APPENDIX Q: CLIMATIC WATER BALANCE

global environmental solutions

Commissiekraal - Site Wide Water Balance for EIA

SLR Project No.: 710.02038.00001

Report No.: 1

October 2015

Tholie Logistics (Pty) Ltd

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1 INTRODUCTION

A site wide water balance model has been prepared to understand flows within the Commissiekraal Project's operational water circuit during average dry seasons and average wet seasons during different phases of the project.

The water balance is steady state and no consideration is given to changes in flows resulting from progressive development of infrastructure, variations in climate or changes in production rate, or storage (e.g. start up water).

To demonstrate how variations in groundwater inflows and operational water requirements will impact upon the water balance, three scenarios are presented during average wet and dry conditions:

- Year 0 – before underground mining commences and only surface infrastructure is in place and operational;
- Year 4 – during initial years of mining before underground working reach Pandana river and operational water requirements are the same as above; and
- Life of Mine – during latter stages of mining when underground workings reach full extent and operational water requirements reach their maximum.

The water balance reviews all relevant design work by the wider project team, estimates the typical flows, and volumetric requirements of make-up water or discharge of surplus water.

The modelled water balance circuit includes water inflows, losses and transfers for the following aspects of the operation:

- Underground Workings;
- Stormwater from Shaft and Stockpile areas; and
- Mining Services and Accommodation (Offices, Change Houses & Workshops).

1.1 WATER RE-USE HIERARCHY

Priority will be given to reusing dirty water from underground, the pollution control dam, and treated sewage before abstraction of water from clean water sources i.e. makeup water and potable water from boreholes.

1.2 METHODOLOGY

A spreadsheet model was used to represent the flows within the operational water circuit using information taken from the following studies:

- Commissiekraal Conceptual Mining Study Report (ECMA, September 2014).
- Hydrology Assessment for the Proposed Commissiekraal Project (Highlands Hydrology, October 2015).
- Groundwater Impact Assessment for the Commissiekraal Project (Delta h, October 2015).

Water sources (inflows) were taken as:

- Groundwater ingress into the underground workings;
- Stormwater collected from dirty catchment and conveyed to the PCD;
- Direct rainfall into the PCD; and
- Makeup and potable water from boreholes.

Water sinks (losses) were taken as:

- Evaporation from the Pollution Control Dam;
- Water usage underground (continuous miners, roof bolters, feeder breaker, conveyor drive and sprays);
- Dust suppression;
- Potable water consumption; and
- Discharge to environment (to be treated if required).

1.3 ASSUMPTIONS AND INPUT PARAMETERS

The water balance assumes the following:

- Rainfall related inflows and evaporation related losses for the wet and dry season scenarios were estimated based on: i) average values during the three driest months of the year; and ii) average values during the three wettest months of the year;
- Runoff and evaporation coefficients for each surface were fixed and not influenced by antecedent climatic conditions, likewise all catchment areas are constant;
- Evaporation from the PCD will only occur if there was water in the dam;
- The service water tanks are sealed, and not subject to rainfall or evaporation;
- This water balance model is run for only steady state average wet season and average dry season conditions and no consideration is given to storage of water at any aspect of the infrastructure modelled i.e. flow in = flow out.

The input parameters used for the water balance are presented in Table 1.

TABLE 1: WATER BALANCE INPUT PARAMETERS

Parameter	Description	Source
Climate Data	• Average wet month rainfall = 181mm • Average wet month evaporation = 160mm • Average wet month rainfall = 11mm • Average wet month evaporation = 96mm	• Highlands Hydrology, October 2015
Underground Dewatering	• Year 0: ○ Zero inflows. • Year 4: ○ Low = 203 101m^3/yr ○ Average = 239 414m^3/yr ○ High = 259 831m^3/yr • Life of Mine: ○ Low = 603 667m^3/yr ○ Average = 660 572m^3/yr ○ High = 734 680m^3/yr	• Delta H, October 2015
Underground Water Demand	• Year 0: Zero demand • Year 4: 50 871 820 litres/year • Life of Mine: 101 742 640 litres/year	• ECMA, September 2014
Potable Water Demand	• Year 0: Assumed the same as year 4 • Year 4: 35 350 litres/day • Life of Mine: 40 150 litres/day Assumes 286 working days per year. Assumes 10% of potable water is lost during consumption and does not require treatment.	• SLR assumption • ECMA, September 2014
Dust Suppression	• Year 0: Assumed all stormwater collecting in PCD will be used for dust suppression. • Year 4: 50 000 litres/day • Life of Mine: 100 000 litres/day	• SLR assumption • (ECMA, September 2014)
Pollution Control Dam	• PCD: ○ Catchment = 5.8ha ○ Footprint = 6 000m^2 ○ Runoff Coefficient = Wet Season: 17%, Dry Season = 6%	• Highlands Hydrology, October 2015 • SLR assumption

1.4 RESULTS

The water balances for the wet and dry seasons for years 0, 4 and life of mine are presented in Figure 1 to Figure 6 below.

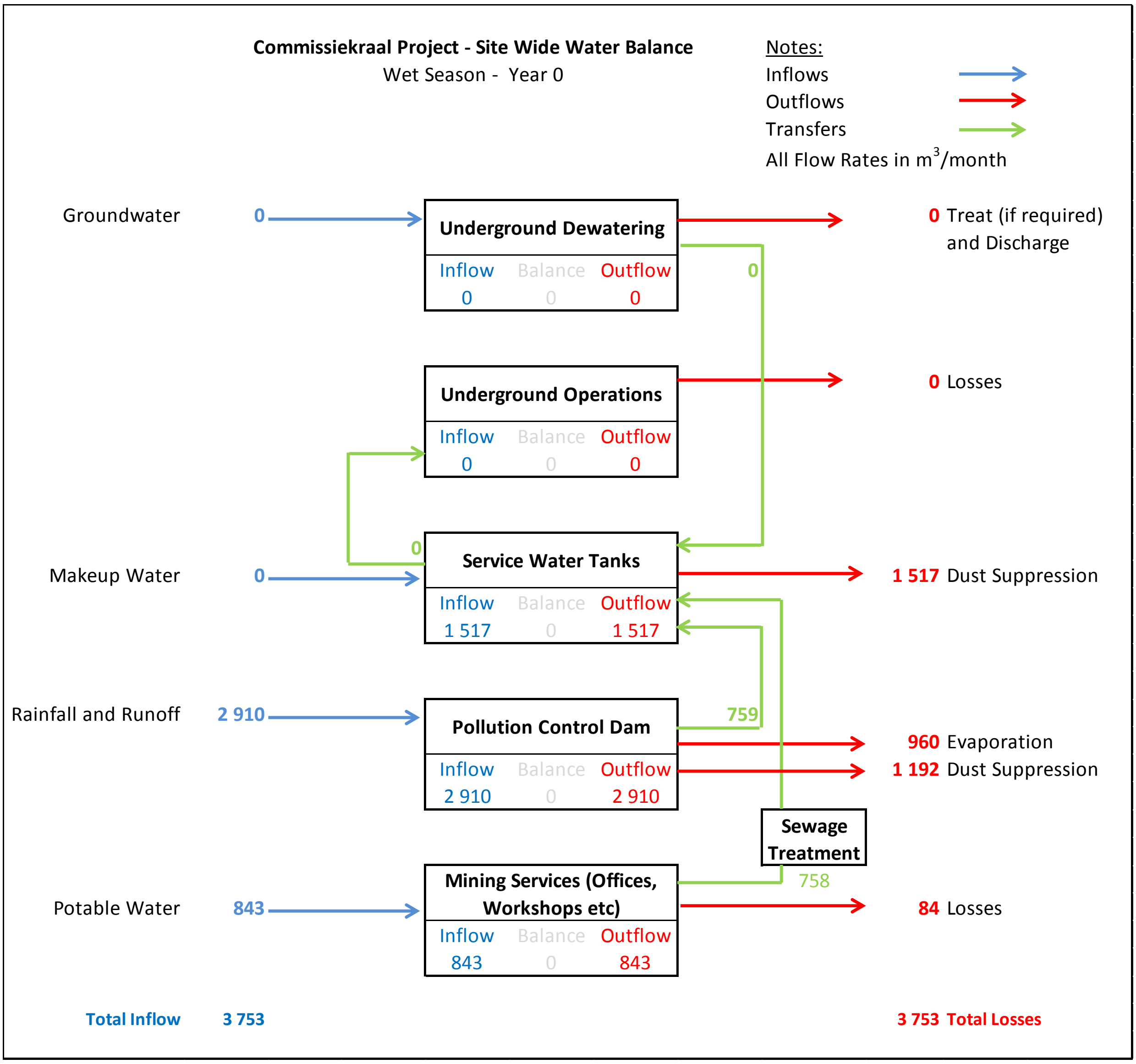

FIGURE 1: WATER BALANCE - YEAR 0, WET SEASON

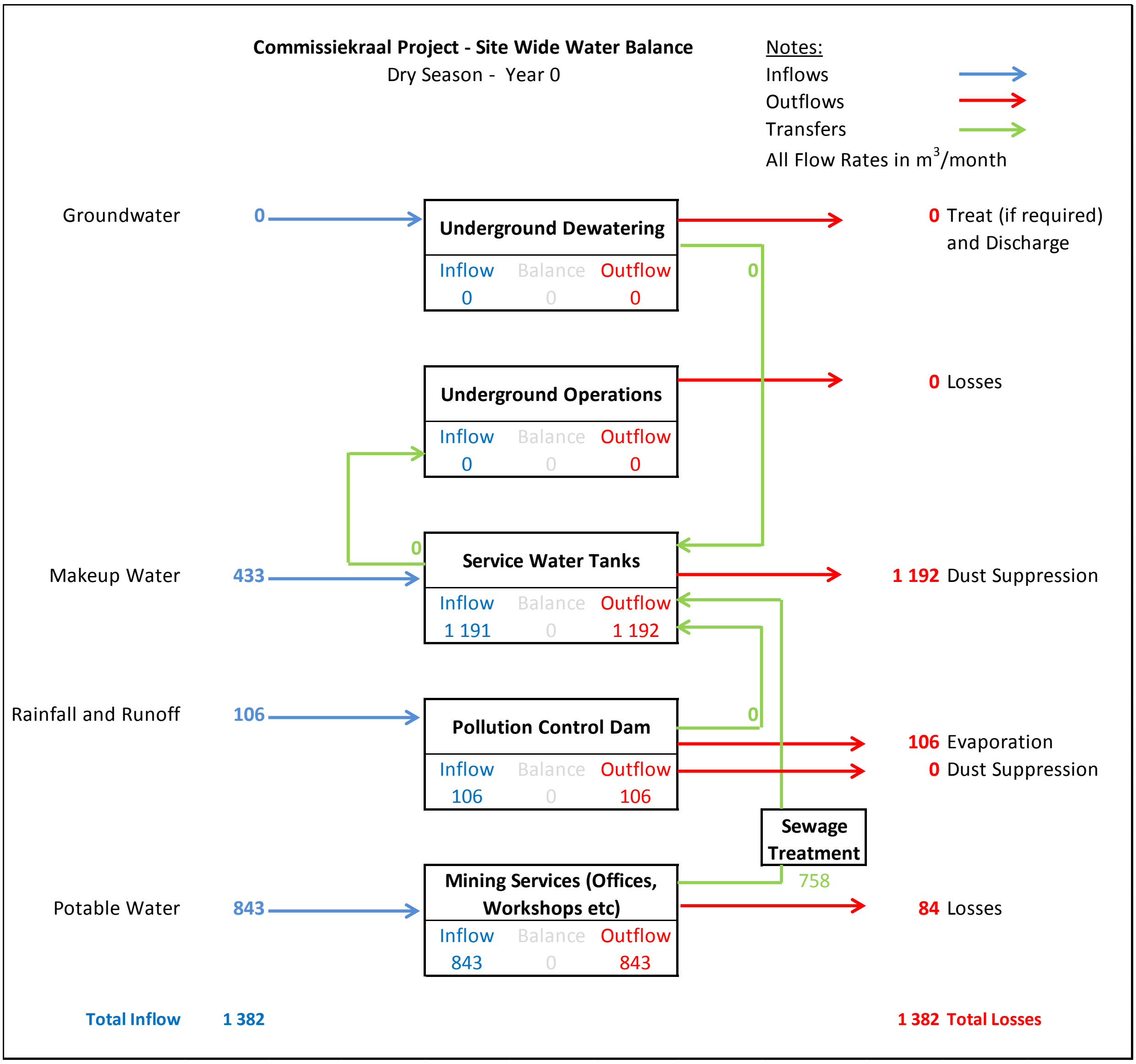

FIGURE 2: WATER BALANCE - YEAR 0, DRY SEASON

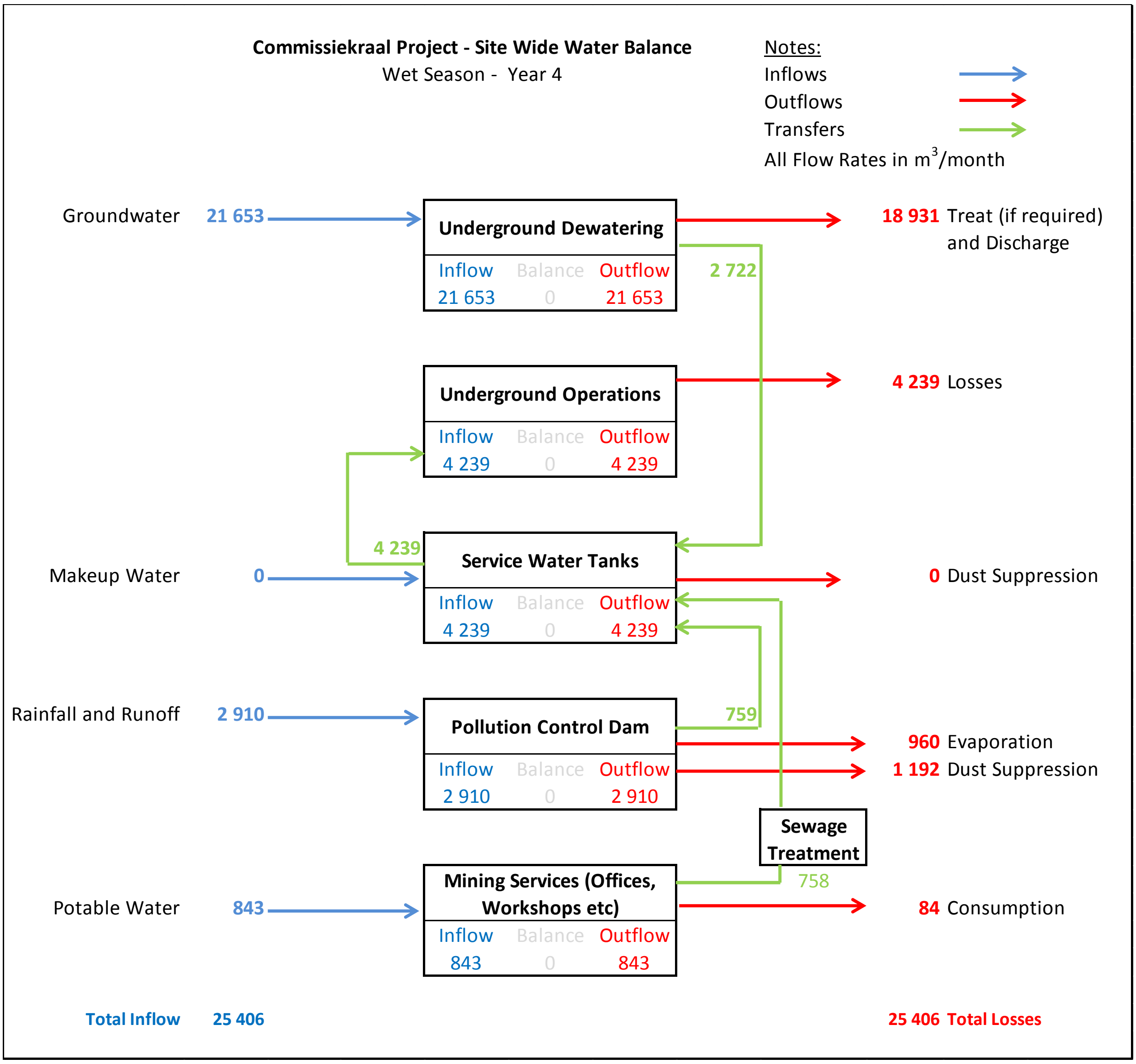

FIGURE 3: WATER BALANCE - YEAR 4, WET SEASON

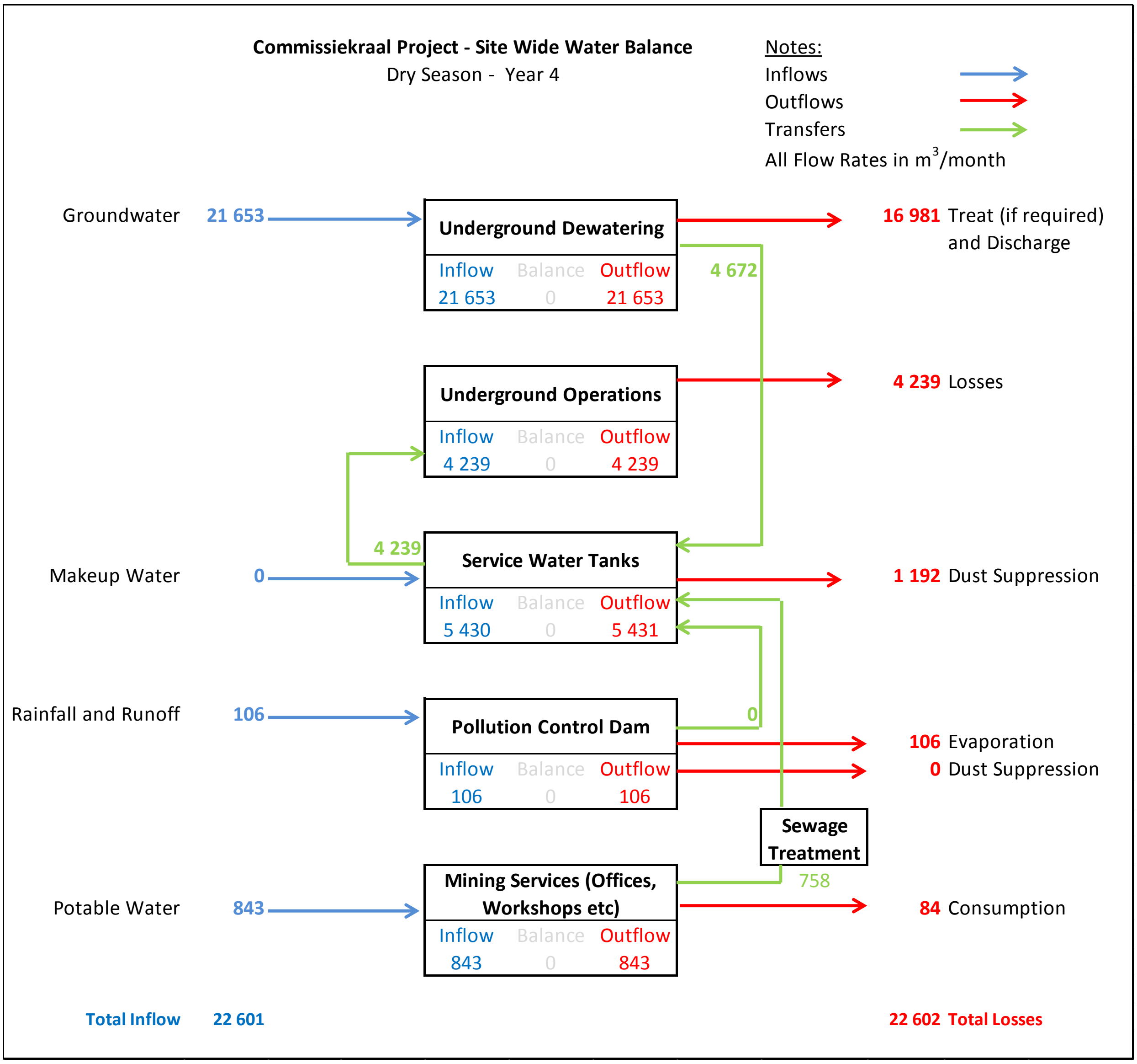

FIGURE 4: WATER BALANCE - YEAR 4, DRY SEASON

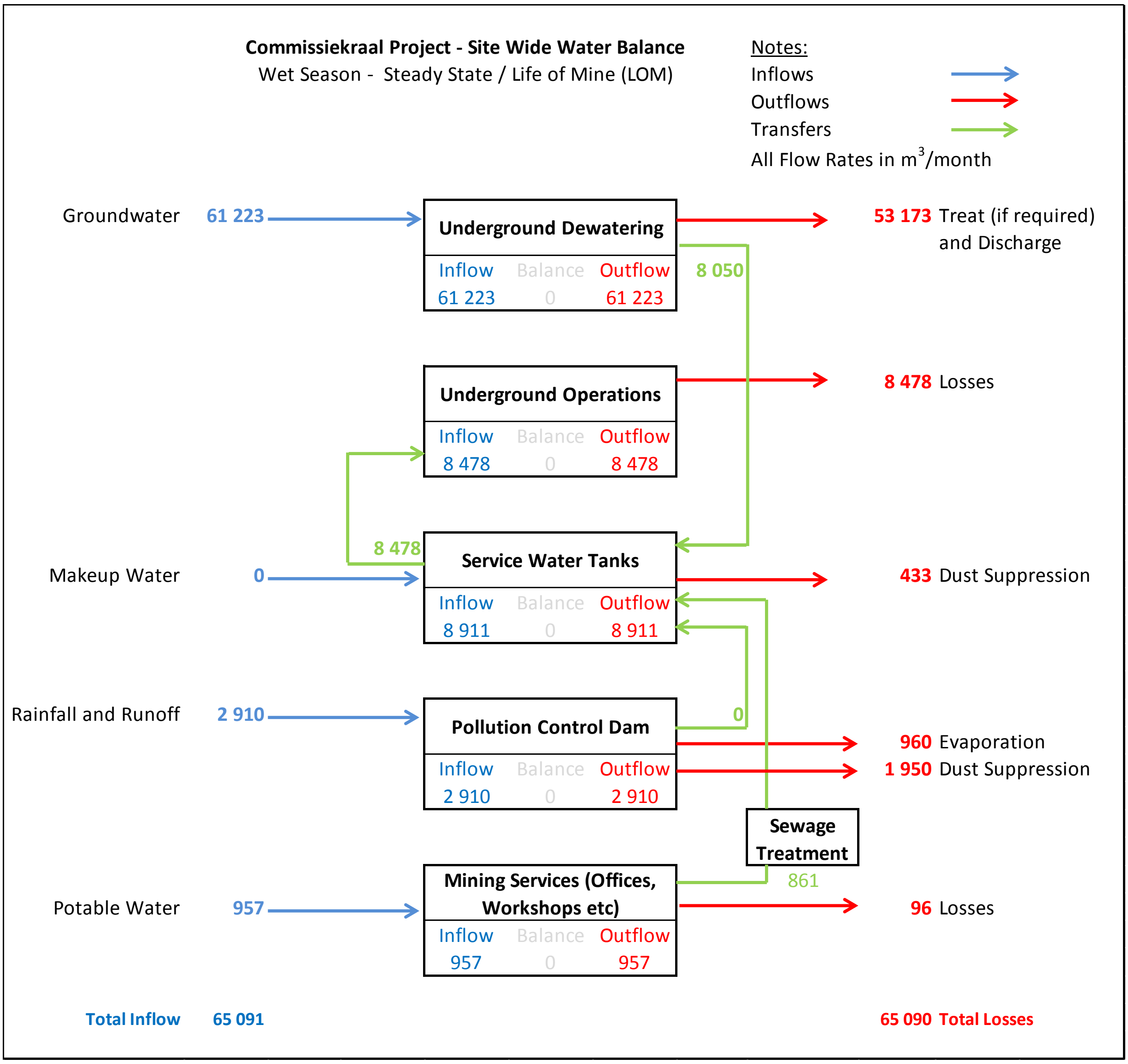

FIGURE 5: WATER BALANCE – LIFE OF MINE, WET SEASON

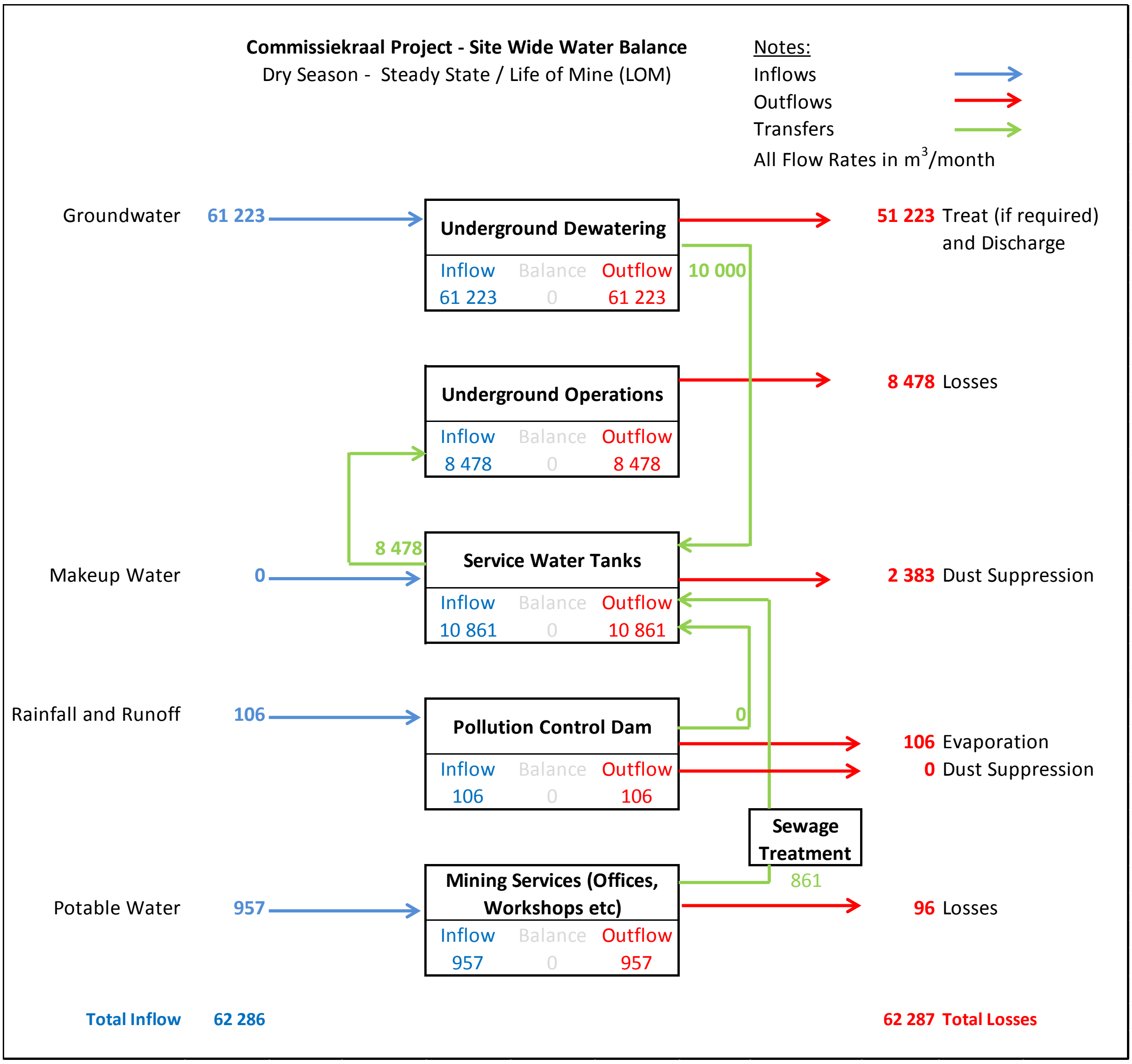

FIGURE 6: WATER BALANCE – LIFE OF MINE, DRY SEASON

The water balance shows little variation between wet and dry season, as would be expected given that the infrastructure at surface which will be climatically influenced is relatively small in footprint.

Groundwater inflow to the underground mine workings is the most significant aspect of the water circuit. During initial stages of the mine, when groundwater inflows are negligible the operation will require a small amount of makeup water (likely to be borehole water) during the dry season to satisfy operational water requirements i.e. the mine is water negative. However as the underground workings progress groundwater inflows quickly exceed the mine's water requirements i.e. the mine becomes water positive, and there is a requirement to discharge excess water.

1.5 LIMITATIONS AND FURTHER WORK

This study makes use of various assumed and estimated parameters, and should be updated whenever better information becomes available.

Groundwater inflow to the underground mine workings form critical parts of the mine's water circuit and is the main source of water. Groundwater inflows are based on the available modelled data and it is recommended that groundwater volume measurements are collected and used to calibrate the water balance model presented herewith.