

Investigation into the slimes dams, mine dumps and landfills (residue deposits) as environmental constraints to low-cost housing projects in Gauteng, South Africa

T.E. Manungufala*, M. Sabiti-Kalule*, I. Aucamp*

*Tswelopele Environmental (Pty) Ltd, Randburg

Email: thomani@eims.co.za

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Abstract

Gauteng is the most industrialized province in South Africa, and one of the most industrialized regions in Africa. The conflict between sustaining an ideal healthy living environment and land uses such as industry and mining is a serious concern in Gauteng. It is possibly more pronounced here than in any of the other provinces. Mining is a major activity in Gauteng and as a result the province has a large number of slime dams, mine dumps, and landfills in areas earmarked for low-cost housing projects.

The paper identifies and describes residue deposits constraining low-cost houses. It examines the potential health and safety hazards associated with residue deposits, and briefly reviews the current environmental legislation and its flaws regarding environmental management of mining activities. Possible rehabilitation or mitigation measures are also prescribed.

1 Introduction

Residue deposit means any [residue stockpile](#) remaining at the termination, cancellation or expiry of a prospecting right, [mining right](#), [mining permit](#), exploration right or [production right](#). Residue stockpile

means any debris, discard, tailings, slimes, screening slurry, waste rock, foundry sand, beneficiation plant waste, ash or any other product derived from or incidental to a [mining operation](#) and which is stockpiled, stored or accumulated for potential re-use, or which is disposed of, by the [holder](#) of a mining right, mining permit or production right [1].

Residue deposits present socioeconomic and environmental liability wherever they are. Residue deposits are safety and health hazards. They contain many harmful elements such as Uranium (U), Arsenic (As), Radon (Ra), Nickel (Ni), Zinc (Zn), and many other radioactive materials. Human exposure to these elements leads to various acute or chronic illnesses, such as cell mutation, cancer, respiratory diseases and many more [5]. Apart from health problems, they can also cause injuries and pollution, such destruction of buildings during floods or heavy rains, pollution of ground and surface water [9].

The Constitution of the Republic of South Africa Act 108 of 1996 chapter 2 bill of rights section 24 subsection 1 (a-b), clearly establishes the basic right of all citizens to a healthy, safe and clean living environment. On the other hand the National Environmental Management Act 107 of 1998 provides the principles and protocols through which section 24 (1a-b) of the bill of rights can be achieved.

The environmental based objectives of the Minerals Petroleum Resources Development Act of 2002 (MPRDA) are to give effect to section 24 of the Constitution by ensuring that the mineral and petroleum resources of the nation are developed in an orderly and ecologically sustainable manner while promoting justifiable social and economic development; and ensure that holders of mining and production rights contribute towards the socio-economic development of the areas in which they are operating. Housing Act of 1997 also calls for sustainable housing development [2].

Sustainable housing development means the establishment and maintenance of habitable, stable and sustainable public and private residential environments to ensure viable households and communities. Therefore, all areas are allowed to have convenient access to economic opportunities, health, educational and social amenities in which all citizens and permanent residents of the Republic will, on a progressive basis, have access to permanent residential structures with secure tenure, ensuring internal and external privacy and providing adequate protection against the elements; and potable water, adequate sanitary facilities and domestic energy supply.

2 Materials and Methods

2.1 Study area

Tswelopele Environmental is currently involved in low-cost houses projects in Gauteng province. Some of these projects were selected as study areas. Figure 1 shows the location of study areas and the residue deposits. These areas were selected purposively. In purposive sampling subjects are selected because of some characteristic [11]. In this case, Goodhope and Reiger Park were selected because they both have residue deposits, which are constraining low cost housing projects. Both sites are situated in Germiston, East rand in Gauteng province. Germiston is characterized by mining activities of the past. Field survey has been used to ground truth the topographic map as well as acquiring the ground photos of the problem areas. Literature in conjunction with field survey has been used to examine potential health and safety risks of residue deposits on the proposed settlement (townships). Literature and scientific experience were the main sources of legislation and rehabilitation strategies.

3 Results and Discussion

3.1 Residue deposits constraining low cost housing in Gauteng

Goodhope informal settlement is surrounded by railway lines, roads and mine dumps. The mining dumps are the end results of Witwatersrand Gold Mine Company (WGMC). Figure 2 shows the location of mine dumps and buffer zones in Goodhope. The distance amongst them is less than a kilometer. Figure 3 shows the status quo of Goodhope and Reiger Park. Reiger park extensions 8 and 11 are situated east of Goodhope. There is a slimes dam on the north of extension 11 and the pipeline from this slimes dam spread contaminated water over extension 11. The radon laden wastewater spread over the site. The radioactivity levels in extension 11 exceed the required level of 200mBq.g^{-1} [22].

3.2 Health and safety hazards of the identified residue deposits

As already mentioned above, Residue deposits present both health and safety hazards to the low-cost housing residents. Apart from health safety, residue deposits are physical barriers to the low-cost housing development. Gold mining is associated with the production of radioactive materials such as Uranium, Radium, Sodium Cyanide and mercury [13-14, 16]. These elements are carcinogenic, mutagenic and teratogenic [21]. Some green vegetables and some plant species have the ability to absorb these elements

from the soil. Due to the bioaccumulation nature of heavy metals, although it has not been scientifically proved at these sites, it is very likely that the consumers of these vegetables will suffer chronic illness. The mine dumps and slimes dams contain very fine particles which are easily inhaled. There is a high chance of the community residing at these sites to suffer cancer mutation or birth defects or both. The exposure could be through inhalation of contaminated dust; consumption of vegetables grown on contaminated soil and drinking of contaminated water as well as through skin contact particularly the radioactive materials [17-18].

3.3 South African environmental and mining legislation

Residue deposits mainly are the results of the past mining activities. The current South African Environmental and Mining legislation does not hold the past responsible for past environmental damage. Nevertheless if they are still operating rehabilitation should be done. This means that all closed mines are a liability to the state and the public in general. For instance, National Environmental Management Act 107 of 1998 (NEMA) does not cover or hold liable the environmental damage done before 1999 [3]. Unfortunately, the National Environmental Second Amendment Bill did not address this issue [7]. Additionally, the MPRDA came into effect on 1 May 2004, and have the same flaw as NEMA [6].

The South African Environmental and Mining legislation is promulgated to deal with the current problems. The National Environmental Management: Air Quality Bill of 2003 (23), National Water Act 36 of 1998, MPRDA to mention few are set to achieve sustainable development. They give principles and guidelines through which development (mining) shall operate. The principles of white papers, acts and policies are really set towards sustainable development. However, there are no means and strategies to address the past. The South African legislation is supposed to focus more in the past than the present, because the damage is already done, particularly in Gauteng province.

Apart from legislation flaws there is lack of law enforcement, which has resulted into the change of paradigm. The change of paradigm includes the formation of Environmental Inspectors, Green scorpions and amendment to the existing legislation. Nevertheless, future holds bright prospects for sustainable development [7].

3.4 Measures to address residue deposits

There is need to amend NEMA and MPRDA, in order to address the past. Gauteng province should have provincial legislation specific to its main problem. In addition implementation and enforcement of environmental legislation should be a top priority to the provinces. The law reform process should also be accelerated to counter the pace of environmental damage.

The following practices or technologies could make mine dumps and slimes dams practical in habitable environments: *Rock cladding* of tailings dams, this has been used to control wind and water (rainfall) erosion of the Doornkop tailings dam in the Westrand, Randfontein Estates gold mine [8]. Rock cladding can also be used to stabilize the slope of a mine dump. This seems to be the most practicable solution to these mine dumps. *Revegetation* can be used in conjunction with rock cladding on mine dumps. Rock cladding can be done on the sides where it is difficult for grass to grow and grass on top. However, drainage is always a problem. In this case a proper drainage can be designed to channel effluent to a proper treatment plant. In situ *Chemical remediation* is also a good option for contaminated soils. This has been used to remediate Reiger Park extension 11 from radioactivity pollution [22].

Apart from rock cladding and revegetation, *buffer zones* could also be used to isolate the dumps from the residential sites. An example of a buffer zone is shown in Figure 3. Lastly but not least, *legislative reformation* could also help to achieve sustainable development.

3 Conclusions

It has been discovered that there is a possibility of making residue deposits inhabitable. The suggested practices and technologies can minimize both health and safety problems of the residue deposits. However, it is expensive to put in place the management and rehabilitation strategies. Therefore, a joint venture between the private and public sector could help to eliminate these problems.

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