Implementing water conservation and water demand management in South Africa's mining industry

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Abstract

Water Conservation and Water Demand Management (WC/WDM) principles are vital for ensuring a sustainable water supply, especially in water-scarce regions like South Africa. To address this, the Minerals Council South Africa, in collaboration with Williams Sale Partnership Ltd. (WSP) and the Department of Water and Sanitation (DWS), has developed the Water Conservation/Water Demand Management Self-Assessment Reporting Tool (WSART) for South Africa's mining industry. This publicly accessible spreadsheet-based tool serves as a platform to implement WC/WDM principles in the mining sector, aligning with regulatory requirements.

The WSART encourages mining organizations to voluntarily report water balance data in a standardized format, facilitating a 5-year commitment to water management improvement. It plays a crucial role in formulating comprehensive water management strategies, aiding in understanding water demands and supply requirements. The tool promotes efficient water usage, water savings, and assesses fit-for-purpose water requirements, water re-use, and recycling efforts through the setting of targets. Successfully presented to mining industry stakeholders, the WSART is integral in driving sustainable water management practices, not only in South Africa but globally. It translates water balance results into WCWDM key metrics, facilitating a systematic approach to sustainable water management within the mining industry.

Keywords: Water Conservation and Water Demand Management (WC/WDM), sustainability, mine water use, water efficiency, mining hydrology, water management, water stewardship

Introduction and Background

The scarcity of water has the potential to substantially influence businesses, environmental conditions, water pricing, and economic policies. In South Africa, the mining sector holds a prominent position as a key driver of the nation's economic growth and is notably reliant on a stable water supply. The fundamental principles of water conservation and water demand management (WC/WDM) are crucial for ensuring a sustainable water supply in regions facing water scarcity, such as South Africa. Therefore, it has become imperative to integrate these principles and ensuing measures into the water management practices at mining sites. With a dedicated focus on this objective, The Department of Water & Sanitation (DWS) working in collaboration with the Minerals Council South Africa and WSP commissioned a project to undertake the "Setting of Water Conservation and Water Demand Management (WC/WDM) Targets for the Mining Sector" (DWS 2016a). This project has been undertaken with the active participation and involvement of both the DWS and a wide range of stakeholders from the mining sector.

An in-depth literature review conducted for the project highlighted that no country globally had established definitive and enforceable Water Use Efficiency (WUE)

targets for the mining sector (DWS 2016a). The complexity of site-specific water variables was identified as a challenge, making it impractical to set national WUE targets. It was recognized that the accuracy and reliability of water balances at mines varied, requiring standardization before establishing accurate baseline conditions for WUE target setting. Australia, a leader in WC/WDM in mining developed the Water Accounting Framework (WAF) with this in mind. This standardized reporting system for water balance information in mines serves as a precursor to potential national or sector-specific WUE targets, with implementation overseen by the Australian Minerals Council (DWS 2016b).

The project adopted the Australian approach to better define water WC/WDM in South Africa's mining sector resulting in the development of a Standardized Water Accounting Framework (SWAF) which is defined as a prescriptive procedure/framework whereby the mine submits a WC/WDM plan (including water balance information, targets, and management actions) and annual WC/WDM performance report to the DWS, as the national water regulator for a defined period. The identification of which water use indicators should be used to guide WC/WDM in the South African mining industry is based on the outcomes of the literature review and the inputs received from the mining and regulator stakeholders that have provided inputs into the project.

The initial phase of the project led to the conclusion that it would not be scientifically or legally justifiable to establish national Water Use Efficiency (WUE) targets applicable to all mines across diverse commodity groups (DWS 2016b). Hence, an alternative process was developed to support the mining industry improve water management practices by:

1. Defining appropriate WUE for the mining sector.
2. Determination of national WUE benchmarks for each commodity group.
3. Development of an implementation methodology that provides technical guidance to mines as to how they should develop a mine-specific WC/WDM plan that includes mine-specific WUE targets.
4. Provision for a mine to report on its performance against its WC/WDM plan in a standardised on-line format is designed to integrate with the mine's water use licensing reporting requirements.
5. Development of regulatory procedures that recognise progress with the development and rapid implementation of mine's WC/WDM plans towards an improved WUE status.

The provision under item four above led to the development of a prototype 'online' tool which standardizes the manner in which water balances are reported to regulators and provides a structured approach for the implementation of WC/WDM in the mining sector. The aptly titled 'Water Conservation/Water Demand Management Self-Assessment Reporting Tool' (WSART) operates on a spreadsheet-based platform and is publicly available for voluntary use by mining organisations. Although the initial deployment of the prototype tool is in its early stages, it establishes a basis for subsequent enhancements with the overarching goal of transitioning the tool to a fully accessible online platform in the future. The WSART has been presented to respective stakeholders of the mining industry and training has been rolled-out by the Minerals Council SA, the DWS, WISA (Water Institute of South Africa) and WSP to create further awareness and encourage the use of the tool industry.

Principles and objectives of the WSART

The fundamental principles and objectives guiding the development of the SWAF and applicable to the WSART are outlined as follows (Minerals Council SA, 2020):

- Ensure uniformity, simplicity, and predictability in reporting on WC/WDM plans and their implementation across mines.
- Introduce a standardized spreadsheet format enabling individual mines to report on their WC/WDM plans and track performance in plan implementation.
- Provide mines, mining groups, and the Minerals Council SA with reliable data

on WC/WDM plans, WUE indicators, and progress, facilitating benchmarking within mining groups, commodity groups, or the mining sector as a whole.

It is essential to note that participation in the voluntary use of the spreadsheet WC/WDM reporting tool is encouraged for individual mines across South Africa. This encouragement is motivated by the desire to ensure accurate calculation of WUE indicators and to facilitate integration with an online DWS system in the future.

Development and Key Features of the WSART

WSART was developed on the MS-Excel Visual Basic Application software platform. The advantages for using the MS-Excel platform to develop the prototype tool is the ease of coding and a user friendly and familiar user interface. The tool uses MS-Excel to capture the site description, mining details and water balance results as inputs into the tool. The input pages were structured as spreadsheets where users can input the key data required. Throughout the tool, links are provided to navigate across the different input spreadsheets. Water balance information is entered separately for different pre-defined generic mine "sections". These include the mining operations, mineral beneficiation operations, residue disposal operations and the "other" supporting operations such as administrative services, sewage treatment and other auxiliary services grouped together.

The data collated above is processed in the following steps of the tool. the data is categorised into the streams and sectors. The information undergoes further processing to provide key metrics, such as water use efficiency, water recycling and levels of data accuracy, to assess a mine sites WC/WDM position. Mines are encouraged to enter their water balance data into this standardised format for in order that the calculation of key water use indicators is calculated.

A critical component of the tool is the development of the WC/WDM plan. This plan Is set up in the WSART as a series of spreadsheets capturing the activities the end-user commits to as part of their 5-year commitment to improving water management on site. The tool has a systematic process to capture the WC/WDM targets over the 5 years, preventing targets to be altered post-entry. This was developed to ensure that users cannot manipulate their targets (without record) once initially entered into the software reducing the risk of false WC/WDM reporting.

Reporting functionality has been built into the tool allowing users to view and analyze the input data, WC/WDM Plan and water metrics results in a structured and meaningful format. This allows for consistent comparison between different mines, commodities, and regions. The reports are presented as tables and graphs within the MS-Excel platform. The reports include volumes of water, water quality classes (pre-defined and relating to the ease of reuse of water on site) and accuracy statements (indicating whether the reported data has been measured, calculated, modelled, or estimated). Reported flows can include notes to provide site-specific contextual data or information that is relevant to the interpretation of the reported data and the calculated water use indicators. Export functions in the WSART allow users to save or export data, files, or information from the software application to external formats or locations.

Although derived directly from the mine water balance, it is important to note that the WSART is not designed to substitute the individual mine water balance utilized for operational water management at the mine level. Typically, the mine water balance is more comprehensive and includes substantially more detailed information than what is necessary for the WSART and WC/WDM reporting objectives.

While MS-Excel is a strong platform for the requirements of the WSART, challenges were encountered, making MS-Excel less favorable to advance the development of the tool to its next stage. These include long-processing and run times, limited user-friendliness and issues running as an online tool.

Implementation of the WSART

The WSART relies entirely on the development of a water balance for a mine site. In South Africa, all mines are required

to develop accurate and computerised water balances (DWS 2016b). The level of detail in the balances must, as a minimum, support the information requirements of the SWAF (DWS 2016b). In order for a water balance to be suitable for the development of a WC/WDM plan, it is critical that the computerised water balance is capable of being run in a simulation or predictive mode, where alternative WC/WDM measures and environmental conditions (rainfall/drought) can be simulated in terms of their expected effect or effect on the mine's water use efficiency indicators. The water balance should follow a similar format and include the streams shown in Fig. 1 below.

Developing Water Use Efficiency Targets

The procedure to be followed when mines develop water use efficiency targets is fully described in the DWS WC/WDM Guidelines for the Mining Sector in South Africa (DWS, 2016b). The broad steps set out in the WC/WDM guideline are based on three-phases:

1. Assessment of current WC/WDM status for the site.
2. Planning for WC/WDM measures and opportunities.
3. Implement and manage WC/WDM measures and mine water system.

These steps facilitate the establishment of WC/WDM targets specific to the company, aligning with industry standards and water management objectives. These targets, along with baseline WUE values, are compared to industry benchmarks. The tool makes provision to capture these targets and supports the development of the accompanying WC/WDM plan, which is a series of identified actions to improve the water management on site, with the aim for meeting the WUE targets set. Once the targets have been determined, the user follows a systematic approach to compiling the data into the WSART.

Procedural Steps to Use the WSART

The different steps in the tool for development of the 5-year WC/WDM plan is listed below (Minerals Council SA 2020). The accompanying WSART user manual systematically documents the procedure in greater detail (Minerals Council SA 2019):

1. This initial step enables mine personnel to collect pertinent data relevant to the water balance of the site. The level of detail in data collection can vary, ranging from a simplified to a more detailed approach.

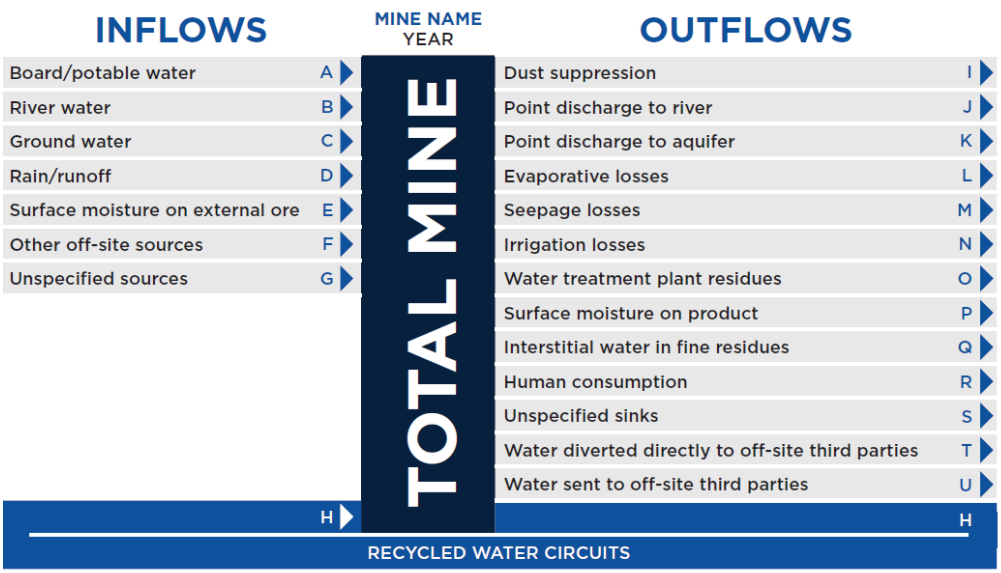

Figure 1 Standardized water balance structure with associated streams (Minerals Council SA, 2020)

2. The tool utilizes the gathered inputs to construct a standardized water balance for the mine site.), calculating baseline water use efficiencies for the mine site.
3. Allows the mine to set WC/WDM targets based on company-specific standards and water management goals. These targets and baseline WUE values are compared to the industry benchmarks.
4. Based on the baseline outcomes and the set targets, a site-specific WC/WDM plan is formulated within the mine's prescribed timelines and budgets. The efficacy of the WC/WDM plan is evaluated by comparing WUE values with those of previous years, the predetermined targets, and the industry benchmarks.
5. Subsequently, a comprehensive review and update of the WC/WDM plan occurs, taking into account the revised water balance resulting from the implementation of selected WC/WDM initiatives. Annual updates to the water balance and WC/WDM can be conducted based on results or management changes within the mine.

This process is represented graphically as shown in Fig. 2.

The reports generated are graphically presented in the WSART from the comprehensive water data collected and calculations through the process. This approach ensures that the information presented is not only accurate but also easily comprehensible for the user. The utilization of summarised data allows for a transparent interpretation of the results, enabling high-level evaluation of the performance in WC/WDM over the plan's lifespan. Some artificial key results, for the purpose of demonstration, are provided from the WSART shown in Figs. 3 and 4 below.

Conclusions

The WSART plays a pivotal role in formulating a comprehensive water management strategy for mining operations, aiding in the understanding of water demands and supply requirements. It assists in identifying various initiatives to enhance water management, promoting efficient water usage and resulting in water savings. Notably, the tool facilitates the assessment of fit-for-purpose water requirements, levels of water re-use, and recycling efforts. The WSART has been presented to respective

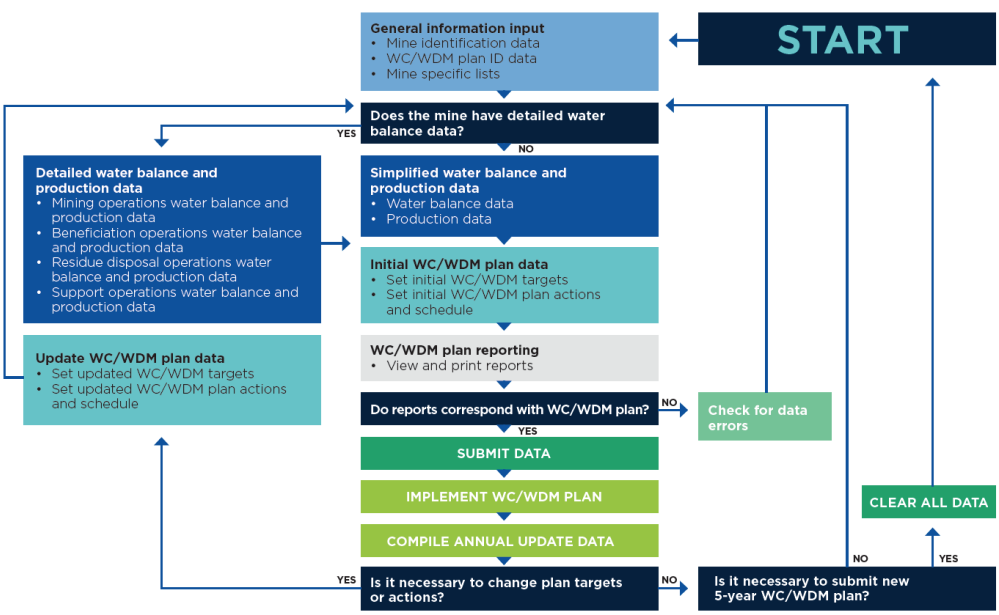

Figure 2 Workflow procedure to conducting a five-year WCWDM plan (Minerals Council SA, 2020)

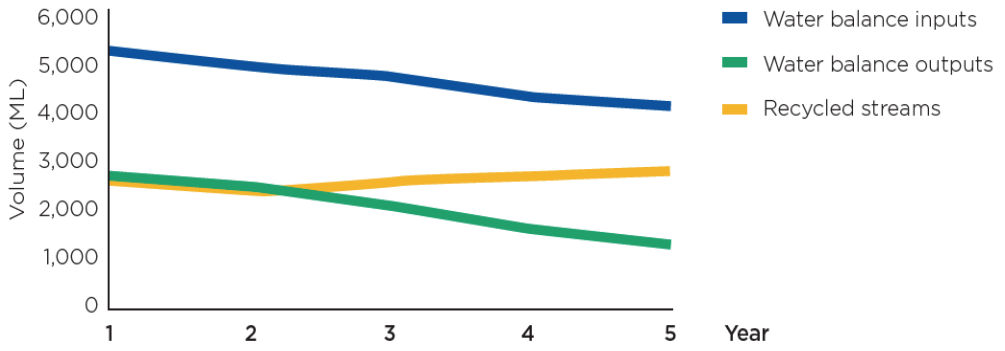

Figure 3 *WSART Water balance inputs, outputs and recycle streams (Minerals Council SA, 2020)*

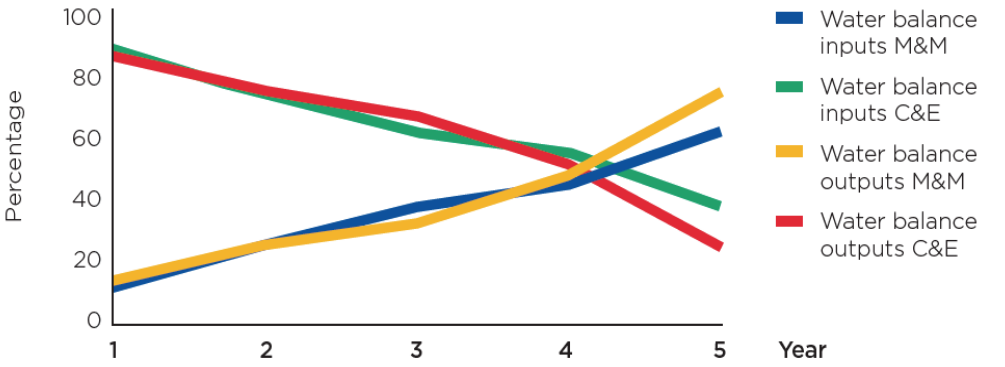

Figure 4 *WSART Water balance accuracy trends (Minerals Council SA, 2020). C&E are calculated and estimated data sources whereas M&M are modelled and measured data sources as inputs into the WSART*

stakeholders of the mining industry and has been well-accepted. It offers a standardized water accounting framework and reporting system, encouraging mining organizations to voluntarily record their water balance data in a consistent and standardized format.

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