

Volspruit Mining Company (Pty) Ltd

COMPUTERIZED WATER BALANCE SIMULATION MODEL

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LIST OF ABBREVIATIONS

ABBREVIATION	MEANING
BH	Borehole
CVMR	Chemical Vapour Metal Refining
DWS	Department of Water and Sanitation
DHSWS	Department of Human Settlements, Water and Sanitation
Evap	Evaporation
FD	Flow Diagram
ID	Irrigation Dam
IWBSM	Integrated Water Balance Simulation Model
IWUL	Integrated Water Use Licence
IWWMP	Integrated Water- and Waste Management Plan
PCD	Pollution Control Dam
PWD	Process Water Dam
ROM	Run of Mine
RWD	Return Water Dam
RWR	Raw Water Reservoir
Seep	Seepage
SG	Specific Gravity
STP	Sewage Treatment Plant
SWMP	Storm Water Management Plan
TSF	Tailings Storage Facility
WC/WDM	Water Conservation and Water Demand Management
WRD	Waste Rock Dump

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1 INTRODUCTION

Water Hunters, under the lead consultancy of EcoPartners, compiled this report for Volspruit Mining Company with a specific focus on updating the existing Water Balance Model with the latest groundwater- and forecasted production data. The proposed Volspruit Mining Operation is located approximately 18km south of Mokopane in the Waterberg District of the Limpopo Province of South Africa.

The proposed Volspruit Mining Operation covers orebodies that will be mined for PGMs and other base metals, such as copper and nickel, through two opencast pits. When operational, the Volspruit mine will have a mine, processing plant, two smelter modules and a Chemical Vapour Metal Refining (CVMR) refinery.

A dynamic Computerized Water Balance Simulation Model (CWBM) was initially commissioned in 2013 to determine the water use/demand on site, to indicate the feasibility of the project in terms of minimum water requirements, and to support the water use licence application.

The latest update of the CWBM (that was developed at the time) estimates that the Volspruit Mining Company (based on the production curve supplied for the production period of January 2024 until December 2043) will use an average of:

- About 8 100m³ of raw water per month - supplied from the Grass Valley borehole
- About 71 600m³ of raw water per month from toe-drain recoveries
- About 205 800m³ from groundwater inflows into the pits
- About 3 700m³/month of water is added to the system from moisture in the Run-Of-Mine ore
- Rainfall runoff contributes a further 46 400m³ per month, making up the total of approximately 353 600 m³ water used per month

Only a negligible amount of raw water (50 m³ per month) is used as make-up water to the system and this can be eliminated by optimising operational rules. Based on calculations using the current input data, and the set of assumptions made in the model, there is practically no shortfall of water for normal operations as planned by the Volspruit Mining Company.

This report contains a summary of input data used, assumptions made, logic applied, and results generated. Recommendations are based on simulation results and are detailed at the end of the report.

2 Model Principles

2.1 Linear vs Dynamic Water Balance Models

A clear distinction should be drawn between water balance models based on linear calculations and models that are non-linear, and therefore dynamic, in nature. To illustrate the difference a simple example of calculating rainfall, rainfall runoff, evaporation, and seepage on a Tailings Storage Facility (TSF) follows below.

When calculating each of the above volumes, the surface area of the TSF plays an important role. In the case of the linear model, when the surface area is determined beforehand and used to determine the pool area, along with the wet- and dry beach areas to be used in conjunction with the average rainfall-, evaporation- and seepage rates, no allowance is made for the hourly changes in surface area brought about by tailings deposit rates, decant rates, rainfall, evaporation and seepage from the TSF. Rainfall, rainfall runoff, evaporation and seepage volumes will differ significantly when the pool size of the TSF changes. As TSFs are by nature very large, simple linear calculations may be seriously inadequate. The same principle will apply to the calculation of evaporation and seepage volumes for all other storages that are non-linear in nature.

Again, for the linear model, when an average monthly rainfall value is used in conjunction with a predetermined surface area to determine the rainfall and rainfall runoff on a TSF, no consideration is given to different rainfall intensities, with the calculation then typically linear. A high intensity rainfall event of 100 mm in one hour will for example have a much higher rainfall runoff volume than the same 100 mm falling over the space of 7 days. A dynamic simulation model accommodates different rainfall intensities.

The Department of Water and Sanitation emphasizes the importance of using a dynamic Computerized Water Balance Model (CWBM) in its Guidelines for WC/WDM Implementation in the mining sector¹. The characteristics of the dynamic approach are outlined in section 2.2 below.

¹ Guideline for the development and implementation of water conservation and water demand management plans for the mining sector. DWS 2016.

2.2 Characteristics of a dynamic non-linear water balance model

2.2.1 Calculation of storage volumes and surface areas

The Volspruit Operation's Computerized Water Balance Model (CWBM) employs the following principles when calculating rainfall, rainfall runoff, evaporation, and seepage applicable to the different storage types:

Tailings Storage Facilities

Rainfall and all incoming flows into the TSF are added to the pool volume while evaporation, seepage and returns from the TSF are subtracted every hour to calculate a new pool volume. Pool volumes and related surface areas are calculated hourly by employing the formula listed in Figure 1 below.

A spherical cap (bottom slice of a sphere) is used for the following reasons:

- It is the geometric object that closest resembles the shape of large open surface dams and is especially suitable for dams where the depth is less than one tenth of the diameter of the dam.
- Mathematically, the surface area and volume in a spherical cap has a quadratic relationship. This means that twice the surface area of a dam will store four times more water. In other words, if the volume of water in such dams changes with the factor x, the surface area changes by a factor of the square root of x. This principle is applied to the hourly recalculation of the surface areas of TSF pools (and all dams with the same quadratic relationship) when water is added and/or subtracted from the pool.
- The above logic is an improvement to models that assume fixed rates for evaporation and rainfall runoff from TSF pools, irrespective of the everchanging pool sizes.

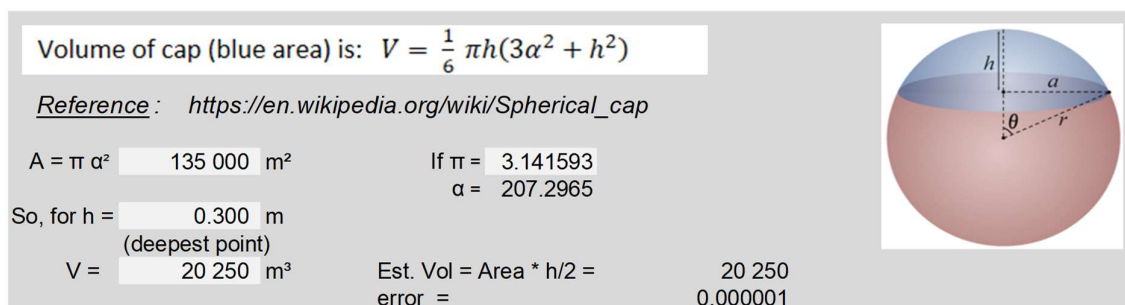


Figure 1 Formula and example for calculating varying pool volumes and related surface areas on TSFs and all other dams with a variable pool size.

Rainfall runoff for the Volspruit Operation's TSF is calculated as follows:

- The pool area attracts 100% of the rainfall coefficient informed by source data² to calculate rainfall runoff.
- Rainfall intensity determines the factor applied to the rainfall runoff coefficient to calculate the rainfall runoff volume. Higher intensity rainfall events will attract a higher rainfall runoff factor.
- 50% of the remainder (total surface area minus pool area) of the surface area is considered to be wet beach area where the runoff factor varies according to the intensity of the rainfall event. Higher intensity rainfall events will attract a higher runoff factor.
- The other 50% of the remainder (total surface area minus pool area) of the surface area is considered to be dry beach area where the runoff factor is lower than that of the wet beach area, but still varies according to the intensity of the rainfall event. Higher intensity rainfall events will attract a higher runoff factor.

Note that wet and dry beach areas and associated runoff factors are estimates based on extensive experience. With calibration on a range of sites these values have been found to be widely applicable and of sufficient accuracy for modelling purposes.

Evaporation is calculated as follows:

- For the pool area: 100% of the monthly evaporation rate, as informed by the source data, is applied.
- For the wet beach: 30% of the monthly evaporation rate, as informed by the source data, is applied.
- No evaporation takes place from the dry beach.

Seepage is calculated as follows:

- For the pool area: 100% of the daily seepage rate (as informed by the source data and listed in the input sheet) is applied.
- For the wet beach: 30% of the daily seepage rate (as informed by the source data and listed in the input sheet) is applied.
- No seepage takes place from the dry beach.

For all other dams with a variable pool size (storm water dams, pollution control dams, etc.) the following principles apply:

- The surface area of the dam is recalculated every hour and used to dynamically calculate rainfall volumes. Rainfall on the surface areas of dams is added to all other inflows to the dam and used to update the storage volumes hourly.
- Pool areas attract 100% of the rainfall coefficient to calculate rainfall runoff.
- For additional catchment areas rainfall runoff is calculated on the catchment size using a variable runoff coefficient and added to the rainfall calculated for the pool area.
- Rainfall intensity determines the factor applied to the rainfall runoff coefficient to calculate the rainfall runoff volume. Higher intensity rainfall events will attract a higher rainfall runoff

² Volspruit SWMP Report CC1.pdf

factor.

- Cement- and lined dams have zero seepage.
- Evaporation is modelled as a fixed rate based on monthly evaporation figures³ (listed in the rainfall tab of the input sheet) over a variable surface area (updated hourly) for each open dam. Closed reservoirs have no evaporation.

For all dams with a constant surface or pool area (Settling Dams, Open Tanks) the following principles apply:

- Rainfall runoff is calculated on the constant pool area with a 100% rainfall runoff factor.
- Evaporation is calculated on the constant pool area with a 100% evaporation rate.
- Dams with a constant pool size are generally either cement dams or lined. As such these dams do not incur any seepage.

2.2.2 Volspruit Operations CWBM Rainfall Generator

The Volspruit Operation's CWBM uses a robust in-house (Water Hunters) developed rainfall engine based on historical and actual rainfall data coupled with a strong statistical base to support the generation of an estimated rainfall close to reality. The difference between linear rainfall generation (where a rainfall figure is read from a spreadsheet and applied to surface areas for the time frame of a whole month) and dynamically generated rainfall events of different intensities and durations throughout any one month can be illustrated by modelling outcomes where simulation results often reveal that discharges from dams to the environment occur, more often than not, after a few days of average rainfall events, rather than after the occasional high rainfall event. The CWBM's sensitivity to rainfall intensity, as well as to the duration of rainfall events, is pivotal for risk analysis. More detail about the way in which the Volspruit CWBM calculates rainfall is contained in section 4.2.7 below.

2.2.3 Calculation of scheduled and unscheduled maintenance events

The Volspruit CWBM calculates the impact of maintenance events as follows:

Scheduled and unscheduled maintenance events occur randomly, but within certain limits, to arrive at the up-time hours (actual production hours) for mines and plants as advised by the client. The mean time to failure between maintenance events as well as the mean time to repair once a maintenance event has occurred, varies accordingly. Maintenance events influence water use rates dynamically, mimicking reality as closely as possible.

2.2.4 Calculation of flow volumes

The Volspruit CWBM employs the following principles:

All flow volumes (except for potable flows supplying drinking water) are calculated dynamically. Each flow volume is determined by the variable demand as dictated by production rates, storage levels and maintenance events. These variables change hourly, demanding dynamic flow logic to accommodate variability.

³ Volspruit SWMP Report CC1.pdf

3 OBJECTIVES AND SCOPE OF THE MODEL FOR VOLSPRUIT MINING OPERATIONS

3.1 Objectives of this project

- Update the CWBM representing the planned operations at Volspruit Mining Company to integrate:
 - new planned production rates from mining operations over time
 - new groundwater data (fissure rates for the no-grouting scenario)
 - variable volumes of all flows
 - variable rainfall volume and intensity
 - dynamic evaporation
 - dynamic seepage and water loss
 - any factor with significant impact on the Volspruit Mine Operations
- Update the necessary input and output analysis files in Microsoft (MS) Excel to present model results and enable scenario analysis if necessary
- Update the static water balance that reflects all water gains and losses in the system (based on simulated results)

3.2 Scope of work

The following work has been undertaken to deliver on the scope required by the client:

- Collection and review of information supplied by client.
- Reworking of data into a compatible format to integrate into the simulation model.
- Building of a dynamic water balance simulation model, with the planned Volspruit Mining Operations as point of departure. Key elements included in the project calculations were:
 - all in- and outflows at the Volspruit Operations
 - all dirty water flows between mining sites, plants, storages and TSF
 - rainfall runoff, evaporation, and seepage from the site area and associated dams
 - clean water flows to plant
 - net losses at plant and mining sites
- Multiple runs of the Volspruit Mining Operation's simulation model and calibrating the results against available planned data for future periods.
- Analysing simulation results and identifying potential risks that pose a threat to the operation's water requirements.
- Developing a static water balance summarising all gains and losses into and from the system.
- Compiling a report summarising the assumptions, model logic applied, and the results for the base case model.

4 COMPONENTS OF THE WATER BALANCE MODEL

The integrated water balance model consists of a Flow Diagram (FD), input sheets, and output sheets.

4.1 Flow Diagram (FD)

The Flow Diagram (FD) forms the core of the model (Figure 2). All major flow components are captured onto a Google Earth background showing the mining- plant- and operational areas. The setup is quite simple, with clean water flows depicted as blue lines and dirty water as red lines, respectively. Dark brown lines indicate water in tailings while light brown lines indicate slurry and inherent TSF moisture. Each of the flows is uniquely numbered, with these reference numbers used in the input and output data sheets. The flow lines also show a flow direction. The model is set up for dynamic visual simulation to provide the user with a real feel for how water behaves during operations. During a visual run the flow direction can be viewed and the rate of a flow in relation to other flows can be observed, with high flow volumes moving much faster than low flow volumes.

Other variables, which include rainfall on dams, rainfall runoff from catchment areas, and evaporation and seepage losses from dams, are all calculated hourly. These values are not made visible in the flow diagram as this would make the dynamic visualisation too busy and potentially distracting. The values are, of course, captured in the results file for analysis.

Inputs are read from Excel sheets in the Input file to allow for easy sensitivity analysis of variables. These input sheets are elaborated on in section 4.2 below. The simulation run is set up for a 20-year period (Jan 2024 to end of Dec 2043) but can easily be adapted for any period requested by the client.



4.2 Input data sheets

The following sub-section explains the input data sheets used. The full sheets are provided electronically.

4.2.1 General sheet

The first table displays general variables, including the start date and duration of the simulation model. Plant maintenance affects operational hours, and maintenance events occur randomly to simulate down-times in the operations. General assumptions can be included in the sheet to test different set-ups such as forcing a drought scenario into the model if required.

Table 1 - A list of operational variables used in the simulation

Period to simulate in years	20	yrs
Simulation start date (yyyymm)	202401	yyyymm
Actual data. After this period planned data is used.	0	months
Working Hours per Working Day	24	h
Smelter: % uptime (operating hours/total hours)	88%	percentage
Plant: % uptime (operating hours/total hours)	92%	percentage
Evaporation in mm per annum	1 759	mm / a
Wet tailings SG (slurry)	1.24	m ³ / ton
Concentrator : Process water use per tonne	1.22	m ³ / ton
Smelter : Process water use per tonne	0.04	m ³ / ton

4.2.2 Production sheet

Water requirements are calculated based on the production ramp-up schedule and the ratios of water required for different production areas. The water use ratios were supplied by Volspruit Mining Operations. All water flows at the various sites follow the planned production rates. Higher/lower production rates will result in higher/lower water flow rates. If production stops, or if the site is down for a maintenance event, water flows also stop for the duration of that event.

The production sheet contains the planned tonnages from January 2024 to end of December 2043. Planned production tonnes were supplied by the client and contained 9 years and 4 months of planned production tonnes for the North Pit. The client advised that the assumption should be made that production at the South Pit will commence once the North Pit production ceases and that a steady state production rate of 150 000 tonnes/month could be assumed (refer to Table 2 below). Production at the Smelter/CVMR commences in January 2028 with forecasted feed tonnes supplied by the client.

Table 2 - Production ramp-up schedule that drives the water use rates (excerpts only).

Month	Year	Concentrator feed	Smelter & CVMR feed	Tailings
		tonnes / mth	tonnes / mth	tonnes / mth
Jan-24	2024	677	-	663
Feb-24	2024	2 130	-	2 087
Mar-24	2024	94	-	92
Apr-24	2024	13 050	-	12 789
May-24	2024	19 575	-	19 184
Jun-24	2024	27 936	-	27 377
Jul-24	2024	11 008	-	10 788
Aug-24	2024	10 823	-	10 606
Sep-24	2024	9 348	-	9 161
Oct-24	2024	150 000	-	147 000
Nov-24	2024	99 674	-	97 681
Dec-24	2024	120 594	-	118 182
Jan-25	2025	12 275	-	12 030
Feb-25	2025	150 000	-	147 000
Mar-25	2025	25 629	-	25 116
Apr-25	2025	130 796	-	128 180
May-25	2025	55 070	-	53 968
Jun-25	2025	149 997	-	146 998
Jul-25	2025	150 000	-	147 000
Aug-25	2025	150 000	-	147 000
Sep-25	2025	150 000	-	147 000
Oct-25	2025	150 000	-	147 000
Nov-25	2025	150 000	-	147 000
Dec-25	2025	150 000	-	147 000
Jan-26	2026	150 000	-	147 000
Feb-26	2026	150 000	-	147 000
Mar-26	2026	150 000	-	147 000
Apr-26	2026	150 000	-	147 000
May-26	2026	150 000	-	147 000
Jun-26	2026	150 000	-	147 000
Jul-26	2026	150 000	-	147 000
Aug-26	2026	150 000	-	147 000
Sep-26	2026	150 000	-	147 000
Oct-26	2026	150 000	-	147 000
Nov-26	2026	150 000	-	147 000
Dec-26	2026	150 000	-	147 000
Jan-27	2027	150 000	-	147 000
Feb-27	2027	150 000	-	147 000
Mar-27	2027	150 000	-	147 000
Apr-27	2027	150 000	-	147 000
May-27	2027	150 000	-	147 000
Jun-27	2027	150 000	-	147 000
Jul-27	2027	150 000	-	147 000
Aug-27	2027	150 000	-	147 000
Sep-27	2027	150 000	-	147 000
Oct-27	2027	150 000	-	147 000
Nov-27	2027	150 000	-	147 000
Dec-27	2027	150 000	-	147 000
Jan-28	2028	150 000	7 500	147 000

Continues with supplied values up to end of December 2043

4.2.3 Flows sheet

The flow volumes between components are determined by the water use rates, water levels in dams, and the flow logic applied (Table 3). The table below shows an excerpt of the flows. The full table is available electronically as part of the input file. Each flow has a flow number, a description of where the flow starts, and where it flows to. Each flow has three variables that can be altered depending on the complexity of the model or the particular sensitivity that needs to be tested. Each flow is programmed in Arena with the pseudo code for the operational logic recorded in the last column of the table.

Table 3 – An excerpt of flows between components with logic applied as used in the model

Water Flow Variables		parameters to calculate flows...			FLOW LOGIC / RULE
No	Flow From	Flow To	input 1	input 2	
1	Raw Water Reservoir (RWR)	Concentrator (drinking/change houses...)	0	0	0.00
2	Raw Water Reservoir (RWR)	Concentrator (gland services, flocculants...)	0	0	0.00
3	Moist in Concentrator Feed tonnes	Concentrator	0	0	0.03
4	Process Water Dam (PWD)	Concentrator	0	0	0.00
5	Concentrator	Losses	0	0	0.10
8	Concentrator	Tailings Storage Facility (TSF)	0	0	0.00
9	Concentrator	WWTW	0	0	0.00
11	Raw Water Reservoir (RWR)	Smelter & CVMR (drinking/ablation...)	0	0	0.00
12	Raw Water Reservoir (RWR)	Smelter & CVMR (services)	0	0	0.00
13	Process Water Dam (PWD)	Smelter & CVMR	0	0	0.00
14	Rainfall	Tailings Storage Facility (TSF)	0	0	0.00
15	Smelter & CVMR	Losses (incl. evaporation, final product losses)	0	0	1.00
16	Tailings Storage Facility (TSF)	Evaporation	0	0	0.00
17	Tailings Storage Facility (TSF)	Seepage to the sub-surface	0	0.00%	0.00
18	Sub-surface	Toe-drain recoveries	0	100.00%	0.00
19	Smelter & CVMR	WWTW	0	0	0.00
20	Sub-surface	Seep to groundwater	0	0.00001%	0.00
21	Tailings Storage Facility (TSF)	Interstitial Losses	0	0	0.15
22	Tailings Storage Facility (TSF)	Return Water Dam (RWD)	0	0	232.00
23	Return Water Dam (RWD)	Process Water Dam (PWD)	0	0	599.00
24	ROM stockpile	Recovered runoff	0	0	0.00
25	WWTW	Losses	0	0	0.10
26	WWTW	Process Water Dam (PWD)	0	0	0.00
27	Pollution Control Dam (PCD)	Process Water Dam (PWD)	0	0	149.00
28	Raw Water Reservoir (RWR)	Process Water Dam (PWD) make-up	0	0	299.00
29	Irrigation dam silt trap	Irrigation dam	0	0.00%	0.00
30	Irrigation dam silt trap	Return Water Dam 1 (RWD 1)	0	100.00%	0.00
31	Fissure	South Pit	0.99	1	1.01
32	South Pit	Return Water Dam 3 (RWD 3)	0	0	399.00
34	Fissure	North Pit	0.99	1	1.01
35	North Pit	Irrigation Dam (ID) via a settler	0	0	499.00

4.2.4 Storages sheet

Table 4 details the different water storage components. The levels of these storage components influence the flows between them. The rainfall runoff coefficient, along with the surface- and catchment area of each dam, determines the total runoff that is captured per rain event.

Table 4 - A list of the water storage components used in the model

	Description	Capacity (m ³)	Start ops level (m ³)	Min ops level (m ³)	Max ops level (m ³)	Surface Area of Max pool (m ²)	Catchm (m ²) (incl Surface)	Max Runoff Coef.	Seepage (mm/day)
1	Tailings Storage Facility (TSF)	500 000	10 000	10 000	92 250	300 000	1 005 000	-	10
2	Return Water Dam (RWD 1) Cell 1	119 091	97 500	5 000	95 273	48 533	-	0.70	0.0001
3	Pollution Control Dam (PCD) at Plant	35 095	25 000	500	30 000	9 567	258 000	0.70	0.0001
4	Process Water Dam (PWD)	8 000	8 000	4 000	8 000	4 000	-	-	0.0001
5	Raw Water Reservoir (RWR)	2 000	1 950	500	1 950	-	-	-	0.0001
6	North Pit	10 000	-	-	10 000	5 000	667 840	0.70	-
7	South Pit	10 000	-	-	10 000	5 000	325 656	0.70	-
8	Waste Rock Dump PCD	63 340	-	500	35 000	19 272	537 000	0.70	0.0001
9	Irrigation Dam (ID)	100 842	37 500	5 000	90 758	47 807	-	-	0.0001
10	Return Water Dam (RWD 3) Cell 3	118 840	37 500	5 000	95 072	43 630	-	-	0.0001
11	Pollution Control Dam 2 (PCD 2) at ROM stockpile	20 900	20 000	1 000	16 000	8 175	235 000	0.70	0.0001
12	Return Water Dam (RWD 2) Cell 2	116 613	37 500	5 000	93 290	48 628	-	-	0.0001

Each of the storages was verified with the client, and its location checked against spatial layouts. Assumptions were used to derive the storm water catchment data and runoff coefficient information. These assumptions will also need to be verified once more information becomes available.

4.2.5 Boreholes

There is currently only one operational borehole available to supply raw water for drinking and service water purposes to the Volspruit Operations, this being the Grass Valley Borehole. The maximum potential yield for the Grass Valley borehole was obtained from source data⁴. The borehole has a very good yield and could supply sufficient make-up water to the Concentrator and/or Smelter/CVMR plants should this also be required.

Table 5 - Borehole data

No	Name	Yield (L/s)	Yield m ³ /h
1	Grass Valley borehole	10	36

4.2.6 Groundwater inflow rates

Groundwater inflow rates into the North- and South Pits were obtained from specialist studies completed in 2013. The previous Water Balance Model utilized the groundwater inflow rates provided for the scenario where *grouting* of the pits was considered. For the recent update of the model, grouting was no longer considered as an option and a *no grouting* scenario was used. This results in an increase of almost 60% in total groundwater inflows over the 20 year simulation period.

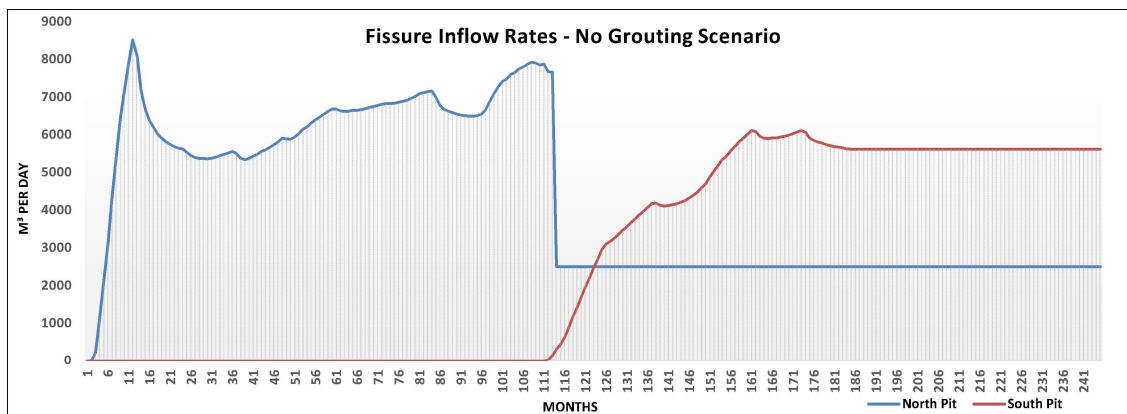


Figure 3 – Groundwater inflow rates for the North and South Pits under a *No Grouting* scenario.

⁴ Groundwater Specialist Study Update for Volspruit Mining Project – GPT Environmental Consulting Scientists – June 2023

4.2.7 Rainfall data sheet

Historical rainfall data sourced from the Volspruit SWMP Report CC1.pdf was used in the simulation model. Future rainfall generated by the simulation model uses these historic averages. Rainfall has a major impact on flows between components. Note that possible impacts of climate change have not been incorporated but could be simulated if required.

Rainfall events are simulated as follows:

- The number of rainfall events per month is based on the historical average.
- Times between rainfall events are calculated using an exponential distribution based on the average time between rainfall events for a given month. For example, October has on average 5.4 rain days, giving an average time between rain events of $31/5.4$ days. An exponential distribution renders many times between events to be shorter than average, and a few longer than average. For some years, in this example, October will be simulated to have fewer rain days, while for others there will be more, but on average there will be 5.4 rain days simulated for the month.
- The intensity of any given rainfall event is based on an exponential distribution of the average rainfall and the number of rain days for the given month. If October's rainfall were to average 90mm with an average of 5.4 rain days, the average volume of one event would be $90/5.4 = 16.67\text{mm/event}$. Using an exponential distribution with an average of 16.67 renders an array of rainfall intensities that often is less than 16.67mm and sometimes much higher than 16.67mm but again it averages 16.67mm in the long run.
- A Poisson distribution is used to randomly generate varying durations for rainfall events of between 1 and 8 hours. Eight hours was selected as a maximum simulation of long rainfall events.

Table 6 - Historic climate data for Volspruit Mining Operations

Month	days in mth	Hist. Rainfall mm/mth	Hist. R_days days/mth	Hist. Evap. mm/mth
Jan	31	88.4	9.10	162.4
Feb	28	64.1	7.30	155.8
Mar	31	44.0	6.30	121.8
Apr	30	11.3	4.10	100.5
May	31	5.2	1.90	79.9
Jun	30	2.4	0.70	88.1
Jul	31	3.6	0.50	122.4
Aug	31	15.8	0.70	162.8
Sep	30	47.9	1.80	192.3
Oct	31	90.3	5.40	185.2
Nov	30	127.7	7.70	195.3
Dec	31	117.4	8.20	192.7
Annual total	365	618.1	53.7	1 759.2

5 APPROACHES AND ASSUMPTIONS

A number of assumptions are necessarily included in setting up the model for the Volspruit Operations. These assumptions can be changed or updated as new or better data becomes available, or as the situation changes.

The base case model represents the planned operations at Volspruit Mining Operations and the model is set up with all the assumptions and inputs as described below.

The following assumptions were adopted for the model runs:

- The model runs from 1 January 2024 to 31 December 2043 (20 years in total). Runs for the full 20 years are based on flow volumes supplied and used for model calibration.
- Rainfall and evaporation rates follow seasonal trends, but rainfall is distributed about the monthly averages and may render dry spells (droughts) or wet spells (floods) on a random basis.
- There is no seepage at the Raw Water Reservoir, with very little seepage at the three Return Water Dams (RWDs), the Process Water Dam (PWD), the Irrigation Dam, the two Pollution Control Dams (PCDs) and at the Waste Rock Dump PCD.
- Evaporation rates sourced from the *Volspruit SWMP Report CC1.pdf* are used in the model.
- For all Plant operations:
 - Water demand requirements (use rates) were supplied by the client as part of the planning data and used in the model.
 - The plants have an up-time of 92%, averaging 668 up-time hours per month. This is inclusive of planned and unplanned maintenance. To compensate for down time-hours the model use slightly increased production rates per up-hour that average out with the zero production during downtime-hours. Due to natural variability in unscheduled downtime the monthly production will sometimes be slightly lower and at other times slightly higher than the average tonnes per month - but over time it will average out to represent the production figures supplied. The Smelter and CVMR only comes online at the beginning of year 5 of the simulation period.
- Water demand (or water requirement) is driven by the production rate of the Plants. The following assumptions were adopted:

Actual water pumped is sourced from the Return Water Dams (RWDs), Pollution Control Dams (PCDs), Process Water Dam (PWD), Irrigation Dam (ID) and the Raw Water Reservoir (RWR).

 - Inherent moisture for Run-Of-Mine (ROM) was taken as 3% of dry tonnes mined.
 - Excess water is pumped back to the various RWDs and PCDs for reuse.
 - The necessary drinking and service water is sourced from the Raw Water Reservoir (RWR) that is fed from the Grass Valley borehole. The maximum borehole yield was set at 10.0 L/s or 36.0m³/h as informed by source data⁵.

- Raw water use for drinking and services was calculated from the data supplied.
- Plant losses were calculated at 10% of all incoming water in the Plant feeds.
- The Plant has a requirement of 2.55m³/tonne for normal operations.
- Planned production rates as supplied by the client was used in the simulation model (Table 2).
- Interstitial losses were set at 15%.
- Rainfall, Evaporation and Seepage volumes were calculated on an hourly basis using the sizes of the pools, the wet beach and the dry beach respectively for each entity.
- Seepage to the TSF sub-surface was calculated as 10mm per day on the pool area of the TSF plus 40% on the wet beach area. Of this seepage, some 0.00001% or 3 m³ is lost to the groundwater due to the effectiveness of the planned liners while toe-drain recoveries are set to 100% less the 0.00001% lost to the groundwater of the calculated seepage.
- Evaporation losses follow a seasonal rate in mm/month as illustrated in Table 6 and are also applied on the pool area plus 40% of the wet beach area. Note that the pool area is dynamic and changes every hour.
- Waste water (sewage) flows are captured and shown individually.
- Dust suppression is added to the model. An estimate of 18m³/day was used, calculated per hour when the Irrigation Dam had sufficient capacity available.
- All calculations in the model update hourly, including the surface areas of all the dams. Evaporation and seepage losses are based on these surface areas. The in- and outflows to smaller reservoirs require continuous calculations to control the levels between the desired minimum and maximum levels.

6 KEY RESULTS

Simulation results are captured with monthly interval data in an output file made available to the client in electronic format. The data is then copied into a modified Excel output file. Here the user is able to view all flow- and stored volumes in the following formats:

- A set of time series graphs showing the monthly flow volumes for any selection of flows. Also the minimum/maximum stored volume levels for any selected storage.
- A summary table showing the 20-year flow volumes for each flow in the model. This table also shows average annual flow volumes.
- A static water balance shows the results in a schematic format. All flows can be shown as average daily, monthly or yearly flows with a clear separation of all the gains into the system (left-hand column) and all the losses from the system (right-hand column). The period of interest can also be set. For example a single (or few) month(s), a particular year (or years) or the full period simulated can be selected. The static balance draws its values from the dynamic model, making it possible to obtain a static balance for any scenario tested with the model.

No metered data is as yet available to confirm water use rates.

6.1 Total water used by Volspruit Mining Operations

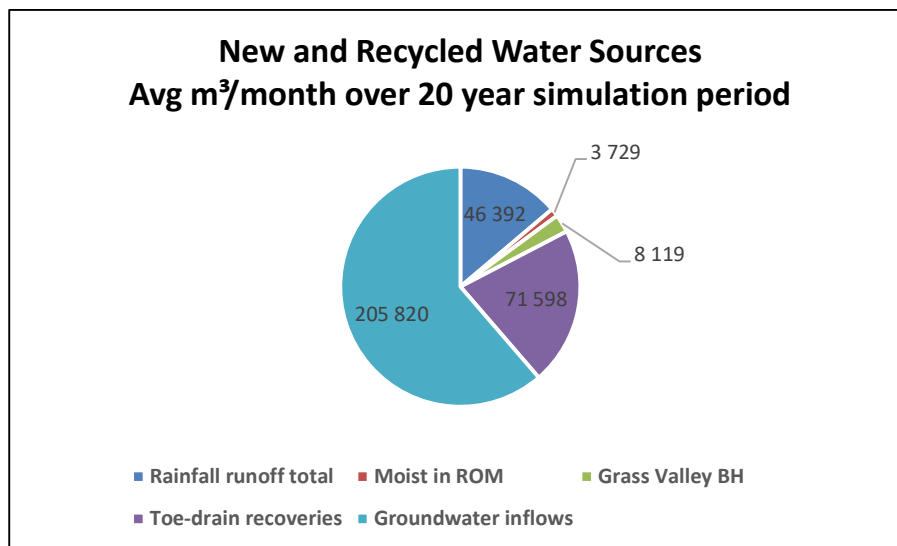


Figure 4 –Water sources used at Volspruit Mining Operations in average per month.

Groundwater inflows made up the largest portion of the total water used by the Volspruit Operations at 61%, followed by water recycled from the TSF through toe drain recoveries at 21%, and rainfall runoff collected at 14%. Water from the Grass Valley borehole was only required for drinking and service water and contributed 2% of total water used.

Groundwater inflows increased with almost 60% from the *Grouting* to the *No Grouting* scenario, resulting in no make-up water required from external sources.

6.2 Total water lost by Volspruit Mining Operations

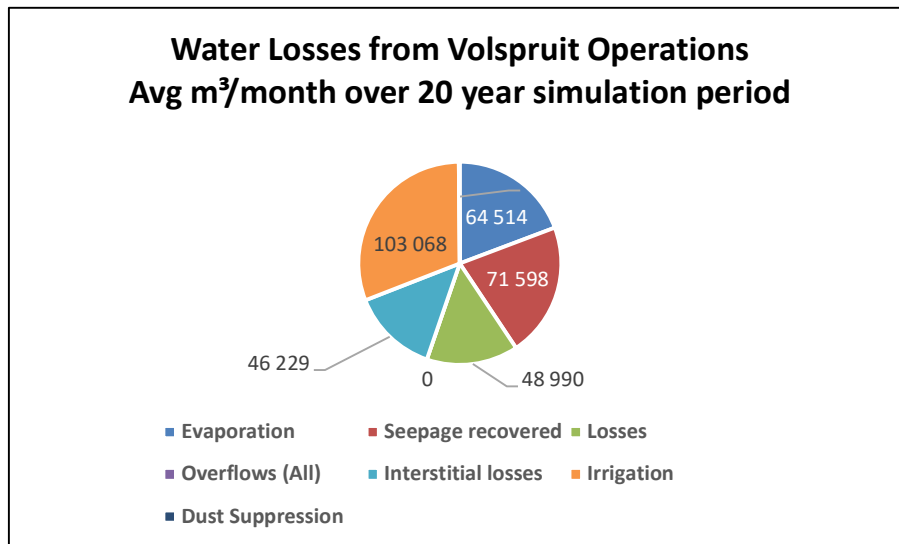


Figure 5 –Water losses from Volspruit Operations.

The largest loss from the system is irrigation water to the farmers at 31% of all water lost. This high figure is a function of ample water available from pit dewatering and the operational rules implemented to prioritise irrigation while minimising discharges to the environment. Seepage recovered is not in actual fact a loss to the system as it represents the water recovered through the TSF toe drains and recycled back to the Plants.

Evaporation (19%), Plant losses (15%) and interstitial losses at the TSF (14%) made up the majority of the rest of total losses.

6.3 Historic versus simulated rainfall

The simulated rainfall satisfactorily matches the historic data, averaging 615.4 mm/a while the historic average is 618.1 mm/a.

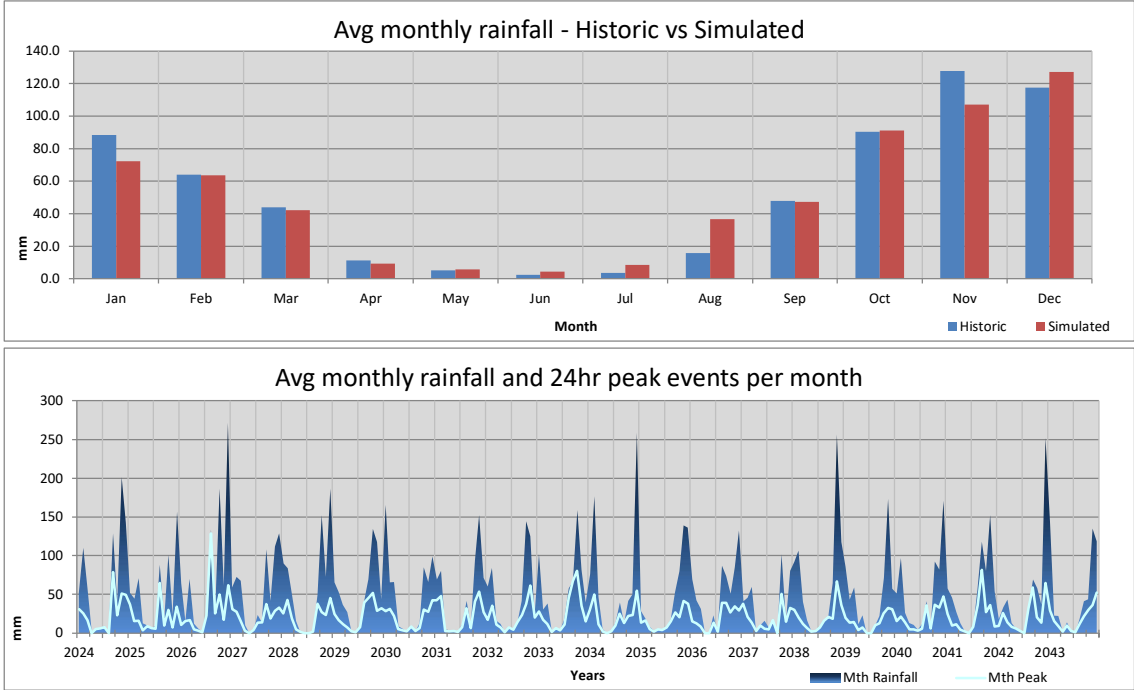


Figure 6 - A very good correlation exists between historic- and simulated rainfall.

The bottom graph shows typical seasonal variation - with the light blue line indicating the peak rainfall event in each month. A flood event of 130.2 mm in a 24 hour period was simulated and occurred in August 2026. The impact of this event is evident in all storage graphs of storages collecting rainfall runoff. This has great value in considering and preparing for such potential events.

6.4 Water balance summary results

The summary table below shows the simulated 20-year totals, yearly averages, total inflow, total outflows, and losses. The table further indicates the start and end levels of all storages, with the gains and losses over the simulated period.

Table 7 - Water balance summary from the 20 year simulation result

No	Flow From	Flow To	20 yr m³	avg m³/a	INFLOWS	OUTFLOWS	INTERNAL USE
1	Raw Water Reservoir (RWR)	Concentrator (drinking/change houses...)	1 029 871	51 494			51 493.56
2	Raw Water Reservoir (RWR)	Concentrator (gland ervices, floclulants...)	821 119	41 056			41 055.94
3	Moist in Concentrator Feed tonnes	Concentrator	894 960	44 748	44 747.99		
4	Process Water Dam (PWD)	Concentrator	80 469 638	4 023 482			4 023 481.92
5	Concentrator	Losses	8 218 572	410 929		410 928.58	
8	Concentrator	Tailings Storage Facility (TSF)	73 967 145	3 698 357			3 698 357.26
9	Concentrator	WWTW	1 029 871	51 494			51 493.56
11	Raw Water Reservoir (RWR)	Smelter & CVMR (drinking/ablution...)	51 494	2 575			2 574.68
12	Raw Water Reservoir (RWR)	Smelter & CVMR (services)	34 665	1 733			1 733.26
13	Process Water Dam (PWD)	Smelter & CVMR	3 397 199	169 860			169 859.95
14	Rainfall	Tailings Storage Facility (TSF)	5 471 188	273 559			273 559.42
15	Smelter & CVMR	Losses (incl. evaporation, final product losses)	3 431 864	171 593		171 593.21	
16	Tailings Storage Facility (TSF)	Evaporation	8 365 355	418 268			418 267.73
17	Tailings Storage Facility (TSF)	Seepage to the sub-surface	17 183 448	859 172	859 172.39		
18	TSF Sub-surface	Toe-drain recoveries	17 183 446	859 172			859 172.31
19	Smelter & CVMR	WWTW	51 494	2 575			2 575
20	Sub-surface	Seep to groundwater	2	0		0	
21	Tailings Storage Facility (TSF)	Interstitial Losses	11 095 072	554 754		554 754	
22	Tailings Storage Facility (TSF)	Return Water Dam (RWD)	42 770 692	2 138 535			2 138 535
23	Return Water Dam (RWD)	Process Water Dam (PWD)	82 447 558	4 122 378			4 122 378
24	ROM stockpile	Recovered runoff	100 610	5 030			5 030
25	WWTW	Losses	107 055	5 353		5 353	
26	WWTW	Process Water Dam (PWD)	974 310	48 715			48 715
27	Pollution Control Dam (PCD)	Process Water Dam (PWD)	522 819	26 141			26 141
28	Raw Water Reservoir (RWR)	Process Water Dam (PWD) make-up	11 960	598			598
29	Irrigation dam silt trap	Irrigation dam	-	-			0
30	Irrigation dam silt trap	Return Water Dam 1 (RWD 1)	17 183 446	859 172			859 172
31	Fissure	South Pit	19 162 408	958 120	958 120		
32	South Pit	Return Water Dam 3 (RWD 3)	19 656 572	982 829			982 829
34	Fissure	North Pit	30 234 509	1 511 725	1 511 725		
35	North Pit	Irrigation Dam (ID) via a settler	29 952 798	1 497 640			1 497 640
36	Pollution Control Dam 2 (PCD 2)	Irrigation Dam (ID) via a settler	24 057 724	1 202 886			1 202 886
37	Irrigation Dam (ID) via a settler	Irrigation water to farmers	24 736 335	1 236 817		1 236 817	
38	Irrigation Dam (ID) via a settler	Return Water Dam (RWD) return and overflow	24 781 401	1 239 070			1 239 070
39	Return Water Dam 3 (RWD 3)	Pollution Control Dam 2 (PCD 2)	24 151 824	1 207 591			1 207 591
41	Pollution Control Dam (PCD)	Return Water Dam 3 (RWD 3)	354 471	17 724			17 724
42	Pollution Control Dam (PCD)	overflow to environment	-	-		0	
43	Waste Rock Dump PCD	Return Water Dam 3 (RWD 3)	1 790 583	89 529			89 529
44	Irrigation Dam (ID)	Return Water Dam 3 (RWD 3)	3 365 631	168 282			168 282
45	Return Water Dam 1 (RWD 1)	Return Water Dam 2 (RWD 2)	117 181 701	5 859 085			5 859 085
46	Return Water Dam 2 (RWD 2)	Return Water Dam 3 (RWD 3)	87 863 049	4 393 152			4 393 152
47	Return Water Dam 3 (RWD 3)	Return Water Dam 1 (RWD 1)	84 473 875	4 223 694			4 223 694
48	Return Water Dam 2 (RWD 2)	Return Water Dam 1 (RWD 1)	28 164 274	1 408 214			1 408 214
49	Pollution Control Dam 2 (PCD 2)	overflow to environment	-	-		0	
50	Irrigation Dam	Dust Suppression	122 501	6 125		6 125	
52	Grass Valley borehole	Raw Water Reservoir (RWR)	1 948 609	97 430	97 430		
56	Waste Rock Dump PCD	overflow to environment	-	-		0	
		Rainfall runoff		556 699.46	556 699		
		Evaporation		774 165.81		774 166	
		Seepage		859 177.87		859 178	
		TOTAL			4 027 896	4 018 914	39 083 889
Average yearly water balance (inflows - outflows)					8 982	(remains in storage)	

Table 2 Water balance over 20 years

+Starting levels (all dams)	274 950
+ Total gains	80 557 923
- Total losses	80 378 274
- Ending Levels	454 600
Water balance	0

7 CONCLUSIONS

The Base Case results from this simulation estimate that the Volspruit Mining Company (based on the production schedule provided) will use:

- About 8 100m³ of raw water per month - supplied from Grass Valley borehole;
- About 3 700m³ of water per month is added to the system through the moisture in the ROM;
- About 46 400m³ of water per month is added to the system through rainfall runoff;
- About 71 600m³ of raw water per month from toe-drain recoveries, and
- About 205 800m³ from groundwater inflows into the pits.

The above figures are the average values per month for the full simulation period (January 2024 to end of December 2043).

- Water returned from the North- and South Pits, together with toe drain recoveries from the TSF and rainfall runoff, provides sufficient water to sustain the planned production at Volspruit Mining Operations.
- The *No Grouting* scenario opted for, resulted in about 60% more groundwater inflows into the North- and South Pits. The knock-on effect was that the dewatering rate had to be doubled from the pits to the respective receiving dams (RWD 3 and Irrigation Dam) to ensure that acceptable water levels are maintained in the Pits. This further resulted in an increase in irrigation to the farmers from 29 000 m³/month to 103 000 m³/month.
- The Grass Valley Borehole is the only external source required and this is only needed to supply the requirement for drinking and service water at the plants. This made up only 2% of total water consumed. Only 30% of the maximum potential yield of the Grass Valley borehole was utilised.
- No make-up water from any external source was required to supplement the Plants' water requirements.
- No discharges occurred to the environment as the current operational rules/model logic is set up to prioritise irrigation to the farmers when dam levels reach capacity.
- The static water balance shows all the water gains and losses for an average month over the full simulation period of 20 years. These gains and losses balance with the differences in the storage levels over the same period. Any date selection can be made in the static balance to show the preferred time period or time unit for which results are required.

8 RECOMMENDATIONS

- Groundwater/fissure inflows into the North- and South Pits are the largest source of new water to the Volspruit Operations. The water balance model used fissure inflow data from specialist studies completed in 2013. The accuracy and validity of these figures should be confirmed, as it is pivotal to the results achieved and deductions made.
- The dewatering pump rates from the North- and South Pits had to be increased to 400 m³/h and 500 m³/h respectively, to maintain acceptable Pit levels. These rates need to be confirmed as cost effective and manageable.
- At present, the model is set up to still receive dewatering from the North Pit after the pit has been rehabilitated (according to the fissure inflow model⁶ some 2500³/day still materialises). This, together with the approximately 5000 m³/day dewatering from the South Pit, more than provides for the process water demand at the plant and smelter. One suggestion to be considered is that feed from the North Pit could cease once the Pit is rehabilitated.
- The simulated irrigation rate of 103 000 m³/month should be confirmed as viable. At this irrigation rate, there are no discharges to the environment.
- Implement the lining of the dams to ensure no water (or as close to zero as possible) is lost through seepage.
- Installation of flowmeters and monitoring systems are important to ensure that reliable data is available for water management once the mine is operational.

⁶ Groundwater Study – Giep du Toit 2013

APPENDIX A: Static Water Balance (Average flows in m³/month.)

