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WATER BALANCE STUDY

Stuart Coal South Colliery

Mpumalanga Province, South Africa

Report: 1.002-3B.4
Date: 2019/04/01

Director: Walter Michael Scharf

Revision register

Revision	Report number	Date	Description
0	1.002-3B.0	2018/10/31	First issue
1	1.002-3B.1	2018/11/05	Water balance updated.
2	1.002-3B.2	2018/11/28	Water balance updated.
3	1.002-3B.3	2019/02/12	Water balance updated.
4	1.002-3B.4	2019/04/01	Report updated with comments from CSEC

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1. INTRODUCTION

Gestión Engineering and Project Consultants (Pty) Ltd was appointed by Clean Stream Environmental Consultants (Pty) Ltd to conduct a water balance design and report as part of the Integrated Water and Waste Management plan for the new proposed mining activities for the Stuart Coal South Colliery. This document reports on the design, layout, assumptions and modelling of the water balance network for the site.

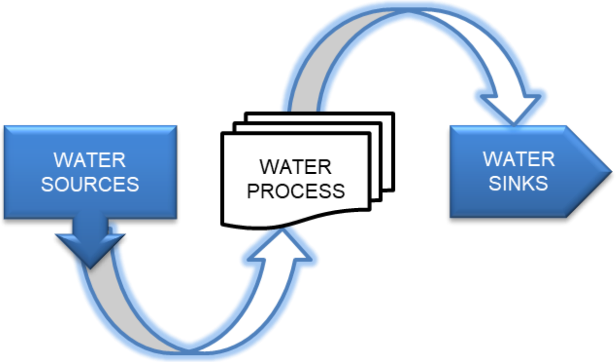

Figure 1: Water balance process

A water balance for any process, or sub-activity thereof, is achieved by modelling the specific water cycle as it relates to the process. This mass balance, based on the principle of continuity, is simplified by **Figure 1** wherein the application water sources are balanced with the water sinks through some water process. This would then simplistically equate to:

Mass of water in = Mass of water out + process losses/gains

Typical water sources are comprised of surface water sources (rainwater, run-off, etc), sub-surface water sources (groundwater influx) and process water (i.e. the output water from a specific process may be an input source to a subsequent process).

1.1. Locality

Stuart Coal South Colliery (hereinafter referred to as "the site") is located on portions 7, 9, 14, 15 and 24 of the farm Moabsvelden 248-I.R, portions 2 and remainder of the farm Vanggatfontein 250-I.R, and the remainder of the farm Vogelfontein 222-I.R. The site forms part of the Nkangala District Municipality in the western part of Mpumalanga, South Africa. The nearest formal settlement is the local town of Delmas (refer to **Figure 2**). The specific coordinates are:

28°49'29.32 E

26°09'0.804 S

1.2. Mine activity and layout

It is envisaged that coal mining operations will be conducted in a series of eight open cast mining sections. The truck-and-shovel operation will be based on conventional rollover mining methods, with the ROM transported with haul trucks to the on-site plant (which includes a beneficiation facility).

Other site facilities will include offices, workshop, weighbridge, haul roads, explosives magazine, pollution control dams (PCDs) and other ancillary infrastructure. An indicative layout is shown in **Figure 3** below.

Figure 2: Locality

Figure 3: Mine layout

2. OBJECTIVES OF WATER BALANCE STUDY

The main objective of the water balance study is to assist the mining operation to manage its water and waste in a responsible and sustainable manner. As part of the Integrated Water and Waste Management plan, the water balance needs to be utilised as a management tool to identify areas that are targeted for water management. The water balance will also assist to identify management measures as part of the water management strategy.

The objective of the study is motivated by the impact of the mining activities on the natural water cycle, especially the proposed water use as part of the mining activity. Since the mining activity as still at conception level, it will be necessary to continuously update and refine these objectives as more information and data becomes available.

Based on the Best Practice Guideline G2 issued by the Department of Water and Sanitation (Department of Water and Sanitation, 2006), a conceptual process flow diagram has been developed as reflected in **Figure 4** below.

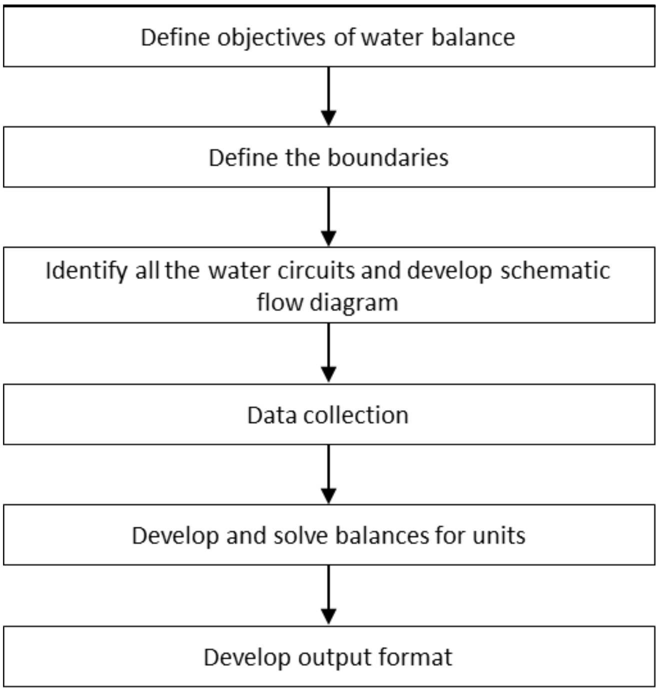

Figure 4: Water balance determination process

The objectives in summary are therefore:

- To define the anticipated water use for the surface mining activities;
- To quantify the probable impact of the mining activity on the natural water cycle;
- To develop water use circuits in order to manage the impact of water usage on consumption and the environment;

3. WATER MANAGEMENT AREAS

For the purpose of this report, the site was divided into numerous Water Management Areas (WMAs). A WMA is basically a dirty water area that has been specifically defined in terms of its use. A minimum buffer area of 10m has been adopted throughout.

3.1. Water management area boundaries

Seven Water Management Areas were identified to represent the water usage on site. The WMAs each consist of an intricate water circuit, although this has only been analysed at a conceptual level. The different WMAs are dynamically linked by means of various water transfer utilities. The summation of the individual WMAs will therefore reflect the combined water balance of the total site.

The following management areas were identified:

1. The series of eight open cast mining pit areas;
2. A series of two existing, as well as additional future Pollution Control Dams (PCDs);
3. Plant area, consisting of a process surge tank, beneficiation plant, slurry plant, and a filter press plant;
4. A workshop area, including a recreation green space;
5. Security hut;
6. Offices, including a recreation green space;
7. Weighbridge;

A schematic flow diagram has been developed to indicate these WMAs, as well as the water flow process. This schematic has been included in **Annexure 2**.

A reporting template for the outcomes of the various water balance modelling scenarios has been designed based on the identified WMAs and the schematic flow diagram. This template provides a convenient summary of the daily averaged flow rates for any particular modelling period. The layout of this template is indicated in **Figure 5** below (kindly read this with the schematic flow diagram included in **Annexure 2**).

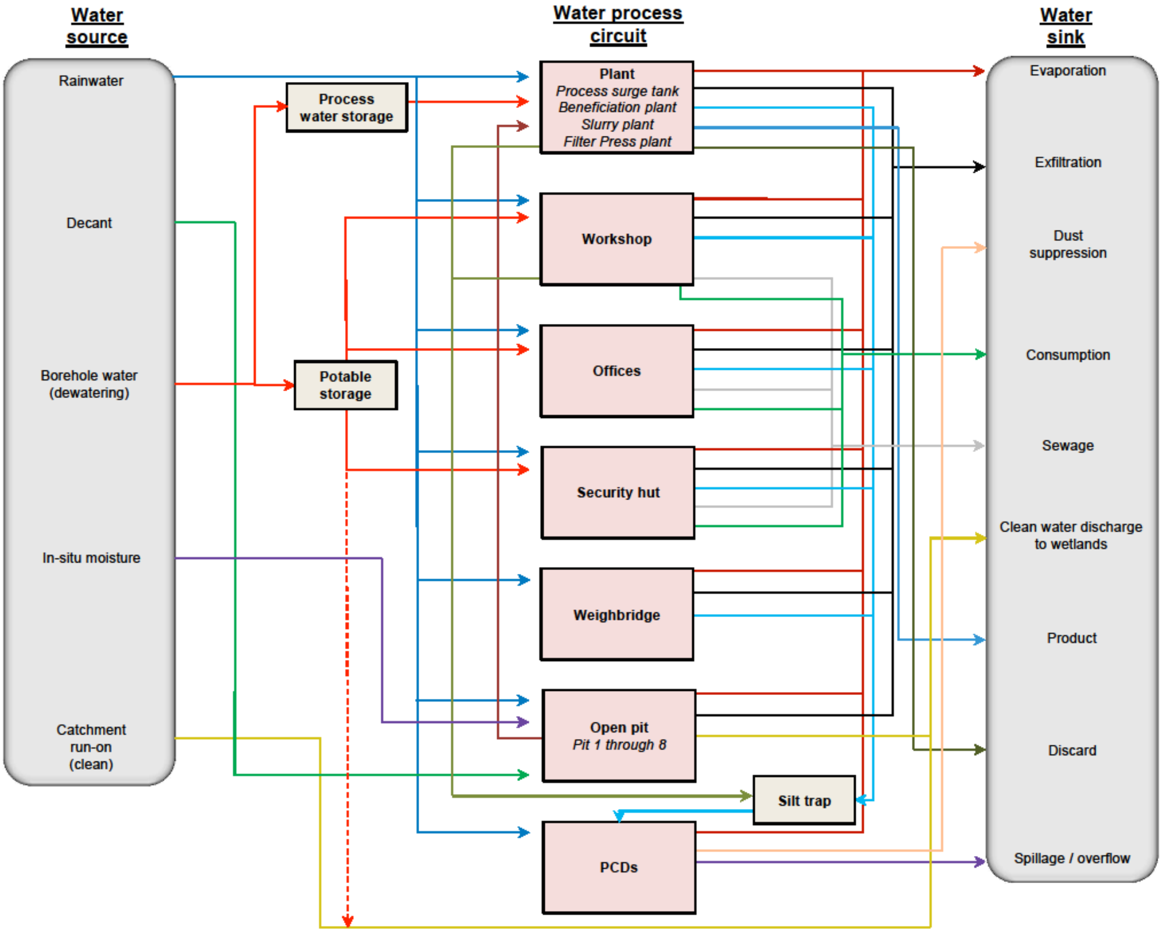

Figure 5: Schematic reporting template for Water Balance

7.1. Water circuits and schematic layout

Referring back to **Figure 1**, the conservation of mass, or continuity, of each water circuit can be simplified by a basic inflow-outflow balance. This is also a convenient way to analyse and report on clean and dirty water flows within each specific water circuit.

The typical principle and layout of this water circuit diagram is illustrated below in **Figure 6**. Inflows to the WMA are provided on the left hand side of the process, divided in “clean” (green) or “dirty” (red) water flows. These water flows are further delineated according the specific source. The same principle applies to the outflows, which are reflected on the right hand side.

From the diagram the overall balance is provided at the bottom of the WMA block. The balance between clean/dirty inflows versus clean/dirty outflows can also be readily be derived.

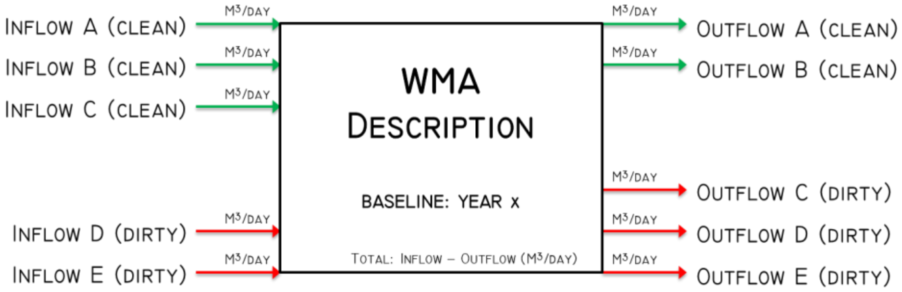

Figure 6: Water circuit diagram

8. DATA COLLECTION AND RESOURCES

The following studies were used as source to quantify the relevant water inputs for the design of the water balance model:

Title	Author	Reference	Date
Surface water baseline study	Gestion Engineering and Project Consultants, 2018	SWR	November 2018
Stuart Coal south block colliery – groundwater study	Delta-H Water System Modelling PTY Ltd, 2018	GWS	October 2018
EIA/EMP phase soil, land use and land capability survey	Van der Waals, 2010	GeoT	January 2010
Outline scheme report: provision of civil engineering bulk services (water and sewer)	MJ Consulting cc, 2018	SR	September 2018

8.1. Key inputs: water sources

8.1.1. Rainwater

The surface water baseline study (SWR) reported on the statistical analysis and probability distribution of the mean annual and monthly precipitation values. A summary of the analysis is provided below in **Table 1.** For the purposes of this study, the following definitions were applied:

Wet season:	Monthly mean precipitation values between the 50th and 90th percentiles.
Dry season:	Monthly mean precipitation values between the 10th and 50th percentiles.
Average season:	Monthly mean precipitation values along the median, or 50th percentile.

Table 1: Summary of statistical analysis of mean annual and monthly rainfall

Month	Standard Deviation	Mean	Minimum	Maximum	95th percentile	10th percentile	90th percentile
January	80.4	135.8	0.0	344.9	269.0	34.5	241.4
February	61.8	79.1	0.0	295.0	180.0	0.0	159.3
March	61.8	90.6	0.0	269.0	193.7	10.8	172.2
April	35.6	42.2	0.0	127.5	99.4	0.0	89.3
May	20.0	14.3	0.0	85.0	47.6	0.0	40.8
June	11.7	6.5	0.0	67.4	25.6	0.0	21.6
July	5.2	2.6	0.0	24.2	11.1	0.0	9.2
August	11.2	7.1	0.0	46.4	26.0	0.0	21.3
September	30.2	20.3	0.0	160.6	70.7	0.0	61.0
October	48.6	72.2	0.0	229.0	151.1	9.2	132.8
November	58.2	104.4	0.0	226.6	199.4	31.7	181.3
December	52.5	117.7	0.0	254.0	203.2	50.8	188.0
Total	**189.1**	**686.0**	**184.4**	**1162.8**	**996.5**	**438.8**	**928.0**

By applying a random probability function to the different (and combined) distributions, a forecast model was constructed and applied to investigate and model the short, medium and long term average daily rainfall (mm/day).

The averaged daily demand, measures in cubic metres per day (m^3/day) is obtained by multiplying the daily rainfall forecast depth (in mm) to the specific water management catchment area (WMA).

8.1.2. Potable water

Potable water demand has been determined by Messrs MJ Consulting for 4 main areas, namely the main office complex (22pax), the workshop complex (20pax), the entrance security (4pax), and the plant complex (31pax). The general consumption (demand) has been estimated to be a daily demand of 1860l, 1240l, 144ll, and 1760l respectively, based on a design consumption of 400l/day per 100m^2.

The potable water demand for the plant complex is for a proposed green area within the complex, for staff recreation. Since the compilation of the services report it has been indicated by the client that this area would rather be provided as part of the office complex, thereby increasing the demand for the office complex from 1 860lday to 3 620l/day. This does however not affect the overall water balance.

Further potable water needs have been indicated for the workshop complex, which will require 10 000l/day of potable water for mainly the wash bays, as well as some consumption.

It is proposed to source the potable water from groundwater abstraction (to be treated if necessary), as discussed later in the report.

8.1.3. Process water

Clean water abstraction from sub-surface aquifers may be required to supplement the water feed for the plant complex. This complex, consisting of *inter alia* a process surge tank, a beneficiation plant, a slurry plant, a spiral plant and a filter press plant, has an expected water intake demand of 300m³/h (as provided by the client). The expected loss through the process is provided as 90m³/h, which same volume needs to be replenished from a dirty water source.

8.1.4. Borehole water (dewatering)

The only groundwater source expected is in the form of anticipated infiltration into the open pit areas. The proposed open cut mining operation will expose the prevalent aquifers in the region, allowing a major proportion of groundwater inflow due to the low potential created. The GWS informed on the expected groundwater inflow into the pit areas, a summary of which is provided in **Table 2** below:

Table 2: Groundwater infiltration rates as reported in the GWS

Pit Area (mining schedule)	Average Inflows (m³/day)
Delta 1 (2019 to 2028)	875
Delta 2(2029 to 2036)	912
Alpha (2037 to 2048)	1 250
Echo 1 (2049 to 2062)	1 402
Beta (2063 to 2075)	1 490
Beta (2076 to 2087)	935
Echo 2 (2088 to 2091)	589
Charlie 1 (2092 to 2097)	762
Charlie 2 (2098 to 2102)	211

It is evident from the values in **Table 2** that the expected groundwater infiltration rates are orders of magnitude larger than all other water balance values. For instance, at an assumed maximum dewatering pumping rate of 4000l/hr, the equivalent dewatering volume for Delta Pit 1 is only 96m³/day. This equates to only about 11% of the inflow. In terms of the recommendations of this report it is proposed to rather deal with this anticipated infiltration by large scale ground water abstraction. This method would consist of an array of groundwater abstraction points hydraulically upstream from the pit area. The groundwater abstraction would locally lower the water table to below the open pit invert (lowest excavation level), this preventing seepage and contamination of the water. The groundwater infiltration will be included in the balance for the borehole water as above.

This issue is discussed in more detail later in the report.

8.1.5. Rehabilitated seepage

In terms of the GWS, the following decant rates are proposed post-closure of the relevant open pit sections:

Table 3: Proposed decant rates post closure

Pit Area	Decant Rate (m³/day)
Delta	267
Alpha	143
Echo1	196
Beta	350
Echo2	51
Charlie1	71
Charlie2	49

For the purposes of the LOM water balance, it is assumed that the expected inflow from rehabilitated pit areas has been included in the ground water seepage values indicated earlier.

8.1.6. Surface water run-on

Clean surface water run-on should be diverted away from any dirty water areas (including the open pit areas) and will therefore not form part of the water balance.

8.2. Key inputs: water sinks

8.2.1. Evaporation

The surface water baseline study (SWR) reported on the statistical analysis and probability distribution of the mean annual and monthly evaporation values as recorded. A summary of the analysis is provided below in **Table 4.**

Table 4: Summary of statistical analysis of mean annual and monthly evaporation

Month	Standard Deviation	Mean	Minimum	Maximum	95th percentile	WR2012
January	30.8	167.7	65.2	255.0	217.0	
February	36.3	153.6	94.8	255.0	215.0	
March	26.7	139.2	93.2	255.0	182.2	
April	25.4	108.4	69.8	255.0	150.8	
May	35.4	92.1	65.8	255.0	150.9	
June	37.7	74.2	51.9	255.0	135.7	
July	26.6	78.0	59.8	255.0	120.8	
August	23.9	106.6	81.9	255.0	146.8	
September	39.1	152.9	95.9	255.0	219.2	
October	29.5	169.1	119.5	272.3	218.8	
November	28.4	169.1	113.2	255.0	216.0	
December	27.4	178.7	119.3	255.0	180.4	
Total		**1589.7**			**2153.6**	**1677.0**

In contrast to the rainfall values, only the mean monthly values for the evaporation data was utilised in the model. This is mainly due to inherent limitations of the modelling software. Since the effective evaporation is dependent *inter alia* on temperature and wind speed, the applied assumption is considered to be valid for the intended application.

8.2.2. Exfiltration (seepage)

The regional geology indicates intercalated arenaceous and argillaceous strata, with upper layers of colluvium and residual diabase (typically classified as SaClLm). WR2012 indicates an Erodibility Index value of 6, which is classified as a general high erosion potential with typical yields of 26000t/a.

In order to develop a dynamic inflow-outflow balance, and based on available information, the Horton Infiltration method was adopted for modelling natural infiltration (seepage), with the following parameters:

Table 5: Adopted Horton infiltration parameters

Input parameter	Natural conditions	Within MWAs
Minimum infiltration rate (mm/hr)	51	38
Maximum infiltration rate (mm/hr)	152	76
Decay constant	4	4
Maximum volume (mm)	786	786

The maximum volume has been taken as the difference between soil's porosity and wilting point, times the depth of the infiltration zone. The following general hydrological parameters were adopted for the natural catchment based on the geology, vegetation and prevalent topographical slopes:

Table 6: Adopted SWMM hydrology values

Input parameter	Natural conditions	Within MWAs
Imperviousness (%)	0 – 5	80-100
Impervious area without depression storage (%)	0	80
Impervious area: Manning's roughness	0.032	0.015
Impervious area depression depth (mm)	D_S = 7.7*S^0.49	
Pervious area depression depth (mm)	7.5	5
Pervious area: Manning's roughness	0.04	0.025

8.2.3. Run-off

The SWR determined an empirical relationship between evaporation, exfiltration and run-off as it pertains to natural overland drainage. These relationships are given in terms of the MAP as:

Evaporation as a function of precipitation:	MAE = 21.5% of MAP
Natural infiltration as a function of precipitation:	MAIL = 74.2% of MAP
Run-off as a function of precipitation:	MAR = 3.8% of MAP

Natural run-off towards each WMA can readily be calculated based on the surface area of the WMA and the applicable random MAP utilised. The water balance model was not designed to recalculate run-off values, but rather to assume the previous stated relationships based on the MAP.

8.2.4. Groundwater infiltration

Groundwater recharge, or exfiltration, has been analysed in the GWS. The study reports the proposed exfiltration rates as follows:

Table 7: Exfiltration rates as reported in the GWS

Unit	Life of Mine		Post-closure	
	(% of MAP)	(mm/a)	(% of MAP)	(mm/a)
Weathered Karoo and Alluvium	± 3	18	± 3	18
Open cuts	± 20	120	N/A	N/A
Unrehabilitated backfilled spoils	± 15	90	N/A	N/A
Rehabilitated backfilled spoils	± 10	60	± 10	60

8.2.5. Dust suppression

Dust suppression on the haul and access roads will be done by means of conventional water tanker application. An application of 35 000l per tanker has been assumed, with dust suppression applied continuously for the operation hours of 07h00 to 19h00. A mean application of 210m^3/day has been utilised for the purpose of this study, depending on the relevant PCD storage volume available. It should be noted that dust suppression volumes need to be discounted against the expected precipitation inputs.

8.2.6. Spillage

Spillage for all dirty water areas must be contained by cut-off channels draining to appropriately sized sumps. Freeboard provision must be designed to accommodate the entire expected 1:50 year rainfall depth of 230.5mm.

8.2.7. Consumption and sewage

General potable water intake has been divided on a 65/35 basis between consumption and sewage, except for the workshop complex, for which 100% of the water intake has been diverted to the PCD.

8.2.8. Discharge

Surface water discharge of clean water will mainly be from the dewatering abstraction of groundwater. It is proposed that this discharge be utilised as part of the environmental requirements for discharge, as well as for the constructed wetlands.

Run-on discharge will be diverted around all WMA be suitably designed channels, the outlets of which needs to be designed to include a silt trap and suitable energy dissipation.

8.2.9. Other

Further water sinks will be through the plant complex, as well as possible discharge for the PCDs or other water containment areas. The water balance is for the plant complex is based on a 30% consumption, which is included in general product uptake and process discard.

8.3. Rehabilitated infiltration and decant

The post-closure expected groundwater decant rates have been modelled in the GWS, and have been reported as per **Table 8** below:

Table 8: Post-closure decant rates as reported in GWS

Pit Area	Decant Rate (m^3/day)
Delta 1	267
Alpha	143
Echo 1	196
Beta	350
Echo 2	51
Charlie 1	71
Charlie 2	49

9. MODEL SETUP AND DESIGN

In order to provide a realistic water balance prediction for the site development, a continuous volume balance model was developed using the Storm Water Management Model (SWMM) as developed by the United States Environmental Protection Agency. The model is designed to predict probability based hydrological values, such as precipitation, infiltration (or seepage/exfiltration), evaporation and run-off. The design and set-up of the model is based on the recommendations provided in the Best Practice Guidelines (G2) issued by DWS.

The model has been set-up to do a LOM analysis of up to 110 years, analysing the data on 1-hour time step and reporting basis (in other words, the continuity is balanced every hour, for a simulation period of 110 years). The output reports on each individual WMA as well as the site in total. The model furthermore allows for “snapshots” to be taken at any desired time period to report on the applicable water balance values.

The model is a dynamic routed model, which interprets that the dynamic water volumes are dynamically modelled. This is very useful in analysing all water storage facilities such as the PCDs.

This report includes the detailed results and diagrams for the following snapshot events:

- Year 1 (baseline)
- Year 10
- Year 20

The results are provided for a wet, dry and median rainfall model individually. The model reported the following continuity:

Table 9: Continuity errors reported

Snapshot event	Rainfall scenario	Continuity error
Year 1	*Dry*	**-2.02%**
Year 1	*Median*	**-0.78%**
Year 1	*Wet*	**-0.30%**
Year 10	*Dry*	**-0.40%**
Year 10	*Median*	**-0.61%**
Year 10	*Wet*	**-078%**
Year 20	*Dry*	**-0.21%**
Year 20	*Median*	**-0.39%**
Year 20	*Wet*	**-0.56%**

The continuity error can be simplistically defined as the overall percentage water loss (-) or gain (+) during the simulation period. It can be seen that the continuity error decreases with the length of the simulation period. The order of magnitude of the report values are however negligible and is considered to be an excellent confidence in the model.

10. EXISTING WATER CONTAINMENT INFRASTRUCTURE

At the time of writing this report two pollution control dams (PCDs) have been designed and constructed on the site. The design details of these two facilities are provided in the report titled "*Detail Design Report for the Pollution Control Dam Structures for the Stuart Coal South Block Mine (Delta Section) On The Farm Vanggatfontein 250 IR Mpumalanga*" by Gestión Engineering and Project Consultants. The more important details are provided below:

POLLUTION CONTROL DAM 1

- Type of dam structure: Earth embankment
- Seepage control: 1,5mm thick HDPE lining with Geosynthetic Clay Liner
- Earth embankment height: 3.84m
- Earth embankment crest width: 4m
- Earth embankment crest length: 400m
- Earth embankment slopes: 1 (v) : 2.5 (h) on outside slope and 1 (v) : 4.5 (h) on inside slope
- Free board: 800mm
- Volume: 14800m^3

POLLUTION CONTROL DAM 2

- Type of dam structure: Earth embankment
- Seepage control: 1,5mm thick HDPE lining with Geosynthetic Clay Liner
- Earth embankment height: 2.84m
- Earth embankment crest width: 4m
- Earth embankment crest length: 300m
- Earth embankment slopes: 1 (v) : 2.5 (h) on outside slope and 1 (v) : 4.5 (h) on inside slope
- Free board: 800mm
- Volume: 6300m^3

As part of the water balance model, a flood routing was done through the two existing dams (in series) to determine the performance based on the latest information and assumptions.

The results from the model indicated that the two dams may overflow during a normal rainfall season. A conceptual third PCD dam (namely PCD3) was subsequently included to ascertain the additional required storage volume. Based on a 20-year model, the maximum volume reached is about 1 660 000m^3, at around year 11. This is considered to be a major deficit.

11. SUMMARY

11.1. Water balance outputs

The following two figures provide a breakdown of the water sources and water sinks breakdown, for the baseline of the model (year 1, median rainfall). It is evident that the largest contribution to water inflow originates from rainwater, whilst clean groundwater abstraction accounts for the major portion of the remaining water sources.

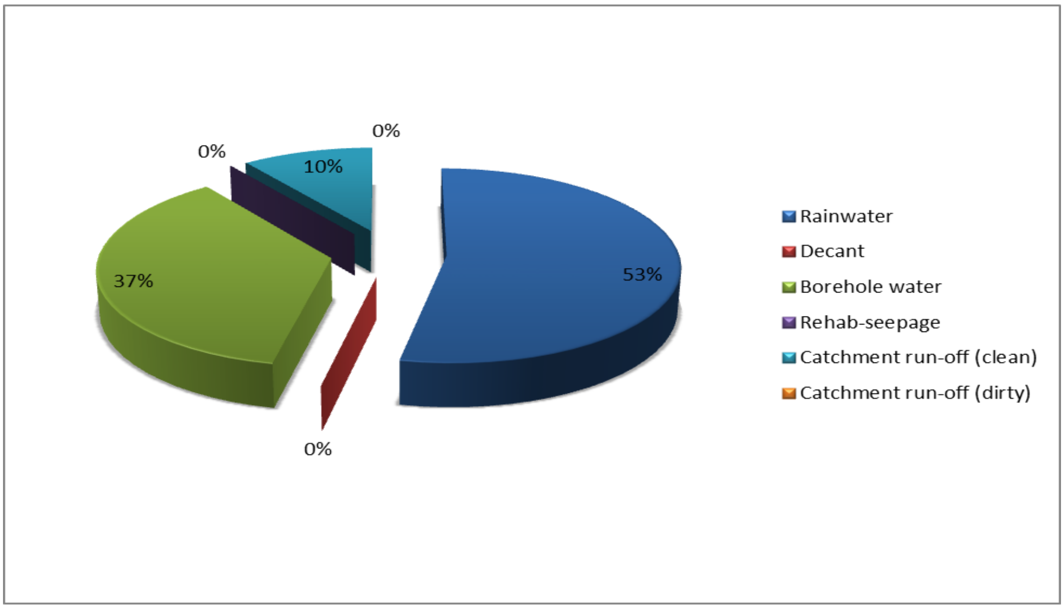

Figure 7: Breakdown of water balance sources

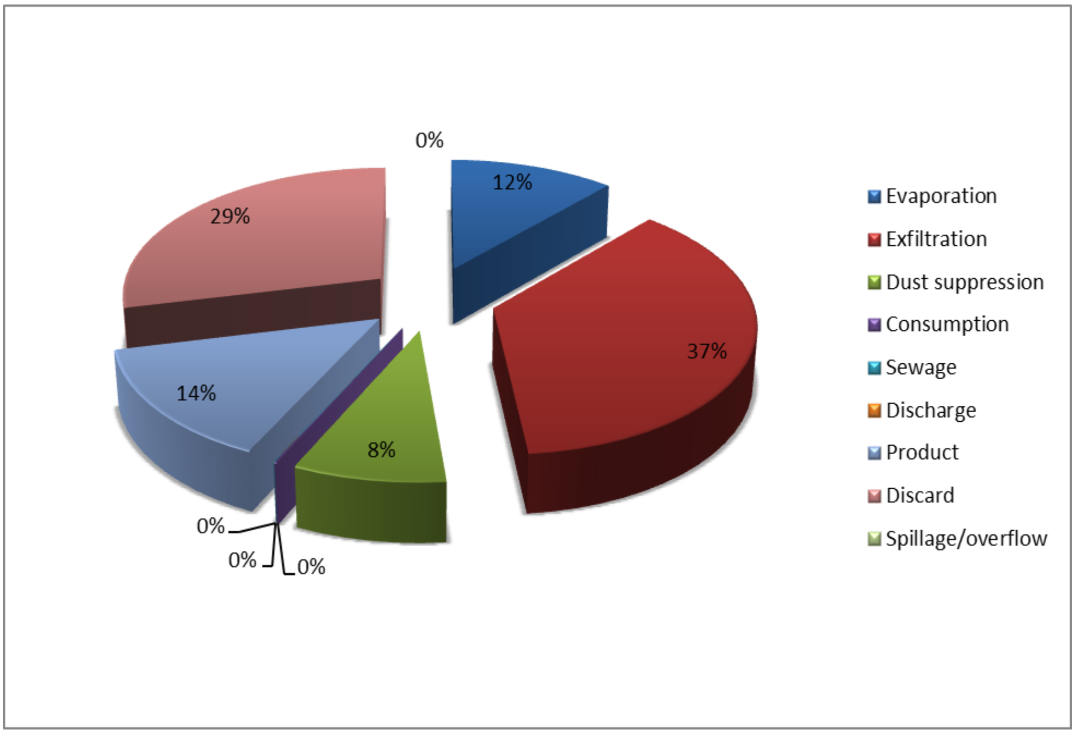

Figure 8: Breakdown of water balance sinks

The largest water outflows are estimated to be from natural exfiltration (53%), which is directly related to the rainfall volume input. Discard (29%), product (14%) and evaporation (12%) accounts for the majority of the remaining outflow volumes.

Detailed model outputs for the individual water cycles, as well as the overall water balance are provided in **Annexures 3, 4 and 5**. The results are provided for all three seasonal evaluations, and for the baseline (year 1) and predicted future scenarios at year 10 and 20 respectively.

11.2. Recommendations

As recorded previously in this report, it is evident that the volume balance of groundwater infiltration to the pit area by far exceeds any balancing volume involved.

With reference to **Figure 9** below, if a conventional approach is followed (Option 1) it would imply a massive amount of pumped water that needs to be accommodated by facilities such as PCD, evaporation dams and treatment plants.

In light thereof it is recommended that a dewatering approach be followed (Option 2) by means of a cut-off borehole wall along a designated alignment along any high potential areas next to the pit areas (this detail needs to be developed with the relevant geohydrologist).

The proposed approach has the added advantage that the clean water that is abstracted from the aquifer could be applied in the environmental balance (for instance wetland rehabilitation). It can also be an invaluable offset against the dirty water balance in total.

This basic principle is illustrated below in **Figure 9**.

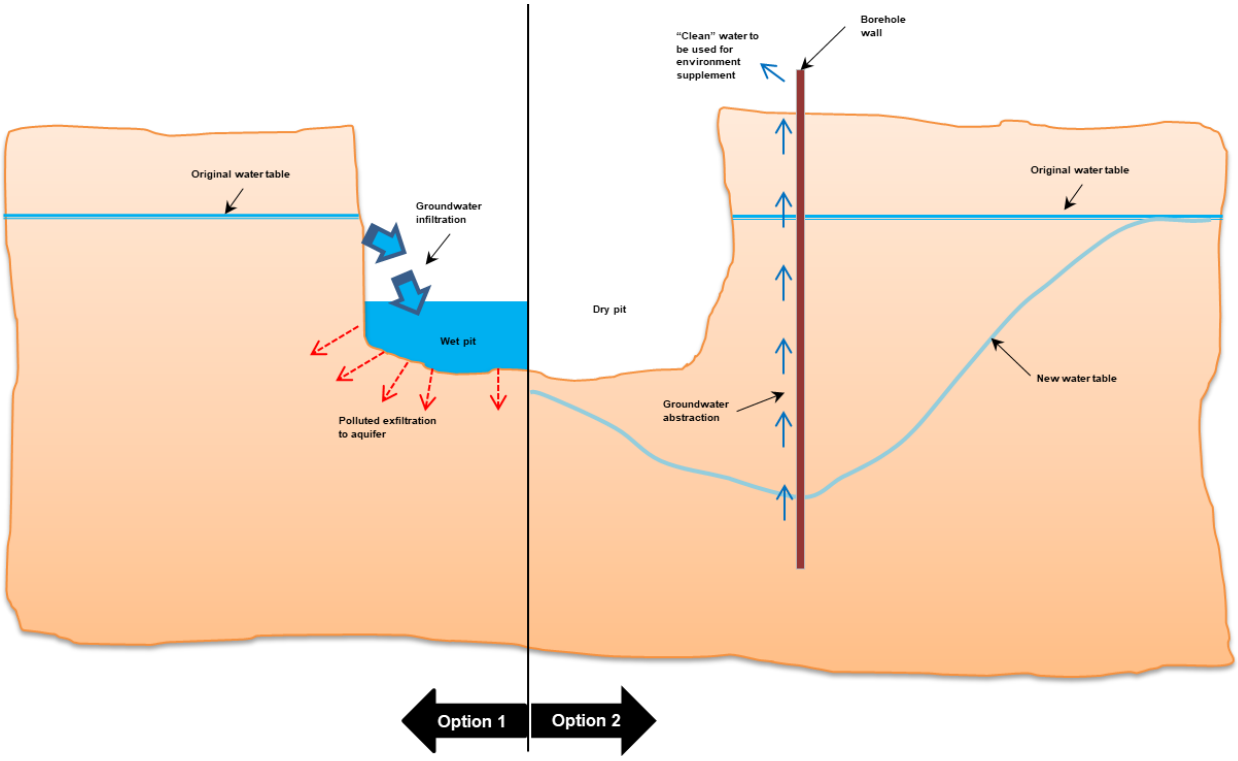

Figure 9: Groundwater abstraction

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Annexure 2: Illustrative site flow diagram

Annexure 3: Water circuit results

Annexure 4: Water balance figures

ANNEXURE 1

References

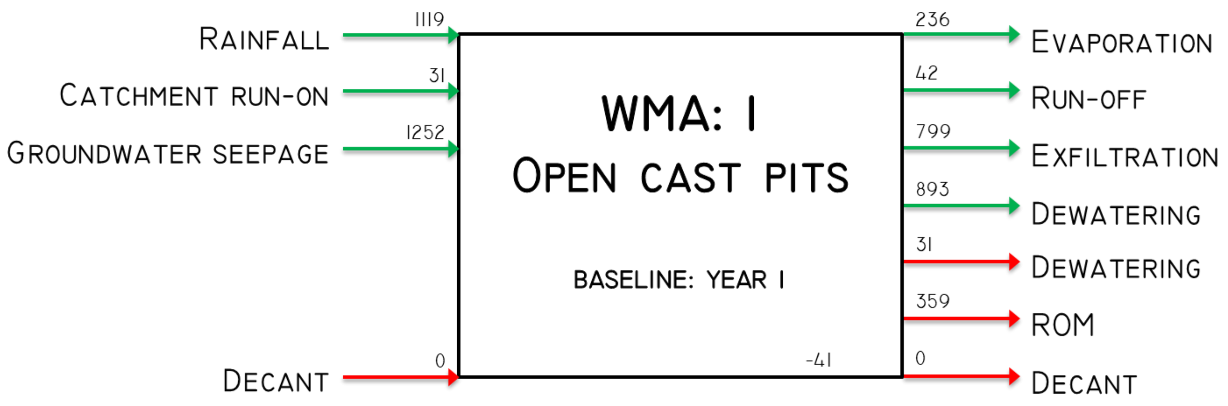
1. Armitage, N. et al., 2014. *Water sensitive urban design (WSUD) for South Africa: Framework and guidelines.* 1st ed. Pretoria: WRC.
2. Armitage, N. et al., 2013. *The South African guidelines for sustainable urban drainage systems.* 1st ed. Pretoria: WRC.
3. Bailey, A. & Pitman, W., 2015. *Water resources of South Africa, 2012 study (WR2012),* Pretoria: Water Research Commission.
4. Delta-H Water System Modelling PTY Ltd, 2018. *Stuart Coal south colliery groundwater study,* Pretoria: Delta-H.
5. Department of Water and Forestry, 1999. *Regulations on use of water for mining and related activities aimed at the protection of water resources.* Pretoria: Government Gazette.
6. Department of Water and Sanitation, 2006. *Best Practice Guideline G2: Water and Salt Balances,* Pretoria: Department of Water and Sanitation.
7. Du Toit, P., 2010. *Surface water investigation ans part of EIA and EMPR,* Pretoria: s.n.
8. Frost, J., 2018. *Statistics by Jim.* [Online]
   Available at: http://statisticsbyjim.com/
   [Accessed 11 August 2018].
9. Gestion Engineering and Project Consultants, 2018. *Surface water baseline study,* Pretoria: Gestion Engineering and Project Consultants.
10. MJ Consulting cc, 2018. *Outline scheme report: Stuart Coal (Pty(Ltd South Block Operation Delmas. Provision of civil engineering bulk services. Water and Sewer.,* Edenvale: MJ Consulting cc.
11. Smithers, J. & Schulze, R., 2003. *The estimation of design rainfalls for South Africa using a regional scale invariant approach.* Port Elizabeth, Water Reseach Commission.
12. Van der Waals, J. H., 2010. *EIA/EMP phase soil, land use and land capability survey,* Pretoria: s.n.
13. WRC/SAWS, 2017. *A climate change reference atlas,* Pretoria: WRC.

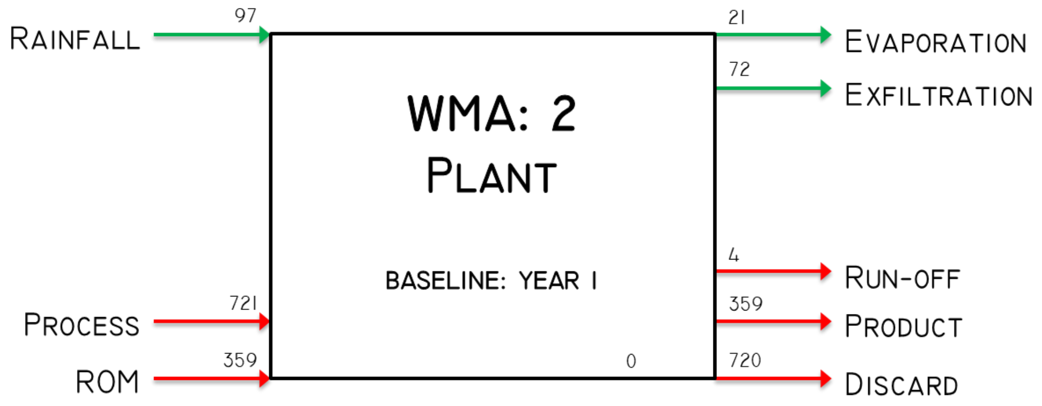
ANNEXURE 2

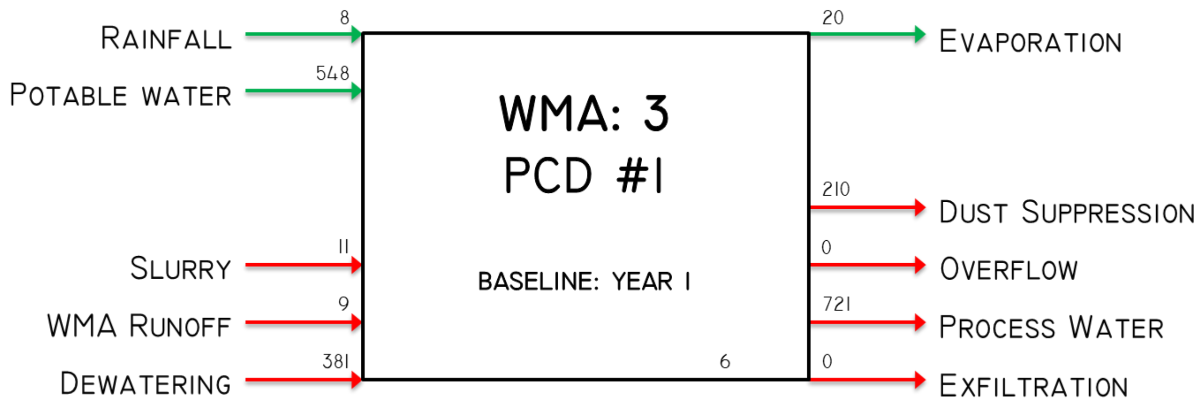
Illustrative site flow diagram

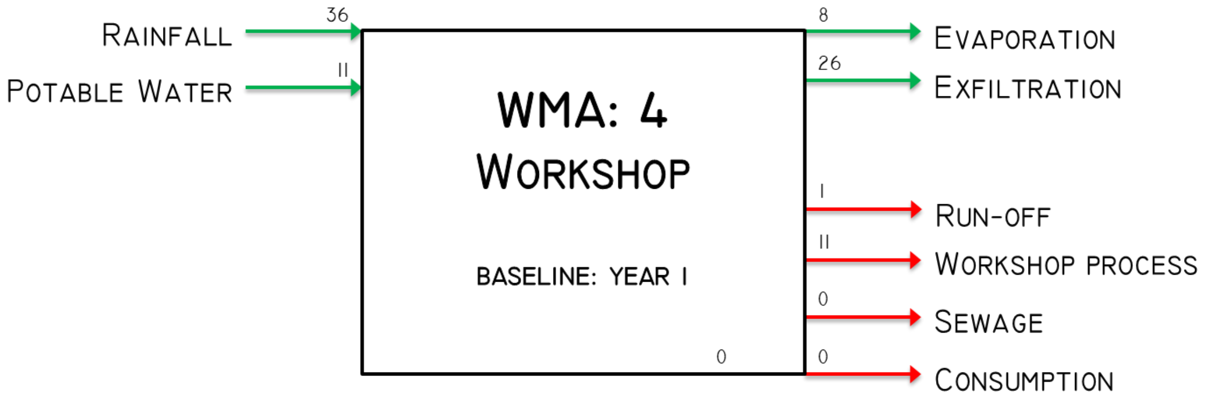
ANNEXURE 3

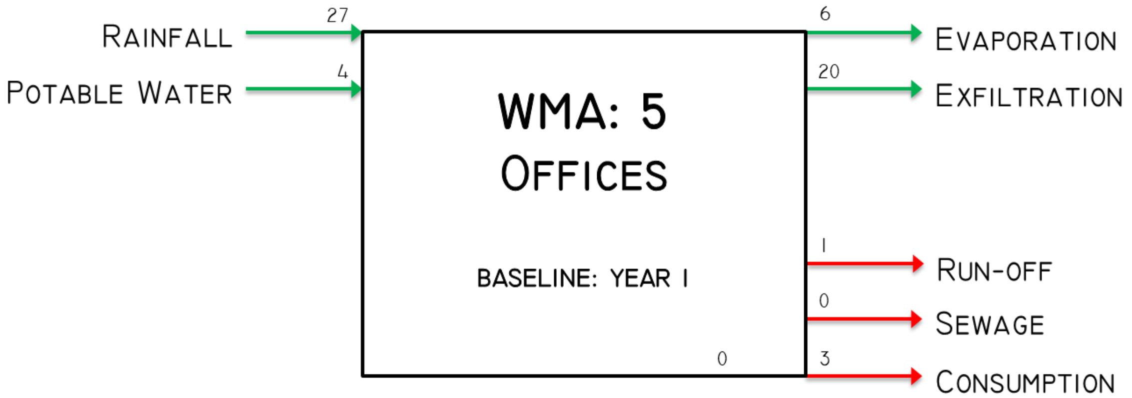
Water circuit results

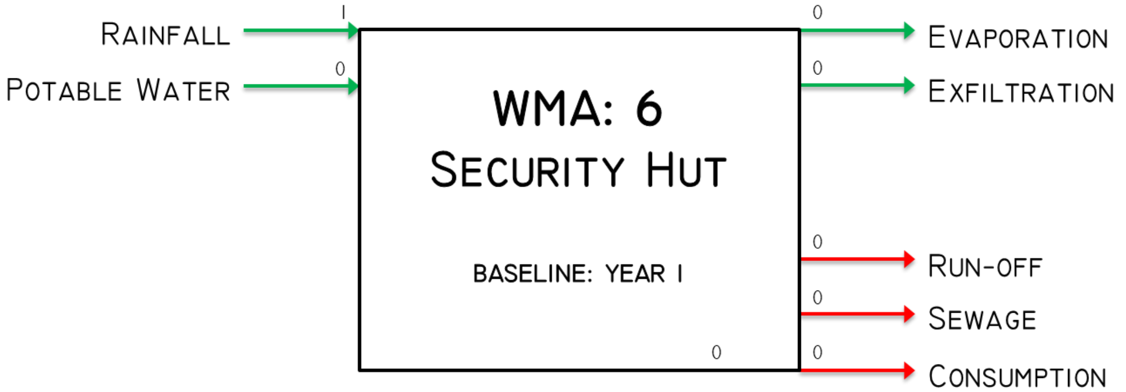

RAINFALL
1119
CATCHMENT RUN-ON
31
GROUNDWATER SEEPAGE
1252
DECANT
0
WMA: 1
OPEN CAST PITS
BASELINE: YEAR 1
-41
236
EVAPORATION
42
RUN-OFF
799
EXFILTRATION
893
DEWATERING
31
DEWATERING
359
ROM
0
DECANT

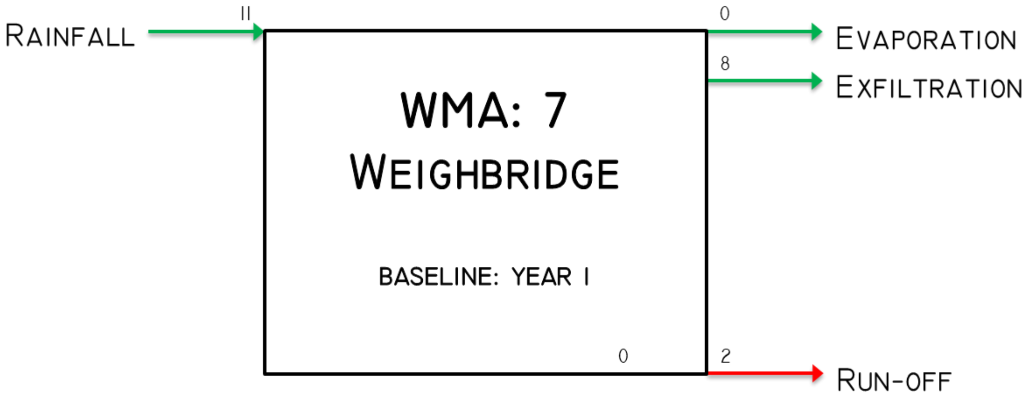

RAINFALL
97
PROCESS
721
ROM
359
WMA: 2
PLANT
BASELINE: YEAR 1
0
21
EVAPORATION
72
EXFILTRATION
4
RUN-OFF
359
PRODUCT
720
DISCARD


RAINFALL
8
POTABLE WATER
548
SLURRY
11
WMA RUNOFF
9
DEWATERING
381
WMA: 3
PCD #1
BASELINE: YEAR 1
6
20
EVAPORATION
210
DUST SUPPRESSION
0
OVERFLOW
721
PROCESS WATER
0
EXFILTRATION


Rainfall
36
Potable Water
11
WMA: 4
Workshop
BASELINE: YEAR 1
0
8
Evaporation
26
Exfiltration
1
Run-off
11
Workshop process
0
Sewage
0
Consumption


Rainfall
27
Potable Water
4
WMA: 5
Offices
BASELINE: YEAR 1
0
6
Evaporation
20
Exfiltration
1
Run-off
0
Sewage
3
Consumption


Rainfall
1
Potable Water
0
WMA: 6
Security Hut
BASELINE: YEAR 1
0
0
Evaporation
0
Exfiltration
0
Run-off
0
Sewage
0
Consumption


Rainfall
11
0
Evaporation
8
Exfiltration
WMA: 7
Weighbridge
BASELINE: YEAR 1
0
2
Run-off

ANNEXURE 4

Water balance figures