The WIN-WIN solution to the clean-up of mine residue - An innovative and cost-effective method to reduce acid drainage from mine residue in Southern Africa that can also provide social upliftment.

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Abstract

South Africa's heritage of over 150 years of gold mining in the Witwatersrand area is continuous exposure of sulphide rich soils and mine dump residue to rainwater. Rainwater increases the acidity in the soils and ground water contributing to the acid mine drainage problem prevalent across 120km of semi-urbanised land. Many of the easily accessible dumps have been removed by mechanised hydro-mining leaving behind thick skins of toxic sediments and contaminated soils. Collection and clean-up of the residual soils requires manual labour. Polluted land has a reduced value despite being very close to fast growing nodes of urbanisation. This short paper describes how the South Africa Government's Working for Water Programme (WfW) can be adapted to create a WIN WIN programme where training and employment can be used to remove polluted sediments and pay for itself by selling the valuable metals and increasing the value of the land. The paper concludes by listing the advantages of the WfW clean up to social development, water protection and economic development of the Witwatersrand. Implementation in other polluted areas is a possible add-on.

Keywords: ICARD | IMWA | MWD 2018, WIN-WIN, water protection, ground water protection, land values and social upliftment

Introduction

The Witwatersrand is an arc of mining activity centred on Johannesburg that has a history of gold mining dating back to the late 1800's. Gold and other metal ores such as Silver and Copper were mined from reefs that were then crushed and processed, using an increasingly efficient refining process. Millions of tons of processed, crushed rock have been deposited as mine waste dumps and Tailings Residue Facilities (TSF's), collectively known as mine dumps. The residues from the hydro-mining of the dumps often contain high concentrations of Gold, Silver, Cadmium, Cobalt, Uranium and other metals.

Johannesburg is one of the few cities in the world that is not located on a river. The water needed for mineral processing came originally from underground, (e.g. Zuurbekom pumping station near Soweto) and distant surface water supplies such as the Vaal dam. As Johannesburg grew, the urban nodes and water distribution system occupied the sites of the original mining villages which then became towns and coalesced into the Witwatersrand urban conurbation. The Witwatersrand has over 120km of land running East-West that is contaminated by mining activities including and dominated by re-processed mine dump residue. Acidic runoff and ground water base flow enters the streams and rivers which then contaminate the water supply system.

Figure 1 shows the Rand Water pipeline network and its proximity to mine waste dumps.

Many people live close to the old gold mine dumps; often in informal settlements with very high unemployment and are affected by the pollution emanating from mine dumps in the form of seepage water and polluted ground water. Figure 2 shows the proximity of informal settlements to the gold mining areas.

The proximity of people to the mine dump areas means their health is compromised. The

Figure 1 *Rand water pipeline and proximity to mine waste dumps on the Witwatersrand. (Source John McCann).*

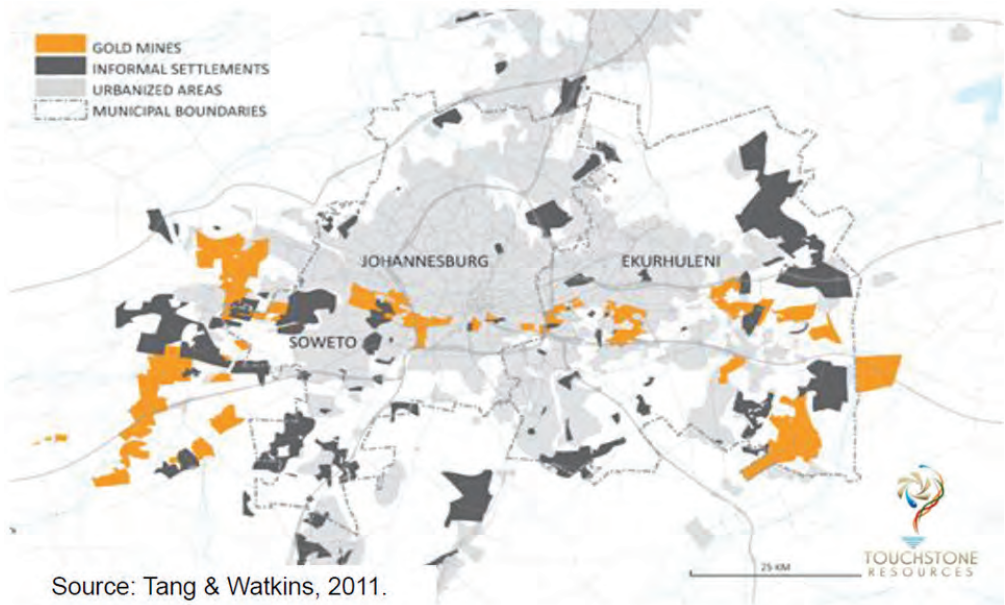

Figure 2 *Proximity of gold mines and informal settlements.*

Tudor Shaft settlement near Krugersdorp on the West Rand has been occupied for over 15 years with people living on top of old mine dumps where children are exposed every day to polluted soils and water, which are often radioactive. Naidoo (2017) gives a comprehensive list of the polluted areas and social impacts.

Figure 3 shows the Tudor Shaft settlement and Figure 4 shows the proximity of Grootvlei Snake Park settlement in Soweto to an eroding mine dump.

The soils and sediments comprise pyritic rock, which creates acidic runoff whenever it rains. This adds to the acidic seepage from underground sources of abandoned mines that are now decanting. The United Nations estimated cost of conventional clean-up is US$60Bn. This cost is beyond the mining rehabilitation fun, the government and NGO's.

Figure 3 *Tudor Shaft settlement on mine dump residue (Source M Liefferink)*

All the polluted water flows into river systems used for drinking water. If contaminated soils and sediments are removed and the land rehabilitated, the water pollution will decrease and the cost of water treatment in the catchment reduced. Radioactivity levels will also decrease when the source material is removed.

Figure 4 *Grootvlei Snake Park settlement, Soweto (Source M Safodien)*

Figure 5 shows the location of the major streams draining the Witwatersrand

A lot of the mine dumps along the Witwatersrand have been reprocessed, but often the roots of the mine dumps have been left behind. The roots and bases of the old mine dumps have the highest value in terms of unprocessed metals. Early mineral processing techniques were inefficient and therefore the lower layers of the mine residue dumps have high concentrations of gold, silver and other valuable metals. May 2018 prices were:

- Gold US$ 1291.10/Oz (ZAR16,220/Oz)
- Cadmium US$ 1.85/Kg
- Cobalt US$ 91.49/Kg
- Silver US$ 16.19/Oz
- Uranium US$ 44.38/Kg
- Potassium nitrate US$ 7.82/Kg

Source: www.metalprices.com

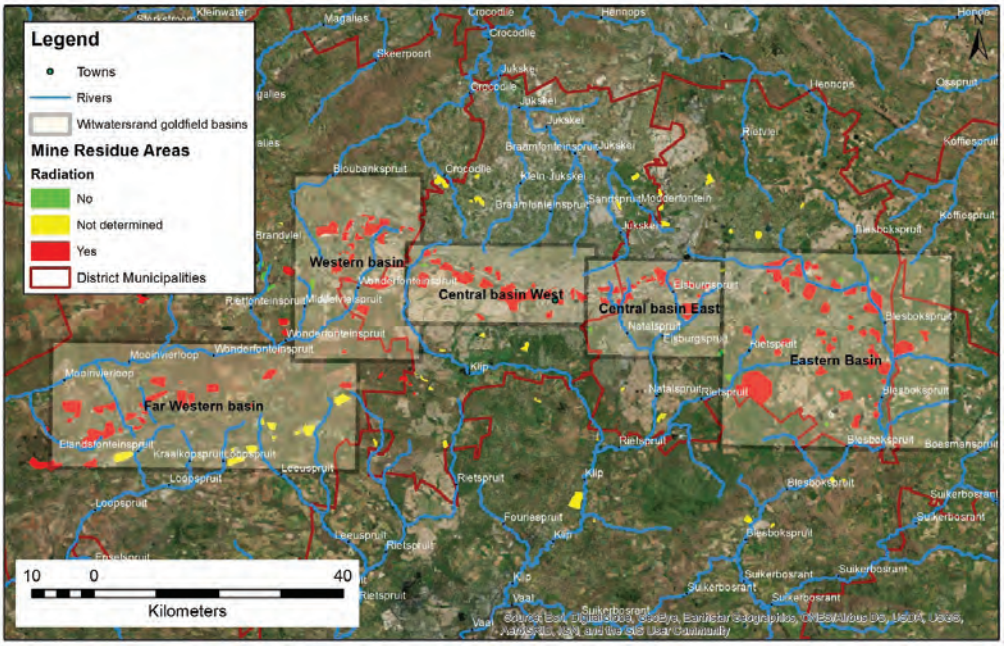

Figure 5 Drainage basins and drainage streams affected by mine dumps in the Witwatersrand (Source John McCann and Rand Water)

Solution

There is opportunity to collect the mine residue and extract value. The main cost is labour. The reason the roots of the mine residue dumps were not collected for reprocessing, was the difficulty of using machinery to collect the soils and sediments. Many deposits are inaccessible, except through shovelling and sweeping. Both activities are labour intensive.

There is a will amongst people living next to the dumps to clean up and create employment. The proximity of informal settlements to mine dumps means, with proper training in hazardous material clean up, local labour is available to collect the soils and sediments machinery is unable to collect.

When people are trained in waste clean-up and the use of appropriate Personal Protection Equipment (PPE), then the soils and sediments can be bagged, collected, transported to refineries and the metals extracted. The revenue from the metals can be used to reinvest in training and expansion of the work programme into other areas requiring clean-up. This programme has been called a WIN -WIN solution for mine dump clean up and acid drainage reduction.

The WIN-WIN programme imitates the very successful Working for Water (WfW) programme initiated by the South African Government.

Since 1995, WfW has cleared more than one million hectares of invasive alien plants providing jobs and training to 30 000 people from among the most marginalized sectors of society per annum. 52% are women. WfW, through the Department of the Environment, has 300 projects in all nine of South Africa's provinces.

WfW is globally recognized as one of the most outstanding environmental conservation initiatives on the continent. It enjoys sustained political support for its job creation efforts and the fight against poverty. WfW considers the development of people as an essential element of environmental conservation. Short-term contract jobs created through the clearing activities are undertaken, with the emphasis on endeavouring to recruit women (the target is 60%), youth (20%) and disabled (5%). (Department of Water and Sanitation web site July 2017).

WIN-WIN aims to build on this success and develop a skilled work force in environmental monitoring, Hazardous waste clean-

up, Human Resources Management , training, logistics and management.

The WIN-WIN solution for clean-up of mine residue, requires the consultation and co-operation of the affected parties and land owners, Environmental and Water departments and mine processing plant owners. It also requires the development of a funding, Human Resources and logistics plan.

Conclusions

The programme is called WIN-WIN because not only will it result in the clean-up of the polluted mine waste land around the Witwatersrand there are other advantages:

- Unemployed become trained, skilled and employed
- Contaminated land is cleaned up
- Living areas become habitable
- Land becomes valuable and sales can pay for rehousing and further clean up
- Valuable metals are collected which funds further clean up
- Costs of water treatment for water supply are reduced saving Rand Water money
- Health care costs reduce
- Healthier work force and healthier children
- Boost to the economy

The next steps and work in progress comprises:

- Public Private Partnership (PPP)
- Planning and obtaining seed money
- Linkage of communities, trainers, permit experts, land owners to process plant owners
- Agreement with the Department of Environment and Department of Water and Sanitation to plan and permit the Win-Win solution
- Implement a pilot site – suggested Tudor shaft area

Acknowledgements

The author thanks Dr Guy Preston of the Department of Environment for his contributions to the planning of the implementation of the WIN-WIN Solution and the financial support of the Water Research commission (WRC) with advice and guidance from Dr Jo Burgess.

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