financial provision, provided for through the quantum of financial provision guideline (2005), is not comprehensive enough and does require improvements.

The Chamber of Mines (CoM) of South Africa's guidelines for the rehabilitation of mined land, Phil Tanner and Maryna Möhr- Swart. This document is a result of a he amount of scientific knowledge experts. It is an on the ground reference document which provides written guidelines on the best rehabilitation techniques. Of value is how the document distinguishes between the financing, the planning and the licensing components of a typical mining program. An effective planning process is all about communication: communication between planners and rehabilitation specialists, communication between mine staff and interested and affected parties, and communication between these parties and government officials. The complexity of the process comes about in large part because of the need to ensure that this communication takes place. It is effective in identifying key issues that will affect the long-term success of the rehabilitation activity and in addressing these.

Source: CoM (2007)

1.1.5 Inter-government departmental

A report by Auditor-General (AG) to Parliament which was a performance audit of the rehabilitation of abandoned mines at the Department of Minerals and Energy October in 2009 was evaluated. The paper presented a very broad problem statement and focusses in on the provision of a framework within which the State can implement management measures, including undertaking the rehabilitation of derelict and ownerless mines. It also proposes an action plan for a programme to address challenges related to these mines.

1.1.6 International

a. The Infomine E book _ Mine closure (Dr. A. Robertson and S. Shaw)

The Infomine E book _ Mine closure (Dr. A. Robertson and S. Shaw), provides for the 'six tenets for sustainability of mining' provide the foundation for sustainability planning at a mine site. This gives rise to the need to do more than 'Design for Closure', requiring that we also prepare 'Post Mining Sustainable Use Plans' for the mine site and affected area. This concept is described by Robertson et al., 1998 and Robertson and Shaw, 1999. It also requires that all stakeholders, including the succeeding custodian, be consulted in the preparation of mine development, operations, closure and post closure sustainable use plans. Any closure plan must consider the long-term physical, chemical, biological and social/land-use effects on the surrounding natural systems (aquatic, groundwater, surface water etc.). Therefore there must be an understanding of the pre-mining environment (step 1) and the effects of past and future mine development (step 2) on the pre-mining environment. Operational control measures must be selected (step 3) for implementation during mining in order to minimize the impact on the surrounding ecosystems. Impact assessments (step 4) must be done prior to measures selection as well as periodically during operations in order to determine the success of the measures implemented. Alternative mine closure measures are developed (step 5) and assessed (step 6) during mine design to ensure that there are suitable closure measures available to remediate the impact of the selected mine development. Figure 2 below provides this in a schematic.

b. Planning for Integrated Mine Closure: Toolkit

The International Council on Mining and metals (ICMM) produced a document, "Planning for Integrated Mine Closure: Toolkit," in 2008. The document is specifically focused on providing support to an organization in achieving post closure status and leaves behind an enduring and positive legacy in the community. "Planning for closure is about how to design and mine operation in order to facilitate closure" (ICMM (2008:3)). The toolkit is from the first page evidently interested in ensuring that the user thereof will not underestimate the value of community involvement and stakeholder expectation, but also that there is a pertinent difference between rehabilitation, decommissioning, closure, post closure and final relinquishment. Page 12, paragraph 4 states that "Successful closure depends on setting, continually reviewing and validating and finally meeting closure goals that align with company and stakeholder requirements. There should be minimum residual risk to the company, and the community should realize benefits that will continue to exist without further input form the company."

The process of closure planning using this toolkit advocates integration on a number of fronts, such as:

- Between the closure practitioner(s) from the distinct stages of a mining operation's development as they make decisions that affect closure at different times along the lifecycle (e.g., the exploration, feasibility, construction, operations, corporate and decommissioning teams);
- Between the different operational disciplines of a company during each particular stage, for example between the individuals/teams that deal with social and environmental planning, feasibility and design, financial

management, risk management, budgeting and resourcing and, an important component, strategic planning; and

- Between the company and the various external stakeholders who provide input for, take ownership of and participate in the closure planning and execution processes required for successful outcomes.

The tools and guidance provided in this document bring community engagement, early closure planning, operational implementation of progressive closure planning and a cross-functional approach into effective exit strategies.

2. BRIEF DESCRIPTION OF THE PROJECT

2.1 Overview of the Mining operations

The mining method to be employed at the level of opencast, underground, stoping, stooping, total extraction, bord and pillar, block caving, shrinking, dredging, pumping, monitoring, etc. and provide a concise description of the intended magnitude thereof, in terms of volumes, depth and aerial extent.

Mining methods vary widely and depend on the location, type and size of mineral resources. Typical mine infrastructure includes haul roads; spoil dumps; surface and underground facilities (e.g. offices, workshops, car parks and warehouses); tailings and waste rock disposal areas; transport and service corridors (e.g. roads, pipelines, conveyers, power and water corridors); product stockpiles; chemicals and fuel storage and housing facilities (AEPA, 1996).

UNLESS OTHERWISE STATED, THE INFORMATION CONTAINED BELOW REGARDING THE MINING DESIGN, METHODOLOGY AND INFRASTRUCTURE PROPOSED FOR THE MAMATWAN MANGANESE MINE, HAS BEEN EXTRACTED DIRECTLY FROM THE LATEST CONCEPT ENGINEERING STUDY (ROYAL HASKONINGDHV, 2013.

2.2 Mining design

Table 2 below illustrates the mine design criteria applied in the latest concept study (Royal HaskoningDHV, 2013).

Table 1: Mine design layout

Key Design Criteria	Values
Production	100,000 tpm
Primary access	Trackless Twin Decline,
Secondary access	On reef decline
Rock Hoisting	Truck

Men and Material movement	Trackless Decline
Stoping method	Room and Pillar
Shift system	5 day week
Labour	Gate wage
Service water tonnes per tonne of rock	1 for stoping, 0.6 for development
Ventilation (allowance for methane)	6 m^3/sec/kiloton/month
Support	2 m Full column resin bolts at 2.5 m^2 per bolt
Dilution	0% (ore body is thicker than the mining cut)

The mining method adopted for this study is room and pillar, the standard method in use throughout the KMF where underground mining is required. Owing to the average height or thickness of the ore body of 11 m it is possible that in the steeper areas drift open stoping could be considered as an alternative if the project proceeds to the PFS level.

The room and pillar method adopted is based on mining the rooms and splits to spans of 7 m in 2 cuts, a 5 m high top cut and 6 m high bench. The pillars are sized at 8 m x 8 m to cater for the overall mining height of 11 m.

The mining operation will be divided into 9 room sections covering a total section extent of 127 m; which caters for two main design requirements:

- The geotechnical requirement for 20 m wide regional pillars at a maximum spacing of 135 m; and
- The 9 room section optimises the utilisation of the equipment suite for the blast hole drilling, support, rock handling and peripheral activities in the section. Previous experience at the neighbouring Middelplaats Manganese operation averaged three blasts per day per section.

It is planned to mine a 5 m high top cut followed by benching the 6 m to the final 11 m height. It is intended to employ horizontal drilling on the benches to standardise the drilling equipment. Each blast in the top cuts and benches are expected to produce 530 t and 604 t respectively from face advances of 4.2 m from 4.6 m blast holes. The Mamatwan manganese ore body is ideally suited to utilising top of the range drilling and rock handling equipment. This will allow the production of 100 000 tonnes per month from 4 suites of equipment in 2 top cuts and 1 bench section with the 4th suite used in advancing the ramp access and providing back up for the other suites. It is planned to blast 3 faces per day on 21 days (5 day week) per month to produce 32 000 tonnes and 36 000 tonnes per top cut and bench section respectively.

2.2.1 Life of Mine Schedule (Primary and Secondary Access)

Primary: A single box cut to access both declines will take approximately 3 months to establish. The two declines (6 m by 6 m in section) will be developed through the over burden. This will take approximately 17 months, at an average advance rate of 40 m per month to access the ore body. A maximum advance rate of 80 m per month through good ground conditions is anticipated whilst a minimum advance rate of 20 m per month through the poor ground conditions (clay) has been factored into the development schedule .The necessary surface infrastructure will be established in conjunction with the sinking of the declines. This includes a blind sink ventilation shaft which will be required for mine ventilation requirements.

Secondary: On completion of the two declines through the waste material, the on-reef development access will begin in month 21 with the concurrent development of two ore declines and two ledging drives, one on either side of the ore declines. All four development ends will be 5 m in width and 5.3 m in height. It is assumed that these ends will advance together at 40 m per month. The processing plant will take approximately 12 months to construct. This construction will take place in parallel with the build-up of ore production. The processing plant will be completed prior to the mining operation achieving its full production rate.

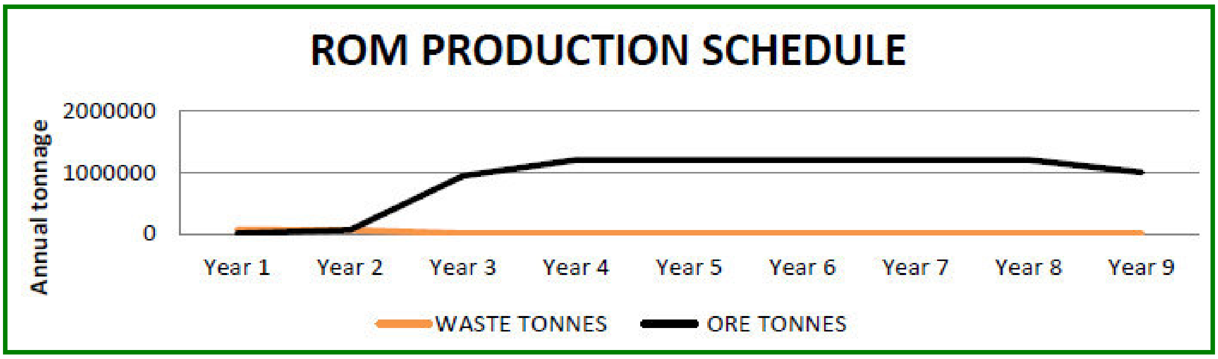

Figure 1: Run of mine production schedule

2.2.2 Production build-up

At the 40 m per month development rate, the reef access declines and ledging development will open up the first production section in approximately four months. The subsequent two ore production sections will be available to produce by production month ten. The combination of three sections and the reef access development will produce 100 000 tonnes per month. In summary, it will take 20 months to develop declines through the waste material underground to get to the manganese reef, and a further 10 months to get up to full production of 100 000 tonnes per month (see Figure 15 above).

2.2.3 Ventilation

Adequate ventilation systems will be installed. This system will be in line with the legal requirements of the Mine Health and Safety Act and Regulations. The purpose of ventilation is to provide fresh air for human respiration and to dilute and remove pollutants. In the case of shallower mechanised mines, the principal pollutants are diesel exhaust gases, heat in the proximity of diesel machines and dust generated from mining and transportation operations. Another pollutant that must be addressed is flammable gas.

During the design of the ventilation system due regard will be given to practicality, the safety of the workforce and equipment against pollutants, heat, the effects of a fire and to provide an acceptably short re-entry interval after blasting. A full Ventilation computer simulation model of the mine would be constructed to determine accurate airflows, cross over sizes and accurate fan operating points. The ventilation system is designed to cater for the following

- Initial development of the surface declines;
- Production rate of 100 000 tonnes per month based upon the active diesel powered fleet; and
- Leakage allowance appropriate for Room and Pillar mining.

List of the main mining actions, activities, or processes, such as, but not limited to, access roads, shafts, pits, workshops and stores, processing plant, residue deposition sites, topsoil storage sites, stockpiles, waste dumps, access roads dams, and any other basic mine design features.

The main mining actions, activities and processes are listed below:

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2.2.4 Underground Infrastructure

a. Primary access

The primary access is via a twin ramp system that is established from the high wall of a single, open, box cut excavation. The ramp is inclined at 9.5 degrees and the portal position is approximately 20 metres below surface. The time to excavate and construct the box cut is estimated to be 6 months and the total length of the ramp is approximately 680 metres. A conventional sink and line, 6 metre diameter, ventilation shaft has been provided for and which is planned to be constructed as a concurrent activity while the ramp system is developed. This depth of this shaft will be approximately 107 metres, with some 500 metres of off shaft development being carried out to reach the settler and dams positions and the main mining level breakaway position.

b. Logistics

All men, material and rock transport will be handled via the twin ramp system. The twin ramp system will be equipped with the appropriate electrical and water handling and pumping services. The dirty water pumping facility is based on the use of relay pump stations which are constructed as the ramp system is developed. Vehicle passing bays and truck loading bays have also been provided to expedite the overall development and to ensure that the truck hoisting capability is achieved by preventing congestion in the decline.

c. Service water

Mining service water is to be fed from a reservoir on surface, situated adjacent to the portal, and will be piped to the various working faces in a 150 NB steel column, fitted with pressure reducers where required. Spent service water, together with groundwater inflow will be picked up from the footwalls with submersible pumps, which will pump it to a nearby sump equipped with a vertical spindle pump, which in turn will deliver this dirty water to a main pump station. Four main pump stations are proposed throughout the life of the mine. Two settling ponds will be excavated on surface, so that duties can be alternated between them, to facilitate regular cleaning out of mud. Clarified water will be pumped back into the service water reservoir. Any excess of water from underground will be pumped to the process plant for make-up there. Should there however be a short fall, it would have to be made up from an external source such as the Vaal Gamagarra Water Scheme.

d. Potable water

Potable water lines will be installed from the reservoir on surface to the portal, and also to the underground area. There will be a main potable water column in the decline with branches and small diameter gate valves / tee pieces at regular intervals to provide drinking water and fire protection to each refuge bay.

e. Underground workshops

Underground service bays have been provided for, for daily servicing, maintenance and repairs of LHD's drill rigs and roof bolters. Articulated dump trucks will be serviced on surface. One of the bays will have an elevated ramp and another, a pit to access vehicles from underneath. A separate store, hydraulic service area, and tyre store has been provided.

A wash bay has been included, with oil trap, to meet the ISO 14001 requirements. All the necessary tools and equipment required for cleaning, lubricating, maintaining, servicing and minor repairs have been provided for, but no provision has been made for major overhauls since it is planned that these are to be carried out by the OEM. Diesel shall be delivered to the underground workings by fuel cassettes initially. In the pre-feasibility study, consideration should be given to pie fuel underground.

f. Electrical reticulation

The underground electrical reticulation will be supplied from the main substation which is located on surface; the reticulation will be at 11 kV and will be supplied via cabling. Underground load points will be equipped with mini-substation units (MSU) suitably sized to cater for the specified electrical loads. The LV reticulation will be performed at 525 V and 400 V via motor control centres (MCC), gulley boxes and small power distribution boards.

2.2.5 Process Plant and Tailings

The ore to be processed is from the Lower Manganese Ore body (LMO). The Upper and Middle Manganese Ore bodies in the lease area are not sufficiently well mineralized to be considered for exploitation. The sub-divisions of the LMO are divided into Z, M, C and N zones. Ore to be obtained from the Z, M, C and N zones are considered to be of sufficient manganese grade to be direct shipping ore, without any upgrading being required.

Low phosphorus lump manganese ore will be stockpiled for sale to the market or it will be fed into a sinter plant. The generally required product is a lump with the size range of -75+6mm. The fraction finer than 6mm is generally screened at 1mm, with the -1 being discarded to a tailings dam and the -6+1 mm being stockpiled either for sale or as feed to a sinter plant.
A crushing and screening plant will be required to produce the -75+6mm product. The -6+1 mm product will be stockpiled. The screening plant could either make use of wet screening or dry screening.

Run-of-Mine ore will be delivered from underground and either fed directly onto the grizzly feeder ahead of the primary jaw crusher, or dumped onto the ROM stockpile ahead of the jaw crusher. During the times that ROM ore is not available from underground, ore can be reclaimed from the crusher stockpile with a front-end-loader and fed to the jaw crusher. Grizzly feeder oversize will be crushed by the jaw crusher. The grizzly feeder undersize will join the product from the jaw crusher and will be conveyed onto the secondary ore stockpile. This stockpile will have a live capacity equivalent to 12 hours of secondary crushing plant throughput, to take account of routine maintenance periods on the jaw crusher.

Ore will be withdrawn from the secondary crusher feed stockpile via vibrating feeders onto a conveyor and fed to the secondary screen feed bin. Ore will be withdrawn from the bin with a vibrating feeder and fed to a grizzly screen with a

cut-point of 75 mm. Screen undersize will be conveyed to the product sizing screen feed bin and the oversize to the secondary crusher feed bin. Ore will be withdrawn from the secondary crusher feed bin with a vibrating feeder and fed to the secondary crusher. Secondary crusher product will be returned to the secondary screen feed bin.
Ore with a nominal top size of 75 mm will be withdrawn from the product sizing screen feed bin and fed to the product sizing screen. This double-deck screen has decks cutting at 6 mm and 1.5 mm. The screen will be operated as a washing screen to remove adhering fines from the product particles. The top-deck product will be the lump product, with a size range of -75 + 6 mm. The bottom deck oversize will be -6 + 1.5 mm and will be conveyed to the fines stockpile for either future sale or as possible sinter plant feed. Fines would be reclaimed from the fines stockpile with a front-end loader and loaded into road trucks for shipment.

The lump product will be conveyed to the lump product stockpile. Lump product will be withdrawn from this stockpile with vibrating feeders and fed to the rail load-out bin. Product from the load-out bin discharges into rail trucks underneath the bin. Should the lump product stockpile reach its maximum capacity, lump can be moved out to the side of the stockpile with a front-end loader. This material would then be reclaimed with a front-end loader and fed back onto the load-out bin feed conveyor as and when required.

The bottom screen deck undersize (- 1.5 mm) is tailings. This stream will be cycloned in a dewatering cyclone, to ensure that coarse material does not enter the thickener. The cyclone overflow will gravitate to a high density thickener. It will be necessary to add flocculent to the thickener feed to assist in settling of the slimes particles. Thickener overflow will be returned to the plant water tank. The thickener underflow will join the cyclone underflow and be pumped to the tailings dam. The cyclone underflow could alternatively be deposited onto the fines stockpile, depending upon its manganese content.

It is not expected that any water will be recovered from the tailings dam penstock, except possibly during an exceptionally heavy rainstorm. Any penstock water recovered will pass to the return water dam and be pumped to the plant water tank at the beneficiation plant.

The plant is required to produce 1,000,000 tonnes per annum of lump product. The screening plant will also produce a -6+1 mm fines product and a -1 mm slimes fraction. Based on operating data from other plants the percentage of fines produced is expected to be between 14 and 21% of the ROM feed, with the higher numbers coming from an open pit operation in which the ore contains a significant quantity of clay minerals. A figure of 16% -6 mm material after crushing has been assumed. The ROM plant feed will therefore be 1,000,000 / (1 – 0.16) = 1,200,000 tonnes per annum. The slimes fraction reporting to the tailings dam will comprise 4% of the ROM feed and the fines fraction 12%. The water consumption in the plant will be minimal, apart from the water required for wet screening. It is expected that the slimes fraction of the ore will comprise 4% of the ROM plant feed. Based on a ROM plant feed rate of 1,200,000 mtpa, the tailings dam capacity will be required to be 48,000 tonnes per annum. It has been assumed that due to the low quantity of water associated with the tailings that is pumped in the tailings dam, that no water will be recovered from the tailings dam, except after heavy rainstorms. As no chemicals are being used in the processing plant, and no deleterious minerals are expected to dissolve into the plant water, a lining will not be required underneath the tailings dam.

2.2.6 Surface Infrastructure

a. Roads

Existing access to the site and internal roads will have to be upgraded to support the additional traffic on the site. The internal haul roads proposed will be approximately 8m wide. The existing access road to the mine site is wide enough for access to the site. However, it is envisaged that approximately 3km of access road will need to be developed from the existing public road onto the mine site. An additional 2km (approximately) of roads will be required within the mine site.

b. Water Supply

Very limited groundwater inflow or surface run-off water is expected. Assuming that the inflow will only be enough to off-set losses to ventilation, air and entrapment in mined rock from underground, then the estimated make-up water requirement will be about 41,000 m^3 per month for a 100 000 tpm mine. Bulk water supply from the existing 300mm Vaal Gamagarra Pipeline (which runs from the Vaal Gamagarra Scheme to Blackrock in the north) is envisaged. This pipeline runs adjacent to the proposed site at Mamatwan. Note that the capacity of this pipeline is currently fully allocated, but plans are being implemented to upgrade the line. Sedibeng Water (who manages the line) has been requested to add this project's requirements to their planning.

The breakdown of make-up water required for the mine is summarised in Table 2 below.

Table 2 Breakdown of make-up water

Total make-up water required				
ROM			tpm	100,000
Water in tailings			m^3/month	4,000
Water in lump product		6%	m^3/month	5,040
Water in fines product		8%	m^3/month	960
Water in air,mud, rock u/g		17%	m^3/month	17,000
Potable water			m^3/month	1,400
Other		10%	m^3/month	12,840
Total make-up water required			m^3/month	41,240
Days per month				26
Hours per day				22
Flow rate	m^3/h			72
Flow rate	l/s			20

c. Bulk supplies – Power

An estimated peak maximum demand of 4, 7 MVA has been calculated for the project. The bulk power supply will be provided by Eskom, at 11 kV, to the main surface substation from where it will be reticulated to the load centres. It is envisaged that the main reticulation voltage will be 11 kV with LV reticulation being at 525 V and 400 V. Eskom has been requested to provide an indicative cost for the bulk power supply as well as an indication of the availability of the required supply.

d. Surface infrastructure

Surface infrastructure proposed would comprise of the design and construction of all building structures, related earthworks and building services, electrical and mechanical and HVAC installations works. This would include inter alia:

- Site clearing and storm water berms and trenches;
- Administration building and first aid;
- Change house and laundry;
- Lamp room, self-rescuer and proto room;
- Access control and security centre;
- TMM Maintenance workshop, services, lubrication, bays;
- Wash bay and oil skimmer;
- Bulk fuel storage area;
- Refueling bay;
- Tyre storage, repair and pump area;
- LVD workshop;

- Fitting, electrical and boiler making workshop;
- Main stores and yard;
- Salvage yard;
- Fire and ambulance parking;
- External parking, shade ports and walkways;
- Electrical, water and sewage reticulation;
- Sewage treatment plant;
- Terraces, pavements, access, internal and haul roads;
- Perimeter and internal fencing; and
- Explosives off-loading, storage and distribution. Magazine.

2.2.7 Product Logistics

a. Rail facilities and operations

For the purposes of this concept study, trade off options have not been considered. It is assumed that the mine will have its own dedicated rail siding for the purposes of loading manganese ore to transport to port for export.

The rail option considered for the study consists of a line that takes off the Middelplaats siding which is currently connected to Mamatwan mine. The siding goes over the farm Shirley 367 to enter the property of the mine in the southwest corner. This is the shortest option considered and was chosen to avoid the need to cross over any existing provincial roads. A loading loop will be provided with a rapid loading station on the north western side of the loop. A shunting locomotive will also not be required. The length of the rail loop will be approximately 9.7 km.

b. Rapid loading station

The rapid loading station consists of a feed conveyor from the product stockpile which feeds product into the silo, which in turn can load both train and road trucks. The silo capacity is 2,000 tonnes of manganese product. The silo discharges product into a loading flask designed to load rail trucks with a capacity of 63 tonnes each. The rapid loading station proposed will be able to load a train of 104 trucks in less than 3 hours. Alternatively 30 tonne road trucks can be loaded via a radial door controlled chute from the bottom of the silo. Since this operation is manually controlled, the loading rate will obviously be a lot slower.

The discharging of the ore from the loading flask to the rail/road truck will be performed either automatically with sensors detecting the presence of the rail/road truck, or manually via the MMI screen.

A PLC control system will be installed at the loading point to provide monitoring and control of the loading. Silo level detection will be installed to prevent overfilling and emptying of the silo. Two loading flasks complete with load cells will be installed to accurately weigh and dispense the correct mass of product into the carriages and trucks. One flask will be for the train loading and the other will be for the truck loading. The desired load per carriage or truck will be controlled with the PLC via a user inputted value on the MMI. The control system will operate the loading and unloading of the load flask.

3. MINE CLOSURE COST ASSESSMENT

3.1 Identified closure components

UNLESS OTHERWISE STATED, THE INFORMATION CONTAINED BELOW REGARDING THE MINING DESIGN, METHODOLOGY AND INFRASTRUCTURE PROPOSED FOR THE MAMATWAN MANGANESE MINE, HAS BEEN EXTRACTED DIRECTLY FROM THE LATEST CONCEPT ENGINEERING STUDY (ROYAL HASKONINGDHV, 2013).

Table 3 The identified closure components (Mamatwan)

NO	Item	Description
Mine Access and declines		
1	Primary Access (decline shafts 1)	Sealing of shafts adits and inclines
2	Primary Access (decline shafts 2)	Sealing of shafts adits and inclines
3	Ventilation Infrastructure (intake excavation 1)	Sealing of shafts adits and inclines
4	Ventilation Infrastructure (intake excavation 2)	Sealing of shafts adits and inclines
5	Ventilation Infrastructure (intake excavation 3)	Sealing of shafts adits and inclines
6	Ventilation Infrastructure (intake excavation 4)	Sealing of shafts adits and inclines
7	Stockpile	1.11 Rehabilitation of processing waste deposits and evaporation ponds (basic, salt-producing waste)
Plant and process infrastructure		
8	Access road	Rehabilitation of access roads
9	Ore receiving conveyor	1.1 Dismantling of processing plant and related structures (including overland conveyors and power lines)
10	ROM Stockpile feed conveyor	1.1 Dismantling of processing plant and related structures (including overland conveyors and power lines)
11	ROM Stockpile	1.11 Rehabilitation of processing waste deposits and evaporation ponds (basic, salt-producing waste)

12	Reversible conveyor	1.1 Dismantling of processing plant and related structures (including overland conveyors and power lines)
13	Scalping screens feed bin conveyor	1.1 Dismantling of processing plant and related structures (including overland conveyors and power lines)
14	Scalping screens	1.2 Demolition of steel buildings and structures
15	Conveyor	1.1 Dismantling of processing plant and related structures (including overland conveyors and power lines)
16	Secondary crushing	1.1 Dismantling of processing plant and related structures (including overland conveyors and power lines)
17	Conveyor	1.1 Dismantling of processing plant and related structures (including overland conveyors and power lines)
18	Tertiary screens building	1.2 Demolition of steel buildings and structures
19	Tertiary crusher feed bin conveyor	1.1 Dismantling of processing plant and related structures (including overland conveyors and power lines)
20	Conveyor	1.1 Dismantling of processing plant and related structures (including overland conveyors and power lines)
21	Tertiary and fines crusher building	1.2 Demolition of steel buildings and structures
22	Fines screening building	1.2 Demolition of steel buildings and structures
23	Conveyor 1	1.1 Dismantling of processing plant and related structures (including overland conveyors and power lines)
24	Conveyor 2	1.1 Dismantling of processing plant and related structures (including overland conveyors and power lines)
25	Conveyor 3	1.1 Dismantling of processing plant and related structures (including overland conveyors and power lines)
26	Conveyor 4	1.1 Dismantling of processing plant and related structures (including overland conveyors and power lines)
27	Conveyor 5	1.1 Dismantling of processing plant and related structures (including overland conveyors and power lines)
28	Sinter, coke & anthracite stockpiles	1.11 Rehabilitation of processing waste deposits and evaporation ponds (basic, salt-producing waste)
29	Conveyor 1	1.1 Dismantling of processing plant and related structures (including overland conveyors and power lines)
30	Conveyor 2	1.1 Dismantling of processing plant and related structures (including overland conveyors and power lines)
31	Conveyor 3	1.1 Dismantling of processing plant and related structures (including overland conveyors and power lines)
32	Transfer tower	1.1 Dismantling of processing plant and related structures (including overland conveyors and power lines)
33	Conveyor	1.1 Dismantling of processing plant and related structures (including overland conveyors and power lines)
34	Conveyor 1	1.1 Dismantling of processing plant and related structures (including overland conveyors and power lines)
35	Tippler	1.1 Dismantling of processing plant and related structures (including overland conveyors and power lines)
36	Loading station	1.2 Demolition of steel buildings and structures

37	Sinter plant	1.1 Dismantling of processing plant and related structures (including overland conveyors and power lines)
Other Surface Infrastructure		
38	Plant main stores building	1.2 Demolition of steel buildings and structures
39	Plant vehicle workshop, office and store	1.2 Demolition of steel buildings and structures
40	Plant workshop and stores	1.2 Demolition of steel buildings and structures
41	Medical facility	1.7 Demolition of housing and facilities
42	Assay laboratory	1.7 Demolition of housing and facilities
43	Admin offices	1.7 Demolition of housing and facilities
44	Dining facility	1.7 Demolition of housing and facilities
45	G.A. Change House	1.7 Demolition of housing and facilities
46	Security house	1.7 Demolition of housing and facilities
47	Diesel Storage	1.2 Demolition of steel buildings and structures
Rail facility and logistics		
48	Railway line	Demolition and rehabilitation of electrified railway lines
49	Rapid loading facility	1.2 Demolition of steel buildings and structures
Water and Waste management		
50	Tailings Dam	1.11 Rehabilitation of processing waste deposits and evaporation ponds (basic, salt-producing waste)
51	Sump	1.3 Demolition of reinforced concrete buildings and structures
	4.6 Specialist studies	

3.2 Applied Unit rates

Table 4 Applied Master rates

No.	Description	Unit	Master Rate (2013 / 2014)
1	Dismantling of processing plant and related structures	m3	R 11.41
2 (A)	Demolition of steel buildings and structures	m2	R 158.99
2(B)	Demolition of reinforced concrete buildings and structures	m2	R 234.30
3	Rehabilitation of access roads	m2	R 28.46
4 (A)	Demolition and rehabilitation of electrified railway lines	m	R 276.13
4 (A)	Demolition and rehabilitation of non-electrified railway lines	m	R 150.62
5	Demolition of housing and/or administration facilities	m2	R 317.97
6	Opencast rehabilitation including final voids and ramps	ha	R 166 684.63
7	Sealing of shafts adits and inclines	m3	R 85.35
8 (A)	Rehabilitation of overburden and spoils	ha	R 111 123.09
8 (B)	Rehabilitation of processing waste deposits and evaporation ponds (non-polluting potential)	ha	R 138 401.80
8 (C)	Rehabilitation of processing waste deposits and evaporation ponds (polluting potential)	ha	R 401 984.43
9	Rehabilitation of subsided areas	ha	R 93 048.85
10	General surface rehabilitation	ha	R 88 028.23
11	River diversions	ha	R 88 028.23
12	Fencing	m	R 100.41
13	Water management	ha	R 33 470.81
14	2 to 3 years of maintenance and aftercare	ha	R 11 714.77

3.3 Specialist studies

Table 5 An estimation of Specialist studies

	CALCULATION OF THE QUANTUM MINE: Mamatwan	estimate of specialist studies	
NO	**Field**	**Description**	**unit**
15a	Pollution management	Studies to meet the closure objectives	R 500 000
15b	Water management	Studies to meet the closure objectives	R 500 000
15c	Biophysical assessments	Studies to meet the closure objectives	R 500 000

3.4 Calculation of closure costs

The Closure cost for the proposed Mamatwan mine is calculated at: R 10 676 366.69 approximately. This includes for all know (as per the planning schedule) closure components reflected as such in section 3.1 above.

Annexure A provides a detailed breakdown of the calculation.

4. CLOSURE STRATEGY

Internationally, there seem to be three schools of thought when defining effective rehabilitation strategies, these are:

- "What the affected community wants, the affected community gets" – that is, the key focus is on providing the end product requested by the affected communities, rather than focusing on the previous status quo
- "Restoration of previous land use capability" – the original thought process in the South African context, because mining often occurs on land with high agricultural potential.
- "No net loss of biodiversity" – the focal point in the ICMM/IUCN dialogue sponsored guidelines for mining and biodiversity, and of many mining corporate policies.

In the South African context, rehabilitation objectives usually contain elements of all three approaches. Historically, restoration of land capability has been the key factor. Currently, rehabilitation objectives should align with the national and regional Integrated Development Plans (IDPs), which may or may not match local community wishes. Therefore the strategic statement for the Mamatwan operation is presented below:

"That all residual environmental impacts associated with the mining method employed, including possible final voids, infrastructure, stockpile, dumps or waste water containment structures, be neutralized or minimised such that the post-mining environment is able to function in a manner which conforms to the concept of sustainable development."

4.1 Company closure objectives

The manganese mining activities at Mamatwan is only a temporary use of land, so it is vital that rehabilitation of land and residue dumps takes place once mining operations have stopped.

Key rehabilitation objectives will guide operational controls, these are:

- To create a free draining post mining landscape that has been returned to a productive post mining land use.
- The land use is likely to be primarily wilderness with the potential for arable agriculture and livestock grazing.
- No new fixed infrastructure will be established on closure and all existing infrastructure will be removed.
- The closure objective regarding groundwater is zero discharge of contaminated water to the environment.
- Shaping and contouring of slimes dams,
- Removal of infrastructure
- Closure of shafts and adits
- Replacement of topsoil,
- Seeding with grasses and planting of trees taking place on the mined-out areas.
- Care is taken to relocate streams, wildlife, and other valuable resources.

Toward achieving these closure objectives are a series of key performance areas identified, particular as these are the key and most important actions that will need to be undertaken to ensure that the closure objectives are institutionalized and becomes part of the daily mining activities. Note that these objectives have been spelled out to be specific, measurable, relevant and achievable:

- Design and implement operational control measures (procedures, SOP's and best practice manuals) as indicated and required by the EMP.
- Ensure post mining provision (financial) is documented and available
- Ensure that environmental compliance and performance aspects are integrated into the operational controls and contracts.
- Establish a close working relationship with adjacent operational institutions and facilitate a common long term closure objective.
- Establish and conform to a frequent monitoring and reporting programme, such that liability assessments as well as legal compliance is tested and screened for improvements.
- Address area specific post mining rehabilitation objectives as stipulated in the section 2.2 below.

4.2 Operational area rehabilitation objectives

4.2.1 Infrastructure Areas

- The removal, decommissioning and disposal of all mining infrastructure, will comply with all conditions contained in the MPRDA. To this end, decommissioning and rehabilitation of all infrastructure areas will follow the following principles:
- Dismantle project related infrastructure. Load and remove from site for re-sale or disposal at an approved waste site.
- Any item that has no salvage value to the mine but could be of value to individuals will be treated as waste.
- Demolish and remove concrete foundations and slabs to an approved waste disposal facility, also to opencast voids and adits.
- Inert ceramics such as bricks, concrete, gravel will be used as backfill or disposed of in a permitted waste disposal site.
- Inert waste, which is more than 500 mm underground, such as pipes will be left in place.
- Dismantle and remove redundant fence for salvage.
- Cover the fence line with topsoil.
- The company contracted to supply fuel will be requested to remove all fuel storage and reticulation facilities.
- All structures will be demolished and terracing and foundations removed to the lesser of 500 mm below the original ground level.
- Rip and grade the above areas for placement of topsoil.
- Rip and grade mine roads for placement of topsoil.
- Maintenance of roads required for maintenance and monitoring.
- Load from stockpile, haul, and place and spread a layer of topsoil on all areas on which vegetation will be established.
- Establish vegetation on top soiled surfaces, including analysis of topsoil, application of fertilisers, application of seed and hand planting as necessary.
- Active maintenance of planted areas for a period of at least a year, including re-seeding and replanting, weed and alien vegetation control as required.
- Passive maintenance of planted areas, including re-seeding and re-planting, weed and alien vegetation control as required.
- Undertake complete groundwater quality and water level monitoring in order to establish long-term groundwater levels and quality trends.
- Haul roads will have consolidated basement materials lifted and disposed in to pit. Footprint of haul roads will be ripped to a depth of 1.0 meters. Topsoil will be spread over the ripped haul road footprint to a depth of 300 mm and reseeded.

- Piping and water treatment infrastructure will be maintained on site until water quality monitoring data proves that the water quality is acceptable for direct release to the receiving environment. The detailed closure plan that will be developed at end of mine life will address Long water monitoring and maintenance requirements.

4.2.2 Shafts and Mine access areas

- The proposed shafts will be sealed, fenced off and shaped to prevent runoff from draining inwards.
- A certain amount of the tailings produced will be pumped underground as backfill.
- No rehabilitation will be done underground as all materials, equipment and bet works will be withdrawn in terms of the relevant health and safety legislation.
- Final site inspections (underground) will ensure that no latent and or potential environmental risk is left, particular hydrocarbon storages.

4.2.3 Mine Residue Deposits

- Mine residue deposit will be capped where necessary and vegetated with a seed mix which will be determined during the closure specialist assessments and studies. Stoloneferous grasses are included to bind the tailings and soils and prevent erosion.

4.2.4 Maintenance of Impacts Identified

- The necessary agreements and arrangement will be made by ENRC Mamatwan to ensure that all natural physical, chemical and biological processes for which a closure condition were specified are monitored until they reach a steady state or for three (3) years after closure or as long as deemed necessary at the time.
- Such processes include erosion of the slimes dams, rehabilitated surfaces, surface water drainage, ground water recharge, air quality, surface water quality, ground water quality, vegetative re-growth, weed encroachment and general biodiversity.
- The closure plan will be reviewed every one (1) years.
- All rehabilitated areas will be monitored and maintained until such time as required to enable the mine to apply for closure of these different areas.

4.2.5 Topography: Surface Infrastructure

a. Mamatwan Management objectives

- Return topography as close as possible to pre-mining topography.

b. Mamatwan Management principles and criteria

- Shape remaining waste rock dumps, slag dumps and tailings dams to ensure that the topography is free-draining.
- Remove structures higher than 5 meters.
- Remove all concrete or steel structures that cannot be used by the community.
- Topsoil and rehabilitate waste rock dumps, slag dumps and tailings dams areas.
- Rehabilitation includes planting and shaping to fit in with the natural topography.
- Soil: Erosion.

c. Mamatwan Management objectives

- To prevent erosion.

d. Management principles and criteria

- It is not anticipated that surface subsidence will occur associated with the underground mined blocks. Some minor settlement may occur on the adits and mine entrances, however the pit is located on very gentle slopes and local settlement is unlikely to result in ponding of water.
- Vegetation establishment in disturbed areas will be undertaken during the rainy season.
- The mine will observe the requirements of the Department of Agriculture in the design of effective erosion control measures on bare soils.
- These requirements are generally as follows:
    - erosion control measures are required in all areas where slope gradients exceed 2%;
    - Engineered erosion control measures are required where slope gradients exceed 7º (15%).
- The following activities will be included:
- Ensure that all slopes are safe in the Long;
- Submission of closure report and application for closure to the authorities; and
- Environmental monitoring and maintenance for three (3) years after closure.
- Rehabilitation of the land will be maintained until a closure certificate is granted or until the land use is regarded as sustainable.

4.2.6 Land Capability: Loss of Grazing Land

a. Mamatwan Management objectives

- Restore disturbed land to grazing potential (being 4ha per large stock unit or 10 small stock units) at all sites other than the tailings dam, slag dump, existing open pits/rock dump and return water dam site.
- After rehabilitation the site will be returned as close as possible to the pre-mining land capability.

b. Management principles and criteria

- The plant and other buildings not utilised will be demolished. Building foundations will be removed to a depth of 0.5m
- All other sites, other than the site of the tailings dam, slag dump, return water dam and rock dump, will be landscaped so that the slope gradient is as gentle as possible and minimal erosion control measures are required
- Sealing of the shafts to be followed by rehabilitation of all disturbed areas.
- Spread available topsoil on all areas on which vegetation will be established.
- Before seeding and planting, topsoil should be sampled and analysed to establish fertility status and fertilised accordingly.
- Maintain planted areas for a period of at least 3 years, including fertilization, re-seeding and replanting, weed and alien vegetation control as required.

4.2.7 Natural Vegetation: Loss of Biodiversity and Ecological Function

a. Mamatwan Management objectives

- Restore disturbed land to grazing potential (being 4ha per large stock unit or 10 small stock units) at all sites other than the tailings dam, slag dump, existing open pits/rock dump and return water dam site.

b. Management principles and criteria

- Rehabilitated areas of grazing capability will comprise a grass community dominated by grasses of pasture origin. These areas will be managed by a combination of grazing or mowing or veld burning to effect defoliation. Mamatwan to monitor re-grassed areas as indicated in order to demonstrate the trend towards the areas becoming self-maintaining in these rehabilitated systems.

4.2.8 Surface Water: Compliance with the Regulation 704 and Condition of Approval of Water Use Licenses

a. Mamatwan Management objectives

- To ensure compliance with Regulation GN 704 and conditions of approval of the water use licence. Where compliance is not possible due to old existing infrastructure (pre 1999) ensure that exemption from compliance is applied for.

b. Management principles and criteria

- All new projects or expansions have been planned in compliance with GN 704 Regulations and will be designed, constructed, operated and decommissioned in accordance with these regulations.
- Any rainfall falling on the waste rock dump, slag dump or tailings dam areas will be contained in the pollution control dam. If unpolluted, this water will be allowed to flow free.

4.2.9 Groundwater: Lowering of Groundwater Levels

a. Mamatwan Management objective

- To prevent unacceptable negative impacts on surrounding groundwater users.

b. Management principles and criteria

- The water levels in existing groundwater monitoring boreholes and the newly recommended boreholes will be monitored on a quarterly basis for up to 3 years after mining ceases.
- There should be ongoing communication with adjacent mines and water users in order to best understand the influence of mining on the groundwater to the north.
- The groundwater flow and transport model should be recalibrated at closure to calculate any potential risks with regards to draw down rates and possible future contaminant movement.
- Any users that lose a groundwater resource as a result of the project mining activities will be compensated accordingly and provided with an appropriate alternative water supply.
- It is recommended that the existing opencast be modelled and the effects quantified to estimate the influence of an extension of the opencast reliably for operational and closure phases.

4.2.10 Groundwater: Deterioration of Water Quality as a Result of Seepage

a. Mamatwan Management objectives

- To limit the impact of infiltration of potentially contaminated leachate to the underlying aquifers.

b. Management principles and criteria

- All disturbed areas will be rehabilitated and revegetated.
- The groundwater flow and transport model should be recalibrated at closure to identify any potential risks of possible contaminant movement.
- Any users that lose a groundwater resource as a result of the project mining activities will be compensated accordingly and provided with an appropriate alternative water supply.

4.2.11 Visual Aspects: Negative Visual Impact

a. Mamatwan Management objectives

- To limit the visual impact of the project on both the surrounding landowners and the Magaliesberg reserve.

b. Management principles and criteria

- All disturbed areas to be rehabilitated.
- Areas to be revegetated with endemic trees and grass species.
- Remaining waste rock dumps, slag dumps and tailings dams to be flattened, sloped, covered with topsoil and vegetated.

4.2.12 Regional Socio-Economic Impacts

a. Mamatwan Management objectives

- To mitigate the impacts of the termination of the project. Mine closure will result in cessation of employment, with a limited number of workers benefiting from closure and decommissioning activities.

b. Management measures

- Mamatwan will give advance warning of the closure of the mine as early as practically possible, so that employees have the maximum time to seek alternative employment.
- Mamatwan will offer professional employee counselling to deal with the effects of job loss to reduce the traumatic effect of dismissal. Where dismissal based on operational requirements becomes necessary the company will offer training in small business development and relevant skills to encourage job creation and financial independence.
- Mamatwan will provide severance payments and assist employees in obtaining social benefits. Mamatwan will take reasonable steps to notify employees, recently dismissed in terms of the Social and Labour Plan procedure, of vacancies, which have occurred subsequent to their dismissal, so that they may apply for re-

employment. Application for such vacancies must be forwarded within the stipulated period and will be considered with due regard to the skills required.

- Local product and service providers will be most affected by the reduced economic activity in the area as a result of the mine's closure. Mamatwan will assist in the re-focussing and diversification of local service providers in accordance with sustainable development principles.
- Rehabilitated land and remaining infrastructure could be used for other purposes, which could include agriculture (grazing), tourism, training centres and other activities.
- Rehabilitation should take account of sustainable development opportunities, formulated with the local community.

4.2.13 Submission of Information

- On completion of mining or the tailings retreatment activity, and subsequent to monitoring having indicated that the post-mining / activity environment is self-sustaining, a detailed closure report will be completed in support of the application for closure of the mine, as required under the Minerals and Petroleum Resources Development Act, 2002 (Act 28 of 2002). The closure plan will address the necessary environmental risk assessment and will include at least the following:
- An evaluation of surface water quality at monitoring points for the periods September to April and April to September. This will include an evaluation of macro and micro constituents and an overall evaluation of groundwater quality in the monitoring boreholes.
- Performance audit to reflect compliance with the environmental management programme as described in this EMP. The audit will be conducted by an independent party and will meet the requirements of the Department of Mineral and Energy as stipulated from time to time. Special attention will be given to environmental performance.
- Review of water balances.
- Water levels in monitoring boreholes (dual levels).

4.3 Overall physical stability

To achieve a state where the infrastructure has been removed, all remaining mining residue has been subjected to either a removal or an on-site stabilization programme and then the closure and shaping of the open pits, adits and shafts have been achieved.

Specific targets would include:

- Removal of non-beneficial surface and subsurface (foundations) infrastructure.
- Identification and documentation of material available for void and or shaft closure (in fill)

- Removal of non-beneficial roads and other servitudes and or services lines (Eskom, Telkom, Local municipality)
- Shaping, compacting of the total area again the pre-designed rehabilitation shape / surface gradient model
- Soil amelioration and seeding techniques

4.4 Overall Health and Safety

To achieve a state where the areas under rehabilitation or those that have been rehabilitated, pose no obvious risk to Human Health and Safety. This achievement should also then include relevant reference to other livening things, such as cattle and wild animals.

Specific targets would include:

- Proper well established access control and fencing, clear communication of actual and or eminent risk.
- Water and Air quality assessments (monitoring), documented and communicated to assist with inherent and actual risk management.

4.5 Environmental stability

Biodiversity gains are a realistic objective within rehabilitation planning models whether topsoil is, or is not, available as an ecological tool. Also is biodiversity, during its period of establishment and ultimate point of stability very dependent on suitable chemical and structural conditions.

Therefore an overall objective to achieve a stable state, where chemical conditions are supportive to growth, also where structural conditions are adequate enough where within plant and animal live can sustain natural processes and interactions.

Specific targets would include:

- Surface areas and properties well drained
- Application of seed beds, inclusive of pioneer and succession species
- Soil capability suitable for plant establishment, root growth, flower growth and leave growth.
- Water quality on surface acceptable for land use purposes
- Water quality underground acceptable

4.6 Social stability

With reference to the Mamatwan Social and Labour plan are the following targets applicable to stable social conditions post closure applicable:

- Safety of old operational areas, in so not posing any risk to the health and well-being of land occupants, adjacent land owners and or grazing cattle.
- The land should be rehabilitated such that secondary use is an option, meaning that grazing, planting and or settlements can optimize the appropriate areas.

4.7 Ecosystem stability and biodiversity

Once again, the rehabilitation of infrastructure must take into account the requirements of the land-owner in the agreement between the Mine and the landowner. Similarly, the program assumes that the infrastructure must be removed in order to facilitate the above objectives. The following measures to be instituted:

- All domestic or industrial waste generated at the administration infrastructure or workshops (respectively) to be removed from site to a registered waste disposal site.
- All concrete foundations are to be ripped and removed to the biggest haulage area that will be used as backfill.
- Finally, all infrastructure areas to be ripped, to a minimum depth of 300mm, and the seed mix and maintenance as suggested this document applied.

4.8 Land use and land capability

Land use and land capability are interlinked and holds the key to true sustainable development. Therefore the Mamatwan operation applies the following measures:

- Areas of underground working cannot be used for residential purposes, until proven safe. These areas will be earmarked for grazing and or high yield agriculture.
- Rehabilitated slimes and waste rock dumps will not be used for residential and or associated land uses, neither will these areas be suitable for agriculture and grazing would be the most appropriate land use.
- Rehabilitated areas under the old plant and offices areas, which is not waste rock dumps will be used as high yield grazing and or agricultural land.

Mamatwan is committed to the ongoing assessment of land use and land capabilities to support accurate mine closure objective setting and planning.

5. ANNEXURES

5.1 Annexure A: Mine Closure cost assessment

	CALCULATION OF THE QUANTUM MINE: Mamatwan	Step 4.7 CALCULATION OF THE CLOSURE COST									
NO	Item	Description	unit	DME Unit	SQ	DMEQ	DIM (3)	Master Rates 2013	Mult F	Weight F	E=A*B*C*D (Amounts 'R' escalated 2010)
		Mine Acess and declines									
1	Primary Acess (decline shafts 1)	Sealing of shafts adits and inclines	m	m2	36	36	6	R 85.35	1	1	R 3 072.76
2	Primary Acess (decline shafts 2)	Sealing of shafts adits and inclines	m	m3	36	36	6	R 85.35	1	1	R 3 072.76
3	Ventilation Infrastructure (intake excavation 1)	Sealing of shafts adits and inclines	m	m2	25	25	5	R 85.35	1	1	R 2 133.86
4	Ventilation Infrastructure (intake excavation 2)	Sealing of shafts adits and inclines	m	m2	25	25	5	R 85.35	1	1	R 2 133.86
5	Ventilation Infrastructure (intake excavation 3)	Sealing of shafts adits and inclines	m	m2	25	25	5	R 85.35	1	1	R 2 133.86
6	Ventilation Infrastructure (intake excavation 4)	Sealing of shafts adits and inclines	m	m2	25	25	5	R 85.35	1	1	R 2 133.86
7	Stockpile	1.11 Rehabilitation of processing waste deposits and evaporation ponds (basic, salt-producing waste)	m2	ha	2.00	4.00	4.00	401 984.43	1	1	1 607 937.70
		Plant and process infrastructure									
8	Access road	Rehabilitation of access roads	m	m	4000	2000	1	R 28.46	1	1	R 56 910.00
9	Ore receiving conveyor	1.1 Dismantling of processing plant and related structures (including overland conveyors and power lines)	m	m3	90	270	6	R 11.41	1	1	R 3 081.65
10	ROM Stockpile feed conveyor	1.1 Dismantling of processing plant and related structures (including overland conveyors and power lines)	m	m3	348	208.8	1.2	R 11.41	1	1	R 2 383.14
11	ROM Stockpile	1.11 Rehabilitation of processing waste deposits and evaporation ponds (basic, salt-producing waste)	m2	ha	1.5	0.75	1	R 82 700.00	1	1	R 62 025.00
12	Reversible conveyor	1.1 Dismantling of processing plant and related structures (including overland conveyors and power lines)	m	m3	61	36.6	1.2	R 11.41	1	1	R 417.73
13	Scalping screens feed bin conveyor	1.1 Dismantling of processing plant and related structures (including overland conveyors and power lines)	m	m3	350	210	1.2	R 11.41	1	1	R 2 396.84
14	Scalping screens	1.2 Demolition of steel buildings and structures	m2	m2	147	73.5	1	R 158.99	1	1	R 11 685.84
15	Conveyor	1.1 Dismantling of processing plant and related structures (including overland conveyors and power lines)	m	m3	246	147.6	1.2	R 11.41	1	1	R 1 684.63
16	Secondary crushing	1.1 Dismantling of processing plant and related structures (including overland conveyors and power lines)	m2	m3	158	158	2	R 11.41	1	1	R 1 803.33
17	Conveyor	1.1 Dismantling of processing plant and related structures (including overland conveyors and power lines)	m	m3	176	105.6	1.2	R 11.41	1	1	R 1 205.27
18	Tertiary screens building	1.2 Demolition of steel buildings and structures	m2	m2	139	69.5	1	R 158.99			R 0.00
19	Tertiary crusher feed bin conveyor	1.1 Dismantling of processing plant and related structures (including overland conveyors and power lines)	m	m3	128	128	2	R 11.41	1	1	R 1 460.93
20	Conveyor	1.1 Dismantling of processing plant and related structures (including overland conveyors and power lines)	m	m3	270	162	1.2	R 11.41	1	1	R 1 848.99
21	Tertiary and fines crusher building	1.2 Demolition of steel buildings and structures	m2	m2	209	209	2	R 158.99	1	1	R 33 229.12
22	Fines screening building	1.2 Demolition of steel buildings and structures	m2	m2	355	355	2	R 158.99	1	1	R 56 441.81
23	Conveyor 1	1.1 Dismantling of processing plant and related structures (including overland conveyors and power lines)	m	m3	72	43.2	1.2	R 11.41	1	1	R 493.06
24	Conveyor 2	1.1 Dismantling of processing plant and related structures (including overland conveyors and power lines)	m	m3	130	78	1.2	R 11.41	1	1	R 890.25
25	Conveyor 3	1.1 Dismantling of processing plant and related structures (including overland conveyors and power lines)	m	m3	10	6	1.2	R 11.41	1	1	R 68.48
26	Conveyor 4	1.1 Dismantling of processing plant and related structures (including overland conveyors and power lines)	m	m3	238	142.8	1.2	R 11.41	1	1	R 1 629.85
27	Conveyor 5	1.1 Dismantling of processing plant and related structures (including overland conveyors and power lines)	m	m3	85	51	1.2	R 11.41	1	1	R 582.09
28	Sinter, coke & anthracite stockpiles	1.11 Rehabilitation of processing waste deposits and evaporation ponds (basic, salt-producing waste)	m2	ha	1.8	0.9	1	R 401 984.43	1	1	R 361 785.98
29	Conveyor 1	1.1 Dismantling of processing plant and related structures (including overland conveyors and power lines)	m	m3	200	120	1.2	R 11.41	1	1	R 1 369.62
30	Conveyor 2	1.1 Dismantling of processing plant and related structures (including overland conveyors and power lines)	m	m3	198	118.8	1.2	R 11.41	1	1	R 1 355.92
31	Conveyor 3	1.1 Dismantling of processing plant and related structures (including overland conveyors and power lines)	m	m3	335	201	1.2	R 11.41	1	1	R 2 294.11
32	Transfer tower	1.1 Dismantling of processing plant and related structures (including overland conveyors and power lines)	m2	m3	40	80	4	R 11.41	1	1	R 913.08

33	Conveyor	1.1 Dismantling of processing plant and related structures (including overland conveyors and power lines)	m	m3	200	120	1.2	R 11.41	1	1	R 1 369.62
34	Conveyor 1	1.1 Dismantling of processing plant and related structures (including overland conveyors and power lines)	m	m3	190	114	1.2	R 11.41	1	1	R 1 301.14
35	Tippler	1.1 Dismantling of processing plant and related structures (including overland conveyors and power lines)	m2	m3	144	216	3	R 11.41	1	1	R 2 465.32
36	Loading station	1.2 Demolition of steel buildings and structures	m2	m2	840	420	1	R 158.99	1	1	R 66 776.22
37	Sinter plant	1.1 Dismantling of processing plant and related structures (including overland conveyors and power lines)	m2	m3	12000	42000	7	R 11.41	1	1	R 479 367.00
		Other Surface Infrastructure									
38	Plant main stores building	1.2 Demolition of steel buildings and structures	m2	m2	950	475	1	R 158.99	1	1	R 75 520.73
39	Plant vehicle workshop, office and store	1.2 Demolition of steel buildings and structures	m2	m2	1260	630	1	R 158.99	1	1	R 100 164.33
40	Plant workshop and stores	1.2 Demolition of steel buildings and structures	m2	m2	535	267.5	1	R 158.99	1	1	R 42 530.09
41	Medical facility	1.7 Demolition of housing and facilities	m2	m2	538	269	1	R 317.97	1	1	R 85 534.33
42	Assay laboratory	1.7 Demolition of housing and facilities	m2	m2	543	271.5	1	R 317.97	1	1	R 86 329.26
43	Admin offices	1.7 Demolition of housing and facilities	m2	m2	840	420	1	R 317.97	1	1	R 133 548.03
44	Dining facility	1.7 Demolition of housing and facilities	m2	m2	1190	595	1	R 317.97	1	1	R 189 193.04
45	G.A. Change House	1.7 Demolition of housing and facilities	m2	m2	900	450	1	R 317.97	1	1	R 143 087.18
46	Security house	1.7 Demolition of housing and facilities	m2	m2	110	55	1	R 317.97	1	1	R 17 488.43
47	Diesel Storage	1.2 Demolition of steel buildings and structures	m2	m2	90	45	1	R 317.97	1	1	R 14 308.72
		Rail facility and logistics									
48	Railway line	Demolition and rehabilitation of electrified railway lines	m	m	9700	9700	1	R 276.13	1	1	R 2 678 451.30
49	Rapid loading facility	1.2 Demolition of steel buildings and structures	m2	m2	840	420	1	R 158.99	1	1	R 66 776.22
		Water and Waste management									
50	Tailings Dam	1.11 Rehabilitation of processing waste deposits and evaporation ponds (basic, salt-producing waste)	m2	ha	1.5	0.75	1	R 401 984.43	1	1	R 301 488.32
51	Sump	1.3 Demolition of reinforced concrete buildings and structures	m2	m2	3650	1825	1	R 234.30	1	1	R 427 592.03
	4.6 Specialist studies										R 1 500 000.00
											R 8 643 866.69
					1	Preliminary and general				12.5% of Subtotal 1	R 187 500.00
					2	Administration & Supervision Cost				6.0% of Subtotal 1	R 90 000.00
					3	Eng drawings and Specs				2.0% of Subtotal 1	R 30 000.00
					4	Engineering and procurement of specialist work				2.5% of Subtotal 1	R 37 500.00
					5	Development of closure plan				1.25% of Subtotal 1	R 18 750.00
					6	Final Ground water modeling				1.25% of Subtotal 1	R 18 750.00
					7	Contingency				10.00% of Subtotal 1	R 150 000.00
								Grand Total			R 10 676 366.69

5.2 Annexure B: Closure Guidelines Mamatwan mine

5.2.1 Slimes dams and Waste rocks dump

The disposal of mine residue commonly involves the stacking of material in a wet or dry state at surface. These stacks have the potential to slide or flatten or to be eroded. In any of these instances there is a potential risk to life, property and the environment. The constituents of mine residues frequently include elements that upset the natural environmental balance that existed before residue disposal. Mine residue disposal therefore presents a potential hazard to society and to the environment.

Mine residue disposal is an integral part of mineral and natural resource exploitation, but there is a moral obligation to ensure that the benefits of the exploitation of finite assets are optimized for everyone and that no avoidable problems or legacies are left to future generations to resolve.

a. Aims of residue disposal

In order to address the potential hazards, avoid the manifestation of undue risks and ensure the optimization of resource exploitation, owners of mines and practitioners of mine residue disposal have a moral responsibility to conduct disposal practices in accordance with the following set of fundamental objectives and principles. These objectives are best described as a set of performance criteria. These performance criteria are the fundamental principles with which all residue facilities should comply and the yardsticks against which they should be assessed or judged.

b. Safety

Residue deposits pose a hazard, by virtue of their nature, size and position. Statutes, common law and moral obligations require that life, limb or property of society at large shall not be threatened or at undue risk from any mine residue disposal facility. This implies that facilities should possess an inherent degree of safety. This safety can be threatened by climatic conditions, geotechnical instability, poor design, poor operational practice or management, adverse environmental impacts or inadequate access controls. In the quest for the optimum solution, the costs of engineering to ensure acceptable risk levels have to be balanced against the costs and benefits to society. The safety yardstick is therefore site specific with risks identified and mitigated.

c. Environmental responsibility

Environmental responsibility should be inherent in all mine residue disposal systems, because failure to accept the responsibility can lead to risk and costs to society that diminish or even exceed the benefits of the original exploitation of the resource. The impact on the environment is the most significant tangible manifestation of mine residue disposal. The level of responsibility remains a subject of debate and consequently definitive targets cannot be stipulated. Each facility is unique and, when limits are being set, the costs and benefits to society should be balanced.

When the impacts on the environment are being considered, the environment should be interpreted in its broadest sense to encompass social and natural environments, considering not only the impacts downstream of the facility but also impacts on upstream resources in the generation and disposal of the residue. These impacts include the generation of wealth, manpower and mineral resources.

d. Consultation

All potentially affected parties and relevant authorities should be identified before or during the decommissioning phase and at all high hazard safety classification deposits and deposits with potential residual impacts.

Closure aims as suggested in this document should be extended in consultation with these parties. Specific environmental targets or objectives (or both) should then be negotiated with the relevant parties if there is a significant impact on any environmental aspect.

Consultation with all relevant authorities should continue as deemed necessary in accordance with the risk or hazard (or both) and potential environmental impact involved.

If third parties other than the state are required to take over certain or all responsibilities, the necessary contractual agreements should be entered into, arranged and finalized before closure.

e. Investigations, assessment and monitoring

For all deposits where a significant impact on water quality has been predicted, water quality monitoring for both surface and groundwater should be undertaken in accordance with an approved programme (EMP or closure plan) until an acceptable steady state has been reached, after which annual checks might still be required, or as deemed necessary.

Air quality monitoring should be done regularly in accordance with an approved programme until an acceptable level has been reached, after which it may be scaled down.

Monitoring in general should continue until all the agreed environmental and land use conditions have been reached.

The sampling and analysis of water should preferably be done in accordance with accepted SABS standard methods.

Normal visual inspections should continue as required for various aspects such as:

- Erosion control;

- Seepage; and
- Vegetation covers.

In the case of undermining, a rock mechanics strata control investigation should be done, to prove that seismic events and strata failure will not impact on the structural stability of the deposit.

f. Effective stabilization and structural integrity

Measures placed or constructed on the slope of the deposit should not compromise the structural integrity.

Adequate measures should be taken to ensure that any material placed on the toe of a deposit does not impede the internal drainage from the embankment or prejudice the pollution control requirements.

Diversion measures to ensure that storm water run-off from higher ground does not reach the deposit, should be maintained at a capacity that could contain a 1:100 year, 24-hour storm event, plus 0,5 m of freeboard.

Freeboard on top of the tailings deposits (medium hazard and high hazard safety classification) should be as is legally required (see R287 of the Water Act).

If the deposit is elevated, no water should be held near the outer slopes of the deposit unless the deposit was designed for that purpose.

All residue deposits should be left in such a state that they are able to withstand, with a minimum of detrimental consequences, the effects resulting from the maximum probable precipitation appropriate to the location of the deposit.

Penstocks, delivery pipes and outfall pipes should be left in such a state that they do not constitute a potential source of failure.

g. Erosion control and Air Quality

Paddocks around the perimeter of the deposit should be adequately designed and maintained.

The length and angle of the slopes of a deposit should be optimally reduced to ensure, inter alia, that the velocity of run-off water on the slope does not become too high and that erosion protection measures do not become dislodged.

All penstocks and pipes should be removed or should be in such a condition that they do not constitute a route whereby residue can escape and form piping erosion.

Adequate erosion control measures should be implemented on the surface of the deposit. If vegetation is chosen as the erosion control method, the following are recommended:

- The soil or seedbed should be ameliorated to such a condition that the sown seed will germinate readily and healthy plants will develop rapidly.
- More than one species should be used.
- The design of the seed mix should be determined by the specific purpose.
- A certain degree of ecological and climatic modelling should be done and the species chosen should be adapted to the ambient geographical conditions.
- The natural colonization of indigenous species should be allowed into the interlocking cover.
- To be effective, the vegetation cover should cover as large an area as practicably possible, both from a leaf area index and a basal cover (plants per square metre) perspective.

In the case of all tailings or fine material (or both), the control measures chosen should cover as large an area as possible, including the top.

Sharp edges should be avoided, especially on the crest and, if needed, reshaping should be done, especially on the predominantly windward side.

The characteristics of the residue material should be taken into consideration when the control measures are designed and implemented.

h. Water pollution and water quality

Specific water quality aims and targets should be set for each constituent of concern for both surface and groundwater within the affected zone.

No diversion measures or control measures should be constructed in which contaminated material is used.

i. Other environmental considerations

For aesthetic purposes and in a sensitive area, the deposit may be shaped, where appropriate, to break contrast and to blend into the topography according to the sensitivity of the landform.

Appropriate vegetation should be planted and maintained, where applicable, to blend the visual appearance with the natural surroundings.

Aspects such as surrounding infrastructure, graveyards, etc., should be taken into consideration when final rehabilitation measures are being designed and implemented.

5.2.2 Mine adits and vent shafts

a. Fences and Gates

- Fences or gates shall be used where it is essential to occasionally enter or gain access to shafts or adits.
- Fences, gates or other closure techniques that maintain or enhance bat and other wildlife habitat shall be considered where habitat exists.
- Where bats or other wildlife inhabit the mine, and wildlife friendly closures are not feasible, an exclusion plan for the bats or other wildlife shall be written and implemented.
- Fencing, gates, caps, and walls shall be used only where periodic inspection and maintenance is ensured through a maintenance agreement with a responsible government entity, landowner, or organization.
- Fences or gates shall be constructed to keep unauthorized persons out and shall be located where subsidence or caving will not break their integrity.
- Where applicable, fences and gates shall be designed to maintain or improve habitat and access for bats and other wildlife. Fences or gates shall be made of steel, concrete, masonry, or "anti intruder" chain link and barbed wire fences or a combination of these materials.
- Stockpiled soil or rock materials shall be protected from erosion until used.

b. Safety

- If hazardous gas is present, a person with Mine Safety and Health Administration (MSHA) certification for underground work shall be on site to monitor safety during the site investigation and practice installation.
- During construction, a collapse established, clearly marked with fencing and warning notices, and no person shall enter this zone without wearing proper safety equipment.
- Bumper blocks or other devices must be used to keep machinery and trucks from falling into shafts and subsidence pits. If possible, equipment blades and buckets shall be larger than the opening being filled. If explosives or items that resemble explosives are found, do not handle them and report the findings to the local MSHA office.
- At the completion of the closing, filled or plugged shaft or adit locations shall be marked in the field and an affidavit of mine closing shall be recorded with the local register of deeds to reduce the risk of future development over the shaft or adit.

c. Site investigation reports

- Geology and groundwater conditions at the site
- Access conditions into mine
- Risks to life and property associated with the mine
- Equipment and trash within mine
- Presence of hazardous gases
- Presence of acid mine drainage
- Mine history including mine plan if available
- Inventory of plant or animal species using the mine
- Potential for surficial changes due to water table variation

d. Designed filling or sealing

- Shafts and adits shall be cleaned of all trash, debris, metal, timber, wire and other materials that could hinder an effective designed filling or sealing.
- The finished surface of the filled or plugged shaft or adit shall be graded to provide free drainage away from the opening and vegetation established in accordance with NRCS standards.
- All materials removed shall be disposed of by burning or burying at approved sites or transported to approved landfills.
- Shafts or adits shall be filled to about 3 feet from the surface with a designed filter consisting of non-acid-forming, free-draining materials or polyurethane foam.
- The remainder of the shaft or adit shall be filled with earth materials including a minimum of 3 feet of clay compacted in 9-inch lifts or other impervious materials that would retard the passage of water or gas.
- Shaft openings shall be overfilled 10 percent of the depth of the shaft, or 3 feet, whichever is less to allow for settlement. Subsidence pits that are open, active, and/or passing a significant quantity of water require a designed filter of non-acid-forming, free draining material.
- Sufficient soil covering shall be placed to sustain planned vegetation. Subsidence pits that are closed, inactive and not passing a significant quantity of water shall require only backfilling with suitable soil material.
- Sinkhole openings shall be overfilled 10 percent of the fill depth, or 3 feet, whichever is less to allow for settlement.

e. Sealing with Plugs

- Shafts shall be closed with plugs only if another practical solution is not available. Installed below the ground surface, plugs are used where the shaft is to be filled to the surface but the shaft below is to remain open.

- Plugs shall be constructed of reinforced concrete designed to support anticipated loads.
- The reinforced concrete shall be placed on firm bedrock. Plugs may be designed to be watertight and gastight or to allow drainage and venting of gases.
- Shaft above the plug shall be filled to about 3 feet from the surface with a designed filter consisting of nonacid-forming, free-draining materials or polyurethane foam.
- The remainder of the shaft above the plug shall be filled with earth materials including a minimum of 2 layers of clay, approximately 2 feet thick, or other impervious materials that would retard the passage of water or gas.
- Shaft openings shall be overfilled 10 percent of the depth of the shaft above the plug to allow for settlement.
- The finished surface of the plugged shaft shall be graded to provide free drainage away from the opening and vegetation established.
- Sealing with Caps and Walls. Caps and walls shall be constructed of reinforced concrete or steel beams and grates or solid steel plates to completely close shaft or adit openings.
- Caps and walls shall be designed with sufficient strength to support anticipated loads and shall be securely anchored.
- The cap, wall, fittings, access holes and vent pipe shall be reasonably vandal proof. The surface of a cap over a shaft must be raised not less than 1 foot above the surrounding terrain to provide good visibility and positive drainage away from the cap installation.

f. Sealing with Barriers

- Barriers shall be constructed to restrict humans and animals from entering adits, and may be used to prevent lateral spreading of backfill material and to support fill used to cover adit openings.
- Barriers shall be constructed of stones, crushed rock, quarry-run rock, gravel or similar nonacid-forming, free-draining materials.
- The minimum filled length of the barrier shall be three times the maximum adit height or width within the barrier section, whichever is greatest. Concrete or masonry wall may be used to support the barrier.
- Barriers not supported by concrete or masonry walls shall have 3 horizontal to 1 vertical or flatter slopes. Barriers at the ground surface shall be covered with soil materials to a minimum vertical thickness of 4 feet and vegetation shall be established in accordance with NRCS standards.
- Where needed, a permanent drainage system using pipe or rock toes shall be installed through this covering.
- Traps to prevent air or gas passage shall be used where necessary.
- Sealing with Dams.
- Dams are constructed to prevent water flow into or out of adits. Dimensional requirements are those stated for barriers in the previous section.
- The fill shall be essentially watertight and designed to support anticipated structural and hydraulic loads.

- Designed filters shall be incorporated to prevent piping of the fill material.

g. Plans and Specifications

Plans and specifications for closing shafts and adits shall be in keeping with this standard and shall describe the requirements for applying the practice to the specific site to achieve its intended purpose or purposes.

h. Operation and Maintenance

Barriers, fences, gates and caps are to be maintained to accomplish their purpose. A site-specific operation and maintenance plan shall be developed for all gated, fenced and capped closures. Regular inspections shall take place and prompt repair and follow-up shall be carried out. Additional maintenance activities shall be outlined in the maintenance plan.

i. Public participation

The public and other interested and affected parties should be consulted on decisions that might affect them but that are made by the owner of a mines. Decisions relating to sitting, selection of safety and environmental objectives and choice of measures to achieve safety and environmental aims are the most important. At least the following parties should be consulted:

- Adjacent land owners upon whom the abandoned mine could have an impact;
- Authorities concerned with the regulation of aspects of the environment; and
- Interested and affected non-government organizations concerned with the environments upon which the abandoned mine could have an impact.

j. Environmental management programme

The requirements of and outputs from this standard that relate to aspects of environmental management should be recorded in the environmental management programme for the mine.

k. Skills and experience

The onus for the management of a mine shaft deposit lies with the owner of the deposit. The owner should ensure that suitably qualified persons are engaged for conceptualization, site investigations, design, construction, commissioning, operation, decommissioning, closure and aftercare.

5.2.3 Plant and stockpile footprint

All infrastructure, delivery systems and draining pipes that are not intended for further use should be removed to ensure that they do not constitute a potential risk to people or to the environment.

All aspects needing maintenance during the aftercare (including post-closure) period should be assessed and the required maintenance should be done in accordance with an approved programme.

Any sloping or earthworks (or both) that are required should be done as quickly as possible and shall not impede on any of the normal pollution control and stability measures, unless so designed.

Adequate access control by means of fencing or other effective measures, together with prominent placement of signs to prevent inadvertent access, will be required at all deposits of a medium hazard to high hazard safety classification and also where there are significant residual impacts or maintenance requirements (or both).

If access is not controlled, all slopes of height exceeding 3 m should be appropriately angled to ensure that minimum danger exists to humans and animals.

END