water affairs
Department:
Water Affairs
REPUBLIC OF SOUTH AFRICA

POSTION STATEMENT ON THE VAAL RIVER SYSTEM AND ACID MINE DRAINAGE

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1. INTRODUCTION

As the trustee of South Africa's water resources, it is the goal of the Department of Water Affairs (DWA) to pro-actively plan for all foreseeable eventualities and to timeously implement suitable management interventions where appropriate. In so doing, the Department aims to contribute towards sustainable development in an integrated fashion, co-operating with its other partners in government.

2. BACKGROUND

2.1. Reconciliation strategies

Since the publication of the National Water Resource Strategy in 2004, the Department of Water Affairs has embarked on a series of Reconciliation Strategy Studies for all the large river systems supplying the metropolitan areas with water. These studies developed future water requirement scenarios for each area in close collaboration with the users, investigated methods to reduce the demand, studied possible further resource development options (which included accounting for the possible impact of climate change), and developed strategies (including integrated water quality management strategies) to ensure continuing supply of water for the next 25 – 30 years into the future.

Strategies have *inter alia* been completed for the Vaal River System, the Crocodile (West) River System, and the Greater Bloemfontein Water Supply Area (Version 1), while a study is currently underway to also address the Olifants River System.

2.2. Stakeholder involvement

Strategy Steering Committees consisting of representatives of the Department of Water Affairs, Provincial and Local Government, as well as from all the major stakeholders, have been formed in all of these areas. The function of these Committees is to-

- monitor the implementation of the strategies;

- update the strategies as new information requires it;
- make recommendations to the institutions responsible for various parts of the strategy; and
- communicate progress to the stakeholders and the public.

2.3. The Vaal River Reconciliation Strategy

2.3.1. Area of supply and water resources

The area supplied by the Vaal River System stretches far beyond the catchment boundaries of the Vaal River and includes most of Gauteng, Eskom's power stations and Sasol's petro-chemical plants on the Mpumalanga Highveld, the North-West and Free State goldfields, Kimberley, several small towns along the main course of the river, as well as irrigation all along the main stem of the river and the large Vaalharts Irrigation Scheme.

Supplying this huge area is achieved through a very complex water supply system of dams, pumping schemes, diversion weirs, canals, pipelines and inter-basin water transfer schemes. The system will soon be extended to also supply water to the developments on the Waterberg coalfields near the town of Lephalale. An important characteristic of the Vaal River System is that a substantial quantity of water is transferred in from the Thukela, the Usutu and the Senqu (in Lesotho) Rivers. The Vaal River serves as conduit to transfer water to the Upper, Middle, and Lower Vaal Water Management Areas (WMAs). Significant water transfers out of the Upper Vaal WMA occur through the distribution system of Rand Water to urban and industrial users in the Crocodile West and Marico WMA. Water is also transferred to the Olifants WMA, mainly to supply the power stations in this region.

The Vaal River System meets the water resource needs of 60% of the national economy and serves 20 million people (*i.e.* approximately 45% of South Africa's population) in the country.

Figure 1 provides a map of the extended study area showing the Vaal River and linked systems.

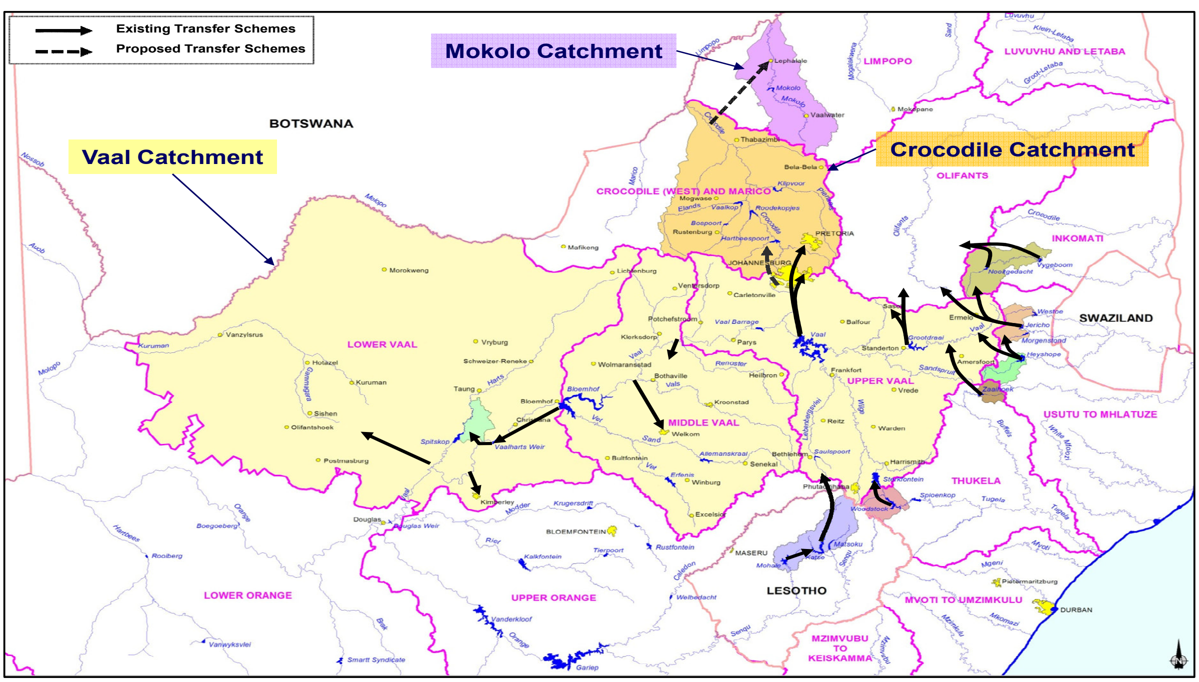

Figure 1: Integrated Vaal River System

2.3.2. Planning studies completed

The recently completed *Vaal River System Large Bulk Water Supply Reconciliation Strategy* study investigated future use, all the resource options, and developed a strategy to ensure future water supplies to all users of the Vaal River System.

Water quality is a very important aspect of the management of the Vaal River System and must be fully integrated with the management (distribution and use) of quantity. To this end the development of an *Integrated Water Quality Management Strategy* for the Vaal River System was conducted parallel to the Reconciliation Strategy study.

A third very important study, *Potential Savings through Water Conservation and Water Demand Management* (*WC/WDM) in the Upper and Middle Vaal Water Management Areas*, was undertaken at the same time to assess prospects for the reduction of demand through various measures.

2.3.3. The Vaal River Strategy

The Vaal River System Reconciliation Strategy identified five core actions to ensure that sufficient water is available to users:

- Apply all the necessary resources to eradicate extensive unlawful water use as a national priority.
- Implement water conservation and water demand management measures to reduce losses and reduce the urban demand by at least 15% by 2014.
- Undertake a feasibility study into the re-use of water, with first priority being underground mine water from gold mines.
- Implement the Vaal River Integrated Water Quality Management Strategy. This has a focus on salinity, eutrophication, microbiological pollution, and institutional challenges.
- Implement Phase 2 of the Lesotho Highlands Water Project.

This strategy was approved by the Top Management of the Department of Water Affairs and the Minister at the time, and was also presented to Cabinet when approval was obtained to proceed with the Lesotho Highlands Water Project (LHWP 2).

2.4. Salinisation of the Vaal River System

Key contributors to salinisation of the integrated Vaal River System are sewage return-flows, AMD and diffuse pollution (including atmospheric fall-out *inter alia* associated with power generation). The ever-growing salt-loading of the Vaal River System has now reached the point where steps need to be taken to limit and eliminate the sources of such salt-loading. Addressing salinisation associated with AMD, had been prioritised since it constitutes the most concentrated salt-stream. Desalinisation of sewage return-flows and strict control of other sources of salinisation are to follow. However, mechanisms to recover some of the cost associated with the desalinisation of AMD from all contributors to the salt-loading of the Vaal River System, and the application of the Waste Discharge Charge System and tariffs on raw water use need to be further investigated.

2.5. The impact of acid mine drainage on the Vaal River System

The Strategy Steering Committee of the Vaal River Reconciliation Strategy met on 21 October 2010 to discuss progress with the implementation of the various elements of the strategy. Various options to deal with AMD that were analysed were presented. The results from the two most important options are summarised here.

The options were analysed using the Water Resource Planning Model, a very sophisticated simulation model that models the complicated Vaal River System in great detail, both for water quantity and water quality (specifically salinity). For every analysis, 1 000 stochastically generated sequences of hydrological time series are used to do risk analysis up to 2050. The results from the analysis were interpreted in simplified diagrams that are used for the explanations of the results below.

2.6. Description of options

2.6.1. Limited treatment option

This option assumes that the water from the East, West and Central Rand Mining Basins will be pumped to the surface (from the Environmental Critical Level (ECL)) and neutralised. Most of this water will then be discharged to one or more tributaries of the Vaal River and will flow into the Vaal Barrage.

The latest information on the salt concentrations that could be expected from the mine water was used in the analysis, some of which could be as much as 6 500 mg/l. This will push the salinity level of the Vaal River downstream of this point to a level that is unsuitable for the downstream users.

The only method to alleviate this unacceptable situation is to release water with a very low salt content from the Vaal Dam to dilute the highly saline water from the mines to a level of 600 mg/l in the Vaal Barrage.

The results from this option is summarised in **Figure 2** and further discussed below.

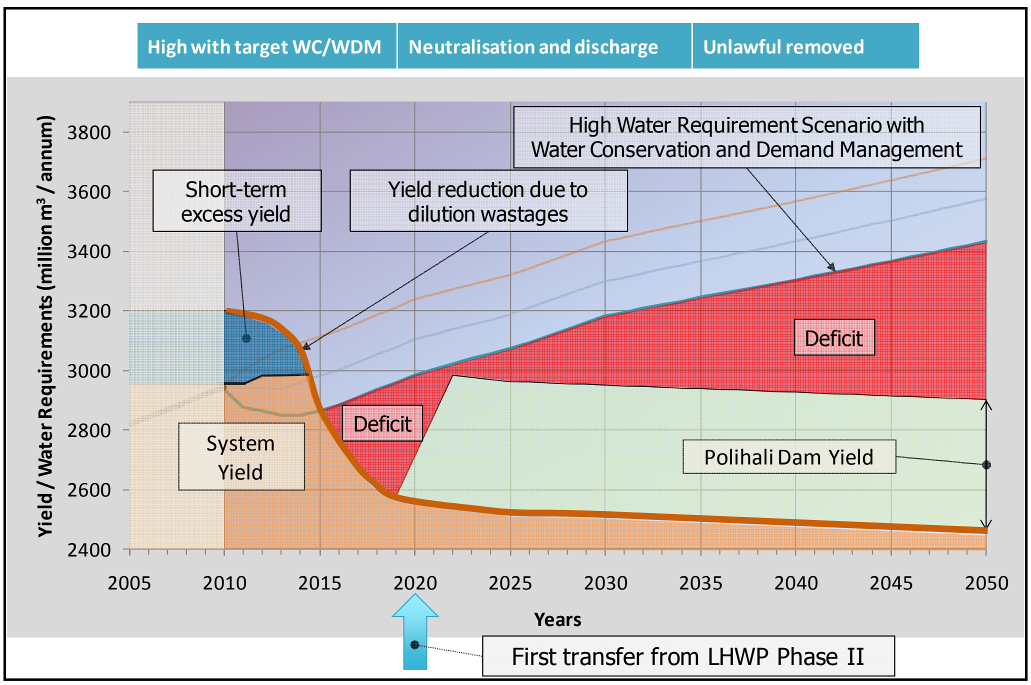

Figure 2: Vaal River system water balance (AMD neutralised and released into the Vaal River)

It can be seen from Figure 2 that the amount of water that is required from the Vaal Dam to dilute the saline mine water will reduce the long term yield by about 400 million m³ per annum.

This means that the yield of the future Phase 2 of the Lesotho Highlands Water Project (LHWP) is effectively lost from the system.

There will be a shortage of 400 million m³ of water per annum as soon as the mine water starts to flow and by the time LHWP Phase 2 comes on line, the demand would have grown to such an extent that the shortage will just worsen. In order to "replace" this lost yield, it will require another surface water scheme like the Thukela Water Project to be implemented. If this project is started immediately, it would only be able to deliver water by 2025 and would cost in the order of R9 billion (2007 prices).

In the report *P RSA 000/00/12610 - Assessment of the Ultimate Potential and Future Marginal Cost of Water Resources in South Africa, September 2010* a first order cost comparison was done of all future schemes to supply the Vaal River System. The report gives the Unit Reference Value (URV), using capital and operational cost, as R8/m³ for the treatment and re-use of the mine water and R9/m³ for the Thukela Water Project.

However, what is not included in any of the comparisons is the fact that, even with the dilution option in place, the salinity levels of the river will be elevated from the Vaal Barrage to Douglas where the Vaal River flows into the Orange River, right down to the ocean at Alexander Bay with negative impacts on a total irrigation area of about 100 000 ha. Instead of solving the problem where it originates, this option is just spreading the water quality problem over a much wider area, externalising cost and also affects international obligations South Africa has towards Namibia. The negative effect of an increase in salinity for the users downstream has not been costed.

2.6.2. Desalination and re-use option

This option also assumes that the water from the East, West and Central Rand Mining Basins will be pumped to the surface (from the Environmental Critical Level (ECL)) and neutralised. It would then be desalinated and potentially supplied for industrial use or as drinking water in Gauteng.

Figure 3 shows how this option effectively keeps the long term yield of the Vaal River System on the level of about 3 000 million m³ per annum and how the system, with the addition of LHWP 2, will have enough water up to about 2050.

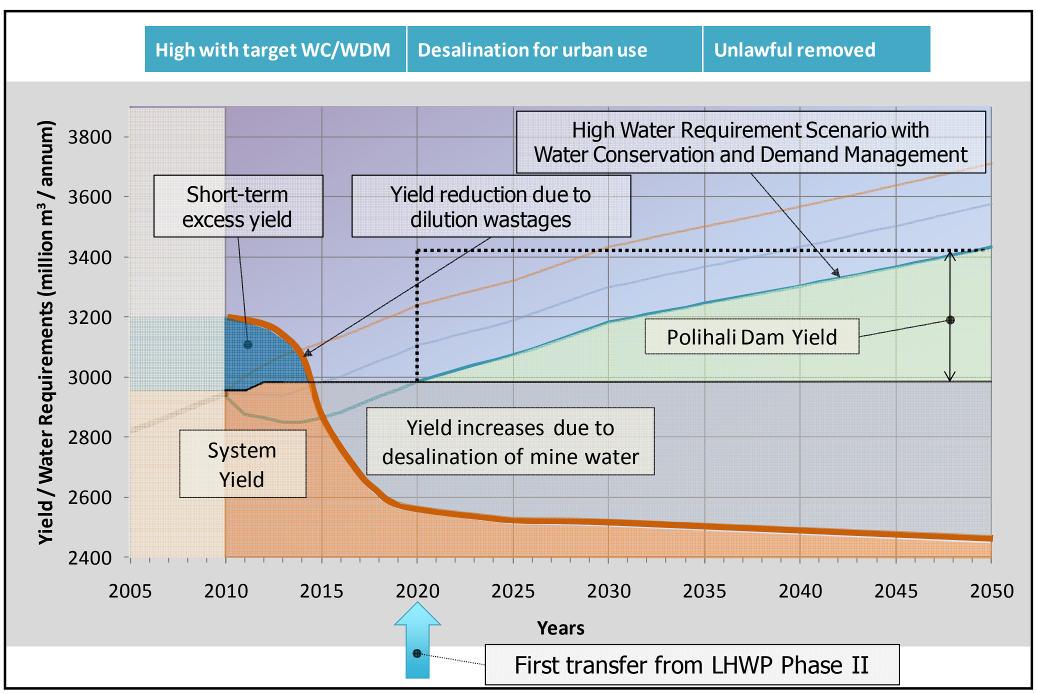

Figure 3: Vaal River system water balance (AMD treated and re-used in Rand Water supply area)

3. CONCLUSIONS

It is clear from the above that to only neutralise the AMD and then release it into the Vaal River will have serious long-term consequences for the system. Water demand requirements could be partially addressed by immediately starting with the building of the Thukela Vaal Project. This will, however, cost more and will not solve the problem of spreading the salts from the mines over huge areas of prime irrigation land and externalising the cost to receiving water users.

The desalination of the mine effluent offers a responsible sustainable long-term option for the whole system.

The Department of Water Affairs, in collaboration with its other partners in government, urgently needs to finalise a feasibility plan for the implementation of this option. Such a feasibility study should amongst others include-

- an assessment of funding, as well as cost recovery mechanisms that are available through the application of the Waste Discharge Charge System and water pricing tariffs on raw water use;
- the implementation of the appropriate institutional model;
- agreement on the apportionment of liabilities;
- the necessary engineering studies and cost-comparison of options (options analysis); and
- a communication strategy to involve key-stakeholders and the public.

4. REFERENCES

Department of Water Affairs, South Africa. September 2010. ***ASSESSMENT OF THE ULTIMATE POTENTIAL AND FUTURE MARGINAL COST OF WATER RESOURCES IN SOUTH AFRICA,*** Report No. P RSA 000/00/12610.

Department of Water Affairs and Forestry, South Africa, September 2009. ***INTEGRATED WATER QUALITY MANAGEMENT PLAN FOR THE VAAL RIVER SYSTEM: TASK 8: WATER QUALITY MANAGEMENT STRATEGY FOR THE VAAL RIVER SYSTEM,*** Report No. P RSA C000/00/2305/7.

Department of Water Affairs and Forestry, South Africa. March 2009. ***VAAL RIVER SYSTEM: LARGE BULK WATER SUPPLY RECONCILIATION STRATEGY***: **SECOND STAGE RECONCILIATION STRATEGY**, Report No. P RSA C000/00/4406/08.