ENGINEERING

HARMONY SAVUKA WATER BALANCE

GOLDEN CORE TRADE AND INVESTMENT (PTY) LTD

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WATER BALANCE REPORT

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EXECUTIVE SUMMARY

Eco Elementum (Pty) Ltd (Eco E) was appointed by Golden Core Trade and Investment (Pty) Ltd to perform an update to the Water Balance (WB) model in the study area (Savuka Operations). Gold mining at the Mponeng Operations, formerly known as the West Wits Operations, commenced in 1958. The Mponeng Operations comprise three deep-level mines: Mponeng, Tau Tona and Savuka. Among these, Mponeng is the deepest mine in the world, reaching a depth of 3,891 meters below datum and 2,062 meters below sea level (mbsl).

The update is conducted to ensure that the mine is still compliant with the existing Water Use License (WUL). According to the Department of Water Affairs and Forestry's (currently known as the Department of Water and Sanitation) Best Practice Guideline (2006, p.1), the water and salt balance models are undertaken to determine the following:

- To assist with the storage requirements and to ensure that dirty water containment facilities are still compliant to contain all dirty water inflows and to prevent any chance of the system spilling more than once in 50 years.
- To provide the required information to aid in the development and implementation of water management strategies.
- To assist in the decision-making process for water management by simulating and analysing various water management options prior to implementation.
- To identify and quantify excessive water consumption or waste locations, as well as pollution sources. When the balances are utilized as an auditing and assessment tool, seepage and leakage spots can also be found and quantified.

Following the findings and the results of the water balance model, it is clear that:

- The total capacity for dirty water containment on site is approximately 414,558 m^3, however, due to the dams being silted up, the mine loses approximately 30% of its total capacity to contain dirty water on site.
- Excess water in the SWD and RWD is at risk of overflowing into the downstream environment (with the dam's current silted capacities), with the potential to degrade the surface and groundwater qualities of surrounding areas as the dams do not have adequate storm buffer capacity due to siltation.
- The North RWD and SWD need to be de-silted to ensure compliance with the requirements as contained in the NWA, Regulation no. 7 of 1999 (GN 704).
- The capacity of South RWD (29,313 m^3) is required at Savuka to allow for maximum storage capacity and plays a vital role in ensuring that none of the dams surpass its full supply level more than once in 50 years.

- The following capacities for the RWDs and SWD would be sufficient to contain all dirty water inflows without the dams spilling more than once in 50 years:
  - North RWD = 35,245 m^3.
  - South RWD = 29,313 m^3
  - SWD = 350,000 m^3.

The table below summarises the average flows for the Savuka Operations where the dams are silted and for a simulation where the dams are restored to their full capacity:

Table 0-1: Savuka Water Balance Summary (Mℓ/day)

Source	Destination	Silted Dams (Mℓ/day)	Desilted Dams (Mℓ/day)
White Tanks	Domain 3 Tanks	3.47	3.47
White Tanks	Savuka Plant	4.24	4.24
Domain 3 Tanks	TSF L19	7.18	7.15
TSF L19 – Dormant TSF	Savuka Plant	8.82	8.82
TSF 5 & 7	Return Flow	3.89	3.78
RSWD Complex	Domain 3 Tanks	3.71	3.68
TSF 5 & 7	Interstitial Storage	4.78	4.78
Entrained Tailings	TSF L19 – Dormant TSF	1.79	1.78
TSFs	Seepage	1.43	1.40
Savuka Plant	Water in Tailings	12.22	12.22
RSWD Complex	Overflows	**0.15**	0.00

CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

ABBREVIATION	TERM
AEP	Annual Exceedance Probability
AWBM:	Australian Water Balance Model
CLR	Carbon Leader Reef
HGM	Harmony Gold Mining Company Limited
IWUL:	Integrated Water Use License
LOM:	Life of Mine
MAE:	Mean Annual Evaporation
MAP:	Mean Annual Precipitation
MBSL:	Meters Below Sea Level
MWP:	Mine Works Plan
NWA	National Water Act
PFD:	Process Flow Diagram
ROM:	Run of Mine
RWD:	Return Water Dam
RSWD:	Return Storm Water Dam
SWD:	Storm Water Dam
TSF:	Tailings Storage Facility
WB:	Water Balance
WMA:	Water Management Area
WUL:	Water Use License

REFERENCED DOCUMENTS

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KEY PROJECT INFORMATION

Table 0-2: Project Information

PROJECT	Harmony EoR Savuka – Water Balance
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1 INTRODUCTION

1.1 Activity Background

Eco Elementum (Pty) Ltd was appointed by Golden Core Trade and Investment (Pty) Ltd to perform an annual update for the Water Balance model in the study area (Savuka Operations). Gold mining at the Mponeng Operations, formerly known as the West Wits Operations, commenced in 1958. The Mponeng Operations comprise three deep-level mines: Mponeng, Tau Tona, and Savuka. Among these, Mponeng is the deepest mine in the world, reaching a depth of 3,891 meters below datum and 2,062 meters below sea level (mbsl). The mine is located on the northwestern margin of the Witwatersrand Basin in South Africa, which hosts one of the world's most significant gold deposits. The Carbon Leader Reef (CLR) at Tau Tona is extracted via the Mponeng Shaft, which is the sole operational shaft within the Mponeng Operations. In 2017, closure procedures began for the Savuka and Tau Tona mines (Agreenco, 2023).

The update is conducted to ensure that the mine is still compliant with the existing Water Use License (WUL). According to the Department of Water Affairs and Forestry's Best Practice Guideline (2006, p. 1), the water and salt balance models are undertaken to determine the following:

- To assist with the storage requirements and to ensure that dirty water containment facilities are still compliant to contain all dirty water inflows and to prevent any chance of the system spilling more than once in 50 years.
- To provide the required information to aid in the development and implementation of water management strategies.
- To assist in the decision-making process for water management by simulating and analysing various water management options prior to implementation.
- To identify and quantify excessive water consumption or waste locations, as well as pollution sources. When the balances are utilized as an auditing and assessment tool, seepage and leakage spots can also be found and quantified.

1.2 Locality

The Savuka Tailings Storage Facility (TSF) is owned and operated by HGM, and its active compartments are utilised by Savuka Gold Plant. The Savuka Plant forms part of the HGM Wes Wits Operations in the West Rand area and is situated approximately 9 km southwest of Carletonville in the Gauteng Province within the Merafong City Local Municipality and West Rand District Municipality. The locality of the site is shown in Figure 1-1.

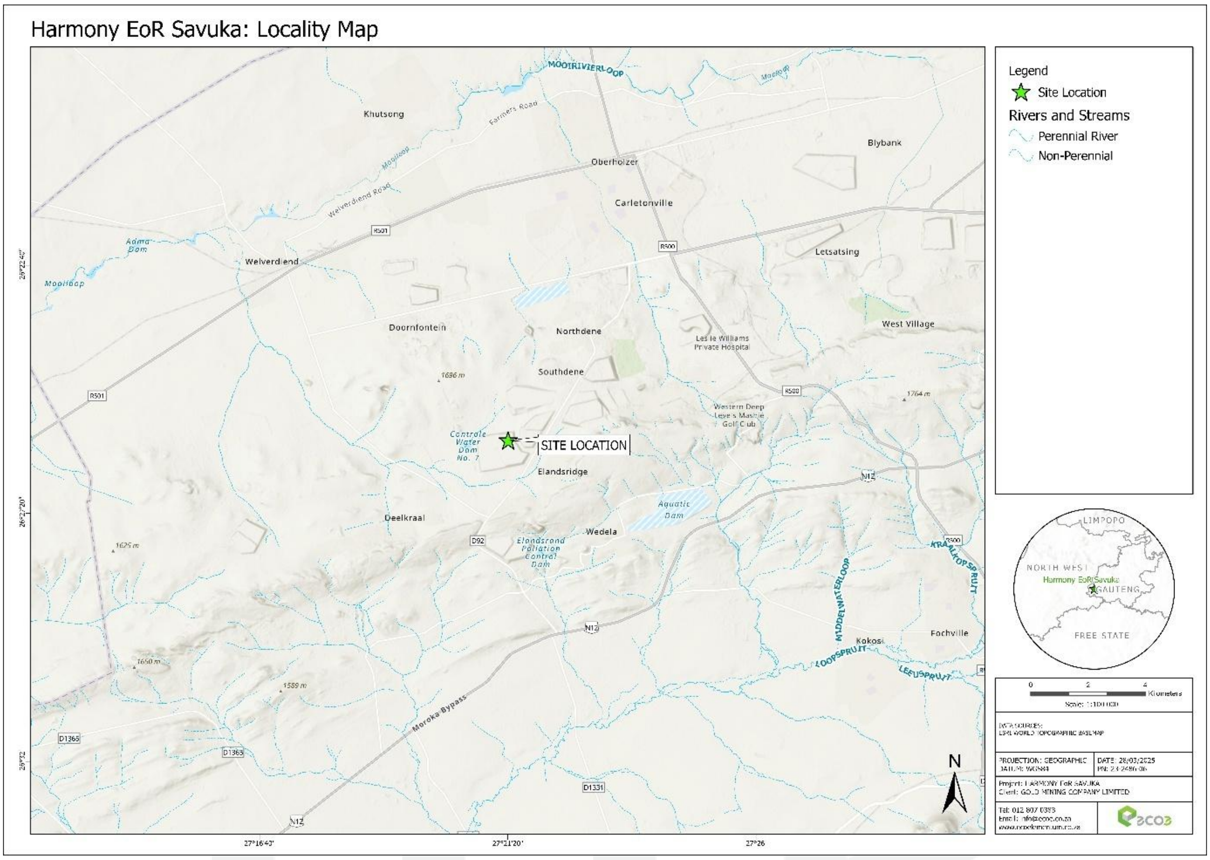


Figure 1-1: Locality Map

2 DESCRIPTION OF THE CURRENT ENVIRONMENT

2.1 Water Management Area – Locality and Physical Characteristics

The Savuka Section falls within the Upper Vaal Water Management Area (WMA), and more specifically within the southern region of the C23E quaternary catchment. The site will naturally drain into unknown non-perennial tributaries of the Mooi River, a tributary of the Vaal River. The position of the site relevant to the quaternary catchment is shown in Figure 2-1.

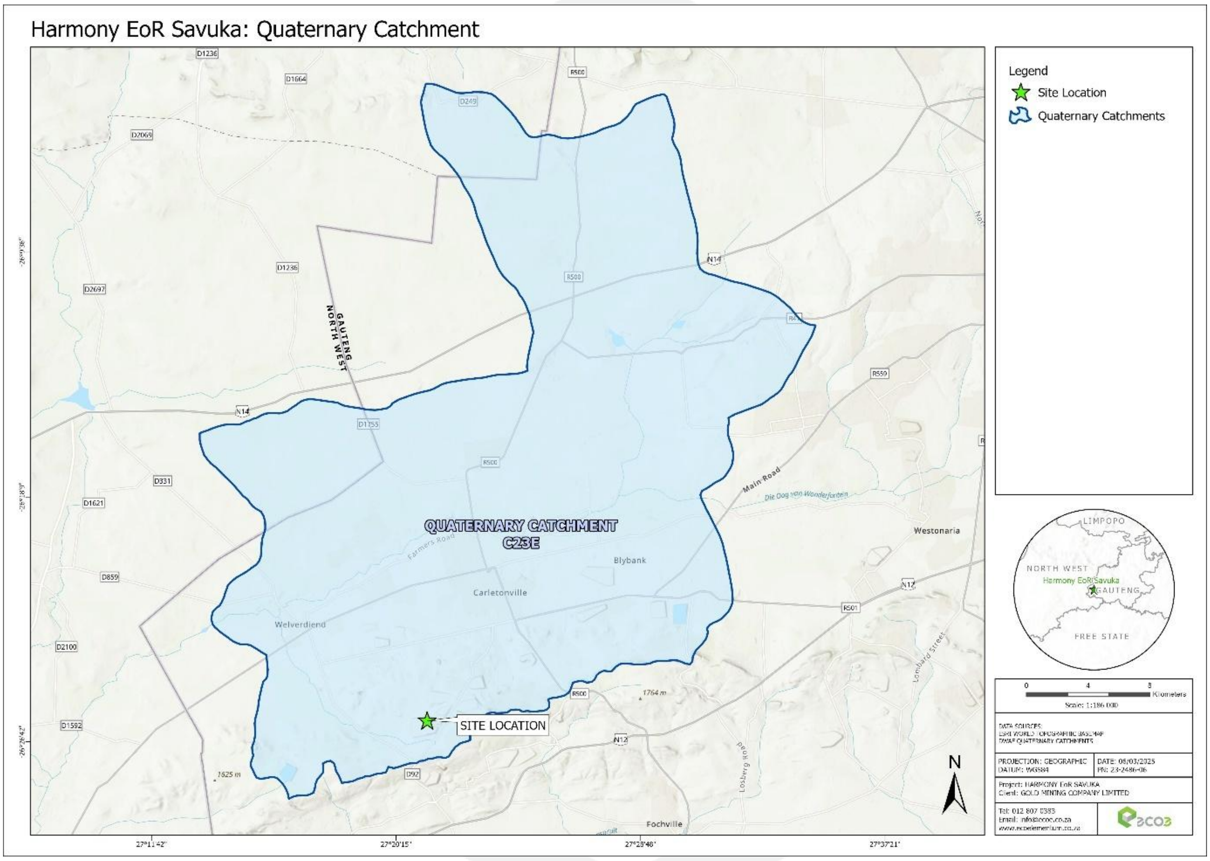


Figure 2-1: Quaternary Catchment C23E

3 CLIMATIC CONDITIONS

3.1 Rainfall and Evaporation

The Savuka operations fall within the summer rainfall region of South Africa, which is warm temperate, with cold dry winters and warm summers. The summer rainfall is sporadic, with frequent thunderstorms, associated with high-intensity rainfall events.

The Blyvooruitsig (GM) Weather Station (0474684_W) is the closest station (6.5 km) to the study area with extremely reliable (97%) and long-term (59 years: 1941 – 2000) historic rainfall data that correlates with the recorded rainfall readings. The Mean Annual Precipitation (MAP) at this weather station is 705 mm per annum. Daily rainfall depths were extracted using the daily rainfall data extraction utility developed by Richard Kunz, from the Institute for Commercial Forestry Research (ICFR), in conjunction with the School of Bioresources Engineering and Environmental Hydrology (BEEH) at the University of KwaZulu-Natal, Pietermaritzburg, South Africa. This utility will assist the user in extracting observed and infilled daily rainfall values from a database that was developed by Steven Lynch during a Water Research Commission (WRC) funded research project (K5/1156) awarded to BEEH. The project, titled "The development of a raster database of annual, monthly and daily rainfall for southern Africa", was completed in March 2003.

Evaporation data was obtained from the closest DWS meteorological station (C2E009). Moderately high levels of evaporation occur in the area. The maximum evaporation rate occurs from October until January, with a mean rate of 6.4 mm per day. Evaporation is greater than rainfall for all months of the year resulting in a marked moisture deficit in the region. The average rainfall and average evaporation figures are shown in Table 3-1.

Table 3-1: Summary of Rainfall and S-Pan evaporation data

Month	Mean Precipitation (mm)	Mean Evaporation (mm)
January	115.8	188.4
February	98.6	159.8
March	91.7	147.8
April	60.7	114.4
May	20.2	95.4
June	9.0	76.6
July	5.6	85.3
August	6.9	119.7
September	20.6	160
October	71.9	186.9
November	97.7	189.9
December	106.0	198.7
Mean Annual Total	**705**	**1 723**

3.2 Historical Site Rainfall

Historical monthly rainfall data for the study area is available and will be incorporated into the calibration of the water balance model. This dataset provides long-term records of precipitation trends, enabling a comprehensive understanding of seasonal and interannual variability. The data will be analysed to identify wet, dry, and average conditions, ensuring the model accurately reflects real-world hydrological conditions. The dataset over the 17-year period spans from January 2008 until the present date.

Table 3-2: Summary of Site Rainfall (Savuka)

Month	Mean Precipitation (mm)
January	154.8
February	147.6
March	105.6
April	75.9
May	28.4
June	11.5
July	5.8
August	5.9
September	16.9
October	58.1
November	99.2
December	170.2
Mean Annual Total	**880**

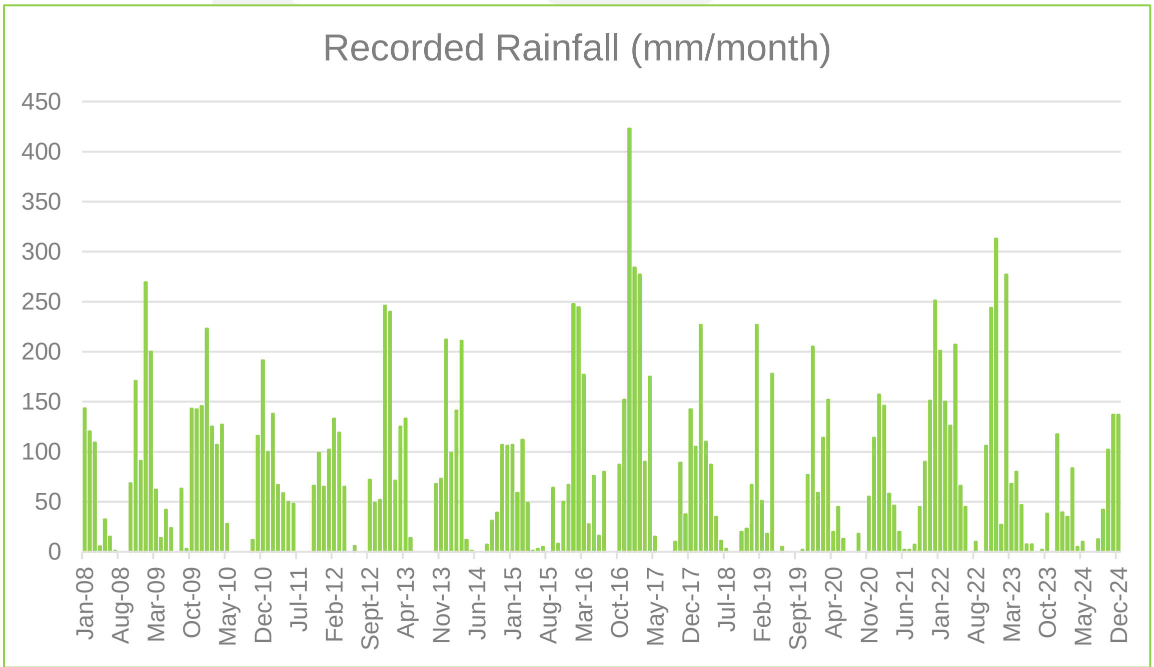


Figure 3-1: Recorded Rainfall - Savuka

4 WATER BALANCE MODEL – MODEL COMPONENTS

The formulation of the water balance model was done to determine if the dirty water management systems are sized adequately to accommodate all dirty water inflows without the existing facilities spilling more than once in 50 years. The model was designed to provide the necessary data to assist in the decision-making process for water management, as well as to determine and quantify excessive water consumption or waste locations, including pollution sources. Additionally, the water balance model was conducted to ensure that the mine complies with the requirements as contained in the NWA, Regulation no. 7 of 1999 (GN 704).

4.1 Model Overview

The water balance model is a continuous stochastic model formulated using the GoldSim simulation software package. Figure 4-1 illustrates the interface, as well as, an overview of the main elements used in the GoldSim Software for Savuka. GoldSim water balance models utilize a Monte Carlo simulation engine to assess the current operational functionality of the system against multiple potential future outcomes and try to quantify the potential risks associated with the different water management scenarios.

The core of a water balance model usually includes the formulation of a deterministic model in which the various components are represented by the aid of using averaged values of the system variables. When real-time and measured data is not available for the various site-specific operations at hand, the averaged values can be defined based on assumed values from similar operations. All these respective system element variables, that form part of the water balance cycle, will then be simulated over predetermined time steps to indicate how the overall system will operate.

However, due to the probabilistic nature of the hydrological and processing plant water requirements, and using their averaged values, limits the accuracy and usefulness of the model outputs. Monitoring data can give an incomplete and sometimes vague account of the past. It is therefore only valid, and representative of the water system monitored in the past, and of the climate sequence that occurred during that specific period.

The use of the stochastic model gives the capability to simulate the model components that were not monitored. The system can also be tested against the different climatic events that could potentially be encountered (dry spells, wet spells, extreme storm events, etc.) and the expected timing of these events throughout the simulation.

The quantification and likelihood of these events occurring during the design life of the system at hand will greatly contribute to ensuring the system meets the design criteria and the constraints from the regulatory approval procedures.

Figure 4-1: Goldsim Interface for Savuka Water Balance Model

The water balance model will include / incorporate the following focus areas:

- Tailings Storage Facilities (TSFs).
- Return Water Dams (RWDs).
- Storm Water Dam (SWD)
- Dirty Water Dams / Tanks.
- Wash Plant.
- Plant Sewage.
- Dirty runoff areas (Waste Rock Dump and Side Walls).

According to the latest IWWMP (Agreenco, 2023), the Savuka TSF comprises of the Compartments 5A, 5B, 7A and 7B. Final treated pulp residue from the Savuka Gold Plant is pumped to the Savuka (New North) TSF where the solid particles settle out onto the tailings dam. Water is decanted using the penstocks at the centre of the facility and is piped into the return water dams (RWDs). The water in the RWDs is pumped back to the plant as process water via the Domain 3 Tanks. Excess water in the RWDs will be pumped to the Storm Water Dam (SWD).

The plant sources water from the dormant TSF (L19), which receives majority of its water from the Domain 3 tanks. Additional water at the plant is sourced from the White Tanks that obtain water from the nursery dams (North Boundary Complex).

The main components of the water balance model will include:

- Rainfall generator model: Stochastic rainfall generation based on historic local rainfall patterns.

- Catchment model: Run-off and recharge simulation of the various dirty water areas.
- Water use model: The allocation of collected dirty water.
- Pond model: The storage and transfer of water from the containment facilities (RWDs).

4.2 Water Reticulation

Information supplied by the Client included the water reticulation components for the operation at the Savuka Section. Figure 4-2 illustrates the water reticulation for the Mponeng and Savuka operations (supplied by the client). Additional information was obtained from a monthly water balance conducted by Harmony. There were some imbalances noted and due to the lack of updated and missing data, some of the modelling parameters were based on assumptions. These assumptions include and are not limited to:

- The North RWD and SWD were presumed to be silted up by roughly 30% (A bathymetric survey should be conducted to accurately determine the dam's silted capacity, and the as-built information of the Surface Dams should be sourced to ensure that the model can be updated accordingly).
- All runoff from the TSF side walls and surrounding areas will be conveyed to the SWD via trenches.
- Excess water in the RWDs was pumped to the SWD to manage the water levels in the RWDs.
- To meet the plant's top-up demands, water was sourced from the SWD during extremely dry conditions.
- There is approximately 1,785.3 m^3/day of water contained in the reclaimed tailings.
- Currently the dams are operated at their maximum capacity, however, this would likely lead to numerous spillage occurrences in the simulation model from the dams.
- The operating levels of the dirty water containment facilities kept the RWDs and SWD at roughly 5% of their current capacity in the water balance model to avoid spills.

It should be noted that minimal information was available with regards to the operating levels, a minority of the pump transfer rates (transfer from the RWDs to the SWD) and most of the control philosophy was based on approaches followed at similar mining operations. The accuracy of the water balance model is, therefore, directly related to these assumptions and if additional and more up to date information becomes available, the water balance model should be updated accordingly.

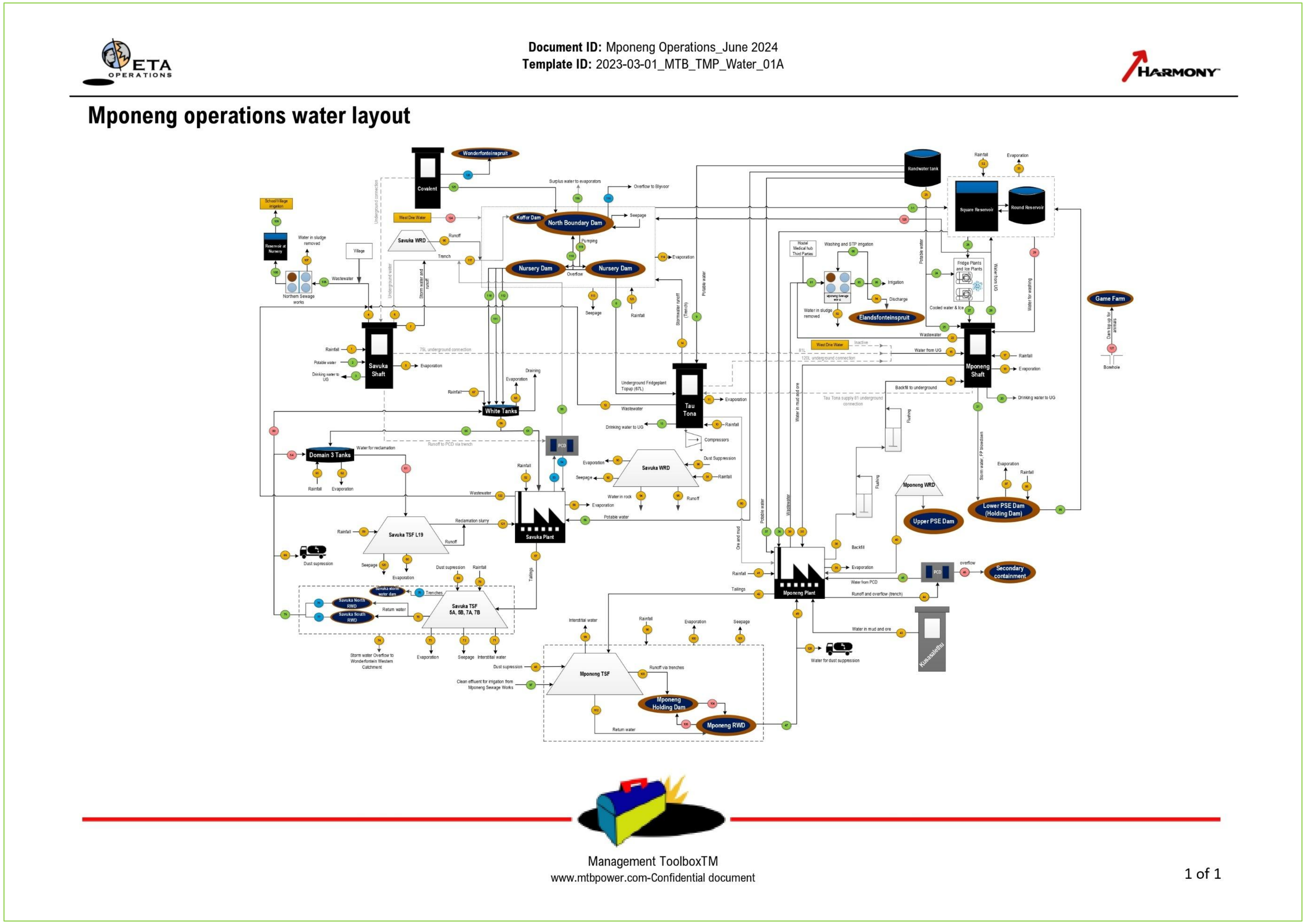


Figure 4-2: Water Reticulation – Mponeng operations water layout (ETA Operations, 2024)

4.3 Rainfall-Run-Off Generator

The available historical rainfall data, for any area of interest, gives a representation of the past rainfall patterns that took place, but limited information regarding the risk of droughts or flood-like activities can be obtained from this data. To ensure that the current dirty water management system is evaluated against a whole range of different rainfall sequences and recurrence intervals, a stochastic rainfall generation model will be implemented in the GoldSim water balance model.

The stochastic rainfall generator is based on Boughton's model (Boughton W.C., 1999). This specific rainfall generation model can generate annual, monthly, and daily simulated rainfall sequences that statistically correlate to the historical observed rainfall data.

The selection of station 0474684_W is made since this is the closest station to the study area with a near-perfect reliability record and minimal patched data (patching of rainfall data requires filling in the missing data with data from nearby stations based on statistical rainfall parameters).

4.4 Storm Water Run-Off Criteria

The Australian Water Balance Model (AWBM) was used to determine the expected run-off and recharge volumes from rainfall in the study area (Figure 4-3). This specific run-off model is non-linear, and the assumption made, is that the expected volume of run-off will be lowest during periods of low rainfall. This is due to the initial rainfall first saturating the ground surface by infiltration. Following the saturation of the ground, less water will infiltrate the ground and will thus generate more run-off.

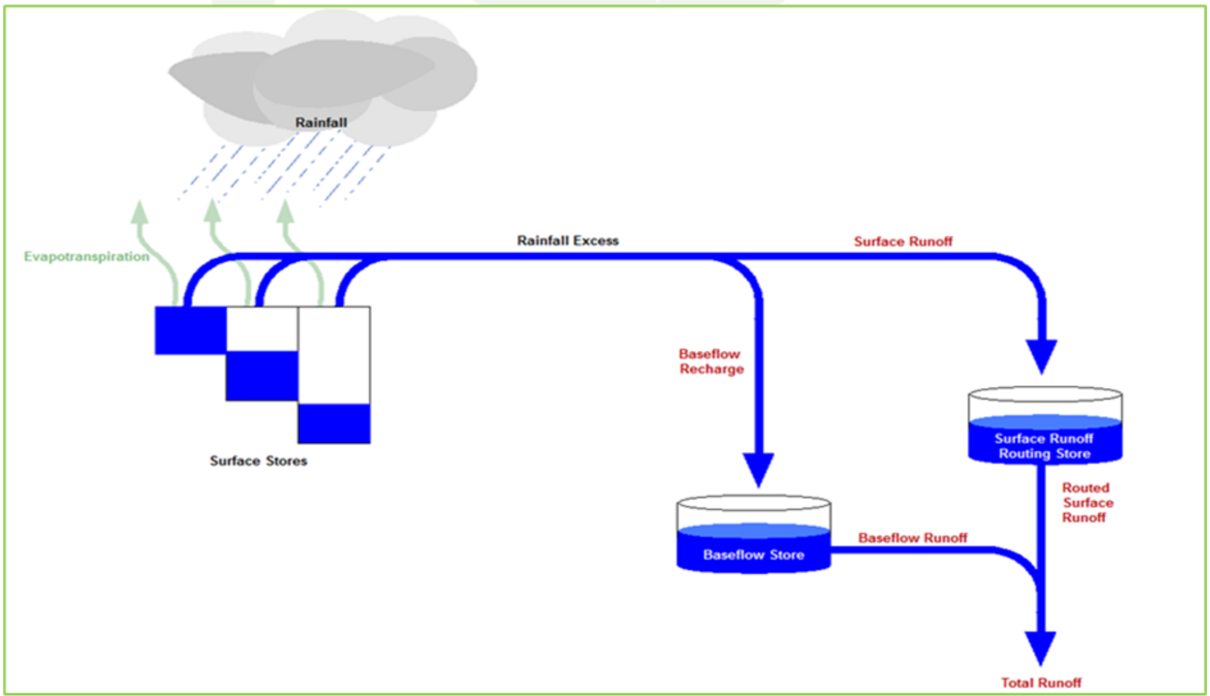


Figure 4-3: Structure of the AWBM (Goldsim)

The non-linear model comprises of a range of conceptional containers that represent the surface storage capacity of the catchment. As mentioned earlier as soon as these surface stores become saturated the catchment area will start generating run-off. The generated run-off is divided into surface run-off and baseflow. A portion of the baseflow contributes to groundwater recharge.

All the different dirty water run-off areas were divided into catchment specific areas to be applied accordingly in the run-off calculations (Figure 4-4). Table 4-1 provides a summary of the different footprint sizes of the various run-off areas and their downstream dirty water containment system where the run-off water will be captured.

Table 4-1 Run-off areas

Description	Area (m^2)	Containment Area
TSF Side Slope 5 (Purple Areas)	261,472	SWD
TSF Side Slope 7 (Purple Areas)	490,053	SWD
Undisturbed Surrounding Area (Green Areas)	672,700	SWD
Wet and Dry Beach TSF 5 & 7	1,237,817	TSF 5 & 7 Pool
Wet and Dry Beach TSF L19	213,965	TSF L19 Pool

Figure 4-4: Savuka TSF 5A, 5B, 7A, 7B and SWD Dirty Water Catchment (Google Earth, 2025)

4.5 Dam Model

The GoldSim software provides a “Pool” element (dam) that calculates the additions and withdrawals into the pool element by computation of the Euler integration method, based on the specific demands of the mentioned pool element. This element will be incorporated to solve the water balance of the dirty water containment entity (Void) in the water balance model. The conceptual schematic of the Void is shown in Figure 4-5.

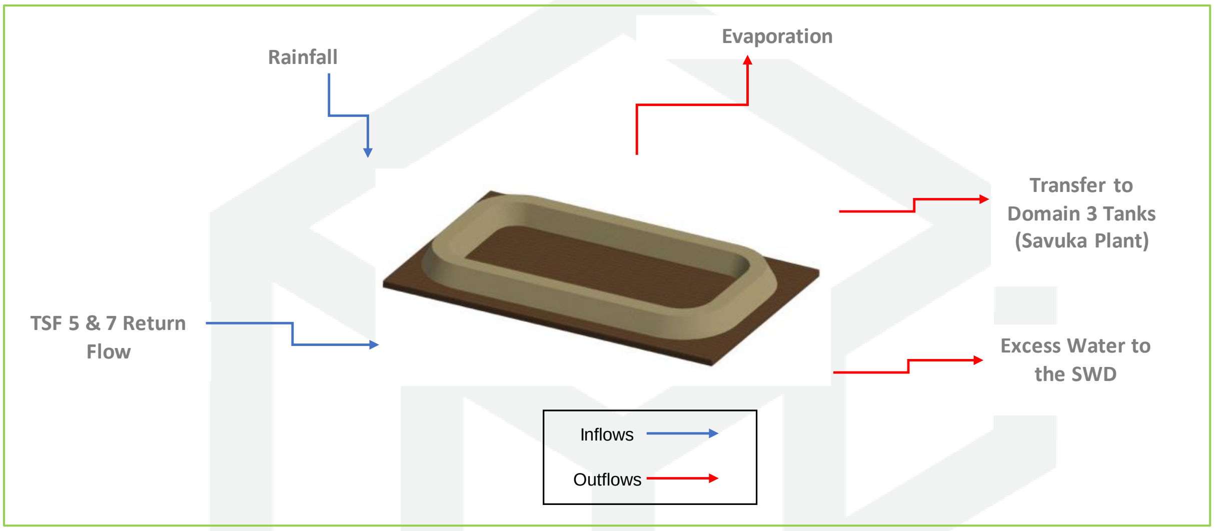


Figure 4-5: Conceptual illustration of the North RWD

Typical inflows into these elements will usually include:

- Direct Rainfall.
- TSF Return Flow.

Typical outflows into these elements will usually include:

- Evaporation (surface of the body of water).
- Water Transferred to Savuka Plant (Domain 3 Tank).
- Excess Water pumped to SWD to manage water levels in the RWD.
- The RWD will need to be a lined facility that will not have any seepage outflows according to the requirements of GN704.

4.6 Flow Meter Records

Flow measurement on all the main dirty water transfer pipelines is done on a monthly basis on-site and this flowmeter data indicated the average pumping rates, as well as, the maximum possible pumping rates that can be achieved. These pumping rates will be applied in the water balance model. All the maximum and average pump rates achieved throughout the measurement period can be seen summarized in Table 4-2.

Table 4-2 Savuka Flow Meter Records (January 2024 – December 2024)

Water Source	Water Destination	Average Flow (m^3/month)	Max Flow (m^3/month)
Main Meter Savuka Mine	Savuka Plant	5 001	7 665
White Tanks	Savuka Plant	129 088	162 397
White Tanks	Domain 3 Tanks	105 618	132 871
TSF 7 RWD Complex	Domain 3 Tanks	102 807	115 915
TSF Slurry Water (TSF L19)	Savuka Plant	268 421	289 011
Savuka Plant	Savuka Tailings (TSF 5 & 7)	371 827	423 309
North Boundary Dam Complex	White Tanks	234 706	295 268

4.7 Pumping Rates and Control Philosophy

Flow measurement on all the main dirty water transfer pipelines is done monthly on-site and this flowmeter data indicates the average pumping rates that can be achieved. These pumping rates were obtained from the 2024 plant water balance sheet provided by the client. During the recorded period (Jan 2024 – December 2024), the model utilises the recorded flows.

A control philosophy was incorporated in the water balance model, to try and replicate the current operating conditions on site and to ensure that the transfer of dirty runoff and TSF return water is done in a timeous manner for future simulations. The control philosophy also manages the water volumes in the RWDs and SWD. The transfer rate and operational philosophy for each containment facility used in the water balance model are listed in Table 4-3.

The plant top-up water demand supply (Water transferred to Domain 3 Tanks) is controlled by an “Allocator” element in the GoldSim model. This element allocates an incoming signal (the make-up water demand) to several outputs according to a specified set of demands and priorities. The outputs in this case being the transfer of dirty water from the RWDs and SWD. The allocator element then keeps track of the total amount of occurrences that the plant top-up water could not be fully supplied from the return flow supply from the dirty water dams.

Table 4-3: Pumping Philosophy

Source	Max Rate (m^3/day)	Destination	Operating Philosophy
White Tanks	3,470	Domain 3 Tanks	Use recorded flows. Constant average pumping rate.
White Tanks	4,242	Savuka Plant	Use recorded flows. Constant average pumping rate.

Source	Max Rate (m^3/day)	Destination	Operating Philosophy
Domain 3 Tanks	9,083	TSF L19 – Dormant TSF	Constant average pumping rate.
TSF L19 – Dormant TSF	8,819	Savuka Plant	Use recorded flows. Constant average pumping rate.
South RWD	9,248	Domain 3 Tanks (Priority 1)	If RWD > 5%: Pump at Max Rate until Plant Demand is met. If RWD < 5%: No Pumping. If Plant Demand is met No Pumping.
South RWD	10,000	SWD	If RWD > 65%: Pump at Max Rate. If RWD < 65%: No Pumping. If SWD > 90%: No Pumping.
North RWD	9,248	Domain 3 Tanks (Priority 1)	If RWD > 5%: Pump at Max Rate until Plant Demand is met. If RWD < 5%: No Pumping. If Plant Demand is met No Pumping.
North RWD	10,000	SWD	If RWD > 60%: Pump at Max Rate. If RWD < 60%: No Pumping. If SWD > 90%: No Pumping.
SWD	9,248	Domain 3 Tanks (Priority 2)	If SWD > 5%: Pump at Max Rate until Plant Demand is met. If SWD < 5%: No Pumping. If Plant Demand is met No Pumping. *(Priority 2 – Only pump if North and South RWD cannot meet plant demand)*

4.8 Size of the Containment Facilities

The characteristics of the dirty water containment facilities on site are summarised in Table 4-4 below. The RWD have starting (initial) levels ranging from 80 – 97% of the dam's capacity as dam level readings for the RWDs were provided. The volumes of the dirty water containment facilities were determined by measuring the facility's footprint via aerial imagery and applying an average depth. It should be noted that, determining the capacities of the containment facilities by means of measuring the footprints from aerial imagery and applying a depth factor, is not good engineering practice. A bathymetric survey should be conducted to accurately determine the dam's silted capacity, and the as-built information of the Surface Dams should be sourced to ensure that the model can be updated accordingly.

Table 4-4: Storage Facilities Characteristics

Containment Facility	Original Capacity (m^3)	Modelled Capacity (m^3)	Surface Area (m^2)	Estimated Silted Percentage (%)
North RWD	35,245	24,672	14,098	30%
South RWD	29,313	29,313	11,725	0%
SWD	350,000	245,000	168,330	30%
Domain 3 Tanks	8,000	8,000	2,225	0%
White Tanks	1,000	1,000	153	0%
North Boundary Complex	326,127	326,127	93,179	0%

4.9 Domestic Water

Domestic water is generally used on site for food preparation in the canteens, for basic uses such as for the operation of ablutions and for water consumption and use in the change house (showers). According to the (WRC) Report No 527/1/96, large volumes of water are supplied to mine offices and change houses. A mine usually utilises between 0,1 and 0,6 m^3/person/day of potable water.

According to the flow meter data, a total of 60,016 m^3/annum was sourced from the Rand Water Dam and supplied potable water to the Savuka plant operations.

There are no records of wastewater and Jones and Wagener calculated that 107 people will generate roughly 60 litres per person per day (l/p/d) of sewage at the Savuka Plant, which equates to roughly 6.4 m^3/day.

5 WATER BALANCE RESULTS – CURRENT SILTED DAMS

The water balance model was designed to indicate if the existing infrastructure is adequately sized to contain water inflows and to prevent any chance of the dirty containment facilities spilling more than once in 50 years. The model simulation was run with 250 realisations in the GoldSim software over 20 years. The following sections will discuss the analyses of the results and findings.

5.1 Goldsim Inputs - Current Silted Dams

The annual water balance update was run using the following model settings and assumptions:

- Simulation Time: 20 years (Daily Time Steps).
- Realisations: 250.
- Simulated values focused on hydrological processes (rainfall, runoff, evaporation).
- The North RWD and SWD were presumed to be silted up by roughly 30%.
- All runoff from the TSF side walls and surrounding areas will be contained in the SWD.
- A maximum pumping rate of 10,000 m^3/day was incorporated for the transfer from the RWDs to the SWD.
- Excess water in the RWDs was pumped to the SWD to manage the water levels in the RWDs.
- To meet the plant's top-up demands, water was sourced from the SWD during extremely dry conditions.
- There is approximately 1,785.3 m^3/day of water contained in the reclaimed tailings.
- The operating levels of the dirty water containment facilities kept the RWDs and SWD at roughly 5% of their current capacity.
- Interstitial Storage was based on the calculations provided by the client and the following figures were provided by the operations team:
    - Average Dry Density = 1.25 t/m^3.
    - Tailings Solid Density = 2.7 t/m^3.
    - Specific Gravity of Solids = 2.63.

The graphs (Figure 5-1 – Figure 5-5) presented in the following section depicts a comparative analysis of rainfall patterns over two years, showcasing both recorded data and simulated probabilities. Through detailed and on-site measurement and statistical modelling, this visualization sheds light on the variability and potential future trends in precipitation utilising the rainfall-runoff generator mentioned in Section 4.3.

Year One: Recorded Data (Black Line)

In the initial year of observation, depicted by the solid black line, the graph reveals the actual recorded data used in the analysis. Each data point represents a measured value provided by the client, offering a tangible representation of the natural fluctuations in the dam levels over time.

Year 2 – 20: Simulated Probability Results

In contrast to the recorded data, the remaining years on the graph unveils a series of probability results generated through a simulated model. These results, depicted by shaded green regions, represent a range of potential outcomes based on statistical analysis and modelling techniques. By exploring various scenarios, this simulation provides insights into the probabilistic nature of rainfall patterns, allowing for informed decision-making and risk assessment during wet and dry periods.

The 98% threshold was selected for dam overflow analysis as it corresponds to a 1-in-50-year probability event. The return period (or recurrence interval) represents the likelihood of a particular event occurring in any given year. A 1-in-50-year event has a 2% annual exceedance probability (AEP), meaning there is a 2% chance of this event occurring in any given year. By analysing the 98^{th} percentile of the data, extreme conditions are captured that align with this probability, ensuring that the assessment accounts for rare but significant overflow events.

5.1.1 North RWD

The North RWD volume probability results following the 250 realisations over a 20-year period from the GoldSim model can be seen in Figure 5-1. The RWD has an estimated capacity of 35,245 m^3, however, approximately 10,573 m^3 of storage is lost due to siltation in the dam. The total mean average daily volume of dirty water contained in the RWD during the simulation period is approximately 3,424 m^3 (Roughly 30% of the dam is silted). Referring to the figure below, the RWD reaches a maximum capacity of 35,245 m^3 on during a simulated storm event (98^{th} Percentile – 1:50 Year Probability). Given the RWD's maximum capacity of 35,245 m^3

and referring to Figure 5-2, it is clear that the RWD does spill on multiple (66) occasions throughout the simulation.

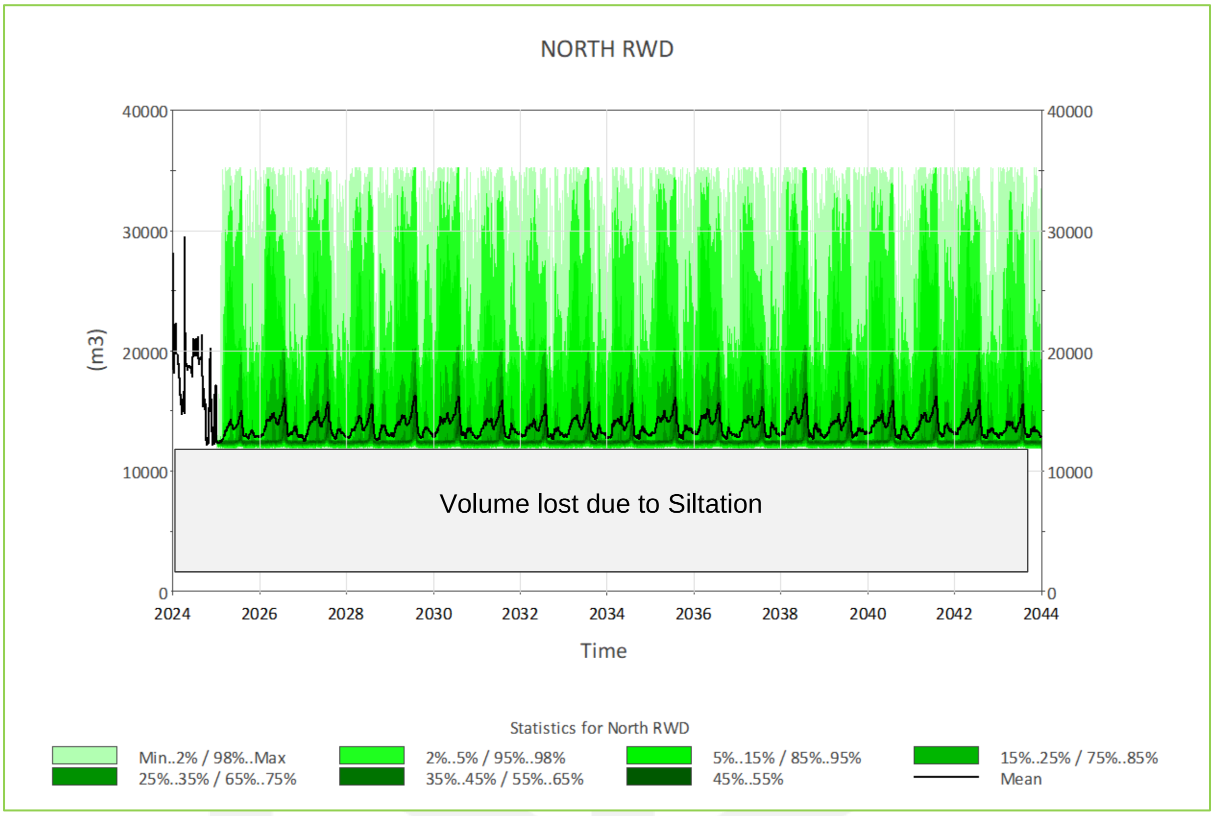


Figure 5-1: Volume Probabilities for the North RWD

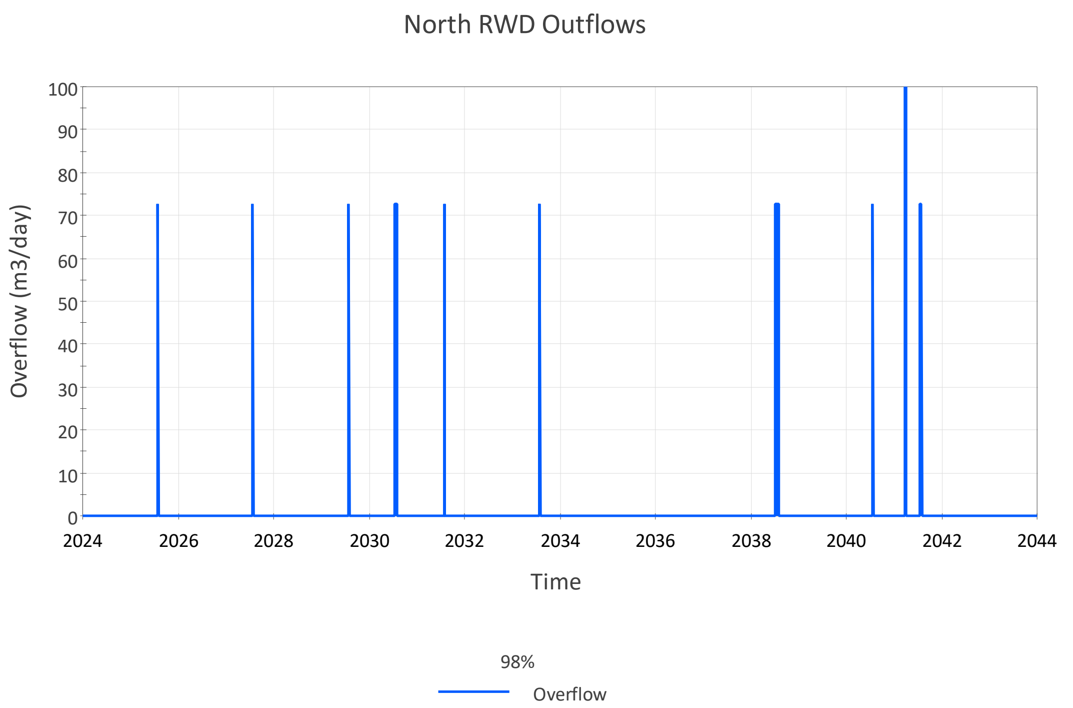


Figure 5-2: North RWD Overflows During a Simulated Storm Event

5.1.2 South RWD

The South RWD volume probability results following the 250 realizations in the GoldSim software can be seen in Figure 5-3. The South RWD has an estimated capacity of 29,313 m^3 and the total mean average daily volume of dirty water contained in the RWD during the simulation period is approximately 3,140 m^3 (roughly 15% of the dam's capacity). Referring to the figure below, the RWD reaches a maximum capacity of 29,313 m^3 on during a simulated storm event (98th Percentile – 1:50 Year Probability). Given the RWD's maximum capacity of 29,313 m^3 and referring to Figure 5-4, it is clear that the RWD does spill on multiple (68) occasions throughout the simulation.

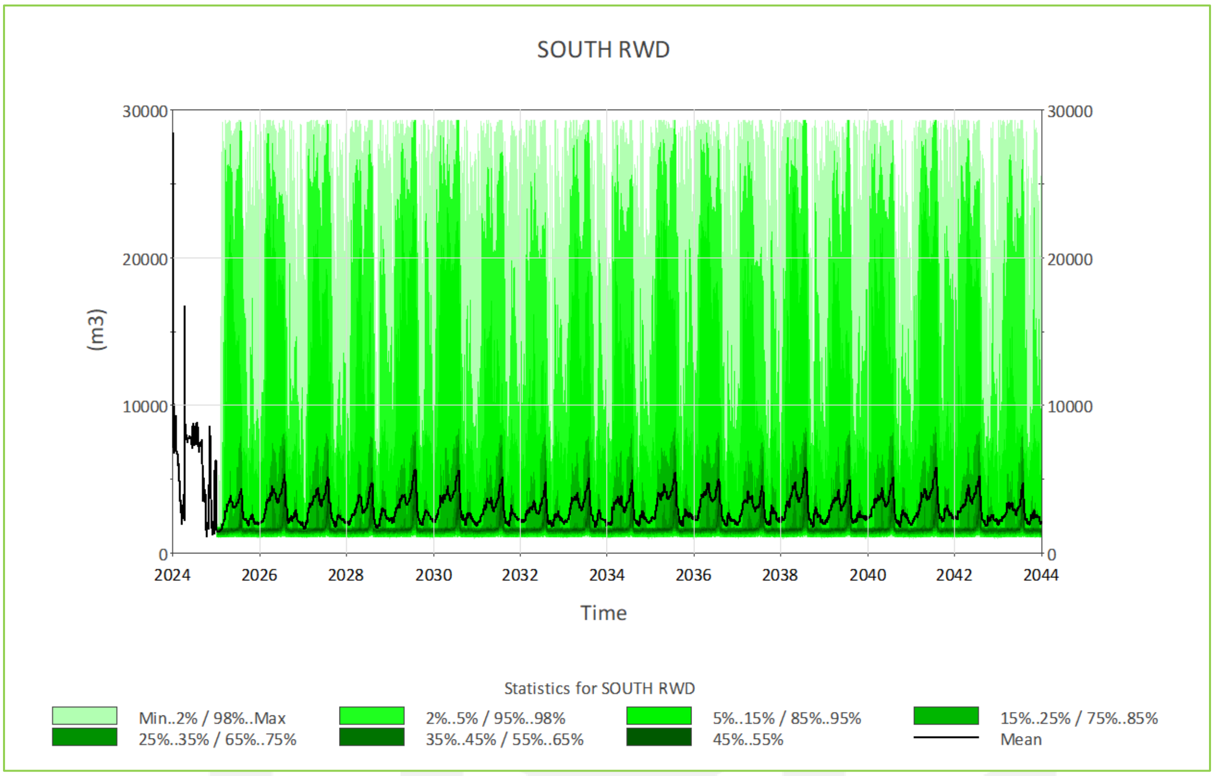


Figure 5-3: Volume Probabilities for the South RWD

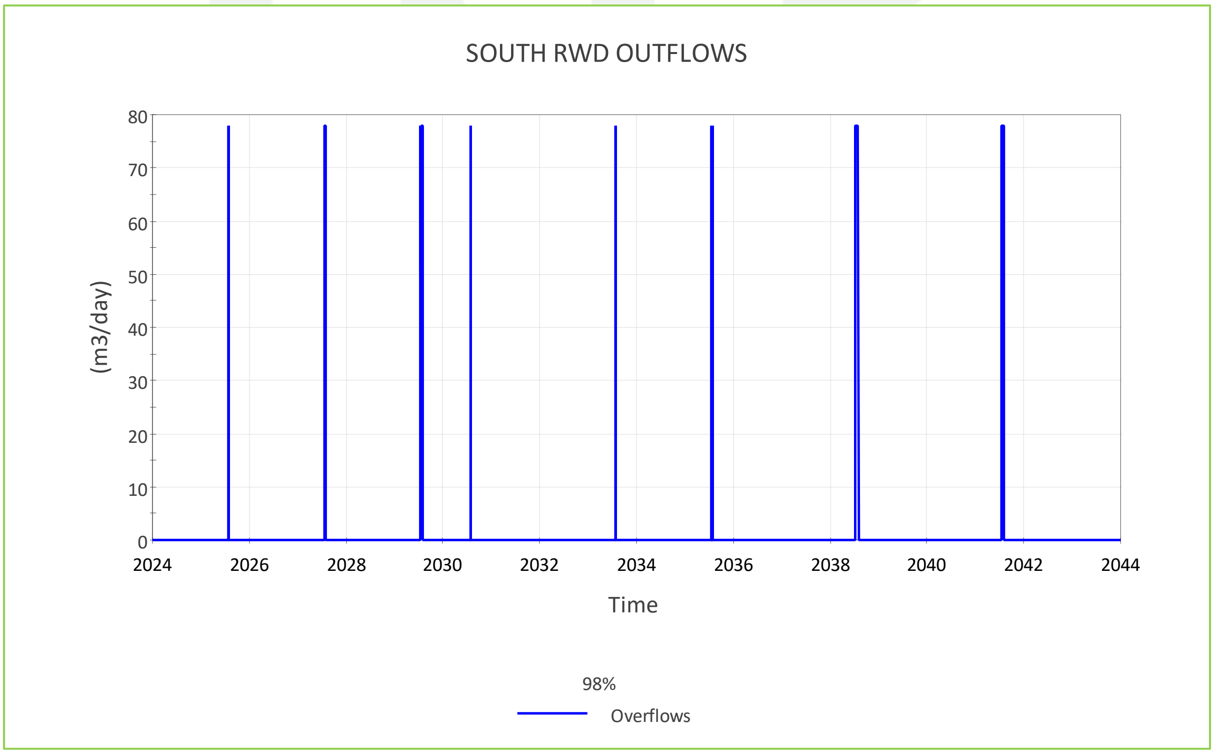


Figure 5-4: South RWD Overflows During a Simulated Storm Event

5.1.3 Storm Water Dam (SWD)

The SWD volume probability results following the 250 realizations in the GoldSim software can be seen in Figure 5-5. The SWD has an estimated capacity of 350,000 m^3, however, approximately 105,000 m^3 of storage is lost due to siltation in the dam. The total mean average daily volume of dirty water contained in the SWD during the simulation period is approximately 55,139 m^3 (roughly 30% of the dam is silted). Referring to the figure below, the SWD reaches a maximum capacity of 350,000 m^3 during a simulated storm event (98th Percentile – 1:50 Year Probability). Given the SWD's maximum capacity of 350,000 m^3 and referring to Figure 5-6, it is clear that the SWD does spill on multiple (68) occasions throughout the simulation.

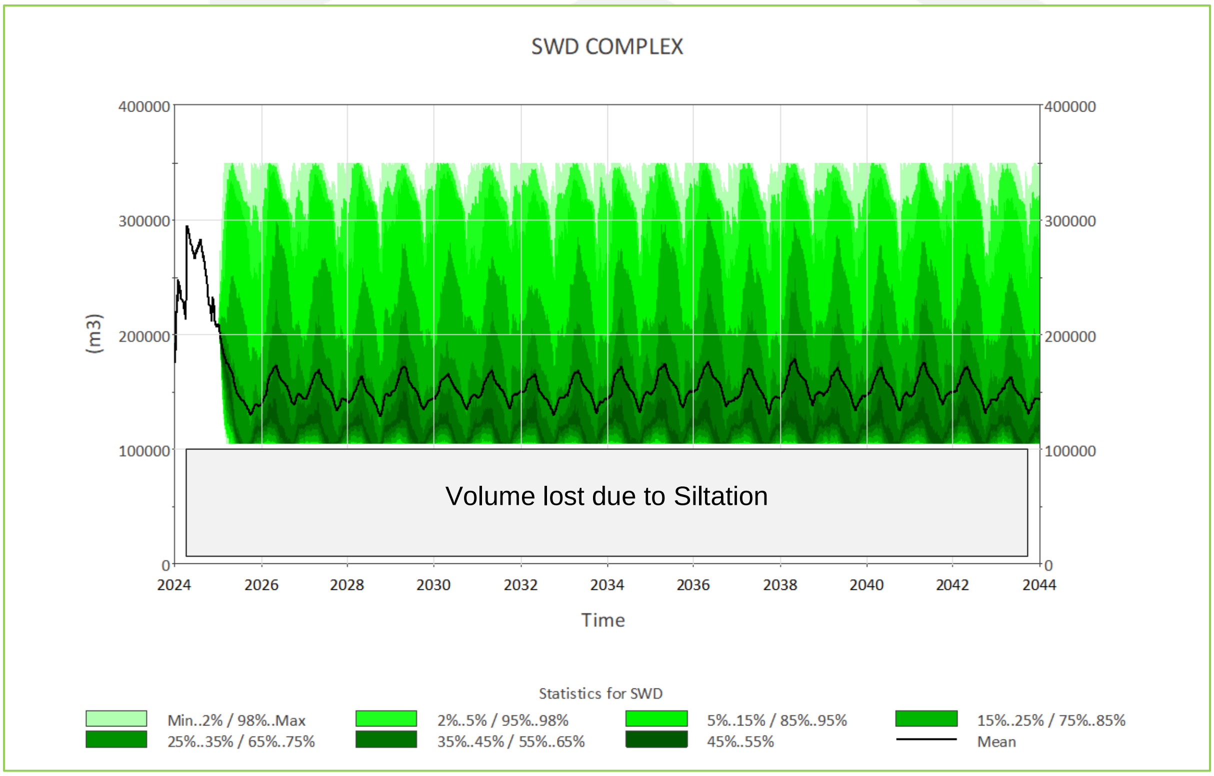


Figure 5-5: Volume Probabilities for the SWD

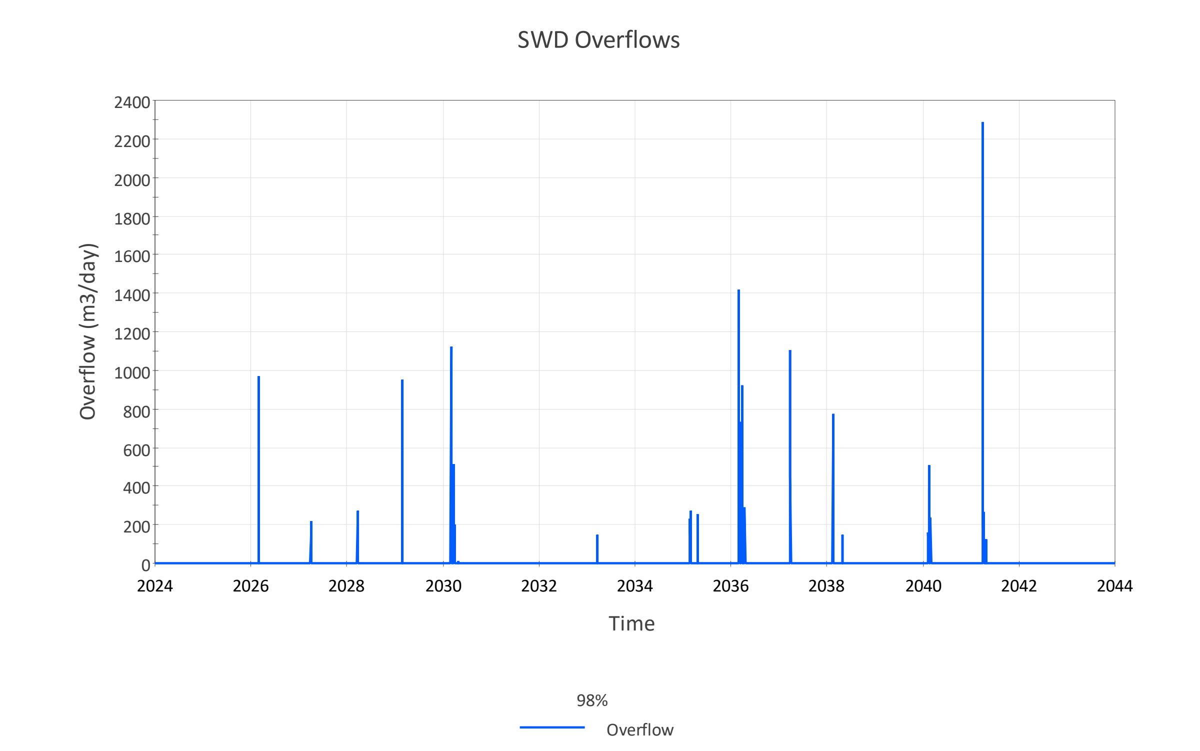


Figure 5-6: SWD Overflows During a Simulated Storm Event

5.2 Water Balance Result Summary – Silted Dams

The following is a high-level summary of the simulation results for the Savuka Section for the current operations (North RWD and SWD are silted by 30%) on site:

- The total capacity for dirty water containment at Savuka (RWDs and SWD) is 298,985 m^3 (excluding siltation volumes).
- The total estimated capacity lost at Savuka due to siltation in the dams is approximately 115,574 m^3 (The total estimated capacity for dirty water containment at Savuka is roughly 414,558 m^3), where:
  - North RWD is silted up by roughly 10,573 m^3.
  - SWD is silted up by roughly 105,000 m^3.
- The total mean average daily volume of dirty water contained in the SWD is approximately 160,139 m^3 (where 105,000 m^3 is lost to siltation).
- The total 98th percentile (1:50-year) daily volume of dirty water contained in the SWD is approximately 325,118 m^3 (where 105,000 m^3 is lost to siltation).

- The total mean average daily volume of dirty water contained in the South RWD is approximately 3,140 m^3.
- The total 98th percentile (1:50-year) daily volume of dirty water contained in the South RWD is approximately 18,297 m^3.
- The total mean average daily volume of dirty water contained in the North RWD is approximately 13,997 m^3 (where 10,573 m^3 is lost to siltation).
- The total 98th percentile (1:50-year) daily volume of dirty water contained in the North RWD is approximately 26,594 m^3 (where 10,573 m^3 is lost to siltation).
- The total mean average daily volume of water transferred from the White Tanks to the Domain 3 Tanks is approximately 3,470.0 m^3/day.
- The total mean average daily volume of water transferred from the White Tanks to the Savuka Plant is approximately 4,241.1 m^3/day.
- The total mean average daily volume of water transferred from the Domain 3 Tanks for reclamation (Dormant TSF) is approximately 7,176.2 m^3/day.
- The total mean average daily volume of water entrained in the Dormant TSF (TSF L19) is approximately 1,785.3 m^3/day.
- The total mean average daily volume of water transferred from the Dormant TSF (TSF L19) to the Savuka Plant is approximately 8,818.7 m^3/day.
- The total mean average daily volume of water transferred from the RWDs to the SWD is approximately 170.8 m^3/day.
- The total mean average daily volume of water transferred from the RWDs and SWD to the Domain 3 Tanks is approximately 3,709.0 m^3/day.
- The total mean average daily volume of water entrained in the dormant TSF (TSF L19) is approximately 1,785.3 m^3/day (the Dormant TSF is being reclaimed, and this is seen as an inflow / unspecified source to the overall water balance).
- The total mean average daily volume of water in the tailings transferred from the plant and deposited on the active Savuka TSF 5 & 7 is approximately 12,216.0 m^3/day.
- The total mean average daily volume of water entrained (interstitial storage) at the active Savuka TSF 5 & 7 is approximately 4,780.3 m^3/day.

- The total mean average daily volume of water returned from the active Savuka TSF 5 & 7 to the RWDs is approximately 3,888.8 m^3/day.
- The total mean average daily volume of water used lost through seepage on site is approximately 1,426.3 m^3/day.
- The total mean average daily volume of water overflowing from the RWDs and SWD to the downstream receptor is approximately 153.3 m^3/day.

The average daily water balance for the Savuka Operations (where the dams are silted) is shown in Figure 5-7 below and the annual water balance volumes are provided in Table 5-1.

SAVUKA WATER BALANCE 2025 - SILTED DAMS
WATER BALANCE FLOW DIAGRAM

DIRTY AREAS - RUNOFF

	IN (m^3/d)	OUT (m^3/d)	
TSF 5 Side Walls	82.3	252.0	SWD
TSF 7 Side Walls	154.3	1036.7	TSF 5 & 7
TSF 5 & 7 Tailings Runoff	1036.7	170.6	TSF L19
TSF L19 Tailings Runoff	170.6		
TSF Surrounding Areas	15.4		
TOTAL	1459.3	1459.3	TOTAL

WHITE TANKS (1,000 m³)

	IN (m^3/d)	OUT (m^3/d)	
Rainfall	0.3	0.6	Evaporation
RWD Split	0.0	3470.0	Domain 3 Tanks
Nursery Dam (North Boundary Complex)	7711.4	4241.1	Savuka Plant
TOTAL	7711.7	7711.8	TOTAL
Decrease in Storage	0.04	0.0	Increase in Storage

DOMAIN 3 TANKS (8,000 m³)

	IN (m^3/d)	OUT (m^3/d)	
Rainfall	4.3	0.8	Evaporation
White Tanks	3470.0	7176.2	Reclamation
Savuka RSWD Complex	3709.0		
TOTAL	7183.4	7176.9	TOTAL
Decrease in Storage	0.0	6.5	Increase in Storage

SAVUKA DORMANT TSF (OLD NORTH)

	IN (m^3/d)	OUT (m^3/d)	
Rainfall	48.9	305.2	Evaporation
Tailings Runoff	170.6	8818.7	Savuka Plant
Domain 3	7176.2	57.1	Seepage
Entrained Tailings	1785.3		
TOTAL	9181.0	9181.0	TOTAL

SAVUKA 5 & 7 TSF

	IN (m^3/d)	OUT (m^3/d)	
Rainfall	470.8	3746.4	Evaporation
Tailings Runoff	1036.7	4780.3	Interstitial Storage
Slurry Water	12216.0	3888.8	Return Flow
Dust Suppression	0.0	1369.2	Seepage
TOTAL	13723.5	13784.7	TOTAL
Decrease in Storage	61.3	0.0	Increase in Storage

RWD SOUTH (29,312 m³)

	IN (m^3/d)	OUT (m^3/d)	
Rainfall	22.9	44.1	Evaporation
TSF Inflow	258.3	1762.1	Domain 3
TSF Return Flow	1686.1	90.1	SWD
		35.6	Overflows
TOTAL	1967.3	1931.9	TOTAL
Decrease in Storage	0.0	35.4	Increase in Storage

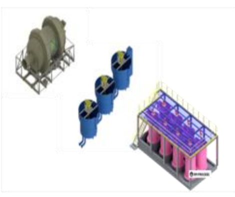
RWD NORTH (35,243 m³)

	IN (m^3/d)	OUT (m^3/d)	
Rainfall	27.5	53.0	Evaporation
TSF Inflow	258.3	1763.4	Domain 3
TSF Return Flow	1686.1	80.7	SWD
		45.8	Overflows
TOTAL	1971.9	1942.9	TOTAL
Decrease in Storage	0.0	29.0	Increase in Storage

SWD (350,000 m³)

	IN (m^3/d)	OUT (m^3/d)	
Rainfall	328.6	481.8	Evaporation
RWD North	80.7	183.5	Domain 3
RWD South	90.1	0.0	Dust Suppression
Side Wall Runoff	236.6	71.9	Overflow
Runoff	15.4		
TOTAL	751.4	737.3	TOTAL
Decrease in Storage	0.0	14.1	Increase in Storage

SAVUKA PLANT (SOW)



	IN (m^3/d)	OUT (m^3/d)	
TSF L19	8818.7	12216.0	Water in Tailings
White Tanks	4241.1	6.4	Sewage
Moisture ROM	84.7	1086.5	Product & Plant Losses
Randwater Dam (Potable)	164.3		
TOTAL	13308.9	13308.9	TOTAL

Figure 5-7: Water Balance Simulation – Daily Average Flows (Silted Dams)

Table 5-1: Water Balance Simulation – Average Annual Flows (Silted Dams)

SAVUKA WATER BALANCE 2025 - SILTED DAMS						
WATER BALANCE FLOW DIAGRAM (m³/annum)						
Facility Name	Water In		Water Out		Balance	Comment
	Water Stream	Quantity	Water Stream	Quantity		
DIRTY AREAS - RUNOFF	TSF 5 Side Walls	30 044	SWD	91 962		
	TSF 7 Side Walls	56 309	TSF 5 & 7	378 404		
	TSF 5 & 7 Tailings Runoff	378 404	TSF L19	62 285		
	TSF L19 Tailings Runoff	62 285				
	TSF Surrounding Areas	5 608				
	Total	532 651	Total	532 651	0.00	Balanced
WHITE TANKS (1,000 m³)	Rainfall	109	Evaporation	211		
	RWD Split	0	Domain 3 Tanks	1 266 561		
	Nursery Dam (North Boundary Complex)	2 814 667	Savuka Plant	1 548 019		
	Decrease in Storage	15				
	Total	2 814 791	Total	2 814 791	0.00	Balanced
DOMAIN 3 TANKS (8,000 m³)	Rainfall	1 586	Evaporation	277		
	White Tanks	1 266 561	Reclamation	2 619 300		
	Savuka RSWD Complex	1 353 788	Increase in Storage	2 359		
	Total	2 621 935	Total	2 621 935	0.00	Balanced
SAVUKA DORMANT TSF (OLD NORTH)	Rainfall	17 855	Evaporation	111 406		
	Tailings Runoff	62 285	Savuka Plant	3 218 829		
	Domain 3	2 619 300	Seepage	20 844		
	Entrained Tailings	651 639				
	Total	3 351 079	Total	3 351 079	0.00	Balanced
SAVUKA 5 & 7 TSF	Rainfall	171 830	Evaporation	1 367 443		
	Tailings Runoff	378 404	Interstitial Storage	1 744 800		
	Slurry Water	4 458 835	Return Flow	1 419 416		
	Dust Suppression	22 263	Seepage	499 768		
	Decrease in Storage	96	Increase in Storage	0		
	Total	5 031 427	Total	5 031 427	0.00	Balanced
RWD SOUTH (29,312 m³)	Rainfall	8 355	Evaporation	16 100		
	TSF Inflow	94 278	Domain 3	643 155		
	TSF Return Flow	615 430	SWD	32 903		
	Decrease in Storage	0	Overflows	12 976		
			Increase in Storage	12 930		
	Total	718 063	Total	718 063	0.00	Balanced
RWD NORTH (35,243 m³)	Rainfall	10 046	Evaporation	19 358		
	TSF Inflow	94 278	Domain 3	643 647		
	TSF Return Flow	615 430	SWD	29 454		
	Decrease in Storage	0	Overflows	16 708		
			Increase in Storage	10 587		
	Total	719 754	Total	719 754	0.00	Balanced
SWD (350,000 m³)	Rainfall	119 951	Evaporation	175 874		
	RWD North	29 454	Domain 3	66 987		
	RWD South	32 903	Dust Suppression	0		
	Side Wall Runoff	86 353	Overflow	26 253		
	Runoff	5 608	Increase in Storage	5 155		
	Total	274 269	Total	274 269	0.00	Balanced
SAVUKA PLANT (SOW)	TSF L19	3 218 829	Water in Tailings	4 458 835		
	White Tanks	1 548 019	Sewage	2 343		
	Moisture ROM	30 916	Product & Plant Losses	396 568		
	Randwater Dam (Potable)	59 982				
	Total	4 857 746	Total	4 857 746	0.00	Balanced

6 WATER BALANCE RESULTS – DESILTED DAMS

The water balance model was designed to indicate if the existing infrastructure is adequately sized to contain water inflows and to prevent any chance of the dirty containment facilities spilling more than once in 50 years. The model simulation was run with 250 realisations in the GoldSim software over 20 years. The following sections will discuss the analyses of the results and findings.

6.1 Goldsim Inputs - Desilted Dams

The annual water balance update was run using the following model settings and assumptions:

- Simulation Time: 20 years (Daily Time Steps).
- Realisations: 250.
- Simulated values focused on hydrological processes (rainfall, runoff, evaporation).
- The RWDs and SWD are not silted up.
- All runoff from the TSF side walls and surrounding areas will be contained in the SWD.
- Excess water in the RWDs was pumped to the SWD to manage the water levels in the RWDs.
- A maximum pumping rate of 10,000 m^3/day was incorporated for the transfer from the RWDs to the SWD.
- To meet the plant's top-up demands, water was sourced from the SWD during extremely dry conditions.
- There is approximately 1,767.8 m^3/day of water contained in the reclaimed tailings.
- The operating levels of the dirty water containment facilities kept the RWDs and SWD at roughly 5% of their current capacity to avoid spills.
- Interstitial Storage was based on the calculations provided by the client and the following figures were provided by the operations team:
    - Average Dry Density = 1.25 t/m^3.
    - Tailings Solid Density = 2.7 t/m^3.
    - Specific Gravity of Solids = 2.63.

The graphs (Figure 7-1 – Figure 6-5) presented in the following section depicts a comparative analysis of rainfall patterns over two years, showcasing both recorded data and simulated probabilities. Through detailed and on-site measurement and statistical modelling, this visualization sheds light on the variability and potential future trends in precipitation utilising the rainfall-runoff generator mentioned in Section 4.3.

Year One: Recorded Data (Black Line)

In the initial year of observation, depicted by the solid black line, the graph reveals the actual recorded data used in the analysis. Each data point represents a measured value provided by the client, offering a tangible representation of the natural fluctuations in the dam levels over time.

Year 2 – 20: Simulated Probability Results

In contrast to the recorded data, the remaining years on the graph unveils a series of probability results generated through a simulated model. These results, depicted by shaded green regions, represent a range of potential outcomes based on statistical analysis and modelling techniques. By exploring various scenarios, this simulation provides insights into the probabilistic nature of rainfall patterns, allowing for informed decision-making and risk assessment during wet and dry periods.

The 98% threshold was selected for dam overflow analysis as it corresponds to a 1-in-50-year probability event. The return period (or recurrence interval) represents the likelihood of a particular event occurring in any given year. A 1-in-50-year event has a 2% AEP, meaning there is a 2% chance of this event occurring in any given year. By analysing the 98th percentile of the data, extreme conditions are captured that align with this probability, ensuring that the assessment accounts for rare but significant overflow events.

6.1.1 North RWD

The North RWD volume probability results following the 250 realisations over a 20-year period from the GoldSim model can be seen in Figure 6-1. The RWD has an estimated capacity of 35,245 m^3, and the total mean average daily volume of dirty water contained in the RWD during the simulation period is approximately 3,330 m^3 (Roughly 9% of the dam's capacity). Referring to the figure below, the RWD reaches a maximum capacity of 35,245 m^3 on during a simulated storm event (98th Percentile – 1:50 Year Probability). Given the RWD's maximum capacity of 35,245 m^3, it is clear that the RWD does reach its full supply level (FSL), however, referring to Figure 6-2 the dam does not spill more than once throughout the simulation as no overflows where recorded.

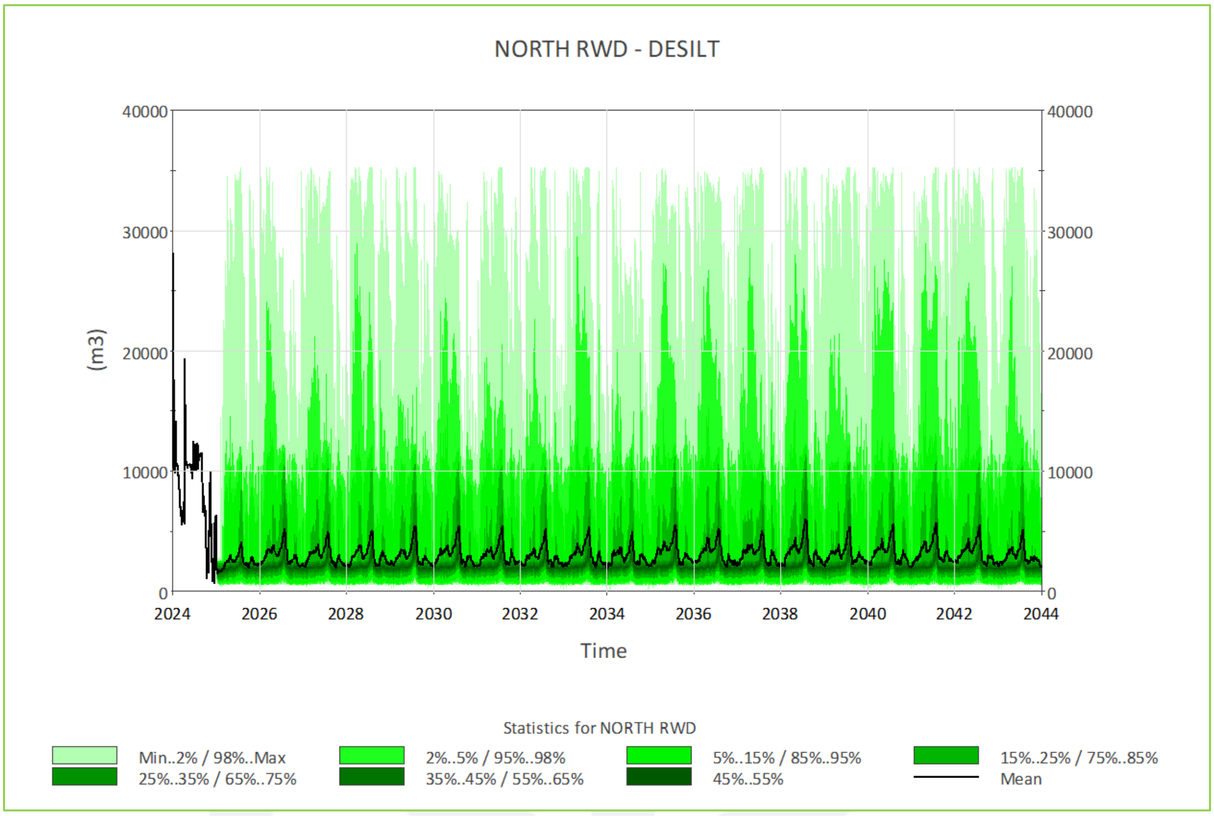


Figure 6-1: Volume Probabilities for the North RWD - Desilt

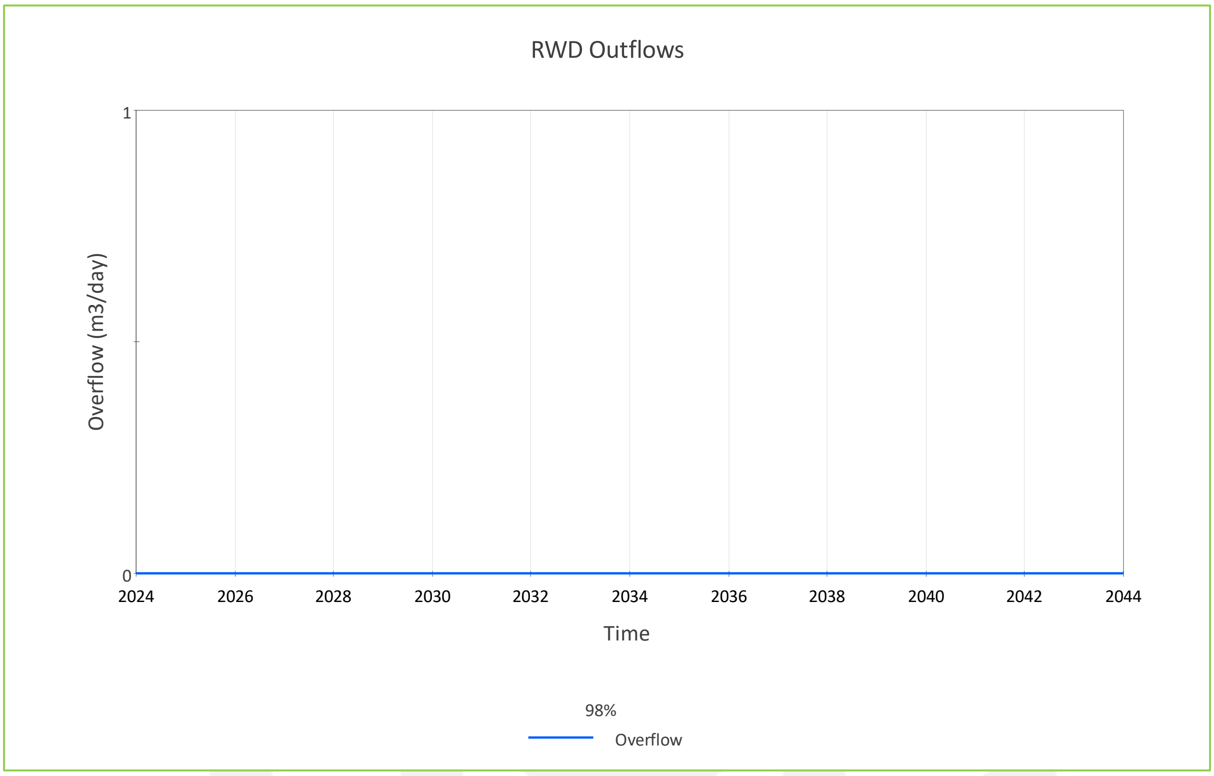


Figure 6-2: North RWD Overflows During a Simulated Storm Event - Desilt

6.1.2 South RWD

The South RWD volume probability results following the 250 realizations in the GoldSim software can be seen in Figure 6-3. The RWD has an estimated capacity of 29,313 m^3 and the total mean average daily volume of dirty water contained in the RWD during the simulation period is approximately 2,520 m^3 (Roughly 9% of the dam's capacity). Referring to the figure below, the RWD reaches a maximum capacity of 29,313 m^3 on during a simulated storm event (98^{th} Percentile – 1:50 Year Probability). Given the RWD's maximum capacity of 29,313 m^3, it is clear that the RWD does reach its FSL, however, referring to Figure 6-4, the dam does not spill more than once throughout the simulation as no overflows were recorded.

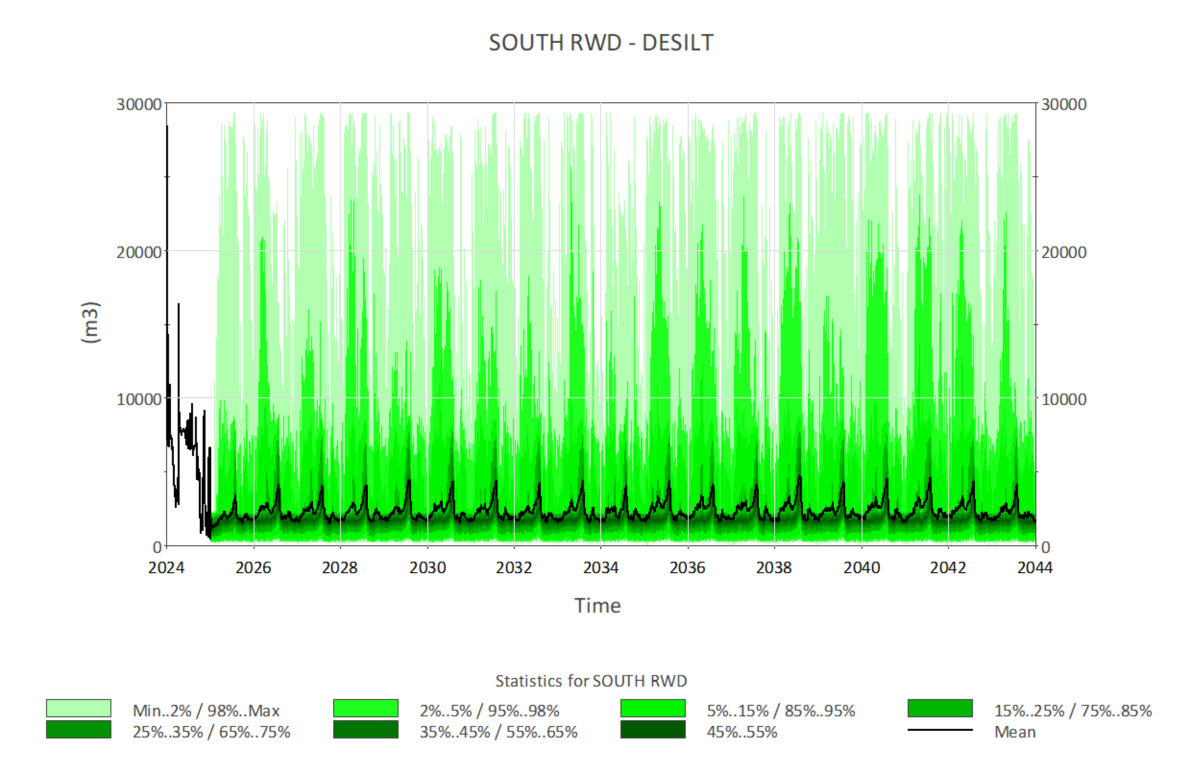


Figure 6-3: Volume Probabilities for the South RWD - Desilt

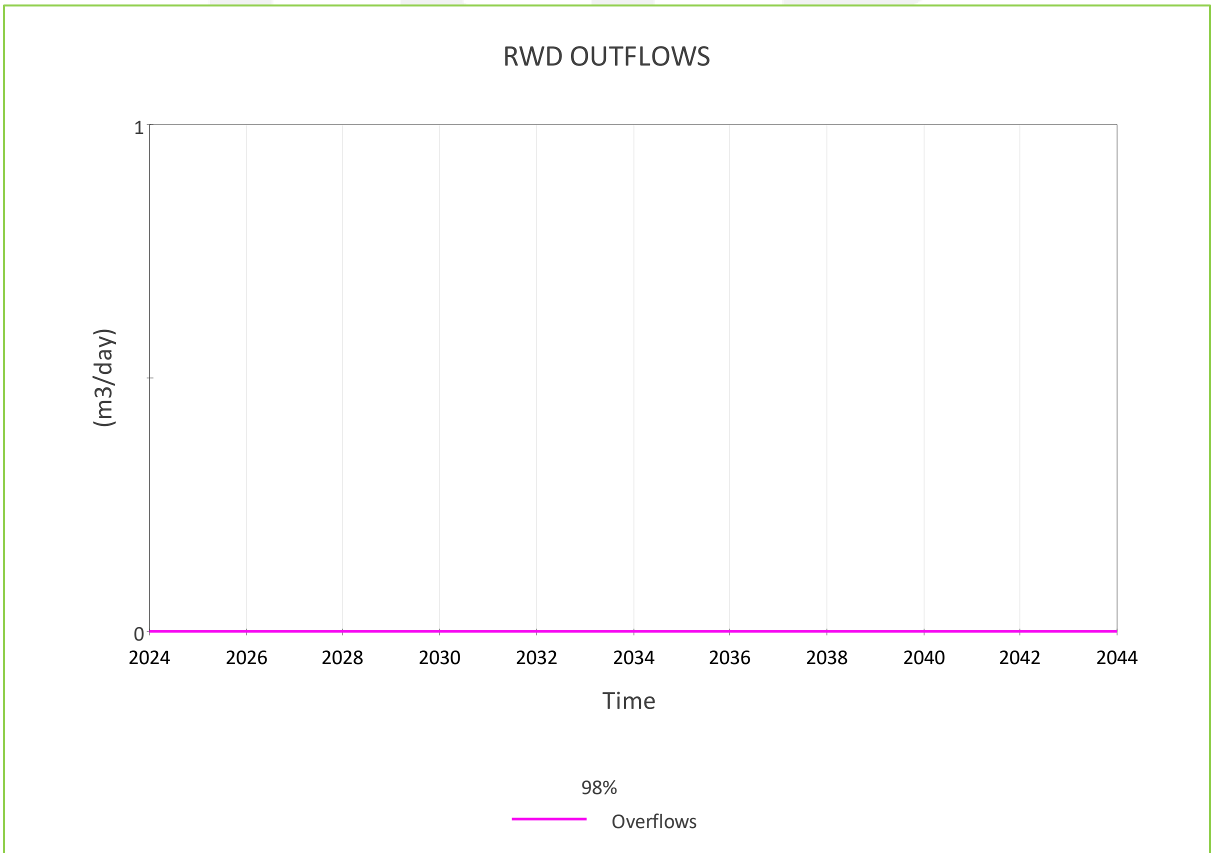


Figure 6-4: South RWD Overflows During a Simulated Storm Event - Desilt

6.1.3 Storm Water Dam (SWD)

The SWD volume probability results following the 250 realizations in the GoldSim software can be seen in Figure 6-5. The SWD has an estimated capacity of 350,000 m^3, and the total mean average daily volume of dirty water contained in the SWD during the simulation period is approximately 51,234 m^3 (Roughly 15% of the dam's capacity). Referring to the figure below, the SWD reaches a maximum capacity of 350,000 m^3 during a simulated storm event (98th Percentile – 1:50 Year Probability). Given the SWD's maximum capacity of 350,000 m^3, it is clear that the SWD does reach its FSL, however, referring to Figure 6-6, the dam does not spill more than once throughout the simulation as no overflows are recorded.

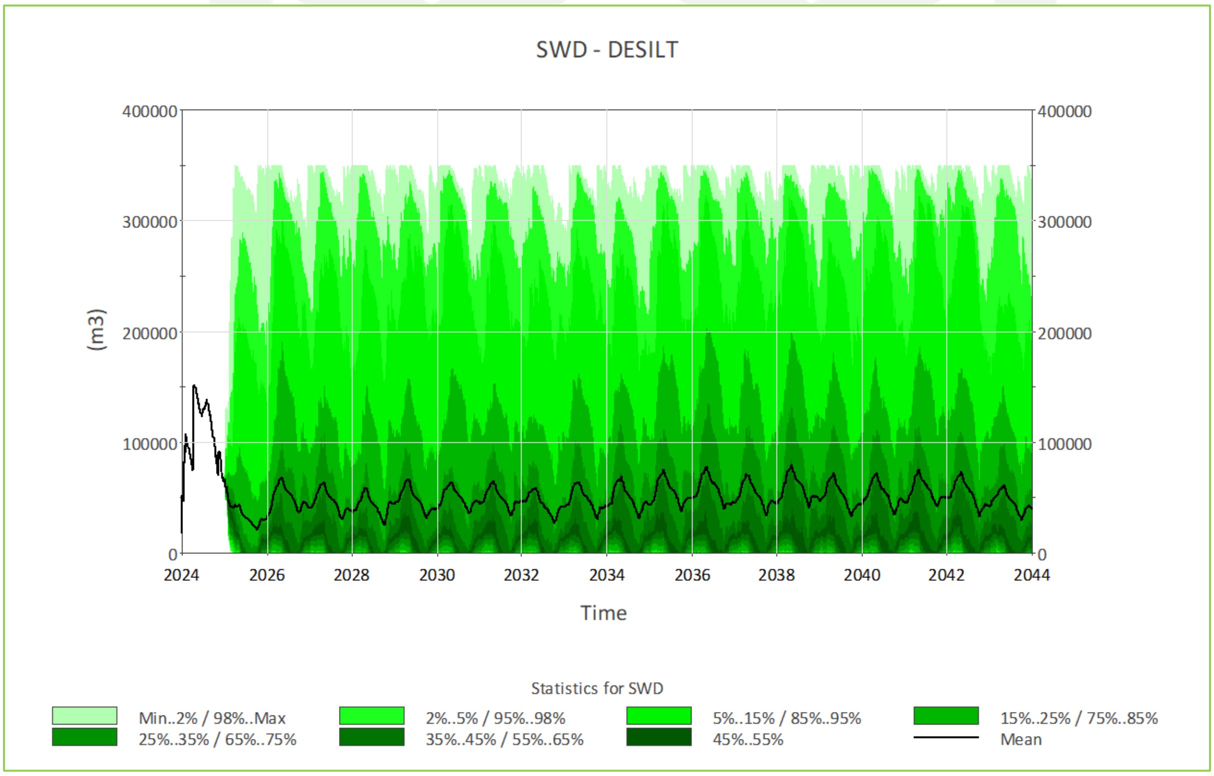


Figure 6-5: Volume Probabilities for the SWD - Desilt

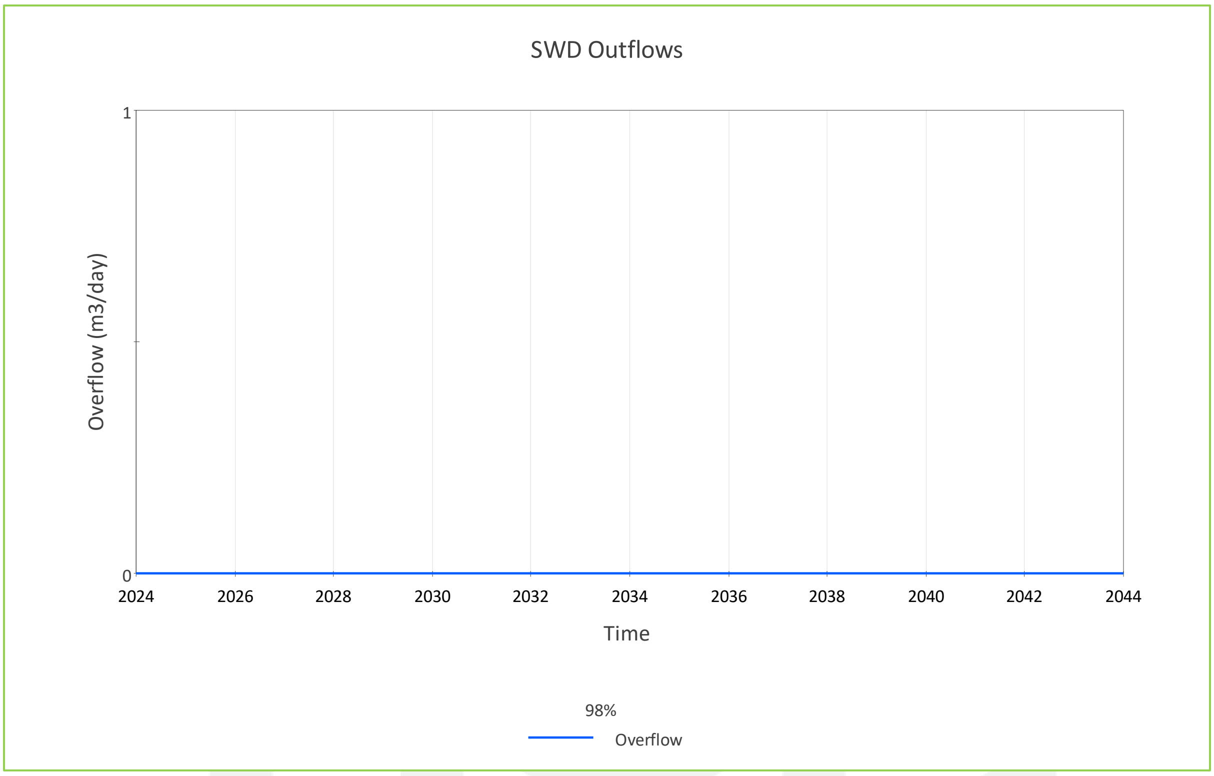


Figure 6-6: SWD Overflows During a Simulated Storm Event - Desilt

6.2 Water Balance Result Summary – Desilted Dams

The following is a high-level summary of the simulation results for the Savuka Section for the proposed operations where the dams have been de-silted on site:

- The total capacity for dirty water containment (RWDs and SWD) at Savuka is 414,558 m^3
- The total mean average daily volume of dirty water contained in the SWD is approximately 51,234 m^3.
- The total 98th percentile (1:50-year) daily volume of dirty water contained in the SWD is approximately 279,638 m^3.
- The total mean average daily volume of dirty water contained in the North RWD is approximately 3,330 m^3.
- The total 98th percentile (1:50-year) daily volume of dirty water contained in the North RWD is approximately 14,261 m^3.
- The total mean average daily volume of dirty water contained in the South RWD is approximately 2,520 m^3.

- The total 98th percentile (1:50-year) daily volume of dirty water contained in the South RWD is approximately 10,884 m^3.
- The total mean average daily volume of water transferred from the White Tanks to the Domain 3 Tanks is approximately 3,470.0 m^3/day.
- The total mean average daily volume of water transferred from the White Tanks to the Savuka Plant is approximately 4,241.1 m^3/day.
- The total mean average daily volume of water transferred from the Domain 3 Tanks for reclamation (Dormant TSF) is approximately 7,145.5 m^3/day.
- The total mean average daily volume of water transferred from the Dormant TSF (TSF L19) to the Savuka Plant is approximately 8,818.7 m^3/day.
- The total mean average daily volume of water transferred from the RWDs to the SWD is approximately 136.6 m^3/day.
- The total mean average daily volume of water transferred from the RWDs and SWD to the Domain 3 Tanks is approximately 3,678.4 m^3/day.
- The total mean average daily volume of water entrained in the dormant TSF (TSF L19) is approximately 1,767.8 m^3/day (the Dormant TSF is being reclaimed, and this is seen as an inflow / unspecified source to the overall water balance).
- The total mean average daily volume of water in the tailings transferred from the plant and deposited on the active Savuka TSF 5 & 7 is approximately 12,216.0 m^3/day.
- The total mean average daily volume of water entrained (interstitial storage) at the active Savuka TSF 5 & 7 is approximately 4,780.3 m^3/day.
- The total mean average daily volume of water returned from the active Savuka TSF 5 & 7 to the RWDs is approximately 3,724.7 m^3/day.
- The total mean average daily volume of water used lost through seepage on site is approximately 1,370.1 m^3/day.
- The total mean average daily volume of water overflowing from the RWDs and SWD to the downstream receptor is approximately 0.0 m^3/day.

The average daily water balance for the proposed Savuka Operations (where the dams are de-silted) is shown in Figure 6-7 below and the annual water balance volumes are provided in Table 5-1.

SAVUKA WATER BALANCE 2025 - DE-SILTED DAMS
WATER BALANCE FLOW DIAGRAM

DIRTY AREAS - RUNOFF

	IN (m³/d)	OUT (m³/d)	
TSF 5 Side Walls	82.3	252.0	SWD
TSF 7 Side Walls	154.3	1036.7	TSF 5 & 7
TSF 5 & 7 Tailings Runoff	1036.7	170.6	TSF L19
TSF L19 Tailings Runoff	170.6		
TSF Surrounding Areas	15.4		
TOTAL	1459.3	1459.3	TOTAL

WHITE TANKS (1,000 m³)

	IN (m³/d)	OUT (m³/d)	
Rainfall	0.3	0.6	Evaporation
RWD Split	0.0	3470.0	Domain 3 Tanks
Nursery Dam	7711.4	4241.1	Savuka Plant
TOTAL	7711.7	7711.8	TOTAL
Decrease in Storage	0.0	0.0	Increase in Storage

DOMAIN 3 TANKS (8,000 m³)

	IN (m³/d)	OUT (m³/d)	
Rainfall	4.3	0.8	Evaporation
White Tanks	3470.0	7145.5	Reclamation
Savuka RSWD Complex	3678.4		
TOTAL	7152.7	7146.3	TOTAL
Decrease in Storage	0.0	6.5	Increase in Storage

SAVUKA DORMANT TSF (OLD NORTH)

	IN (m³/d)	OUT (m³/d)	
Rainfall	48.9	305.2	Evaporation
Tailings Runoff	170.6	8818.7	Savuka Plant
Domain 3	7145.5	8.9	Seepage
Entrained Water in Tailings	1767.8		
TOTAL	9132.9	9132.9	TOTAL
Decrease in Storage	0.0	0.0	Increase in Storage

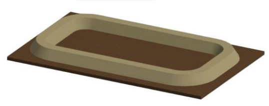
SAVUKA 5 & 7 TSF

	IN (m³/d)	OUT (m³/d)	
Rainfall	470.8	3857.4	Evaporation
Tailings Runoff	1036.7	4780.3	Interstitial Storage
Slurry Water	12216.0	3724.7	Return Flow
Dust Suppression	0.0	1361.1	Seepage
TOTAL	13723.5	13723.5	TOTAL
Decrease in Storage	0.0	0.0	Increase in Storage

RWD SOUTH (29,312 m³)

	IN (m³/d)	OUT (m³/d)	
Rainfall	22.9	44.1	Evaporation
TSF Inflow	177.0	1728.4	Domain 3
TSF Return Flow	1685.4	74.5	SWD
TOTAL	1885.2	1847.0	TOTAL
Decrease in Storage	0.0	38.3	Increase in Storage

RWD NORTH (35,243 m³)



	IN (m³/d)	OUT (m³/d)	
Rainfall	27.5	53.0	Evaporation
TSF Inflow	177.0	1736.4	Domain 3
TSF Return Flow	1685.4	62.2	SWD
TOTAL	1889.9	1851.6	TOTAL
Decrease in Storage	0.0	38.3	Increase in Storage

SWD (350,000 m³)

	IN (m³/d)	OUT (m³/d)	
Rainfall	328.6	493.2	Evaporation
RWD North	62.2	213.6	Domain 3
RWD South	74.5	0.0	Dust Suppression
Side Wall Runoff	236.6		
Runoff	15.4		
TOTAL	717.2	706.8	TOTAL
Decrease in Storage	0.0	10.4	Increase in Storage

SAVUKA PLANT (SOW)

	IN (m³/d)	OUT (m³/d)	
TSF L19	8818.7	12216.0	Water in Tailings
White Tanks	4241.1	6.4	Sewage
Moisture ROM	84.7	1086.5	Product & Plant Losses
Randwater Dam (Potable)	164.3		
TOTAL	13308.9	13308.9	TOTAL

Figure 6-7: Water Balance Simulation – Daily Average Flows (Desilted Dams)

Table 6-1: Water Balance Simulation – Average Annual Flows (Desilted Dams)

SAVUKA WATER BALANCE 2025 - DE-SILTED DAMS						
WATER BALANCE FLOW DIAGRAM (m³/annum)						
Facility Name	Water In		Water Out		Balance	Comment
	Water Stream	Quantity	Water Stream	Quantity		
DIRTY AREAS - RUNOFF	**TSF 5 Side Walls**	30 044	**SWD**	91 962		
	TSF 7 Side Walls	56 309	**TSF 5 & 7**	378 404		
	TSF 5 & 7 Tailings Runoff	378 404	**TSF L19**	62 285		
	TSF L19 Tailings Runoff	62 285				
	TSF Surrounding Areas	5 608				
	Total	532 651	Total	532 651	0.00	Balanced
WHITE TANKS (1,000 m³)	**Rainfall**	109	**Evaporation**	211		
	RWD Split	0	**Domain 3 Tanks**	1 266 561		
	Nursery Dam	2 814 667	**Savuka Plant**	1 548 019		
	Decrease in Storage	15				
	Total	2 814 791	Total	2 814 791	0.00	Balanced
DOMAIN 3 TANKS (8,000 m³)	**Rainfall**	1 586	**Evaporation**	277		
	White Tanks	1 266 561	**Reclamation**	2 608 110		
	Savuka RSWD Complex	1 342 598	**Increase in Storage**	2 359		
	Decrease in Storage	0				
	Total	2 610 745	Total	2 610 745	0.00	Balanced
SAVUKA DORMANT TSF (OLD NORTH)	**Rainfall**	17 855	**Evaporation**	111 406		
	Tailings Runoff	62 285	**Savuka Plant**	3 218 829		
	Domain 3	2 608 110	**Seepage**	3 261		
	Entrained Water in Tailings	645 246				
	Total	3 333 496	Total	3 333 496	0.00	Balanced
SAVUKA 5 & 7 TSF	**Rainfall**	171 830	**Evaporation**	1 407 941		
	Tailings Runoff	378 404	**Interstitial Storage**	1 744 800		
	Slurry Water	4 458 835	**Return Flow**	1 359 509		
	Dust Suppression	0	**Seepage**	496 819		
	Decrease in Storage	0	**Increase in Storage**	0		
	Total	5 009 069	Total	5 009 069	0.00	Balanced
RWD SOUTH (29,312 m³)	**Rainfall**	8 355	**Evaporation**	16 100		
	TSF Inflow	64 595	**Domain 3**	630 860		
	TSF Return Flow	615 160	**SWD**	27 180		
	Decrease in Storage	0	**Increase in Storage**	13 970		
	Total	688 110	Total	688 110	0.00	Balanced
RWD NORTH (35,243 m³)	**Rainfall**	10 046	**Evaporation**	19 358		
	TSF Inflow	64 595	**Domain 3**	633 773		
	TSF Return Flow	615 160	**SWD**	22 686		
	Decrease in Storage	0	**Increase in Storage**	13 983		
	Total	689 801	Total	689 801	0.00	Balanced
SWD (350,000 m³)	**Rainfall**	119 951	**Evaporation**	180 010		
	RWD North	22 686	**Domain 3**	77 964		
	RWD South	27 180	**Dust Suppression**	0		
	Side Wall Runoff	86 353	**Increase in Storage**	3 805		
	Runoff	5 608				
	Decrease in Storage	0				
	Total	261 779	Total	261 779	0.00	Balanced
SAVUKA PLANT (SOW)	**TSF L19**	3 218 829	**Water in Tailings**	4 458 835		
	White Tanks	1 548 019	**Sewage**	2 343		
	Moisture ROM	30 916	**Product & Plant Losses**	396 568		
	Randwater Dam (Potable)	59 982				
	Total	4 857 746	Total	4 857 746	0.00	Balanced

7 WATER BALANCE RESULTS – SOUTH RWD REMOVAL

The water balance model was designed to indicate if the existing infrastructure is adequately sized to contain water inflows and to prevent any chance of the dirty containment facilities spilling more than once in 50 years. The model simulation was run with 250 realisations in the GoldSim software over 20 years. The following sections will discuss the analyses of the results and findings.

7.1 Goldsim Inputs - South RWD Removal

The annual water balance update was run using the following model settings and assumptions:

- Simulation Time: 20 years (Daily Time Steps).
- Realisations: 250.
- Simulated values focused on hydrological processes (rainfall, runoff, evaporation).
- The North RWD and SWD are not silted up.
- South RWD was removed from the water balance.
- All runoff from the TSF side walls and surrounding areas will be contained in the SWD.
- Excess water in the RWD was pumped to the SWD to manage the water levels in the RWDs.
- A maximum pumping rate of 10,000 m^3/day was incorporated for the transfer from the RWD to the SWD.
- To meet the plant's top-up demands, water was sourced from the SWD during extremely dry conditions.
- The operating levels of the dirty water containment facilities kept the RWD and SWD at roughly 5% of their current capacity.
- Interstitial Storage was based on the calculations provided by the client and the following figures were provided by the operations team:
    - Average Dry Density = 1.25 t/m^3.
    - Tailings Solid Density = 2.7 t/m^3.
    - Specific Gravity of Solids = 2.63.

The graphs (Figure 7-1 and Figure 7-3) presented in the following section depicts a comparative analysis of rainfall patterns over two years, showcasing both recorded data and simulated probabilities. Through detailed and on-site measurement and statistical modelling, this visualization sheds light on the variability and potential future trends in precipitation utilising the rainfall-runoff generator mentioned in Section 4.3.

Year One: Recorded Data (Black Line)

In the initial year of observation, depicted by the solid black line, the graph reveals the actual recorded data used in the analysis. Each data point represents a measured value provided by the client, offering a tangible representation of the natural fluctuations in the dam levels over time.

Year 2 – 20: Simulated Probability Results

In contrast to the recorded data, the remaining years on the graph unveils a series of probability results generated through a simulated model. These results, depicted by shaded green regions, represent a range of potential outcomes based on statistical analysis and modelling techniques. By exploring various scenarios, this simulation provides insights into the probabilistic nature of rainfall patterns, allowing for informed decision-making and risk assessment during wet and dry periods.

The 98% threshold was selected for dam overflow analysis as it corresponds to a 1-in-50-year probability event. The return period (or recurrence interval) represents the likelihood of a particular event occurring in any given year. A 1-in-50-year event has a 2% AEP, meaning there is a 2% chance of this event occurring in any given year. By analysing the 98th percentile of the data, extreme conditions are captured that align with this probability, ensuring that the assessment accounts for rare but significant overflow events.

7.1.1 North RWD

The North RWD volume probability results following the 250 realisations over a 20-year period from the GoldSim model can be seen in Figure 7-1. The RWD has an estimated capacity of 35,245 m^3, and the total mean average daily volume of dirty water contained in the RWD during the simulation period is approximately 3,418 m^3 (Roughly 10% of the dam's capacity). Referring to the figure below, the RWD reaches a maximum capacity of 35,245 m^3 on during a simulated storm event (1:50 Year). Given the RWD's maximum capacity of 35,245 m^3, it is clear that the RWD does reach its full supply level (FSL), and referring to Figure 7-2, the RWD does spill on multiple (12) occasions throughout the simulation.

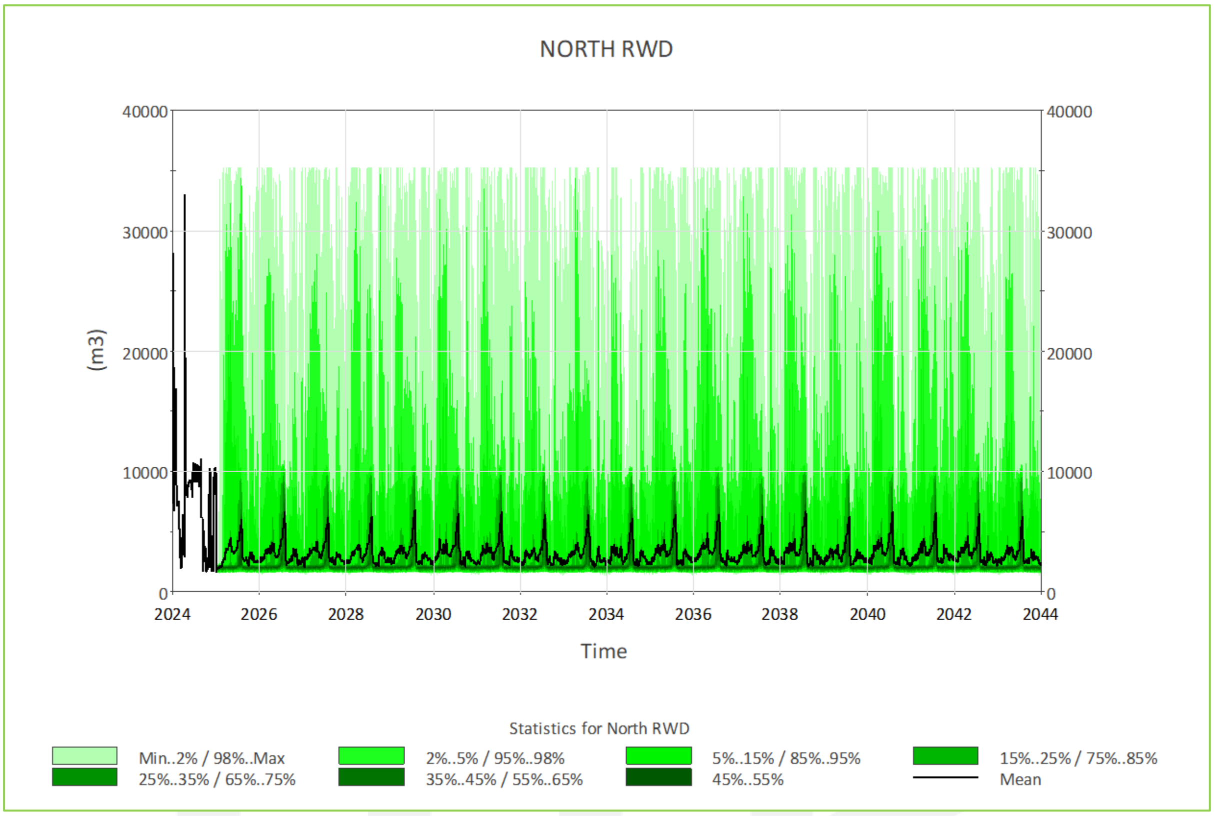


Figure 7-1: Volume Probabilities for the North RWD - South RWD Removal

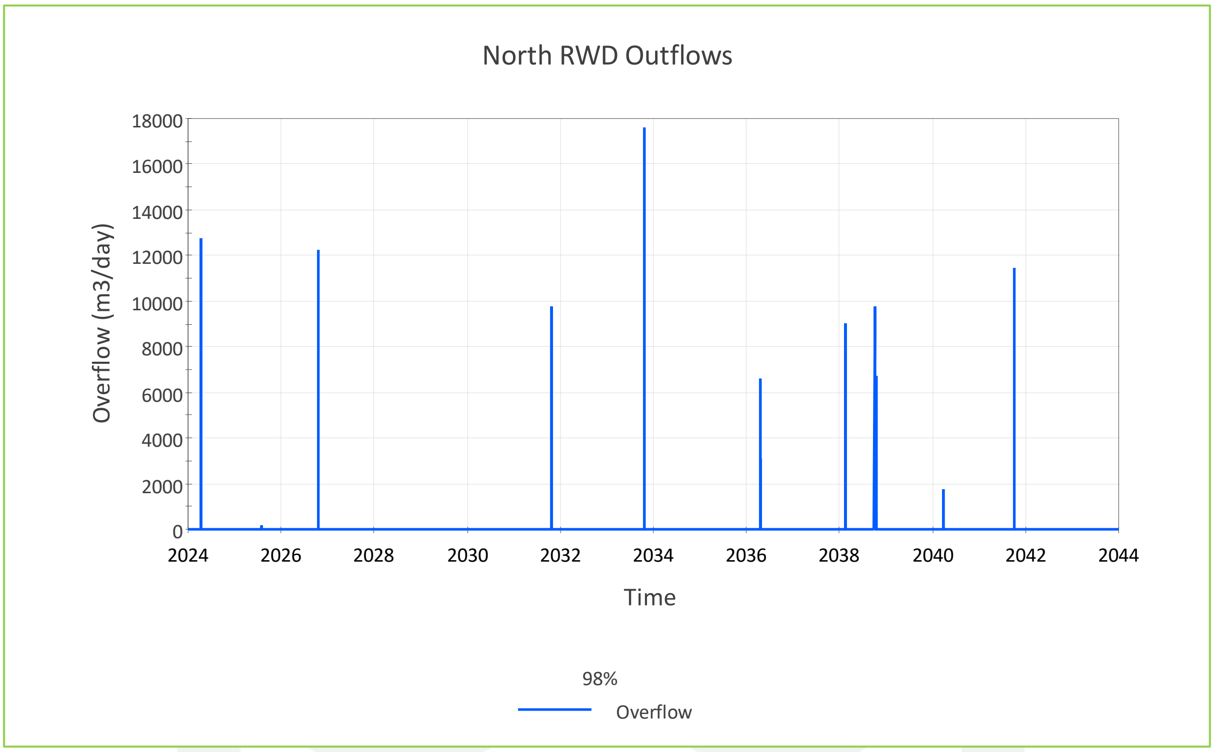


Figure 7-2: North RWD Overflows - South RWD Removal

7.1.2 Storm Water Dam (SWD)

The SWD volume probability results following the 250 realizations in the GoldSim software can be seen in Figure 7-3. The SWD has an estimated capacity of 350,000 m^3, and the total mean average daily volume of dirty water contained in the SWD during the simulation period is approximately 64,518 m^3 (Roughly 18% of the dam's capacity). Referring to the figure below, the SWD reaches a maximum capacity of 350,000 m^3 during a simulated storm event (1:50 Year). Given the SWD's maximum capacity of 350,000 m^3, it is clear that the SWD does reach its FSL, however, referring to Figure 7-4, the dam does not spill more than once throughout the simulation as no overflows are recorded.

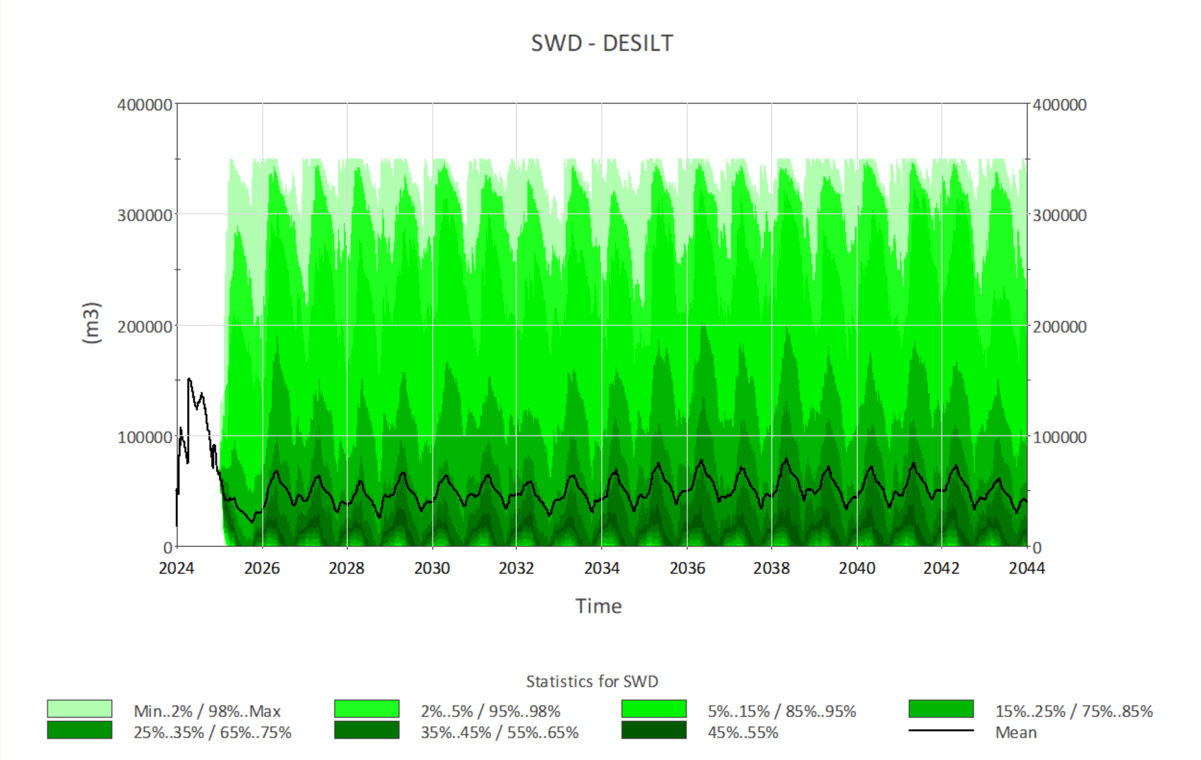


Figure 7-3: Volume Probabilities for the SWD – South RWD Removal

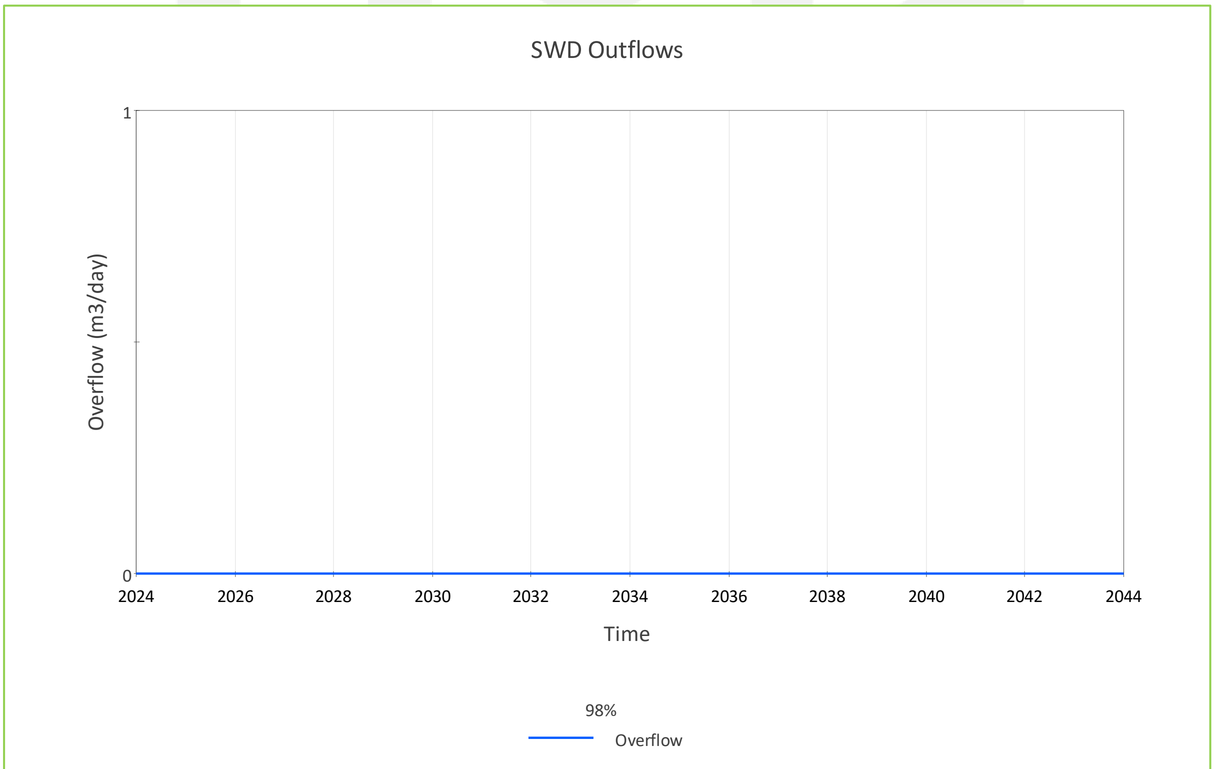


Figure 7-4: SWD Overflows - South RWD Removal

7.2 Water Balance Result Summary – South RWD Removal

The following is a high-level summary of the simulation results for the Savuka Section for the proposed operations where the South RWD has been removed from the operations:

- The total capacity for dirty water containment (North RWD and SWD) at Savuka is 385,245 m^3
- The total mean average daily volume of dirty water contained in the SWD is approximately 64,518 m^3.
- The total 98th percentile (1:50-year) daily volume of dirty water contained in the SWD is approximately 283,469 m^3.
- The total mean average daily volume of dirty water contained in the North RWD is approximately 3,418 m^3.
- The total 98th percentile (1:50-year) daily volume of dirty water contained in the North RWD is approximately 15,507 m^3.
- The total maximum 98th percentile (1:50-year) volume of water overflowing from the North RWD to the downstream receptor is approximately 17,595 m^3 (Figure 7-2).

8 CONCLUSION AND ASPECTS TO CONSIDER

The main purpose of this water balance is to ensure that the sizes of the existing components of the site-wide dirty water management are adequate and to ensure that the mine complies with the requirements as contained in the NWA, Regulation no 7 of 1999 (GN 704).

Following the findings and the results of the water balance model, it is clear that:

- The total capacity for dirty water containment on site is approximately 414,558 m³, however, due to the dams being silted up, the mine loses approximately 28% of its total capacity to contain dirty water on site.
- Excess water in the SWD and RWDs is at risk of overflowing into the downstream environment (with the dam's current capacities), with the potential to degrade the surface and groundwater qualities of surrounding areas as the dams do not have adequate storm buffer capacity due to siltation.
- The North RWD and SWD need to be de-silted to ensure compliance with GN704.
- It is critical to have the South RWD operating at its full capacity (29,313 m³), to ensure that none of the dams surpass its full supply level more than once in 50 years.
- The following capacities for the RWDs and SWD would be sufficient to contain all dirty water inflows without the dams spilling more than once in 50 years:
  - North RWD = 35,245 m³.
  - South RWD = 29,313 m³
  - SWD = 350,000 m³.

The table below summarises the average flows for the Savuka Operations where the dams are silted and for a simulation where the dams are restored to their full capacity:

Table 8-1: Savuka Water Balance Summary (Mℓ/day)

Source	Destination	Silted Dams (Mℓ/day)	Desilted Dams (Mℓ/day)
White Tanks	Domain 3 Tanks	3.47	3.47
White Tanks	Savuka Plant	4.24	4.24
Domain 3 Tanks	TSF L19	7.18	7.15
TSF L19 – Dormant TSF	Savuka Plant	8.82	8.82
TSF 5 & 7	Return Flow	3.89	3.72

Source	Destination	Silted Dams (Mℓ/day)	Desilted Dams (Mℓ/day)
RSWD Complex	Domain 3 Tanks	3.71	3.68
TSF 5 & 7	Interstitial Storage	4.78	4.78
Entrained Tailings	TSF L19 – Dormant TSF	1.79	1.77
TSFs	Seepage	1.43	1.37
Savuka Plant	Water in Tailings	12.22	12.22
RSWD Complex	Overflows	**0.15**	0.00

Following the findings and the results of the overall update, the following is recommended to the client to ensure an accurate water balance model with a high confidence level:

- De-silt the dams at the Savuka operations to provide an additional 126,196 m^3 of stormwater buffer storage to contain dirty water inflows.
- Monitor rainfall data in daily rainfall increments.
- Accurately monitor flow meter data between the various dirty water flow streams to ensure an accurate water balance model.
- Verify / Calibrate flow meters to ensure correct figures are recorded.
- Record the levels of the RWDs and SWD on site in appropriate intervals to aid with the calibration of the water balance model, ensuring more accurate results.
- Update the stormwater management plan to obtain accurate dirty water runoff inflows and reduce the amount of clean water entering the mining operations.
- Monitor domestic/potable water usage on site.

It remains the responsibility of the **holder of the right and / or authorization** to submit this report to the relevant **authority** and retain the proof of submission.