# Selected extracts from South Africa's environmental legislation: challenges with the management of gold tailings within the Witwatersrand gold fields and case studies

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## Abstract

*For most of its history, the mining industry in South Africa has not been subjected to comprehensive environmental regulation. In recent years, however, this has changed significantly, and the industry is now required to comply with a complex web of mining and environmental policy and legislation.*

*Despite these regulatory advances, we still grapple with legacy issues, namely how to manage decades of environmental degradation, mining waste and long-term residual and latent impacts and how to equitably and fairly apportion duties, responsibilities and liabilities for the remediation of mining waste.*

*An analysis of the Witwatersrand gold fields and the management of its uraniferous waste provides an excellent example of the complexity of these issues and lessons learnt.*

**Keywords:** *acid mine drainage, waste, uranium, radioactivity, dump reclamation, environmental legislation, closure*

## 1 Introduction and legal matrix

South Africa's exceptional mineralisation has been an enormously influential factor in the development of the country's political and economic institutions and the laws that underpin them. Nelson Mandela, for instance, speaking at the 104th Annual General Meeting of the Chamber of Mines of South Africa on 8 November 1994, stated that "South Africa is blessed with a special geological heritage. As such, the mining industry has been the bedrock of the South African economy for more than a century."

The lynchpin for sustainable mining is arguably Section 24 of the Constitution of the Republic of South Africa (Constitution) (Republic of South Africa 1996b).

Section 24(a) of the Constitution enshrines the right of everyone "to an environment that is not harmful to their health or wellbeing".

Section 24(b) states that everyone has the right:

> *"to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that (i) prevent pollution and ecological degradation; (ii) promote conservation; and (iii) secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development."*

The objective of the Mineral and Petroleum Resources Development Act (Republic of South Africa 2002) is therefore to:

> *"Give effect to section 24 of the Constitution by ensuring that the nation's mineral and petroleum resources are developed in an orderly and ecologically sustainable manner while promoting justifiable social and economic development."*

In Fuel Retailers Association of Southern Africa v Director-General: Environmental Management, Department of Agriculture, Conservation and Environment, Mpumalanga Province & Others (2007), the Constitutional

Court laid a solid foundation for an integrated understanding of the right to development-in-environment protected by section 24 of the Constitution. In this regard the Court stated:

> *"[D]evelopment cannot subsist upon a deteriorating environmental base. Unlimited development is detrimental to the environment and the destruction of the environment is detrimental to development. Promotion of development requires the protection of the environment. Yet the environment cannot be protected if development does not pay attention to the costs of environmental destruction. The environment and development are thus inexorably linked."*

Vahed J in the 2015 judgement of the matter Minister of Water and Environmental Affairs v Kloof Conservancy (2015) affirmed the critical link between ecological resources and human health and wellbeing, and the need to protect the former as part of the normative scope of Section 24. Vahed J held:

> *"It is undisputed that biodiversity and ecosystems are essential to human survival. They are therefore directly implicated in human health and well-being. Failure to protect biodiversity and ecosystems results in an environment that is harmful to human health and well-being."*

More than 300 laws and sets of regulations address environmental governance in South Africa. This situation leads to a complex legal environment. A few of the laws and regulations, which are specifically applicable to mining, are set out hereunder.

The duties for remediation of environmental damage are described in Section 28 of National Environmental Management Act (Republic of South Africa 1998a) namely:

> *"Every person who causes, has caused or may cause significant pollution or degradation of the environment must take reasonable measures to prevent such pollution or degradation from occurring, continuing or recurring…"*

A similar duty of care is prescribed in Section 19 of the National Water Act (Republic of South Africa 1998b) namely:

> *"19 (1) An owner of land, a person in control of land or a person who occupies or uses the land on which:*
>
> *Any activity or process is or was performed or undertaken; or*
>
> *Any other situation exists, which causes, has caused or is likely to cause pollution of a water resource, must take all reasonable measures to prevent any such pollution from occurring, continuing or recurring."*

Appendix 5 of the Environmental Impact Assessment Regulations (Republic of South Africa 2014) prescribes that a mining company must prepare a closure plan, which must contain *inter alia* closure objectives and measures to rehabilitate the environment to a pre-determined, agreed upon, sustainable future land use.

In terms of Republic of South Africa (2014): Regulations pertaining to the Financial Provision for Prospecting, Exploration, Mining or Production Operations (Republic of South Africa 2015):

> *"an applicant or holder of right or permit must make financial provision for:*
>
> *(a) rehabilitation and remediation;*
>
> *(b) decommissioning and closure activities at the end of prospecting, exploration, mining or production operations; and*
>
> *(c) remediation and management of latent or residual environmental impacts which may become known in future, including the pumping and treatment of polluted or extraneous water."*

The understanding of the interrelationship between development and the environment, notwithstanding South Africa's progressive environmental legislation, has grown progressively more complex. Past and current actions by primary regulators, decision-makers, capitalists, scientists, and mining affected communities, characterised by widespread poverty with little notion of inter-generational equity, have created a complex array of interactions, which is set in a political, socio-economic, scientific, and legal matrix.

To exacerbate the complexity of the situation, the injurers and injured think differently about the solution to these environmental and socio-economic problems (van Eeden et al. 2009a).

An analysis of the Witwatersrand gold fields and the management of its uraniferous waste and acid mine drainage provides an excellent example of the complexity of these issues, the lessons learnt and changes worthy of mention.

# 2 What can the legacy of Witwatersrand gold fields teach us?

The Witwatersrand Mining Basin has been mined for more than a century. It is the world's largest gold and uranium mining basin. It includes the Eastern Basin, the Central Rand Basin, the Western Basin, the Far Western Basin, the Klerksdorp, Orkney, Stillfontein and Hartbeesfontein (KOSH) Basins and the Free State gold mines.

More than 120 mines extracted 43,500 t of gold in one century and 73,000 t of uranium between 1953 and 1995, which resulted in a legacy of more than 270 tailings storage facilities (TSFs) in the Witwatersrand, covering approximately 400 $km^2$ in surface area, and 6 billion tonnes of pyrite tailings containing 600,000 tonnes of uranium (Chevrel et al. 2008; Winde 2013).

These TSFs are mostly unlined and many are not vegetated, providing a source of extensive dust, as well as soil and water (surface and groundwater) pollution.

Pollution related to Witwatersrand mines poses several hazards to surrounding communities. Sutton & Weiersbye (2008) state that the major primary pathways by which contamination can enter the environment from a mine site are:

- The airborne pathway, where radon gas and windblown dust disperse outwards from mine sites.
- The waterborne pathway, either via ground or surface water or due to direct access, where people are affected.
- External irradiation after unauthorised entry to a mine site.
- Living in settlements directly adjacent to mines or, in some cases, living in settlements on the contaminated footprints of abandoned mines.

To limit the health risks, Regulations 17(6) to 17(10) of the Mine Health and Safety Act Regulations (Republic of South Africa 1996a), under the heading 'Safety Precautions' prescribe a distance of 100 m measured horizontally. However, due to numerous complaints received from the public and the mines complaining of either that the mine is creating problems for the people not involved with mining or mines complaining that the residents are encroaching on the mine, the Department of Mineral Resources (DMR) put a rule to extend the prescribed 100 to 2,000 m. However, this is not a blanket rule; it is a case based rule. The legal argument is that this rule, although it is intended to further enhance the relationship between the mine and the residents in terms of health and safety matters, remains inferior to the regulations (M Madubane & M Liefferink, personal correspondence, 28 July 2018).

With the curtailing of gold mining on the Witwatersrand, mining land is being redeveloped. However, inappropriate developments, such as houses or farms, on mine residue deposit (MRD) footprints and other contaminated sites could result in liabilities for the public and the state. Residential townships, edible crop production and livestock grazing are high risk land-uses for TSF footprints and areas within the aqueous or aerial zone of influence of TSF footprints and TSFs. Failure by the industry and regulators to agree on suitable soft end land-uses and buffer zones could exacerbate liabilities for the mine by resulting in subsequent land uses that are sub-economic or risky (Sutton & Weiersbye 2008).

Avoiding built developments altogether and vegetating MRDs and footprints with unsuitable plants species, such as those for pastures and playing fields, can also increase risk through the creation of attractive nuisances. These encourage use by potentially vulnerable receptors such as grazing livestock and children (Sutton & Weiersbye 2008).

It is estimated that 25 percent of the population in Johannesburg and Ekurhuleni live in informal settlements, and approximately one quarter of them, 400,000 people, are in the mining belt. The settlements range from 100 to 40,000 people, with the largest communities in Ekurhuleni (Tang & Watkins 2011).

The majority of mine residue areas (MRAs) is radioactive because the Witwatersrand gold-bearing ores contain almost ten times the amount of uranium than gold (Department of Agriculture and Rural Development 2011).

Three main issues relating to MRAs located in Gauteng are:

- Air-quality, with particular reference to dust pollution (including radioactive dust).
- Water-flux and water quality, with particular reference to acid mine drainage (AMD) and the transport of radioactive materials associated with the exposed uranium ore.
- Geotechnical safety concerns related to the dangers of ground instability and collapse above abandoned mine workings and also around open, unsealed mine shafts that present a danger to nearby settlements.

Long-term risks have been identified in national and international literature *inter alia* the near certainty of contaminated water, which will require some form of decontamination treatment, decanting from closed underground mines, or from lower-lying, interconnected neighbouring mines (Sutton & Weiersbye 2007; Hodgson et al. 2001; Pilson et al. 2000). There is also the near certainty of sulphate, chloride, metal and naturally occurring radioactive material (NORM) contamination of soils and sediments by seepage from unlined TSFs, tailings spillages and plant discharges and the potential for contamination of downstream and downwind soils and sediments (Witkowski & Weiersbye 1998; Rösner & Van Schalkwyk 2000; Rösner et al. 2001; Mphefu et al. 2004; Tutu et al. 2003, 2004, 2005).

The contamination of surface water bodies and their sediments, and groundwater, by seepage from unlined TSFs, tailings spillages, plant discharges and underground workings have also been identified as long-term risks (Cogho et al. 1992; Coetzee 1995; Pulles et al. 1996; Hodgson et al. 2001; Winde 2001; Coetzee et al. 2004; Winde et al. 2004a, 2004b, 2004c).

In addition, there is the potential contamination of surface soils overlying shallow polluted groundwater via evaporative pathways during dry seasons (Naiker et al. 2003; Tutu et al. 2004).

From a groundwater management perspective in the South African gold mining industry, very few specialist investigations appear to have been done to identify the status of the geohydrological regime, the extent of contamination, preferential pathways and predictions regarding long-term migration. As a result, there are very limited mitigation or management options described in the Environmental Management Programme Reports (EMPRs) that specifically deal with the containment and rehabilitation of contaminated groundwater (Pulles et al. 2005).

There are furthermore the risks associated with waste rock dumps, which have large inventories of fine material and which are much more permeable to oxygen than tailings dams. The secondary source of contaminants that remain in the soil after a dump has been removed appears to be universally ignored and it is assumed that removal of the dump removes all potential for pollution from that site (Pulles et al. 2005).

There is the potential for sulphate, chloride, metal and NORM contamination of crop soils irrigated with contaminated surface water or contaminated groundwater (Philips 2007; Sutton et al. 2006) and the concomitant loss of genetic / biodiversity and potentially ecosystem goods and services on disturbed, fragmented or polluted properties (Angus 2005; O'Connor & Kuyler 2005; Weiersbye & Witkowski 2007).

Another long-term risk is the potential for bioaccumulation of some metals and NORMs by flora and fauna (Cukrowska & Tutu 2004; McIntyre et al. 2007; Steenkamp et al. 2005b; Weiersbye et al. 1999; Weiersbye & Witkowski 2003) and the potential for exposure of fauna and humans to bioaccumulated pollutants (Steenkamp et al. 2005b; Weiersbye & Cukrowska 2007).

Other potential identified long-term impacts are the potential for acute and latent toxicity impacts of bioaccumulated pollutants on humans and the potential for radioactivity impacts from NORMs on humans (Philips 2007; Steenkamp et al. 2005a); the potential for human disease as a result of exposure to windblown dust from the reclamation operations and the TSFs (Chamber of Mines 2001); the potential for structural damage to buildings, and other structures and human injury by mining exacerbated seismicity (Le Roux 2005) and mining exacerbated sinkhole formations (Buttrick et al. 2001; Funke 1990; Sutton 2007).

# 3 Waste

As early as 1987, the US Environmental Protection Agency recognised that:

> *"...problems related to mining waste may be rated as second only to global warming and stratospheric ozone depletion in terms of ecological risk. The release to the environment of mining waste can result in profound, generally irreversible destruction of ecosystems."*
> (Manders et al. 2009; European Environmental Bureau 2000)

Waste from gold mines constitutes the largest single source of waste and pollution in South Africa. As at 1997, South Africa produced an estimated 468 million tonnes of mineral waste per annum. Gold mining waste was estimated to account for 221 million tonnes or 47 % of all mineral waste produced in South Africa, making it the largest, single source of waste and pollution (Department of Water Affairs and Forestry 2001; Oelofse et al 2007).

# 4 Wetlands

Wetlands, which have developed downstream of the Witwatersrand's mining areas, have trapped metals and contain elevated levels of metals such as arsenic, uranium, cobalt, copper and nickel (Coetzee et al. 2005).

The Wonderfonteinspruit, also known as the eastern catchment of the Mooi River, is located in West Rand District Municipality, Gauteng, South Africa. The Wonderfonteinspruit, which has been identified in a significant number of studies as the site of significant radioactive and other pollution, generally attributed to the mining and processing of uraniferous gold ores in the area. The mean values for the Wonderfonteinspruit samples were found to exceed not only natural background concentrations, but also levels of regulatory concern for cobalt, zinc, arsenic, cadmium and uranium, with uranium and cadmium exhibiting the highest risk coefficients. These metals may be remobilised by environmentally plausible chemical processes (Coetzee et al. 2004).

The Wonderfonteinspruit Catchment Area is densely populated and the water in the Wonderfonteinspruit is used for recreation, spiritual rituals, domestic purposes, irrigation, watering of cattle and drinking purposes (Liefferink 2015).

Airborne radiometric surveys over the catchment have identified the contamination of wetland areas within the Wonderfonteinspruit and other catchments in the Witwatersrand with radionuclides.

High concentrations of metals and metalloids in birds, which feed in wetlands and rivers draining the gold mining areas, remain a matter of concern. Elevated levels of metals, including uranium and gold, were found in ibis, darter, cormorant, heron and egret eggs from the Vaal River catchment. The high concentrations of pollutants in birds and fish may not only affect the sustainability and ecosystem function but many people who depend on their food and water directly from the rivers may be exposed to metals that may be harmful (ORASECOM 2015; Van der Schyff et al. 2016).

# 5 Acid mine drainage

There is wide acceptance that AMD is responsible for the costliest environmental and socio-economic impacts. AMD is a long recognised problem within the gold mining industry. In 1903, AMD was referred to as an established phenomenon concerning pumped water on the Witwatersrand (Scott 1995).

AMD has a low pH and is high in acidity. In addition to the acidity in AMD, several other elements/determinants are also present in the water, mostly metals. Many of these metals are present in toxic concentrations in the water. Radioactive metals also occur in the water.

AMD is associated with surface and groundwater pollution, degradation of soil quality, harming aquatic sediments and fauna, and allowing metals to seep into the environment. Long-term exposure to AMD polluted drinking water may lead to increased rates of cancer, decreased cognitive function and appearance of skin lesions. Metals in drinking water could compromise the neural development of the foetus, which can result in intellectual and developmental disabilities (Oelofse et al. 2007).

Results indicate that uranium (U) levels in water resources of the whole Wonderfonteinspruit catchment increased markedly since 1997, even though U-loads emitted by some large gold mines in the Far West Rand were reduced. This apparent contradiction is explained by the contribution of highly polluted water which decanted from the flooded mine void in the West Rand from 2002 to 2012. Coetzee et al. (2004) reported a uranium concentration in a surface water body next to the northern watershed of the headwater region of the Wonderfonteinspruit (Robinson Lake) of 16 mg/l. This was after underground mine water decanting into the Tweelopiespruit was pumped into the lake and resulted in the National Nuclear Regulator (NNR), declaring the lake a radiation area. This extreme concentration is believed to be the result of remobilisation of uranium from contaminated sediment by acidic water (Coetzee et al. 2004). Since 2011, the South African Bureau of Standards adopted a value of 15 µg/l uranium for class I water (suitable for lifetime consumption) in line with the new value of the World Health Organisation (WHO) making the analysis of uranium mandatory for water monitoring programmes in SA (South African Bureau of Standards 2011).

The potential volume of AMD for the Witwatersrand Goldfield amounts to an estimated 350 ML/day (1 ML = 1,000 $m^3$). This represents 10% of the potable water supplied daily by Rand Water to municipal authorities for urban distribution in Gauteng province and surrounding areas, at a cost of R3000/ML. The gold mining industry in South Africa, principally the Witwatersrand Goldfield, is in decline. The post-closure decant of AMD is an enormous threat, and this could become worse if remedial activities are delayed or not implemented (Manders et al. 2009).

The current (immediate and short-term) treatment of AMD is by means of neutralisation or a pH adjustment. In most cases, metals will precipitate out of solution if the pH is adjusted upwards, i.e. the water is made more alkaline. It should be noted that the metals do not simply disappear but change to a different oxidation state, which change them from a soluble form to a solid form. The metals are still there, in the area where the precipitation has occurred in the first place. The process can be reversed and the contaminants mobilised, should the water become acidic (Fourie 2006).

The sulphate concentrations in neutralised AMD remain high (2,000–3,000mg/l). High concentrations of sulphate exert predominantly acute health effects (diarrhoea). Sulphate concentrations of 600 mg/l and more cause diarrhoea in most individuals and adaptation may not occur. Usually, individuals exposed to elevated sulphate concentrations in their drinking water for long periods adapt and cease to experience acute health effects (diarrhoea). The numerical limit for sulphate in terms of the resource quality objectives for the Upper Vaal is between 200 and 500 mg/l, depending on the water use.

Elevated sulphate concentrations increase the corrosion rate of metal fittings in water distribution systems.

In livestock watering, it was found that sulphate levels above 250 mg/l suppress copper and selenium which result in poor fertility and condition (Myburgh n.d.). Eskom, a South African electricity public utility, requires water with sulphate levels between 15 and 40 mg/l.

The highest cost burden of combating salinity is currently being carried by the household sector and not by the industry as might be expected. The 'polluter pays principle' in terms of the NEMA is based on the internalisation of externalities and, therefore, is central to the equitable resolution of pollution costs currently being borne by the end user (Pilson 2000).

The Department of Water and Sanitation's feasibility study for the long-term treatment of AMD (Department of Water Affairs 2013) and the Reconciliation Strategies for the Integrated Vaal River System warned that the additional salinity as a result of AMD will create water security risks (Department of Water and Sanitation 2015) and recommended the utilisation of treated effluent and other discharges, especially those from the mines. In order to comply with the regulatory Instream Quality Objective (IQO) limit of 600 mg/l sulphate, good quality water has to be released from the Vaal Dam in order to ensure that the water below the Vaal barrage is fit for use, that is, by means of dilution. The IQOs are not legislated but can be made a condition of a Water Use Licence (WUL). They are set per sub-quaternary reaches (SQR), usually for each WUL but can also be set for the greater SQR to aid the Department of Water and Sanitation (DWS) in monitoring. The projected demand for increased releases from the Vaal Dam of expensive Lesotho water will increase the stress upon the water supply. The additional volume of water that has to be released, as a result of the salinity associated with AMD, has resulted in a considerable reduction of water supply to the Upper Vaal, to the extent that it will cancel out the addition of the total capacity of Phase 2 of the Lesotho Highlands scheme.

# 6 Uranium and radioactivity

As a consequence of the uraniferous nature of the gold ore, Witwatersrand tailings and other mining residues often contain significantly elevated concentrations of uranium and its daughter radionuclides, with the decay series of Uranium-238 being dominant (Coetzee 2008).

Significant radiation exposure can occur in the surroundings of mining legacies, due to:

- Inhalation of Radon-222 daughter nuclides from radon emissions of desiccated water storage dams and slimes dams.
- The inhalation of contaminated dust generated by wind erosion from these objects.
- The contamination of agricultural crops (pasture, vegetables) by the deposition of radioactive dust particles, which can cause considerable dose contributions via ingestion (National Nuclear Regulator 2007).

Strong dust emissions from TSFs occur during wind events. Due to the small particle size of the slimes, particulate matter can be transported over relatively long distances to agriculturally used land in the surroundings. The deposition of radioactively contaminated dust on leaves of vegetable and forage plants can cause radiation exposures exceeding those from the inhalation of contaminated dust substantially (National Nuclear Regulator 2007).

Encroachment of housing onto land close to TSFs, i.e. areas rendered marginal because of the dust hazard and risk of structural failure, has continued unabated for decades, intensifying human exposure to windblown mineral dust. Overall, housing development has experienced a growth of approximately 700% since 1952 at a rate of 14% per year. Analysis of recent monitoring campaign data has confirmed multiple occurrences of quartz rich inhalable dust in residential settings at levels that exceed occupational health standards (Kneen 2015).

There has also been a historical migration of generally elevated radioactive levels to the urban areas of Johannesburg central business district indicating the use of dump and waste material for building purposes as well as downstream plumes in wetlands areas (Strachan et al. 2008).

The measured uranium content of many of the fluvial sediments, e.g. in the Wonderfonteinspruit within the West Rand gold fields, including those off mine properties and therefore outside the boundaries of licensed sites, exceeds the exclusion limit for regulation by The National Nuclear Regulator Act (NNRA) of 1999 (NNR 1999) set up the NNR. The NNRA came into force in February 2000 and its role is to protect the public, property and the environment against nuclear damage. TSFs are defined in the NNRA as 'nuclear installations'.

The sediment pathway can cause radioactive contamination of livestock products resulting in effective doses of the public in some orders of magnitude above those resulting via the water pathway.

In order to determine the extent of mining related pollution in the Wonderfonteinspruit, sediment, water, soil, grass and cattle tissue samples were collected, analysed and compared from an experimental group and a control group. The comparison between cattle tissue samples from the experimental and control group revealed that nickel, zinc, selenium, lead and uranium concentrations all reveal a practically significant difference. Uranium, nickel and lead portrayed the largest differences between the two groups. The uranium concentration in the cattle samples from the experimental group was 126.75 times higher in the liver, 4,350 times higher in the kidney, 47.75 times higher in the spleen, 31.6 times higher in the muscle tissue, 60-times higher in the bone and 129 times higher in the hair than that of the cattle samples from the control group. In addition to this, the uranium did not only accumulate in the predicted tissue samples (bone, liver and kidney), but also in the muscle tissue samples (Hamman 2012).

The most important lesson learnt from the studies in the WFS is that no short cuts exist which would allow certain pathways to be ignored in a study of radioactive contamination within these mining areas (Esterhuyse et al. 2008).

Airborne gamma ray survey data have been collected covering the West Rand Goldfield. These data identify areas of elevated radioactivity. Elevated radioactivity levels were recorded over the mining areas, in particular MRDs as well as downstream plumes in wetland areas and generally elevated count rates in urban areas (Coetzee & van Tonder 2008).

If these issues are not addressed and a sustainable plan implemented to properly manage the variety of concerns raised, this area will not sufficiently recover to at least supply those living in it with a reasonable chance of survival. With the mines in a process of moving out as the dominant economic sector, the area indeed may be irreversibly destroyed for the people, for farming, as well as for cultural and environmental sustainability. The role that capitalism, racism and nationalism would have played then can become interesting debates but will never bring back what once was. However, most importantly at this stage is to progress in the scientific research focus by moving on in time and conducting health impact assessments especially regarding mining pollution matters (van Eeden et al. 2009b).

To this end, the International Agency for Research on Cancer, an intergovernmental agency forming part of the WHO of the United Nations identified gaps and opportunities pertaining to the health effects in populations living around the uraniferous gold mine tailings in South Africa and contracted the Federation for a Sustainable Environment (FSE) to collect 1,600 human hair samples from mining affected communities within the West Rand gold fields. The objective of the sampling was to study the environmental exposure to uranium and its decay products of the population living in close proximity to gold mine tailing dumps in and around Johannesburg (Schonfeld et al. 2014).

# 7 Dump reclamation

In dump reclamation activities, a number of cases have been identified where the re-mining of the dumps was not completed due to the lack of funding on the part of the mining company or due to the heterogeneity in the dumps which were mined. The granting and authorisation for the reprocessing of individual residue deposits by the DMR has allowed the selective extraction of value from portions of a site without ploughing some of that value back into the rehabilitation of the entire area (van Tonder et al. 2008).

The footprints of re-mined MRDs are often left un-rehabilitated. Radiometric surveys have, in some cases, shown elevated levels of residual radioactivity in the soils. Failure by the relevant organs of state to enforce the non-compliances by the mining industry in this regard has resulted in unrestricted development and inappropriate land uses (Liefferink & Liefferink 2014; Liefferink 2017; Solomons 2017a).

The informal settlement of Tudor Shaft within the West Rand gold fields is a case in point. The settlement is situated immediately adjacent to a partially reclaimed uraniferous tailings dam, with some shacks even situated atop the structure. The process by which the tailings dam has come to be classified as a 'radiological hotspot', however, necessitated first the removal of the people, and shifting over time to the removal of the dump. The process has been a gradual one involving a number of social factors, extensive national and international news media coverage and litigation by the FSE (Humby 2013).

The associated contribution to ingress of AMD into the mine voids or basins is likely to be considerable as old tailings are hydraulically mined using high-pressure cannons containing partially treated AMD. This practice introduces air and water into anaerobic tailings, which not only contributes to AMD formation, but there is also evidence for the remobilisation of contaminants such as uranium and cyanides during disturbance of old tailings deposits (Winde et al. 2011; Sutton & Weiersbye 2007).

The Witwatersrand gold fields provide examples of both irresponsible and responsible reclamation operations and management of TSFs. The entire removal of Sand Dump 20, reportedly listed in the 1976 edition of the Guinness Book of Records as the largest man-made sand dump in the world and a significant source of dust and AMD, by Sibanye-Stillwater over a period of 14 years is a good news story as is the responsible management of tailings and concurrent rehabilitation of TSFs by Gold Fields' South Deep Mine (Solomons 2017b).

# 8 Unscheduled closure

In the event of provisional winding up or liquidation of mining companies, the financial provision for rehabilitation is not recognised as a special claim against the company's assets to be set aside prior to satisfying other creditors. This is hugely problematic as the burden of an un-rehabilitated and degraded environment is subsequently externalised to communities and the state.

The Blyvooruitzicht Gold Mining Company and the Mintails Group are recent examples of mines which were liquidated. Notwithstanding the undertaking provided in their legally binding EMPRs that the environment would be left geologically and geophysically stable and would not pose an economic, social and environmental liability to the local community and the state, now or in the future, these mines left in their wake unfunded environmental liabilities of more than R846 million and R460 million, respectively.

These cases suggest that the responsible organs of state are not securing adequate financial provision to rehabilitate damage to the environment and water resources, and the responsible management of tailings.

The Harvard Law School International Human Rights Clinic (IHRC) conducted on the ground investigations in South Africa in 2014, 2012, and 2010, and followed up in 2015 and 2016. The IHRC found that the South African government has failed to live up to many relevant human rights obligations and that its response to the crisis in the West and Central Rand gold fields has generally been slow and insufficient. As a result, mining has not only created environmental and health risks, but it has also prevented community members from realising numerous human rights (Harvard Law School International Human Rights Clinic 2016).

# 9 Conclusion

> *"Active citizenry and social activism is necessary for democracy and development to flourish, to raise the concerns of the voiceless and marginalised and hold government, business and all leaders in society accountable for their actions."* (National Planning Commission n.d.)

As a consequence of sustained advocacy, lobbying and whistleblowing by civil society, in particular the FSE, the South African government has taken some steps to address the adverse impacts of the legacy of gold mining within the Witwatersrand gold fields (Liefferink & van Eeden 2010).

## 9.1 National Nuclear Regulator

The NNR developed a position paper titled 'Remediation Criteria and Requirements' in 2015. The document establishes criteria and requirements for remediation of radioactively contaminated land under the NNR regulation as well as remediation of contaminated land not under the NNR regulation (National Nuclear Regulator 2015a).

The NNR furthermore developed a plan in the same year for the remediation of contaminated sites since the NNR found that it has become essential that an integrated plan be formulated on the remediation of contaminated landforms in South Africa where previous mining activities have taken place that reflects the constitutional rights of all South Africans to an environment that is not harmful to human health. This approach was founded on holistic and inclusive interventions that took into account all relevant legal, environmental socio-economic and technical factors. The objective is that the plan must be based on the collective efforts of regulatory bodies, governmental departments, provincial and local structures, research organisations, mining companies and other institutions and experts that have vested interest in the safeguarding of human health of affected communities and environmental protection (National Nuclear Regulator 2015b).

The South African Human Rights Commission (SAHRC) established its first expert advisory Section 5 Committee in 2011 on the issue of AMD (SAHRC 2011). A national workshop on AMD Treatment Options and Human Rights was held at the end of 2011 to engage the government on the preferred AMD treatment option for the short-term solution, i.e. neutralisation as well as the plans for a long-term treatment plan for AMD. The Commission also wrote to the Department of Health in 2011 to request that signage be erected around mines, especially those affected by AMD, to make people aware of the dangers of occupying land in that vicinity and the impact of the affected environment on children who play in the area (SAHRC 2011).

## 9.2 South African Human Rights Commission

The SAHRC held an investigation into unregulated artisanal surface and underground mining in South Africa and published its report, titled 'Report of the SAHRC Investigative Hearing: Issues and Challenges in relation to Unregulated Artisanal Underground and Surface Mining Activities in South Africa' in 2015. The Commission also made findings and recommendations with regard to the problematic case of the Blyvooruitzicht Mine (SAHRC 2015).

During 2016 the SAHRC held national hearings on the underlying socio-economic challenges of mining affected communities in South Africa and based on its findings directed the DMR to *inter alia*:

- Amend the content guidelines for Environmental Impact Assessments and Environmental Management Programme Reports to include comprehensive information on the quality of land and sustainable options for potential post-closure land use.
- Report on the progress and anticipated timelines for the finalisation of the National Closure Strategy.
- Consider legislative reform to address the gaps in partial and full mine closure.
- Develop a Regional Master Plan aimed at addressing environmental rehabilitation and remediation of derelict and ownerless mines.
- Commission a study to assess the impacts of mining on human health (SAHRC 2016).

## 9.3 Department of Water and Sanitation

The DWS published its Mine Water Management Policy in 2017. The purpose of this policy document is to provide the position of the DWS on mine water management, including AMD, and on long-term policy interventions by the DWS. The policy is meant to provide a basis for holding parties potentially liable for negative effects and damages through AMD related pollution and/or any other negative impacts that can be related to AMD (Department of Water and Sanitation 2017).

The policy identified the following challenges:

- Integrated approaches to mine closure.
- Apportionment of liabilities.
- Optimum use of appropriate and cost effective technology.

- Classification and differentiation of mines.
- Promotion of sustainable mine development.
- User commitment to sustainable water resource protection.
- Environmental vigilance and continuous improvement.
- Institutional arrangements on infrastructure management/transfer after mine closure.
- Reuse of treated mine water, including AMD.

## 9.4 Parliamentary Porfolio Committee on Mineral Resources

The Parliamentary Portfolio Committee on Mineral Resources conducted an oversight visit of the Mintails Group's operations on 14 September 2018 and made the following observations based on the presentations by the DMR and the FSE (Republic of South Africa 2018):

- Mining companies are still operating without adequate financial provision for repairing damage caused to the environment by mining activities, if they suddenly close.
- Mintails Mining SA (Pty) Ltd has not saved all the money they were supposed to set aside under the law to pay for environmental rehabilitation. The shortfall is R460-million.
- The state will inherit these liabilities if the mines are finally liquidated.
- The DMR has failed to implement effectively and carry out the intentions of Parliament to ensure that all mines rehabilitate the damage they cause.
- Changes to the mining law were made by Parliament after 2002 to ensure that in mining, as elsewhere, the polluter must pay.
- The new laws have not proven effective in avoiding this situation where the state and the taxpayer still ends up paying for the environmental harm caused by mining.
- There is a lack of clarity on the rules for the DMR when it comes to Business Rescue Practitioners. It seems there is non-application of the law resulting in a free for all.
- The DMR allowed Mintails to operate between 2012 and 2018, despite the fact that the Department had never approved the environmental management plans of the mine and had never issued the company with a mining right under the law. There is a huge regulatory gap regarding the financial provision of environmental rehabilitation of a mine during the process of business rescue.
- There is a lack of standardisation by the DMR on how to relax environmental obligations of a mine during the business rescue stage.

The Committee recommended:

- The DMR must identify clearly and specifically the gaps between mining, insolvency and company law that have led to this ongoing situation, where the polluter does not pay. The state ends up paying.
- DMR should get specific legal opinion on these complex issues.
- The DMR must report to the Committee in Parliament on what it will do (or needs to do) differently in future to ensure that this situation does not continue.
- DMR must report on what efforts they have made to hold directors and shareholders of Mintails liable for the environmental debts of these failed ventures.
- The DMR must actively ensure that the licensing of mines goes with responsibility and accountability.

- The DMR should further explore the regulatory gaps resulting from the business rescue process and come up with regulations that will ensure full environmental compliance during the period when a mine is experiencing financial distress.
- The DMR should design and implement standardised approach when dealing with the relaxation of environmental financial provisions for mines that are undergoing business rescue process.

These interventions by the South African government are noteworthy and laudable but exist in vain if not implemented. The transformative potential of Section 24 of the Constitution will only blossom if there is a political will to deliver on the objectives of environmental laws through sustained action and enforcement. Government exercising its responsibilities for addressing the legacy of gold mining within the Witwatersrand gold fields, while holding the polluters accountable, offers an important opportunity for participatory and sustainable development that would alleviate poverty and reduce vulnerability not only in the short-term, but into the future.

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