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POLICY BRIEF

Water & Mining

The potential impact of coal-mining on water in the Waterberg

A recently completed WRC-funded project investigated the potential impact of planned coal-mining on water resources in the Lephalale region of the Waterberg.

Scaling up of coal-mining in the Waterberg: questions to be answered

The Lephalale region of the Waterberg in Limpopo Province ranks third in size in terms of its contribution to South Africa's coal reserves. This provides the Waterberg District with the opportunity of becoming one of the country's key areas for coal-fuelled electricity production. The area generally has a dry climate with average rainfall between 285 and 560 mm per year and mean annual evaporation approaching 2 000 mm.

Owing to the planned expansion of the mining enterprises, it is important to determine to what extent mining activities and accompanying developments will impact on the scarce water resources of the region.

A scoping level investigation was consequently performed to consolidate existing information on:

- The different aquifers in the study area and their geo-hydrological parameters;
- Pre-mining water quantity and quality of water resources associated with the Waterberg coal field;
- The acid generating potential of the geology of the area;
- Expected impact of additional mines in the area;
- Potential of mine water reaching decant levels; and
- Recommended management methods that are applicable in and have relevance to the area.

Approaches used in answering questions

Acquisition of the necessary information took place in a number of stages. Initially as many boreholes as possible in the study area were located and samples collected for groundwater quality determinations. In addition, information on the geology of the area was gathered from relevant sources and geological samples obtained for determining the acid potential of the rocks in the study area.

Numerous tests were conducted in the field to determine the parameters necessary for the determination of yields of the different aquifers in the area and for use in numerical groundwater flow modelling. To account for influx of water, groundwater recharge was calculated. Acid-Base Accounting was performed on the collected rock samples to determine which rocks would become acidic upon oxidation. Samples from beneficiation plants at the Grootegeluk colliery were also analysed for acid-forming potential.

Numerical modelling was used to determine the impact the mines would have on groundwater and its direction of flow. During the course of the modelling, attention was also given to simulating different management scenarios in an attempt to establish the dewatering and decant potential of the mine pits.

Geology and mining method

The Waterberg Coalfield, part of the Karoo Supergroup, trends east to west and is heavily faulted. One of three major faults, the Daarby fault, subdivides the coalfield into the shallow western part where opencast mining is possible and the deeper north-eastern part where underground mining is required. The coal is of low quality and needs to be beneficiated to maintain profitability. Beneficiation plants require large volumes of water to operate, which would increase the strain on the groundwater systems if the required water is to be abstracted from boreholes. Furthermore, the discard from the beneficiating plants contains minerals that are prone to acid generation.

The entire area west of the Daarby fault would be mined using the opencast method, owing to the shallow depths of the coal. The form of opencast mining found to be most economical by the Grootegeluk mine is known as bulk mining, which involves the removal and processing of all relevant material, consisting of coal inter-bedded with thin layers of shale and mudstone. New opencast mines planned for the area will in all probability follow the example of Grootegeluk with regard to mining methods, spoil handling, water management and rehabilitation.

Some form of water control is usually required to prevent an open-cast mine pit from becoming an acidic lake. In the Waterberg area, however, the problem of lake formation is of lesser concern owing to the low levels of annual precipitation, low transmissivities, high evaporation and the deep groundwater levels found in the area.

Pre-mining water quality

In the area under investigation, the quality of water that has been unaffected by activities such as mining and power generation can at best be classified as moderate, with a fine line existing between groundwater that is usable or not. The water in general has high electrical conductivity (EC) and Cl^- values, with pH being near-neutral. It is predicted that the addition of new mines will have an adverse effect on the groundwater by increasing the EC and SO_4^{2-} values, owing to acid rock drainage (ARD) in the immediate vicinity of the mines.

Water levels

From observations made regarding the influence that the Grootegeluk Mine and its dewatering have had on surrounding aquifers, it is expected that the excavation of new open pits in the central parts of the area will alter the topography and result in changes to the direction of flow of groundwater.

Aquifer parameter testing

Pumping tests in the western parts of the study area revealed that vast differences exist in the transmissivity of formations and yields of the boreholes. In general, though, the yields and transmissivities of the aquifers in the area are found to be low. New mines planned for the study area should thus not have problems with regard to large volumes of water flooding the mines. Also because of the low rainfall, water levels in the mines are not expected to reach decant levels.

Recharge

The recharge determinations indicated values of between 1.5-1.6% for the entire study area. The low recharge, coupled with the low transmissivities, present both benefits and drawbacks for the mines and farmers in the study area. For mining, low recharge rates are positive in the sense that there will be little inflow of water into the mines. For farmers the impacts will predominantly be negative, since dewatered boreholes will take long times to reach their initial levels and those in the immediate vicinity of the mines are unlikely ever to recover. Therefore, precautions should be taken to minimise the impact of the mining on the groundwater.

Potential for acid generation

There appears, largely, to be sufficient potential for the acid generated through mining to be neutralised, provided every ton of acid rock is mixed with a ton of available base potential rock such as calcite. There are some areas, however, where insufficient calcite is available to completely eliminate the potential for acid generation. Another exception is where sandstone, with its higher acid-generating potential, occurs.

Modelling

Numerical modelling has provided insight into the quantities of groundwater flowing into mines, which impact on mine dewatering and the potential for decant levels to be reached.

Dewatering: The small volumes of groundwater in the area move slowly and predominantly along structures such as dykes, fractures and faults. Accordingly, the intersection of a fault during mining operations would cause a greater volume of water to flow into the mine.

Decant: Model simulations suggested that inflow of water into pits is insufficient ever to cause water in the pits to decant. Even after 50 years following cessation of mining, water levels in the modelled pits will have risen from an average depth of 28 m by no more than 2-3 m, the largest contributor to the rise being surface runoff during periods of high rainfall.

Management

Owing to the small volumes of water expected to enter the mine workings from both groundwater and surface runoff sources, water levels can easily be kept under control by pumping out the water and using it for mining operations such as dust suppression or washing of ore. Care should, however, be taken to minimise the risk of intersecting a fault during mining, which would increase the quantity of water to be pumped. Furthermore, dewatering a fault could cause a significant decline in water levels of farm boreholes in the vicinity.

There are many possible water quality control measures that can be used to either prevent groundwater contamination or to contain any possible contaminants in the mining area. Measures employed at the Grootgeluk mine largely focus on containment of contaminants and have evolved to become particularly effective under the conditions prevailing in the area, thus serving as a sound example for new mining operations.

As far as possible, rocks removed during excavation are placed back in the same order. The pit is backfilled as a series of benches, each lined and sealed, until all the backfill material has been used. Spoils from the beneficiation process are placed into the pit and covered with the rock removed during mining. The spoils, along with other rock units that have the potential to produce acid, are placed at a higher level to keep them as dry as possible to limit acid production. Although the generation of some acidity is unavoidable, the low volume of water entering the pit makes it possible to contain effluent in one location, where it can be more easily treated.

Consolidation of scoping study outcomes

The results and conclusions from the scoping-scale investigations have been drawn together and summarised in a conceptual model of the Waterberg Coalfield. The model displays the locations of primary geological structures and coal seams, the rehabilitation methods designed to the limit the amount of acid generated at the Grootegeluk mine, the effects of mining operations on groundwater levels, information on the acid generating potential of rocks and beneficiation plant wastes, and insight into the quality of water in various localities, both unaffected and affected by mining operations and power generation activities.

Policy guidelines

The establishment of new mines will have a deleterious effect on the quality and quantity of the groundwater in the Waterberg coalfield. In particular, the small volume of water available in the area will be further reduced, with effects being more pronounced west of the Daarby fault owing to the impermeable nature of this fault, which will prevent groundwater inflow into the area.

Since the methods of mining, beneficiation, remediation and water management methods currently being employed by the Grootegeluk mine have been proven to be optimal under existing conditions, such methods are recommended as being appropriate for new mines to be established in the area. Further refinement of these methods needs, however, to be encouraged, based on the outcome of various studies that focus on key topics identified during the course of the studies.

Further reading:
To obtain the report, ***Assessment of how water quality and quantity will be affected by mining of the Waterberg coal reserves west of the Daarby fault*** **(Report No: 1830/1/10),** contact Publications at Tel: (012) 330-0340; Fax: (012) 331-2565; E-mail: orders@wrc.org.za; or Visit: www.wrc.org.za