REVISITING CLOSURE: ENVIRONMENTAL RESTORATION FOR SUSTAINABLE LAND UTILISATION AT ZWARTKOP CHROME MINE

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ABSTRACT

The Zwartkop Chrome Mine, opened in 1935, produced chromite ore from underground workings on the north western rim of the Bushveld Igneous Complex for more than 40 years. In 1978, Transvaal Mining and Finance Company – a wholly owned subsidiary of the General Mining and Finance Corporation, later to become part of BHP Billiton, closed the mine. The workings were secured in accordance with the legislation of the day – poor practice by today's standards. With the coming of new political order in South Africa, a community forcibly removed from the land surrounding the mine made an application to the courts for the restitution of this land. The application was not opposed by BHP Billiton but transfer to the community was made contingent on the company first having access to the land to effect rehabilitation of the land surface in accordance with the company's closure policy.

Final land use optimisation has been made more complex by a number of competing land users at the site – the new owners live some distance away, a portion of the land is occupied by a squatter community and local farmers are reworking some of the old waste deposits.

BHP Billiton and the Centre for Sustainability in Mining and Industry have embarked on a study to assess the process of transition from the old disturbed site to a new rehabilitated surface capable of sustaining economic activity. This paper scopes the challenges of best practice closure in South Africa today using Zwartkop Chrome Mine as an example.

1. INTRODUCTION

Mining is a temporary land use, intrinsically unsustainable as it consumes it's *raison d'être*, the ore deposit. From the moment the first tonne of rock is broken, a mine is guaranteed to close. With the coming of the industrial age, mines became vast enterprises, employing whole communities and radically transforming landscapes. In many instances, and especially in Southern Africa, these industrial mines were founded on massive ore deposits. Their lives often stretched beyond the careers of their planners and initiators. The great African mines of the 20th century – copper mines in the Copperbelt, gold mines in the Witwatersrand, base and platinum group metals in the Bushveld – were commissioned in a triumphalist age when the victory of humans over nature was a cause for celebration. Little thought was given to the impacts of this victory for our future survival. More than century on from the start of these ore body discoveries, we are confronting the legacy of the mines that were the catalyst for the industrialisation of the sub-continent. This legacy is invariably one of environmental degradation and social dislocation.

Sustainable development, with its premise of equity amongst the present and future generations, requires us to address impacts today and leave to our descendants a landscape that will support life-giving ecosystems and economic activity. This new paradigm has infused the thinking of the leading mining companies and mining ventures are now planned with a sustainable post-mining future in mind.

In spite of this, our society is blighted by the very engines of our past development: old, closed mines. In many cases, these mines are ownerless and abandoned and so the burden of their rehabilitation falls to the state. In other cases, mines closed more recently have been legally left with the minimum of surface stabilisation in place.

This paper describes BHP Billiton's Schildpadsnest rehabilitation project – an application of contemporary standards to a long-closed operation for the benefit of the community, the environment, the state and the company.

2. DEVELOPMENTS IN POLICY AND LEGISLATION

Legislative developments in the minerals sector

The legislation in force during the closure of Zwartkop Chrome was the Mines and Works Act (No. 27 of 1956). This Act had no detailed provisions for environmental management and simply required the fencing of disturbed areas and the making safe of openings, such as shafts and adits.

The passing into force of the Minerals Act (No. 50 of 1991) marked a dramatic change in environmental enforcement in the South African minerals sector. This Act greatly increased environmental management requirements on mines, with section 38 requiring the rehabilitation of disturbed surfaces and the provision of information on the manner of

rehabilitation and demonstration of both the technical and financial ability to do so. Section 39 of the Minerals Act required details on planned land uses and made provision for stakeholder consultation (Stein, pers. comm., 2005).

South Africa's new constitution (Act No. 108 of 1996) enshrines the concept of sustainable development (SD) and gives citizens the right to a non-harmful environment. To give effect to this, new minerals legislation, the Minerals and Petroleum Resources Development Act (No. 28 of 2002 – MPRDA) was drafted. The MPRDA came into force on the first of May 2004 and the provisions of the Act incorporate the principles set out in section 2 of the National Environment Management Act (No. 107 of 1998 – NEMA) (Bostock, 2005). The keystone of these principles is that people and their needs are central to environmental management, which must consider the physical, psychological, developmental, cultural and social interests equitably (Bostock, 2005).

The MPRDA is a driver in the move towards SD. It differs from its predecessor (the Minerals Act) in that it emphasizes social aspects in the context of equitable access to mineral rights. The MPRDA has also moved from a focus on rehabilitation to comprehensive SD requirements and it emphasises the economic and social empowerment of previously disadvantaged persons (Cooke & Limpitlaw, 2003).

Sustainable development and company policies

Greater attention was focussed on the impacts of mining during the First Round Table Conference on Mining and Environment, held in Berlin in June 1991, shortly before the Earth Summit in Rio de Janeiro, Brazil, the following year. The Earth Summit placed sustainable development firmly on the global agenda and promoted an appreciation of environmental degradation, not just as a problem for industrialised countries, but also as an issue of survival for developing nations (Dhar & Thakur, 1996). A new understanding of the need for balance emerged. A World Bank Conference in Washington DC, in June 1994 had as its theme "Development, Environment and Mining" – a hitherto inconceivable linkage.

Mining companies, and other stakeholders in the extractive industries, became increasingly aware of the need to move the sector towards sustainable development. This led to the formation of the Global Mining Initiative (GMI) by the world's leading mining and metals companies. The GMI provided funding for a global project to assess the contribution of the minerals sector to SD. This was the Mining, Minerals and Sustainable Development (MMSD) project. It formed the basis for the industry's submission at the World Summit on Sustainable Development held in Johannesburg in 2002. Together with subsequent initiatives, such as the World Bank's Extractive Industries Review, this project greatly raised the profile of SD in the minerals sector. Leading mining companies have operationalised the findings of MMSD and other initiatives through the creation of protocols and guidelines.

One such protocol is the BHP Billiton Health, Safety, Environment and Community Policy, which sets out the Group's commitments to sustainable development. Associated

with the policy is a Closure Standard which has as its intent "All BHP Billiton investment opportunities and controlled operations shall have closure plans which are regularly reviewed and updated and which identify, mitigate where possible, and manage both current and future health, safety, environment and community (HSEC) and other business risks associated with closure". The closure planning and execution process details requirement criteria for all phases from closure concept to post closure, and it was against these post closure requirements that a decision was taken to "clean up the sins of the past" at Schildpadsnest before relinquishing the land to the Baphalane Ba Mantserre Community.

3. ZWARTKOP CHROME MINE

Mining operations for the extraction of chrome from the pyroxenitic lower half of the critical zone of the Bushveld Igneous Complex have continued since the 1920's. Operations at the Zwartkop Chrome Mine were commenced by the African Mining and Trust Co. (Pty) Limited in 1935 on the farms Schildpadsnest 385 KQ and Zwartkop 369 KQ, located approximately 100 km north of Rustenburg (Wasserstein, 1936, in Von Gruenewaldt & Worst, 1986). Through a 1948 merger with Union Corporation Limited, a new company, the Chrome Mines of South Africa Limited, produced ore from the site until 1974. At this time, ownership was acquired by the General Mining and Finance Corporation, later to become GENCOR and then BHP Billiton.

Minerals rights for chrome held by this company extended over the farms Haakdorndrift 374 KQ, Middellaagte 382 KQ, Roodedam 368 KQ, Zwartkop 369 KQ, Schildpadsnest 385 KQ and Vlakpoort 368 KQ (Von Gruenewaldt & Worst, 1986), with mining activities being confined to the latter 3 properties.

Situated in Limpopo Province, some 25 km north west of Northam, the area is flat lying Bushveld, largely covered by black soil and scattered small Acacia type thorn trees (Fig. 1), with Mooskop a conical-shaped hill of pyroxenite being the only topographic feature of the area where mining activities took place. Characterised by hot summers when maximum temperatures often exceed 40°C, and relatively cold winters with night temperatures dropping to below freezing point, rainfall is limited to the summer months, generally not exceeding 550 mm per annum.

Chromitite seams of the Lower Critical Zone, Rustenburg Layered Suite, outcrop for some 9 km across the 3 farms, striking north-east – south-west and dipping in a southerly direction at between 20 and 25°. During the life of the mine the following chromitite seams were mined and are described in chronological order below (the LG1 seam being the lowermost and oldest of the seams mined):

- The Compound seam (LG1), between 27 and 30cm thick.
- The Old seam (LG2), between 25 and 30 cm thick.
- The Intermediate seam (LG3), about 17cm thick, hard, and high grade.
- The New seam (LG4), between 23 and 30 cm thick, with high Cr/Fe.
- The Magazine or Main seam (LG6), between 70 and 90 cm thick.

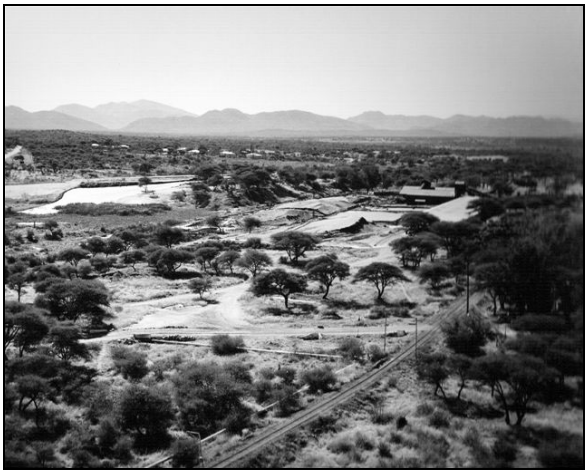


Figure 1. Zwartkop Chrome Mine - No.1 Concentration Plant area, with mine houses in the distance, circa 1968

All mining was underground, drilling being with hand-held jackhammers (Fig. 2), the broken ore cleaned from the stopes with scrapers and hand-trammed to inclined shafts for hoisting to surface. Given the general thin nature of the Chromitite seams, stope widths were kept to the minimum necessary for access and efficient operation, and consequently these narrow, tabular, underground excavations seldom exceeded 100 cm in height.

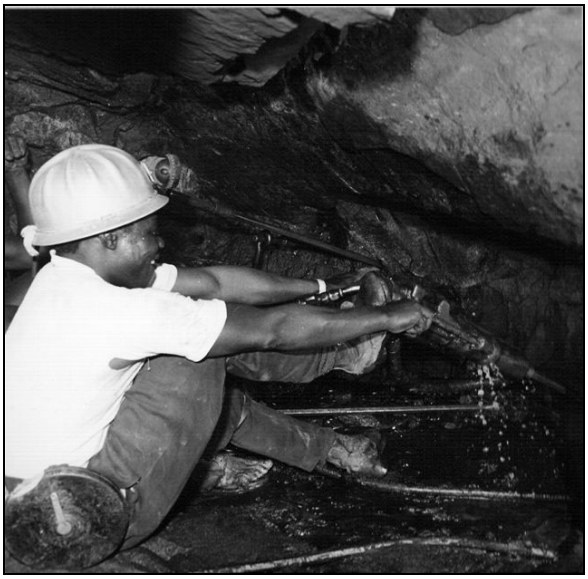


Figure 2. Rockdrill operators underground, circa 1968.

At peak production during 1976/77 some 1000 people were employed at the mine and housed on the property (Fig. 3). At least 25 inclined shafts and winzes from surface operated during the mine's life (Fig. 4a; Fig. 5a), providing ore to 2 separate surface

concentration plants where metallurgical, chemical, foundry sand and refractory grade concentrates were produced for both the local and export markets.

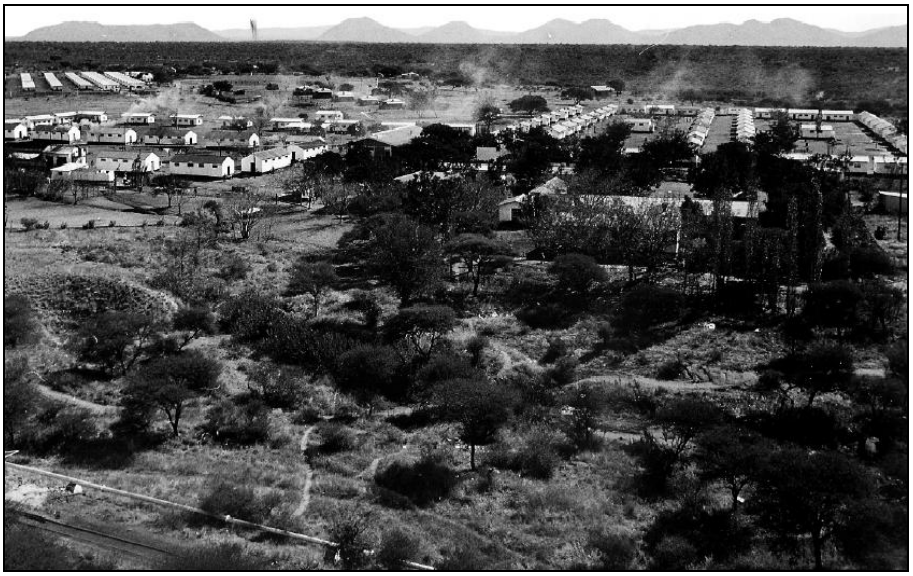


Figure 3. Mining infrastructure and the surrounding terrain at Zwartkop Mine during production.

Underground excavations were frequently holed through to surface to improve underground ventilation, a practice which resulted in numerous small sinkholes developing following closure of the mine.

Under the Restitution of Land Rights Act (No. 22 of 1994), the Baphalane community previously removed from Schildpadsnest 385 KQ, lodged a claim for the restitution and restoration of their land rights. The owners of this land were BHP Billiton and the Republic of South Africa[1]. The claim also affected certain land on which the Amandelbult operations of Anglo Platinum's Rustenburg Platinum Mines are being conducted.

Through the Land Claims Court, the Baphalane community was awarded the rights to the farm Schildpadsnest 385 KQ. As part of the land claim settlement BHP Billiton undertook to rehabilitate the land in accordance with its Closure Standard before the community took possession of the land. The agreement between the community and BHP Billiton provided for a period of two years from the date of the judgement for this rehabilitation to occur, this period for rehabilitation having expired on 6 June 2005.

[1] BHP Billiton owned 428 ha (Portion 1 of Schildpadsnest 385 KQ) and the State owned 1,456 ha.

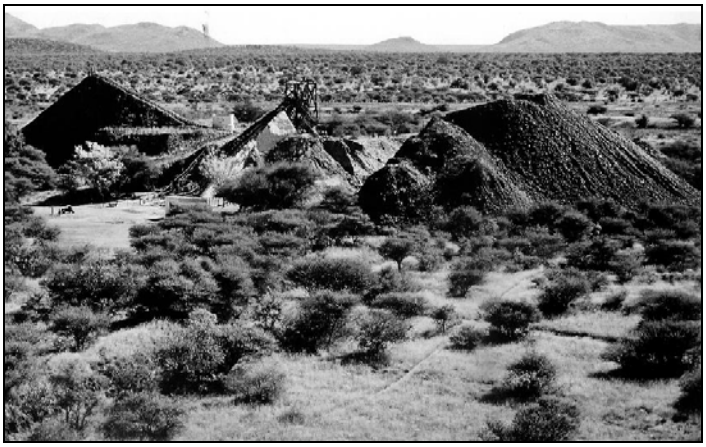
	a. No.4 New Shaft, circa 1968.
	b. The No. 4 New Shaft prior to rehabilitation in 2003
	c. The No. 4 New Shaft area after rehabilitation in 2005

Figure 4. Rehabilitation of the No. 4 New Shaft area.

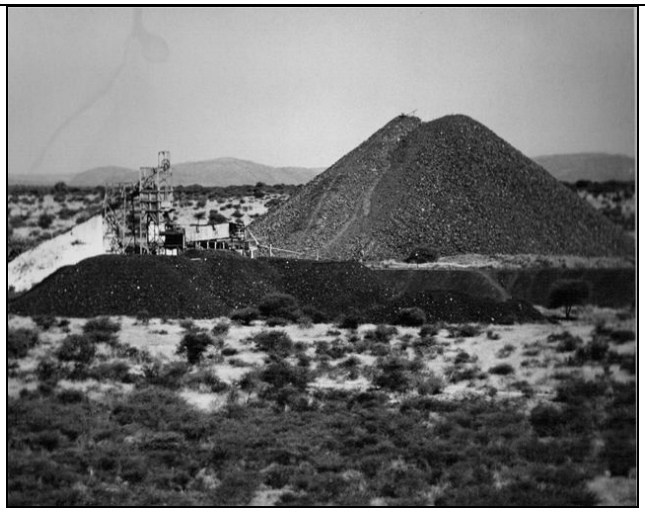
4. SURFACE REHABILITATION AND COMMUNITY ENGAGEMENT

To assess the value of rehabilitation at Schildpadsnest, we asked ourselves how land cover and land use had changed since the Zwartkop Chrome Mine ceased operation and how these changes affected the stakeholders in this land. It is also important to know whether or not these changes have increased the sustainability of the land and its dependant communities. Certainly, from various old photographs taken whilst the mine was still operational (Fig. 4a, Fig. 5a), it is clear that the current informal settlement, estimated to provide accommodation to some 25 000 people, has developed since the 1970's, and probably only subsequent to the closure of Zwartkop Chrome Mine. A research programme is currently underway to address these questions, and a preliminary assessment is provided below.

The Schildpadsnest environment before rehabilitation

Prior to the commencement of any physical rehabilitation at site, the area was extensively mapped and photographed to determine the extent of work required to adequately rehabilitate the area, photo sites being recorded on a control plan for future reference. A firm of Quantity Surveyors were contracted to determine schedules of quantities, evaluate tenders from earthmoving contractors for the physical rehabilitation work, and to monitor and evaluate progress during the rehabilitation work. The successful earthmoving contractor further needed to satisfy certain BEE credentials and successfully complete the work at site within a definite time period.

- Old waste piles – 12 areas were identified where large waste piles existed and were required to be profiled to an acceptable height and slope. A further condition stipulated was that all concrete and brick rubble, along with all old tramp metal and steel wire cable scrap, be buried within the areas to be covered during this waste pile profiling. A total volume of some 226 000 m^3 was estimated to require bulldozing and profiling in this manner (Fig. 5).
- Sinkholes – A total of 48 sinkholes were identified, 28 being along the outcrop position of the Magazine or Main (LG6) seam – this seam having been the main ore supply source during the life of the mine, and where the underground workings had been regularly holed through to surface. All were required to be opened up, side slopes made safe to an angle shallower than the natural angle of repose, and then the bottom "throat" plugged with large fragment size waste rock and concrete rubble, together with old steel wire cables – scraper rope, to act as a mat, prior to the sinkhole being backfilled, mounded and profiled such that the fill material covered a surface area at least twice the size of the original surface subsidence (Fig. 6).



a. The Magazine No. 1 Shaft area at Zwartkop Chrome Mine when the mine was in operation.

b. The Magazine No. 1 Shaft area prior to rehabilitation in 2003 (summer)

c. The area following recontouring in 2005 (winter).

Figure 5. Recontouring of old waste rock dumps at Schildpadsnest.

- Concrete rubble, buildings foundations, tramp metal and old steel wire cables – all had to be collected and buried as described above. Buildings foundations and large pieces of concrete were stipulated to be demolished to a size suitable for further handling and burial in the existing sinkholes and/or under the waste piles, whilst any trenches needed to be filled in.
- Lack of economic opportunity – The local informal community is estimated to number some 25 000 persons, a large proportion of whom are believed to be unemployed. Accordingly, consideration was given to employing suitably qualified and/or experienced persons as part of the earthmoving contractor's site team. The possibility of recovering lumps of chromite by hand-picking from the waste rock piles once rehabilitation and profiling had been completed was also offered as a possible future economic opportunity.

The rehabilitation and community engagement process

The Baphalane community, now resident at Varkensvlei some 40 km south-west of the Zwartkop Mine area, and the community to whom the Land Claims Court awarded the land, were recognised as the major, but not sole stakeholder, with whom agreement needed to be reached prior to physical rehabilitation work commencing. The informal settlement inhabitants, and local farmers (land owners) were also identified and approached for their approval of the envisaged rehabilitation. Approvals from all were readily given once the envisaged rehabilitation work was understood, BHP Billiton committing to keep these parties informed as to progress throughout the rehabilitation work program.

A formal agreement was negotiated and signed with the Baphalane Community whereby BHP Billiton would have unrestricted access to the land to carry out rehabilitation for a period of time not to exceed 2 years, this period to end on 06 June 2005. Whilst it was agreed that actual rehabilitation work should not exceed some 6 months, the 2 year period would allow for evaluation of effects of the rain season on the rehabilitated area prior to hand-over to the community. Acceptance by the community of the work done, and receipt of a Closure Certificate from the DME were agreed as the criteria for successful completion of the rehabilitation program.

The Rehabilitation Program – Work commenced at site on 13 August 2004. An independent safety consultant was appointed to supervise activities at site, and a suitably qualified and experienced person remained full time on site for the duration of the work. Prior to work commencing permits identifying all associated hazards were issued in order to compile risk assessments for each rehabilitation activity. Medical examinations and induction training were given to all personnel, whilst schedules were compiled for pre-use inspections of all mobile equipment and tools. All appointments required in terms of the Occupational Health and Safety Act (No. 85 of 1993) were made. Daily safety task instructions prior to commencement of work, and planned job observations were implemented.

a. A sinkhole in undermined land before the rehabilitation process commenced.

b. Excavation of the sinkhole

c. Backfilling the excavation with waste rock from the abandoned waste rock dumps.

Figure 6. Rehabilitation of sinkholes at Schildpadsnest.

Physical work was completed during December 2004, with only some minor "tidying-up" activity required during January 2005. At this date of completion a total of 10 326 man hours had been worked without a single disabling injury, only one minor safety incident being recorded throughout the duration of the work. A total of 14 persons were employed, 52 sinkholes were made safe, plugged, backfilled and mounded, and some 280 000 m^3 of waste materials – rock, concentration plant tailings, concrete and building rubble, tramp metal and steel wire cables, handled during the rehabilitation work.

The current state of Schildpadsnest

Since January 2005 monthly site visits have been undertaken to evaluate site status and determine any further clean-up requirements. Local inhabitants are actively re-working the dumps to recover lumpy chromite for sale to the local ferrochrome producers, thereby creating alternative livelihoods post rehabilitation whilst not damaging the completed rehabilitation work (Fig. 7). The Baphalane community and the other land owners have formally acknowledged their satisfaction with the work done, and indicated their support for BHP Billiton to now apply to the DME for a Closure Certificate. Schildpadsnest is a stabilised, zero effluent site. No water seeps from the old workings, there are no perennial streams on the property and future pollution of water resources is highly unlikely due to the previous chromite mining activities. BHP Billiton is continuing to be involved with upgrading of school facilities at both Zwartkop and Varkensvlei, and is evaluating further opportunities to assist these communities as part of the Group's policy concerning HSEC and sustainable development.

Figure 7. The local community recovering lumpy chromite from mine waste at Schildpadsnest.

5. CONCLUSION

The surface stabilisation programme is now complete and the site is being monitored to assess the success of the sinkhole infilling programme. The waste rock dumps have been recontoured and previously sterilised land is available to the local community for stock grazing (Fig. 8). BHP Billiton has allowed access to the surface of the waste for chromite picking – an additional source of income for the local community.

Figure 8. Vegetation colonising recontoured mine waste at Schildpadsnest.

The old workings remain, and as in Johannesburg, this land is not suitable for building on. It is also possible that new sinkholes will form in the future and these will require ongoing monitoring.

At Schildpadsnest, BHP Billiton, in partnership with local farmers, the state and the local communities, has applied modern standards of mine closure to a long abandoned site, showing that, with sufficient commitment from all parties, historical damage can be ameliorated. Through this restitution and rehabilitation process, a dispossessed community has had their land restored, a squatter community has had basic services extended to them and has gained access to additional land for stock grazing and for future cultivation of fruit such as oranges, guavas and paw paws.

This site is situated in a sensitive area dedicated to nature conservation and game farming, near the Waterberg Biosphere Preserve. The old mine site is now in greater harmony with an area experiencing a boom in eco-tourism. This is a considerable improvement in the sustainability of the area.

Real, lasting value can now be unlocked for the benefit of current and future generations.

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