South African Mining-Related Water Research and Management - A National Priority

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Abstract
The South African Water Research Commission (WRC) is a member of the Global Alliance of research organisations, which supports the International Network for Acid Prevention (INAP). This paper provides an update of WRC activities since 2009, that have resulted in an improved ability to predict the likelihood of acid mine drainage (AMD), strategies to minimise the production and impact of acid drainage, advances with technologies to treat acid drainage and technology transfer. Media and public attention paid to the national problem of acid mine drainage culminated in the Government's creation of an Inter-Ministerial Committee (IMC) on AMD in 2010 and this report also describes the IMC's mandate and progress to date. The IMC appointed a Team of Experts comprising the WRC, Council for Geoscience, Departments of Mineral Resources, Water Affairs and Science & Technology and the Council for Scientific and Industrial Research, with advisors from three universities. The Team reappraised the national situation (in October 2010), provided an action plan with a list of recommendations for the treatment of AMD in the Witwatersrand, and oversees the implementation of the collection and partial treatment of the AMD in the short term and complete treatment in the long term.

Key Words: AMD; ARD; HDS; water treatment; Witwatersrand

Introduction
The Water Research Commission (WRC) is a publicly-owned institution mandated to lead, co-ordinate and support research related to all aspects of water in South Africa. Its activities relating to mining have increased considerably since the previous report (du Plessis and Burgess, 2009), resulting in a dedicated programme catering exclusively for mining-related projects. Thirteen projects have been completed and published since 2009 covering the following three areas, some of which are described in more detail within this paper:

- Improved predictive ability
  - Evaluation and validation of geochemical prediction techniques for underground coal mines in the Witbank / Vryheid region
  - Development of water balances for pollution prediction from gold mine waste residue deposits
- Minimising the production and impact of acid rock drainage
  - The introduction of cleaner production technologies in the South African mining industry
  - Geochemical sampling and analyses for environmental risk assessment using the Wits basin as a case study (Chihobvu *et al*., 2010)
  - Prediction of how different management options will affect drainage water quality and quantity in the Mpumalanga coal mines up to 2040
  - Arsenate resistance in microbial communities developing in maturing fly ash - AMD solids (Cowan *et al*., 2010)
  - Refinement of the Decision Support System for metalliferous tailing disposal facilities
  - An assessment of how water quality and quantity will be affected by mining method and mining of the Waterberg coal reserves
  - A systematic approach to sulphidic waste rock and tailings management to minimise ARD formation

- Treatment technologies
  - Investigation of sulphide oxidation kinetics and impact of reactor design during passive treatment of mine water
  - Industrial wastewater remediation via wet air oxidation using immobilized transition metal catalysts
  - Ambient Temperature Ferrite Process (ATFP): adapting the laboratory-scale process to treat AMD and Laboratory and pilot-scale development of the ATFP
  - Kinetic development of oxidation zones in tailings dams with specific reference to the Witwatersrand gold mine tailings dams

Twelve new WRC projects are in progress, including such topics as testing methods to determine the evaporation rates of brine solutions; preparation of magnetic nano-composite beads and their application; approaches to and benefits of minimising the formation of AMD through management of the disposal of sulphidic waste rock and tailings; development of a toolkit to enable quantitative microbial ecology studies of sulphate-reducing and sulphide-oxidising systems; passive treatment solutions for the oxidation of sulphide and subsequent sulphur removal from AMD; recovery of water and salts from multi-component hypersaline brines using eutectic freeze crystallization; application of emulsion liquid membranes in the recovery of platinum group metals from metal refinery wastewaters; and development of a sensor for the identification, quantification and detection of heavy metals.

In addition to increased project numbers and outputs, the WRC has also become a member of a national Inter-Ministerial Committee (IMC) on Acid Mine Drainage (AMD) and its associated IMC Team of Experts (IMC-ToE). Some of the activities within WRC projects and the IMC are summarised in the following sections.

Improved Predictive Ability

Evaluation and validation of geochemical prediction techniques for underground coal mines in the Witbank / Vryheid region (Zhao *et al.*, 2010)

This project was undertaken to reduce uncertainty around the applicability of different techniques for the geochemical prediction of long term water quality from mines. It was intended to address the confusion amongst mines, regulators and consultants as to how the available tools should be correctly applied in practice and what their limitations are. The tools that were evaluated included static tests (Acid-Base Accounting (ABA) and mineralogy), kinetic laboratory tests (humidity cell and column leach tests) and equilibrium and kinetic modelling techniques. Extensive data collection was undertaken at two underground collieries in the Witbank and Vryheid coalfields to provide the information, samples and material to apply the various tools. The results demonstrate the value that can be derived from proper application of the tools available. The limitations of the tools for making long-term predictions are demonstrated. Each tool is assessed in terms of its ability to answer typical key questions in a mine impact prediction exercise. A decision tree is provided that shows how to apply the four prediction techniques. If a screening level assessment using static tests shows potential for acid generation, a detailed geochemical assessment, including both kinetic tests and kinetic geochemical modelling, should be carried out for prediction of temporal and spatial variation of potential acid generation and associated contaminants.

Development of water balances for pollution prediction from gold mine waste residue deposits (Pulles et al., 2011)

The value of the predicted pollution potential of mine waste residue deposits is to a large degree predetermined by the accuracy of the water balance that is used, in combination with geochemical models to make the prediction. The inaccuracies associated with the rudimentary water balances for waste residue deposits that are normally available on mines hinder the ability to make reliable predictions with which to design environmental management/rehabilitation strategies. This project developed a methodology to develop accurate water balances for gold mine waste residue deposits. Anglogold and Goldfields tailings dams and waste rock dumps were used for a range of measurements to characterise the water balances of these facilities. The data were collated and the relationships between the datasets from the different instruments were analysed and used to derive water balances and to extract simple 'rules of thumb' to determine screening-level water balances. Such general water balance rules have been derived for runoff, infiltration, evaporation and percolation from tailings dams and for infiltration into waste rock dumps.

The water balance of tailings dams is complex, since these facilities consist of variably unsaturated porous media with saturated and unsaturated zones. The components that influence the water balance of tailings dams were studied and detailed recommendations on how these studies should be undertaken for cases where a screening-level water balance is required and for cases where a detailed and accurate water balance is required are presented. For a detailed water balance, numerical modelling will be required and the report provides guidance on what models could be used, what parameters need to be determined and how the required data should be collected. The outcomes of this project significantly enhance our ability to determine the water balance that underpins reliable and credible assessments of long-term pollution potential for the range of mine waste residue deposits encountered in the gold mining industry.

Minimising the production and impact of acid rock drainage

The introduction of cleaner production technologies in the South African mining industry (Trusler and Mzoboshe, 2011; Barclay et al., 2011)

Unlike other industrial sectors, no projects have been undertaken which were devoted specifically to waste minimisation and Cleaner Production (CP) technologies in the South African mining industry. This project was consequently solicited, with the aim to introduce CP technologies to mining. A scoping study to determine the current status of environmental practices found that the South African mining industry is improving its practices and taking environmental impacts into consideration in project decisions and for operations. However, distinct differences in approach were noted between big and small companies. The environmental policies of larger companies contain CP principles and this can be used as a route to encourage cleaner technology. With smaller companies, cleaner technology options can be used to assist with complying with legislation and in reducing costs. A number of existing water-related threats by and to the mining industry that could be alleviated by CP technologies were identified. These threats thus represent opportunities to facilitate the introduction of CP approaches in the South African mining industry.

Waste Minimisation Clubs (WMCs), have been used in other industries to assist with implementing waste minimisation and CP. Following discussions with members of the mining industry, a decision was made to change the terminology from WMCs to Cleaner Production Forums (CPFs). Two CPFs were formed (one each for coal and gold mining) to share ideas, fight common battles and share success stories. The CPFs proved to be a good way of achieving the goals of CP and minimising the impacts of the mining industry. Life Cycle Analysis (LCA) studies were conducted at an overall impact level to determine priority areas for introducing CP, to acquaint service providers and industry with the technique and to identify areas for the focus of CPFs. An attempt was also made to quantify the ecological footprint of gold production and its associated supply chain in South Africa. Five different mining facilities were practically evaluated using a quick CP assessment which looks at all inputs and outputs to a facility and determines areas where resources can be saved to the benefit of the environment and to save the company money.

A campaign was launched to raise the awareness of the mining industry concerning the benefits and need for adopting CP and the possible methodologies and processes for doing so via seminars for the industry, separate training workshops for industry and regulators, presentations of findings at different fora and the development of a CP guide (Barclay *et al*., 2011) designed to assist mining companies in implementing CP, while simultaneously providing regulators with suggestions on how to promote CP.

Prediction of how different management options will affect drainage water quality and quantity in the Mpumalanga coal mines up to 2040 (Coleman *et al.*, 2011)
Coal mining in the Mpumalanga coal field is mature with many mines already closed and several more heading for closure during the next 20 years. The AMD emanating from closed and operating mines has had a huge impact on the quality of the area's water resources, which will probably increase in future. The area also experiences a shortfall in water supply that is projected to worsen. This project predicted how the quantity and quality of water draining from Mpumalanga coal mines will change for a number of different management interventions.

Available management options that can be applied on mines to reduce volumes and improve water quality of expected decants were identified and the most practical were soil covers of different thicknesses, conventional treatment, use of workings storage and intermine flow. A suite of models was evaluated for potential use. The Agricultural Catchment Research Unit (ACRU)-Salinity model was selected to assess local mining impacts while the Water Resource Planning Model (WRPM) and water quality target model were found best able to assess the regional impacts. WRPM's mine module allows for different mining types, mining plans, use of water on mines and mine storage. The ACRU-Salinity model was applied to the Kleinkopje Colliery and the B11C quaternary catchment. The application of the model showed that it calibrated well and could be applied to assess local impacts of mining on volumes and water quality. Modelling results highlighted the volumes that can be abstracted from mine voids. The increased recharge into a dummy mine void covering half the catchment increased the available water by 40%. This water will however have to be treated.

The application of the WRPM to the catchment was used to determine the impact of management scenarios on the dam water qualities and the excess mine water available. The results of these runs were input into a cost model. The water demands of the local municipalities exceeded the yields of the Witbank and Middelburg Dams. There are no further surface water resources in the catchment that can be developed to meet growing future water demands. The mine water is the only local water source that can be used to meet future demands. Mine water is already treated and supplied as potable water by South African Coal Estates with a 20 Ml/d plant and at Optimum with an 11 Ml/d plant. Based on the available data, there is still a further 65 Ml/d to 100 Ml/d mine water available for treatment and supply. It was found that water treatment is the only management option able to improve water quality within Witbank and Middelburg Dams to Resource Water Quality Objectives levels.

A shortcoming of the WRPM is that changes in water quality over time in the mine workings can not be modelled. The impact of long-term flushing of workings could thus not be considered. However the scenario results provide useful guidance and direction on the way forward.

Refinement of the Decision Support System for metalliferous tailings disposal facilities (Bezuidenhout and Randell, 2010)
The first phase of a three phase research programme to develop a comprehensive Decision Support System (DSS) for the sustainable design, operation and closure of mine residue disposal facilities was published as WRC Report No 1551/1/08 (Rademeyer *et al*., 2008), and described the development of a first order DSS. This project refined the first order DSS. As part of the refinement the project developed a performance demonstration protocol, (i.e. procedure or guidance that can be used to demonstrate the acceptability of a particular technique, technology or approach), assessed the alignment of the DSS to current legislation, undertook specialist studies of specific knowledge gaps and identified and assessed new and promising technologies and approaches that could be used as supporting guidance in the DSS. Fundamentally, the DSS is designed to lead to a decision and is captured in final questions that are posed in such a way that if answered, will lead to a decision higher up in the DSS hierarchy. A demonstration protocol was developed to provide a mechanism for when a question cannot be answered in the positive using existing knowledge and predictive models, to demonstrate the applicability and acceptability of

using a particular technology, approach or technique. The demonstration protocol will form a key characteristic of the comprehensive DSS.

Four specialist studies related to water and geochemistry were conducted, namely (1) depth of the oxidised zone, (2) tailings water balances, (3) pore water quality evolution and (4) protocols to handle uncertainty in model predictions. In all four cases, enough information was available to develop guidance on how a particular question can be answered in order to make a decision based on the technical studies conducted in support of the answer to the question. The identification of new and promising technologies was addressed largely as part of the specialist studies and is included in the specialist reports. This was complemented by a separate study focussed largely on a review of recently published papers and conference proceedings and discussions with practitioners. Several new and promising technologies were identified of which seven are proposed for further research.

An assessment of how water quality and quantity will be affected by mining method and mining of the Waterberg coal reserves (Vermeulen *et al.*, 2010)
The Lephalale region of the Waterberg contains the third largest coal reserves in South Africa and could become a new powerhouse for coal-fuelled electricity production in the country. Due to the planned expansion of the mining enterprises in the area and the accompanying developments, it is important to determine the extent of the impacts these developments will have. This study looked specifically at the impacts these developments will have on groundwater quality and quantity. The project was conducted in several stages, beginning with two hydrocensus to locate as many boreholes in the area as possible. Water levels, borehole depths, location and electrical conductivity (EC) and pH were measured and groundwater samples collected. Other data were gathered from the companies Exxaro, Sasol and Eskom and compiled into a database used for contour maps, the determination of recharge, etc. Tests in the field determined the aquifer parameters of the different aquifers present. Dewatering models indicated that very little water was available in the area with small volumes predicted to flow into the mines. Decant models indicated that there was no possibility of the pits ever reaching decant levels with the highest recorded rise being seven metres, 50 years after mining had stopped. It was concluded that the most effective way to preserve the water quality and protect the groundwater quality from further deterioration was to keep all acid generating material dry as it would not be possible to flood this material once the mine closes. The volumes of water that will enter the mines from groundwater and surface runoff will be small, hence it is recommended that the water be pumped out and used for run of mine operations such as dust suppression or ore washing. Steps should be taken to minimize the risk of encountering a fault during mining. If the mines encounter large faults and start to dewater the faults, many farmers with boreholes along the length of the fault might see significant decline in the water levels of their boreholes. It is recommended that preventative measures be taken rather than containment for the planned new mines. The methods of mining, beneficiation, remediation and water management currently being employed by the Grootegeluk Mine should also be employed by the new mines, as these were demonstrated to be the best possible solutions for the local conditions.

A systematic approach to sulphidic waste rock and tailings management to minimise acid rock drainage formation (Harrison *et al.*, 2010)
One of the major environmental issues in the South African mining industry is that of ARD caused by the disposal of sulphide-bearing wastes on the surface, rather than from the mines themselves. Re-examination of the manner in which waste materials are disposed from the mineral processing and extraction stages of metal recovery was required to relieve the environmental burden created and reduce the time frame of risk. In this study, the approaches to the removal of risk through removal of sulphur species were considered through a review of key work and a set of case studies addressing specific mineral wastes. Aspects of disposal of waste rock and tailings from mining operations processing mineral sulphides (especially pyrite) have been addressed, with the focus of reducing capacity to form ARD through removal of the sulphidic component of the waste. The understanding of the factors governing

ARD generation from waste rock and tailings (similar to those governing mineral bioleaching) has been used to improve categorisation, separation and planned disposal of its components to mitigate ARD generation. While flotation and accelerated bioleaching have been used in the case studies to demonstrate sulphide removal by separation and reaction, a review of suitable unit operations is provided. Further, use of ABA and net acid generation (NAG) methods as static chemical methods for evaluating ARD potential is supported by the development of a biokinetic test for assessing ARD potential under an environment more cognisant with the ARD generating environment, as well as providing kinetic data over a shortened time frame to conventional kinetic tests.

Treatment Technologies

The Ambient Temperature Ferrite Process

Adapting the laboratory-scale process to treat acid mine drainage (Alexander and Ristow, 2010)
This project investigated the viability and the commercial potential of the patented Ambient Temperature Ferrite Process (ATFP). The intention was that once the technology has been proven at pilot scale level it would be designed and offered commercially as a cost effective alternative to high density sludge plants for removing metals from AMD. As a first step, the results obtained in the original study (Morgan *et al*., 2004) were duplicated in this study except that actual AMD, lime (rather than sodium hydroxide) and compressed air (rather than bottled air) were used. Next, a pilot plant was built and operated for several months. Unfortunately the pilot plant was unable to remove ferrous iron from solution and produce ferrite. Although elucidating laboratory tests largely confirmed the feasibility and potential benefits of the process, it became evident that the gap between the laboratory-scale process and a continuous pilot-scale process was too large, and more work is required to develop scale-up parameters before a pilot plant can be operated. The project therefore proceeded as *laboratory and pilot-scale development of the ATFP* (Ristow and Brauer, 2010), commissioned in response to the results above. New lab results indicated a relationship between the operating pH, retention time, ferrite seed concentration and feed ferrous iron concentration in removing the ferrous iron from solution and forming ferrite intermediate on the ferrite seed present. The contact stabilisation reactor was fed Harmony Gold AMD, which contained 280-890 mg FeII/L. The contact stabilisation reactor was capable of removing all of the aqueous ferrous iron from the AMD, but only if the system was operated at a pH of at least 9. The feed ferrous iron was removed from as high as 890 mg Fe/L with seed concentrations of 3 g Fe/L and retention times as low as 10 minutes, although 15 minutes was required for a system operating at pH 9. For solids removal, a clarifier operating with an upflow velocity of 5 m/h was required, resulting in 14 times thickening of the ferrite solids. However, when the ATFP pilot plant was operated under these conditions, the system failed within a few days, indicated by a build-up of brown-coloured material in the process. Numerous changes to the operating procedure were made, but it was shown that it was difficult to maintain high seed concentrations in the system using the existing infrastructure, since the freshly produced ferrite seed had different settling properties to the mine ferrite. This led to a steady deterioration in the solids quality and ultimately process failure. Therefore, it was not possible to operate a successful ATFP treating AMD using lime.

Kinetic development of oxidation zones in tailings dams with specific reference to the Witwatersrand gold mine tailings dams (Yibas *et al.*, 2010)

This project aimed to understand the development and characteristics of oxidation zones in gold tailings dams. Five decommissioned dams were selected. Cross sections and exposed profiles were used to map and characterize the intensity and variations of oxidation in the tailings dams. This together with logging of auger holes of up to 10 m depth enabled the establishment of oxidation zone depths and tracing of the un-oxidized parts of the tailings dams. Overall, three zones of oxidation were recognized based on differences in oxidation intensities, which varied with depth. These zones were: a) mature oxidation zone (OZ), b) Transitional oxidation zone (TZ) and c) primary or un-oxidized zone (UZ). The OZ and TZ constitute the total oxidizing zone. The depth of the matured oxidation zone ranged from 150 to 350 cm.

The combined depth of the active oxidizing zone (transition zone) and the mature oxidized zone varied from 450 to 900 cm.

Quartz, mica, and chlorite/chloritoid were the major minerals in the tailings materials, with pyrophylite and traces of K-feldspar present in some of the dams. Pyrite and jarosite ranging from 2 wt % to <0.5 wt% were also present. The effect of oxidation in the mineralogy of the tailings is apparent in that pyrite decreased with depth and jarosite appeared. The pore water chemistry was approximated from paste pH and AA analyses of water extracted from the samples. The data showed a general increase in pH and metal concentration with depth within the TZ. The metal concentrations in the TZ were higher than that of the mature OZ, suggestive of pore water migration with soluble secondary minerals into the TZ. The geochemical evolution of the tailings pore water provided useful information on the progress, depth and rate of oxidation processes. The geochemical evolution of the tailings pore water indicated that the oxidation process in the studied tailings had reached an advanced stage as indicated by the pH of the pore water (2.5 - 4.1). These low pH values mark the final stage of acid water generation (aluminosilicate break down stage) in all but the unsaturated zone of the Stilfontein No 2 dam (pH = 6.2) which suggests the latter is still at the earliest stage of oxidation (carbonate dissolution stage).

Investigations of hydraulic properties of the tailings showed overall decrease in grain size and residual water content and increase in hydraulic conductivity and moisture content with depth. The effect of fractures as conduits of O_2 and water into the tailings is demonstrated. A decrease of O_2 gas concentration within the pore spaces of the tailings with increasing depth, as a result of O_2 consumption in sulphide oxidation reactions, was observed in the studied tailings. Oxygen diffusion ranged from about 200 to 500 cm with an average O_2 diffusion depth of about 400 cm. Mapped oxidation depth and depth of O_2 diffusion correlated well, thereby suggesting that measuring the O_2 diffusion (which can be accomplished cheaply and quickly) gave a good indication of active oxidation depth and hence the volume of oxidized tailings materials that needs to be considered in geochemical prediction exercises.

Development of a Mine Water Management Action Plan for the Witswatersrand Area

Concerns about the impacts of mine water in the Witwatersrand area (Figure 1) resulted in Cabinet appointing the IMC to address the challenges posed around AMD and mine water management. A Technical Committee chaired by the Director-General of Water Affairs subsequently appointed the ToE to carry out investigations. After intensive research, the ToE made the following recommendations of immediate, short-term, medium-term and long-term activity in the Witwatersrand area:

- Prevent mine water from decanting by pumping underground mine water to ensure that water levels are maintained at or below the Environmental Critical Level (ECL), i.e. a specific level at which underground mine water may threaten the environment
- Implement ingress control measures to reduce the rate of flooding and the eventual decant / pumping volume and costs
- Treatment of AMD and water quality management
- Neutralization and metal removal in the short term
- Removal of salt loads from river systems to be considered in the medium- to long-term (direct use or desalination to potable quality)
- Improve monitoring and undertake research to inform better decision making
- Manage and monitor other AMD sources within the Witwatersrand e.g. diffuse sources such as slimes dams
- Investigate and implement an environmental levy on operating mines to help cover the costs of mining legacies.

On 15 December 2010, the ToE presented their findings, including the above recommendations, in a report entitled *Mine Water Management in the Witwatersrand Gold Fields with Special Emphasis on Acid*

Mine Drainage to the IMC. The AMD Report was accepted by the IMC and was subsequently presented to and approved by Cabinet on 09 February 2011. The AMD Report was thereafter released into the public domain (http://www.dwaf.gov.za/Documents/ACIDReport.pdf). Since Cabinet's approval of the report of the panel of experts tasked to investigate the issue in February, the Department of Water Affairs (DWA), has been hard at work implementing the recommendations stemming from the report. Among the recommendations are to pump the underground mine-water to ensure levels remain below the environmental critical level; to neutralise and remove metals from the pumped water through treatment (in the short term); to reduce further ingress of water into underground workings; to improve monitoring and undertake research to inform better decision-making; and to investigate sustainable medium- to long-term management options.

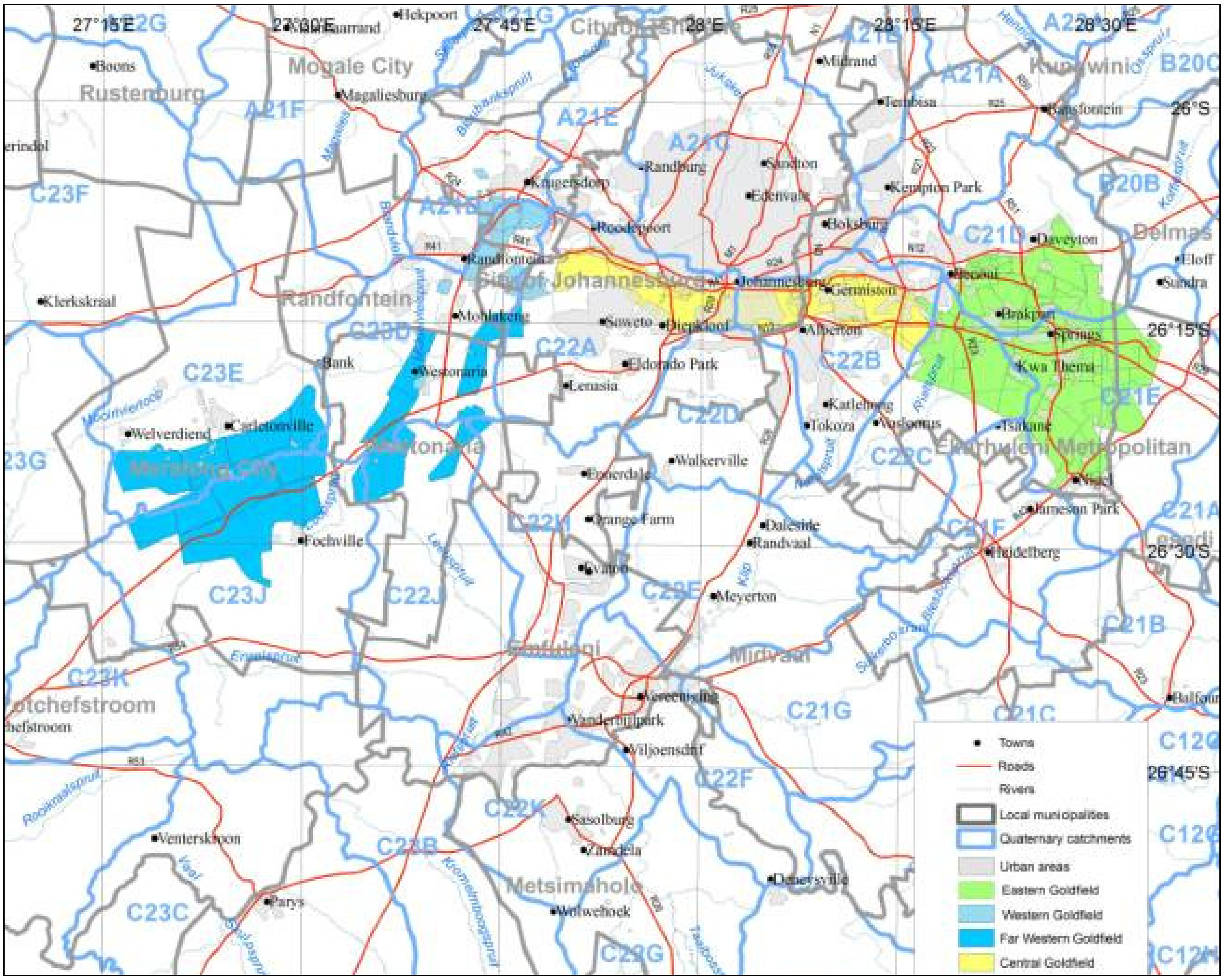

Figure 1. Map illustrating the location of the Witwatersrand in South Africa, and the goldfields within it.

A state-owned entity, the Trans-Caledon Tunnel Authority (TCTA), was directed by the Minister of Water and Environmental Affairs to ensure that these recommendations are implemented. In July, a Due Diligence study was completed to define an optimal short-term solution for each basin. At the time of writing, TCTA was finalising the first tender documents. Given the complexity of the situation and the various disciplines involved, the TCTA sought additional technical expertise by the appointment of BKS Pty Ltd and Golder Associates Africa. The scope of work for the contractors included a due diligence on all available information and on the physical mine water management infrastructure. In formulating an action plan for the three Basins, the hierarchy (in order of decreasing priority) was as follows:

1. The development of solutions to reduce, if not eradicate, the surface decant of AMD currently evident in the Western Basin.
2. The development of measures focused on ensuring that underground mine water levels in the Central Basin do not reach the Environmental Critical Level (ECL).
3. Identification of a key entity within the Eastern Basin and the protection of the ECL in the Basin.

Emergency measures

The Western Basin, where decanting of AMD commenced in 2002, received the most urgent attention. An emergency scheme to upgrade and triple the capacity of an existing Rand Uranium treatment plant to treat up to 35 Ml/day of mine water took place. The plant has been unable to cope with the volumes of decant water, resulting in much publicised pollution of the Tweelopiespruit and the downstream Krugersdorp Nature Reserve and Cradle of Humankind. Increasing the capacity of the plant will at least enable the capture and treatment of average flows (up to 60 Ml/day of acid mine drainage flows from the system during the rainy season). This emergency measure was set for completion before the end of 2011 and will be operated by Rand Uranium. In the short term, treated water will be transferred via the existing channel to the Tweelopiespruit, while sludge will be co-disposed into the Wes Wits Pit. The challenge in the Western Basin is not only to treat the currently decanting water, but to lower water levels in the mine void to the environmental critical level (ECL), which has been established at 165 m below surface (Table 1). Thus, in addition to the upgrading of the Rand Uranium water treatment plant, a new high-density sludge (HDS) plant and associated pumps and pipework are being constructed at Randfontein Estate with a capacity of 35 Ml/day.

Table 1: Status of mine void rewatering on Witwatersrand in October 2011

Basin	October 2011 level (m below surface)	ECL (m)	Potential date of reaching ECL
Eastern	626	290	December 2014
Central	408	186	August 2012
Western	Decanting	165	N/A

The aim of the short-term treatment plant is the neutralisation and metals removal from the mine water. Based on the water qualities in the basin, the minimum treatment includes iron oxidation, neutralisation and metals removal. It will also be prudent to include sulphate precipitation and/or removal to the gypsum solubility in the water (in the order of 2 400 mg/L). Final clarification and removal of precipitated products will be undertaken prior to discharge to the environment. This HDS plant is set for completion by August 2012 and is expected to lower the mine water level to the ECL by June 2013.

Central Basin

In the Central Basin underlying the Johannesburg central business district water has been steadily rising in the mine void at an average 0.36 m/day since pumping stopped in 2008. The flooding of this basin has been associated with an increase in seismic activity. In October 2011 water levels were estimated at around 408 m below surface. The ECL of 168 m below surface does not take into account feasible mining reserves lying between 168 m and 400 m underground. At the time of writing TCTA was negotiating with Central Rand Gold (CRG) to take the water level down to 400 m, with CRG bearing the cost of lowering the level from 168 to 400 m in order to access the gold reserves. A HDS plant is also planned for this basin to be situated at the South West Vertical Shaft. The plant will have a capacity of 84 Ml/day, but initially treat 57 Ml/day. Neutralised water will be transferred through a pipeline into the Elsburgspruit, with sludge co-disposal at Durban DRD Gold via dual lines. The TCTA was also in discussion with Durban DRD Gold regarding the use of treated water produced by the HDS plant. Commission of this plant was also planned for August 2012.

Eastern Basin

A third HDS plant is planned for the Eastern Basin, where mine water lay at around 628 m below ground level in October 2011. Since the potential date of water levels reaching the ECL is only December 2014, the project team have given themselves a deadline of June 2014 for the completion of this plant, which will be constructed with a capacity of 110 Ml/day. Treated water from this plant will be transferred via a new pipeline to the Blesbokspruit.

Witwatersrand conclusions

In addition to the short timeframe, the greatest impediment to the success of the short-term intervention is the cost. Capital expenditure has been calculated at R924-million (US$118.5-million), with a further R385-million (US$49.4-million) required for operations and maintenance. To date, only R225-million (US$28.9-million) has been secured, and discussions were being held with National Treasury. Concerning regulatory and environmental issues, it is hoped to streamline these processes to allow the necessary infrastructure to be constructed in time. Invoking the legislation defining emergency water treatment works, full environmental impact assessments will be undertaken alongside the design and construction phase and the engagement with interested and affected parties has begun. Meanwhile, DWA is in the process of appointing a service provider to assess medium- to long-term options of managing mine water on the Witwatersrand. The department is also increasing its number of monitoring sites in order to obtain more reliable data regarding rates of ingress and water rise underground.

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