Regional Mine Water Treatment Plants: Tolled treatment financial analysis and viability

Ashton Drummond

Aveng Water, Ashton.drummond@avenggroup.com

Abstract

The Upper Olifants River Catchment area located in Mpumalanga is the centre of South Africa's coal mining industry. Coal mining operations in this area generally have a positive water balance, and this Mine Impacted Water (MIW) to be released into the environment has serious detrimental effect on the environment, specifically the catchment streams of the Olifants River.

The capital requirements for a MIW Plant can often delay the execution of a project when funded solely by the mines. A technical and financial analysis has been performed, which investigates what pricing structure would be required for mines serviced by a regional MIW Treatment Plant. The model is based on a capital structure that is comprised of a mix of debt and equity, thus considering an acceptable return on investment for private investors.

Keywords: Mine Impacted Water, Mine Water Treatment, Regional MIW Treatment Plant, Tolled Treatment, Capital funding

Introduction

Aveng Water, together with the Industrial Development Corporation (IDC) are considering the potential opportunity to invest in a regional Mine Impacted Water Treatment Plant in the Upper Olifants River catchment area in Mpumalaga.

The Upper Olifants River Catchment area located in Mpumalaga is the centre of South Africa's coal mining industry. Coal mining operations in this area generally have a positive water balance which needs to be released to the environment. This Mine Impacted Water (MIW) runoff into the catchment streams of the Olifants River can have a serious detrimental effect on the environment.

The construction and operation of a regional MIW plant will bring benefits to the local economy through various avenues:

- Employment created for the construction of the plant and surrounding infrastructure
- Employment created to operate the plant
- Distribution of potable water to water scarce regions
- Sale of gypsum for building material – possible employment opportunity
- Potential recovery of other valuable minerals dissolved in the water
- Enforcement and improvement of environmental management plans for mines in the targeted region

Coal mining activities in the Upper Olifants River catchment area has created a need to treat approximately 200 - 250 ML/day of Mine Impacted Water. This water is found both in currently operating mines, where there is a requirement for water to be pumped out to maintain mining capacity, as well as in defunct mining areas, where rainfall percolates through old mining areas, slowly filling the empty voids with highly saline water which eventually finds the lowest point to decant from. A COALTECH report from 2000 (Maree et al., 2000) estimated that there was 44ML/d of MIW decanting into the river systems of the Upper Olifants river catchment, which amounted to 4.54% of the total water usage (volume), but accounted for 78.4% of the sulphate load in the system. It was estimated in the same report that by the year 2020, the volumes decanting into the river system would be closer to 131 ML/d.

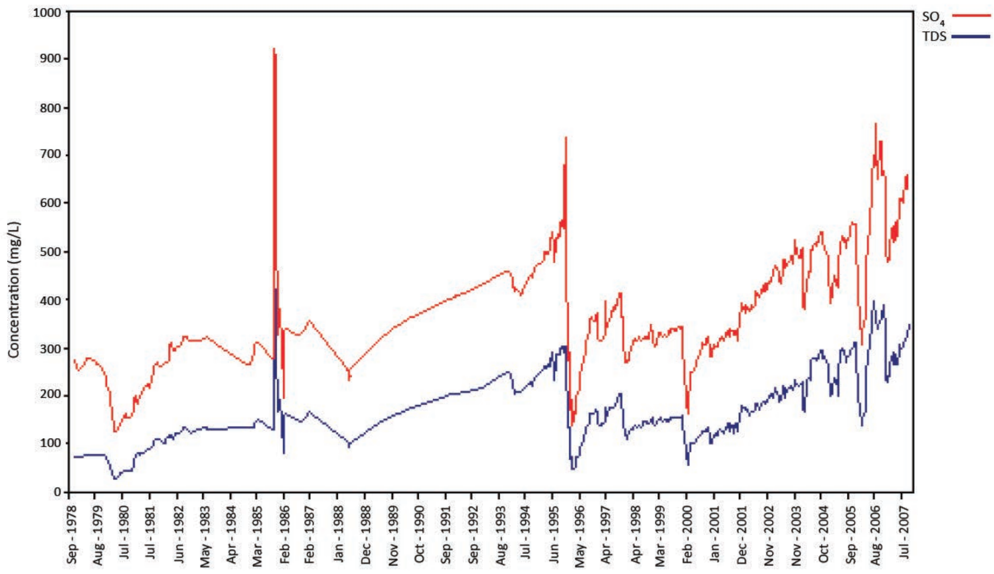

Figure 1 *Concentration of sulphates and total dissolved solids from September 1978 to July 2007 in the Middelburg Dam (Source: Department of Water Affairs)*

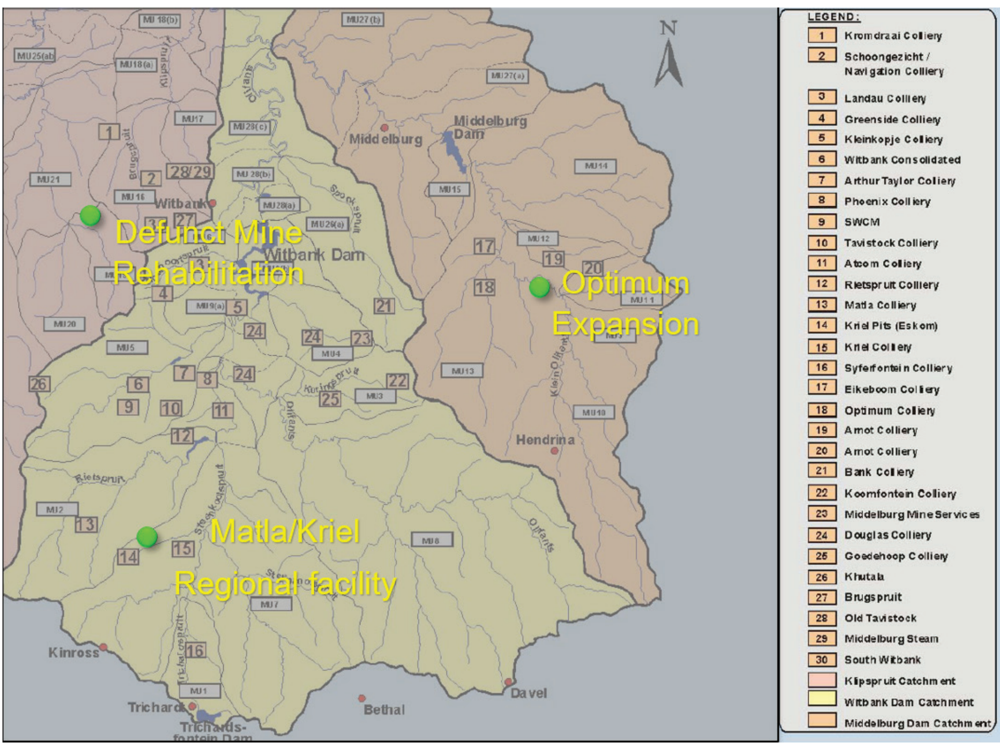

Figure 2 *Potential Locations for a Regional MIW Treatment Plant*

Figure 1 above is an indication of the effect that coal mining has had on the holding dams in the region. The increased salinity is exacerbated in dry periods, and diluted with good rains, but the general trend is undoubtedly upwards for both salinity and sulphate levels.

Current and Future Mining

Plans showing the mining and prospective areas in the upper catchments of the Vaal, Olifants, Komati and Mfolozi-Pangola-Usutu rivers in Mpumalanga (McCarthy, T.S) indicate the potential to increase the mining footprint up to 40% (from the current 14%) of the provincial surface area. This would suggest that the dewatering, and water treatment requirements would be compounded as old mines close down, and new mining areas are explored.

It is worth noting that future mining projects in the region will have difficulty receiving water allocation from the DWEA, due to the current deficit of water in the entire catchment (Cogho, V.E, 2012). This again indicates the potential value in effectively utilising MIW to help the mining economy.

Potential Locations for a Regional Treatment Plant

Figure 2 above indicated three potential locations for a regional plant. The first option for placing a regional plant would be to approach stakeholders in projects which have already been conceptualised and offer to take over responsibility for the capital expenditure and project development. The second would be to identify a new region where there is an obvious need for water treatment, and begin discussions with the mines in the area to get letters of intent from potential MIW suppliers.

The first option could potentially circumvent the EIA and mine negotiation phase, which could fast track a project, and this should be the preferred route for a regional installation.

Optimum Expansion

Mines in the region of the OWRP need extra MIW treatment requirements in the region of 15ML/d. This water would come from; Optimus, Zevenfontein, Pullenshope, Boschmanspoort, Kwagga, Schoonoordt and Eikeboom.

The Arnot Colliery is another potential supplier of MIW in the Optimum region. From the COALTECH 2020 report published in 2000, it was estimated that Arnot colliery had an average decanting rate of 4.43ML/d. The COALTECH 2020 report seemed to underestimate many of the decanting volumes that are well known today. Some examples are below:

1. Kromdraai estimated at 1.26ML/d – reality today is 8ML/d
2. Optimum Colliery estimated at 9.5ML/d – reality today is 15ML/d, needing a further expansion
3. Middelburg Mine estimated at 1.32ML/d – reality today is 20ML/d

It is therefore estimated that there is a considerably higher decant volume to be treated at Arnot Colliery.

Arnot Colliery has used various pits to store MIW, and this volume of water should be treated in the long term to avoid further contamination of ground water, and amounts to approximately 285.7 million m^3, which is over and above the decant flow rate. If this is to be treated over 20 years, this amounts to an extra flow rate of 39ML/d, and gives a sense of how much MIW is available in the region to treat.

From the above mentioned water sources, it is evident that there is at least 35ML/d available to treat in the long term:

- Optimum Colliery and surrounds – 15ML/d
- Arnot – 20ML/d (could be higher as a result of dewatering pit requirements)

Matla/Kriel Regional Treatment Facility

It was mentioned in the Matla tender documentation that the Matla plant would be in operation for approximately 5 years before tying in to the 40ML/d Eskom-led Matla/Kriel Regional Scheme Water Treatment Facility as planned to be commissioned in July 2016. This is a potential opportunity, as it does not seem as if this project has received the go-ahead yet, and there may be a chance to provide the capital and project execution.

Defunct Mine Rehabilitation west of Witbank

The WRC Report No. 1628/1/11 (2011) by Coleman et al. explains that there is a high concentration of defunct and abandoned mines in the Klipspruit Catchment. These mines started in the early 1900's, and the responsibility has since been handed over to the Department of Minerals and Energy. There is an opportunity to construct a regional plant to treat the historical environmental concerns in the region. More investigation would be needed regarding the volumes available to treat, and whether the financial model can be sustained by an array of defunct mines with limited financial backing.

Potential Off takers

Water resources in the Upper Olifants River Catchment area are stressed in terms of usage, which presents many opportunities for potential off-takers of product water emanating from a MIW treatment facility

Irrigation

Irrigation is the largest water user in the Olifants River catchment, with an estimated supply of 508 million m^3/a (Beumer et al., 2011), while the requirement is closer to 708 million m^3/a.

A few research papers (Coleman et al., 2011 for example), have discussed studies regarding using gypsiferous mine water for irrigation. Indications are that neutralized MIW could be used for irrigation, after a 3 year trial at Kleinkopje Colliery. Salinity in the soil increased over the duration of the trial due to high concentrations of Ca^{2+}, SO_4^{2-} and Mg^{2+} in the irrigation water, but was never at levels too high for yields of most crops. Further research is still required to confirm these findings over a longer period, as well as investigate the local environmental impacts of this practice.

Power Plants

The estimated supply of water to power stations located in the Upper Olifants River catchment in 2010 was 228 million m3/a (625ML/d), and due to the poor quality of water in the Olifants catchment, all of this water is supplied from either the upper Komati or the Vaal Systems (Beumer et al., 2011). This adds strain on other crucial water systems, and supplemented water from the Olifants catchment in terms of treated MIW could remove a portion of this import requirement.

The MIW treatment plant could be tailor designed to send a high quality (low TDS) water specification to the power plants, so that extra treatment on their premises would not be necessary.

Municipalities

Emalahleni, as with most municipalities in South Africa, has the growing challenge of scattered informal communities within its area of jurisdiction, in some cases illegally (Coleman et al., 2011). In terms of the Water Services Act, 1997, the municipality is responsible for providing these communities with basic services, and these are currently served by means of water tankers. Witbank town is currently growing rapidly with residential developments covering the range from low- to high-income markets. The future growth of the town will be severely constrained without an additional source of water (Coleman et al., 2011).

Town/Community	Water Requirements (ML/day)			
	2007	2030	2050	Water Source
Witbank (Potable)*	81.4	160.6	195.9	Witbank Dam
Phola/Ogies (Potable)*	6.2	12.2	14.9	Witbank Dam
Highveld Steel (Raw)	22.0	22.0	22.0	Witbank Dam
Total from Witbank Dam	109.6	194.8	232.8	
Rietspruit**	3.0	3.8	4.6	Rietspruit Dam
Kriel/Thubelihle***	3.9	6.1	9.1	Usutu GWS
TOTAL	116.5	204.7	246.5	

*Note: *based on 3% population growth rate; ** 1% growth rate; ***2% (national average)*

Figure 3 *Projected water requirements for the eMalahleni local municipality (Coleman et al., 2011)*

Figure 3 above gives an indication of how the water demands are expected to grow. It should be noted that the requirements of Highveld Steel are now no more. If the current housing backlog is completed and supplied with full services, this demand water demand could increase by 25ML/d (Coleman et al., 2011), and would remove the current water freed up by the Highveld Steel closure.

Current estimates show that by 2030 there will be a shortfall of 83.3ML/d in the Witbank area (Coleman et al., 2011). There is a huge opportunity to make up some of this shortfall with water reclaimed from MIW decanting and storage areas.

Business Case

The initial feasibility investigation has taken the most recent build price for the Middelburg Water Reclamation Plant, and added inflationary effects, together with logarithmic six-tenths-factor rule relationships (Peters & Timmerhaus, 1980) to account for the upscaling of the potential facility to get an estimated capital price for a 35ML/d plant; which includes brine treatment, surrounding infrastructure and solid waste disposal facilities. This amounts to an estimated R 2.9 billion for the project.

Operational costs have been developed to account for chemicals, power, brine treatment, product distribution pumping and membrane replacements, as well as the fixed costs associated with the plant operation. These costs have been developed by using historical data from similar operational MIW treatment plants.

The business model will need to ensure that mines supplying water to the plant pay for the operational costs, as well as finance costs associated with the capital payback.

There is the added income that comes from sale of potable water (assumed to be at R7.00 per m^3), as well as the sale of high quality gypsum that the plant will produce, at R100/ton. With feed water similar to what is found in the Optimum region, this amounts to an income of R0.10/m^3.

The financial modeling involved looking into the requirements for capital spending over and above the plant construction, and includes; interest during construction, senior debt upfront fees, project development costs & success fees, and the working capital injection requirements which increases the total capex spend to just over R3.25 billion.

Outputs from the model show that mines in the region of the plant would be able to send mine water for treatment at an approximate rate of R36.50 per m^3 (depending on water quality from the individual mine), and this would account for the operational expenses as well as capital payback, while servicing the debt and providing a reasonable return on equity for investors.

The analysis is based on a 70:30 debt to equity split for the financing, and results in a 10.5 year equity payback, linked to a 12% ROE over the 20 year project life. Modeling ensured that debt repayment sculpting created debt service coverage ratios that show minimal risk associated with leverage.

Conclusions

This opportunity is hinged on the willingness and ability of the mines to send water to the regional plant. It will be required to meet with the stakeholders in the various mines to discuss this opportunity, with the aim of getting letters of intent signed for sending water to a MIW treatment facility. The interest shown in specific regions will help with the direction that the opportunity needs to be directed.

The costs associated with sending the water to a regional plant can be reasonably well defined, thus it will be crucial to discuss these costs with the potential MIW suppliers to get

Table 1. *Operational cost relating to 35ML/d facility*

Cost Component	Cost Per m^3	Cost per annum
Fixed Cost	R1.67	R 21 395 892
Variable Costs	R12.74	R 162 805 740
TOTAL	R14.42	R 184 201 632

letters of intent based on these costs. The investigation will then need to understand the optimal placement between various mines to ensure that pumping and pipeline costs incurred by the mine does not make the overall scheme unaffordable.

The financial model could always be tweaked to improve return on equity resulting from elevated risks associated with projects of this nature that require exceptional technical knowledge to consistently operate for 20 years. However, from an economic point of view, the return on equity should not as much of a concern due to the positive impact that a project such as this would give the local economy. These include the ability for mines to expand and operate in a more sustainable manner; farmers having access to larger quantities of higher quality water; and communities having access to high quality drinking water.

These project impacts, which encompass the financial, environmental and social benefits, can be delivered to ensure the triple bottom line approach to sustainable business is fulfilled.

Businesses that are designed to be 'future fit', cannot take a one-dimensional view of financial profits as the final decision factor. Projects such as this can ensure that financial profits are improved through social and environmental initiatives that create various spillovers into other industries, with the longer terms view of growing the economy, thus providing a more sustainable business ecosystem in which to operate.

Acknowledgements

The authors thank the IDC for all the assistance with guiding the financial modelling of the project

References

McCarthy TS. The impact of acid mine drainage in South Africa. S Afr J Sci. 107(5/6), Art. #712, 7 pages. doi:10.4102/sajs.v107i5/6.712

Maree JP, van Tonder GJ, van Niekerk AM, Naidoo C. The collection, treatment and utilization of water accumulated in the coal mines located in the Upper Olifants River catchement. Coaltech 2020, 2000.

Cogho VE. Optimum Coal Mine: striving towards a 'zero effluent' mine, Journal of the Southern African Institute of Mining and Metallurgy, 2012.

Coleman T.J., Usher B, Vermeulen D, Lorentz S, Scholtz N. Prediction of how different management options will affect drainage water quality and quantity in the Mpumalanga coal mines up to 2080. WRC Research Report No. 1628/1/11, 2011.

Beumer J, Van Veelen M, Mallory S, Timm D. Development of a reconciliation strategy for the Olifants River water supply system: Preliminary Reconciliation Strategy report, 2011

Peters MS, Timmerhaus KD. Plant Design and Economics for Chemical Engineers. McGraw-Hill, Third Edition. 1980