EXECUTIVE SUMMARY

The Witbank and Middelburg Dam catchments are extensively mined. The water quality has deteriorated in the catchment. The water resources of the catchment are further threatened by the future decants that are expected from the mines post closure. The mines will be closing over the next 20 years. Thereafter the mine workings will fill and start decanting.

The objectives of the study were:-

- Evaluate the available management options that can be used to reduce mine drainage and / or improve its quality on the Mpumalanga coal field.
- Compile the currently available information and acquire additional information as required to model the long term water quality and quantity emanating from the mines in the Mpumalanga coal field.
- Establish an integrated modelling suite that simulates the change in the Mpumalanga coal field as affected by different management options.
- Compare the cost associated with different options with that of treatment to achieve target water qualities.

The approach adopted in the analysis is summarised as follows:-

- Identify a management option.
- Cost the management option.
- Set up the model for the identified management options.
- Run the model of the system and check the Middelburg and Witbank Dam's concentrations against the RWQO.
- Determine the net present value for the option for comparison with other options analysed.

The study involved a data collection phase where the mining data was collected and evaluated. The collection of data showed that the quality of the available data varied considerably from mine to mine. The mine data was collected by means of questionnaires followed by phone calls and site visits. The data collected included water quality, mining areas, types of mining, water balances, floor contours and water use. The data was collated and used as input to the models used to evaluate the management scenarios. The mining data for the Middelburg Dam catchment was better than for the Witbank Dam catchment. The mines were grouped together based on location and logical management of water.

Available management options that can be applied on the mines to reduce volumes and improve the water quality of the expected decants were identified in a literature survey. The options included diversions, covers, treatment (both conventional desalination and passive), underground management of water through seals and spoils handling. The options taken through for analysis were covers, conventional treatment, use of workings storage and intermine flow as these were considered to be the most practical and tested approaches.

A suite of models was selected for use in the study. The available models were collated and ranked. The ACRU-Salinity model was selected for the assessment of the local mining impacts while the Water Resource Planning Model (WRPM) was found to be best able to assess the regional impacts. The WRPM has a mine module that can be used to simulate mine water systems. The module allows for the different mining types,

mining plans, use of water on the mines and mine storage. The data collected was used to set up the mine module for the mines and used in the analysis of the management scenarios.

The ACRU-Salinity model was applied to the Kleinkopje Colliery and the B11C quaternary catchment. The model was calibrated against measured volume and Total Dissolved Solids (TDS) data. 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. The application of the model to the B11C quaternary 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 5 scenarios analysed for the Middelburg and Witbank Dam catchments were:-

- Scenarios 1, 2 and 3 involved using different covers. The three covers used were a poor cover, good cover and a 1200 mm thick cover. The recharge factors used for the covers were 20%, 15% and 10% for the poor, good and 1200 mm cover. The covers were applied to the different mine areas and the time to decant and decant volumes were determined. When the mines decanted, it was assumed that the decant was treated.
- Scenario 4 involved piping water from workings that were filling early to workings that still had capacity. This was applied to the Middelburg catchment where the water from the Kwagga Group was pumped to Schoonoord and the water from Optimum was pumped to Boschmanspoort. The idea being tested was to delay the need for treatment.
- Scenario 5 was the use of intermine flow as a post closure scenario. The use of intermine flow is best suited for mines located in the Witbank Dam catchment. The intermine flow can be directed to a low point at Douglas Colliery from where the water can be abstracted for treatment and supply as potable water to Witbank.

The following conclusions can be made as a result of this study:-

- The catchment situation is dire with deteriorating water quality in the Witbank and Middelburg Dams. There are still new mines to be developed in the catchments and the existing mines are still expanding.
- The water demands of the Steve Tshwete and Emalahleni Local Municipalities exceed the yields of the Witbank and Middelburg Dams. There is no further surface water resources that can be developed in the catchment to meet the growing water demands. The mine water is the only local source of water that can be used to meet the demands. The treatment of mine water and supply as potable water is already being undertaken 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 available for treatment and supply.
- The level of mine information varies from mine to mine. Some mines have a good understanding of the areas, storage volume available and the excess mine water generated over the life of the mine. The collection of information was halted early on in the study so that the analysis work could continue. A number of the mines have made significant progress in improving their water balances. Nonetheless the available data was used and was considered adequate to undertake the study and illustrate the management approaches that can be considered for the catchment.
- The modelling needs identified were to be able to assess the impact of mining on the local and regional water resource impacts. The ACRU-Salinity model was identified as the most appropriate model to apply to assess the local water quantity and quality impacts. The WRPM and the WQT models were identified as the most appropriate for assessing the regional impacts.
- The ACRU-Salinity model was applied to a quaternary catchment and was found to calibrate well against the measured flows and TDS concentrations. The model was used to determine the impact of a

dummy mine on the water resource of the quaternary catchment. The model was also applied to modelling the Kleinkopje mine complex with reasonable success.

- The application of the WRPM to the catchment was used to determine the impact of the mine scenarios on the dam water qualities and the excess mine water available. The results of these runs were input into the cost model.
- The shortcomings in the WRPM identified were that changes in water quality over time in the mine workings could not be modelled. The water qualities are entered in the model based on the measured data. The impact of the long term flushing of workings cannot be modelled.
- The application of the cost model to the scenarios that were formulated showed that the use of covers significantly reduced the water volume that needed treatment. The reduction in recharge also delayed the need for treatment. The total NPV for the scenarios showed that the use of a good cover significantly reduced the NPV of the scenarios. The 1200 mm cover is expensive and did not achieve the same magnitude of the reduction in the total NPV for the catchments.
- The use of storage to delay treatment showed that there was some merit but the cost of the piping to convey the water for storage in the workings was expensive and offset the changes in treatment costs.
- The intermine flow is a promising closure scenario. The water can relatively cheaply be transferred to a low point close to Witbank. A treatment plant can be constructed at the low point for supply to Witbank. The sale of water reduces the NPV significantly as a portion of the operating costs can be recovered. The intermine flow option however requires cooperation between the mines and planning to control the flows between the workings. Issues of liability would also have to be addressed if intermine flow is to be considered as an option.
- The closure of the mines is still some years off. The NPV show that although there are immediate management issues on some of the mines, relatively small sums of money can be provided now to cover the closure costs in 40 or 50 years time.
- The scenarios presented in the study were based on the available data and have not necessarily been optimised. However the scenario results provide useful guidance and direction on the way forward.

The following recommendations can be made as a result of this study:-

- The mines must keep their water balances current and all achieve a similar level of accuracy and confidence.
- Not all the mines were included in the study. There are a number of smaller mines and mining companies whose information should be collated and included in the modelling and long term planning.
- The mines must co-operate and continually update the life cycle costs and seek the most economic solution for the management of water in the long term. This includes incorporating intermine flow as a closure solution.
- The treatment and supply of mine water for potable use is the strategy to achieve reconciliation in the catchment. The long term changes in the recharge rates need to be assessed as the opencast mine workings consolidate and the perched aquifer previously destroyed by the mining starts to re-establish.
- The WRPM should be updated with a simple algorithm to model the water quality changes in the mine workings.
- One of the expenses in treatment is the disposal of brine. Consideration should be given to the storage of brine in the underground workings to reduce the costs of the treatment process.
- Impact of electricity costs on viability should be reviewed.