KUSILE MASS WATER BALANCE

1. Operational Phase

Process water

The key activity water related processes during the operational phase is best described by each component of the water balance[1] and is illustrated in Figure Error**! No text of specified style in document.**-1. The water balance processes include an ultrafiltration system, demineralisation, steam cycle, condensate polishing, auxiliary cooling tower, FGD scrubbers, bottom ash processing, and fly ash processing.

- ***Ultrafiltration (UF) System***
  The ultrafiltration pre-treatment system, including backwash from the auto backwash filters, is based on a recovery of 91.79%. Wastewater from the auto backwash filters and UF system are directed to the Dirty Drains System (Station Dirty Dam Settling Tank and then into the Station Dirty Dam).

- ***Demineralization***
  Makeup to the demineralization plant is taken from the Filtered Water Tanks 1&2 (process) and the Demineralisation Storage Tanks which have undergone primary demineralisation.

- ***Steam Cycle***
  To develop the balance around the steam cycle the steaming rate of 636.1 kg/s was assumed. **Top of furnace** wall soot blowing flows were provided by Hitachi as 3.2 kg/s for duration of 4 hours per day for each unit. **Bottom of furnace** wall soot blowing flows are from service water and is based on 13.9 kg/s for each of eight blowers for a duration of 45 seconds each three times per day. Cycle liquid losses from the steam cycle stage are directed to the process waste recovery tanks where it is filtered and stored in the filtered water tanks where is will be reused as process water.

- ***Condensate Polishing***

  Condensate flow to the condensate polishers for the water balance is based on the 431.9 kg/s. 50% of the regeneration flow (resin sluice water) is assumed to be of high quality and reusable and is collected in the process drains recovery tank, whereas the other 50% (regeneration wastewater) undergoes treatment in the neutralization basin before draining to the holding/recycle dam (HRD).

- ***Auxiliary Cooling Tower***

  Evaporation rate is assumed to be 264.6 m3/h and makeup rate is 354 m3/h, assuming operation at 4 cycles of concentration.

- ***Flue Gas Desulfurization Scrubbers***

  Per the FGD mass balance, raw water is used for gypsum wash and vacuum filter vacuum pump seal water, with holding/recycle dam water supplied for other uses. The zero liquid effluent discharge (ZLED) wastewater treatment system will use clarifiers, brine concentrator evaporators and crystallizers for treatment. Based on the PDNA process flow diagrams, it is assumed that 84% of the water in the chloride bleed stream is recovered as high quality condensate and 16 percent is contained within the dewatered sludge from the ZLED pre-treatment and evaporative processes. Condensate is returned to the process drains recovery tanks for reuse.

- ***Bottom Ash Processing (SSCC)***

  For the submerged scraper chain conveyor (bottom ash processing), it is assumed that 7 m3/hr is lost to evaporation for each unit based on B&V experience for large coal fueled power plants. Water used in washing of the coarse ash was based on the current design value of 1920 m3/d. The loss of water in each unit is made up from the holding/recycle dam.

- ***Fly Ash Processing***

  For fly ash processing, the solids are assumed to be conditioned to 20% moisture content. Fly ash would be moistened by water from the holding/recycle dam.

- ***Ash / Gypsum***

  Water entrained in the active ash dump is equal to the sum of moisture contained in the conditioned fly ash, bottom ash, and FGD solids. Water for irrigation/dust control for the ash dump will be taken from the ash dump dirty dam (ADDD) supplemented, if necessary, by water transferred from

the holding/recycle dam. The ADDD is being sized to contain all stormwater runoff from the ash dump during an 8-day, 50-year rainfall event. After high rainfall events, water will be transferred from the ADDD to the Station Dirty Dam (SDD) by gravity.

Potable Water

An onsite water treatment plant will be used to treat water to potable standards for domestic water use. Potable water uses include the following:

- Make up water to the auxiliary cooling tower, fire water, mine potable water uses, water for bottom furnace wall soot, plant and equipment use and other miscellaneous uses.

- Sewage and kitchen effluent generated on site will be sent to an onsite waste water treatment plant.

Stormwater Management

The storm water runoff from the Eskom Kusile Power Station terrace is directed to two terrace drains systems:

- clean terrace drains system convey storm water from clean areas
- dirty terrace drains system convey storm water from dirty areas

Clean areas are defined as areas where rainfall will not come in contact with pollutants and dirty areas are defined as areas where rainfall will come in contact with pollutants. The dirty areas are further categorized into “dirty-clean” areas and “dirty-dirty” areas. Dirty-dirty areas are defined as areas where the pollutants could possibly include grit, such as ash, coal dust and solids, limestone dust and solids, and flue gas desulfurization (FGD) solids from station operations. Dirty-clean areas are defined as areas where the pollutants will not include the possibilities above.

All terrace clean drains conveyance systems discharge directly to natural drainage systems. The energy of the discharge will be controlled so that no damage occurs to the natural drainage systems. All terrace drains that originate within the dirty areas of the power block are routed through settling tanks incorporating oil/water separators (OWS) before entering the Station Dirty Dam (SDD).

All potentially contaminated water on the Kusile Power Station will be managed in a closed system. The SDD are two equal capacity, lined, holding dams that act as a collection point for all polluted storm-water and wash-down water on the Kusile site, before it is pumped to the Holding/Recycle Dams (HRD).

The SDD will receive inflows from two distinct sources:

1. Coal Stockyard Settling Tanks (CSY ST): The CSY ST will receive inflows from the Coal Stockyard (CSY), EAD, limestone processing area, and a number of grit sumps. Clarified water leaving the CSY ST will travel via gravity pipeline to the SDD.
2. Station Dirty Dams Settling Tanks (SDD ST): The SDD ST will receive inflows from the station terrace area. Clarified water leaving the SDD ST will travel via gravity pipeline to the SDD.

- ***Stormwater: Station Dirty- Dirty Areas***

Stormwater runoff from the boiler block, fabric filter, limestone handling areas, coal stock yard, fly ash handling areas and by-product dewatering areas will collect grit-laden stormwater runoff and direct to the yard grit sumps. These sumps will be designed with an overflow weir to allow grit to settle out and the water to run over the weir into a clear well. The water will then be pumped to the CSY/LB settling facility. Overflow from the CSY settling tanks is directed to the SDD.

The contribution from direct rainfall on the basins is minute in comparison with the rainfall runoff flows, as is the case for all the drains dams. The CSY/LB settling facility will be sized to contain all stormwater runoff from the station dirty-dirty areas during a 1-day, 50-year rainfall event. The balance around the CSY settling basin is a simple in-minus-out calculation.

- ***Stormwater: Station Dirty Clean Areas***

Stormwater from station **dirty-clean** areas containing no grit, drain to the station dirty dam settling tanks (SDD:ST) prior to the draining to the station dirty dam (SDD), which has 2 cells with total volume sized to contain all stormwater runoff from the station dirty-clean areas and additional process wastewater during a 1-day, 50-year rainfall event.

It will be the furthest downstream dirty water structure on the site and therefore is required to be down-gradient from the power station. The natural contours of the site slope downwards to the north-west, towards the non-perennial tributary of the Klipfonteinspruit. The SDD will be optimally located approximately 1 km north-west of the power station's north-west fence corner. The selected position avoids surrounding wetlands and the 1:100 year flood line of the natural stream. The SDD elevation will range from 1 441 meters above sea level (masl) at the sump of Compartment No. 2 to 1 454 masl at the crest of Compartment No. 1.

In case of excessive stormwater in the ADDD, manual controls will allow gravity flow to the station dirty dam contingent on water quality. The outlet

pipe in the ADDD will be elevated above operation volume levels to minimize the conveyance of solids to the SDD. Note that a 50 year, 8 day storm event can be stored in the ADDD for the worst case dirty area of the ash/gypsum disposal facility and that the ADDD is comprised of two 50 % cells so that one cell can remain in service while the other cell is being maintained.

- ***Holding Recycling Dam***

The holding/recycle dam has two cells with total volume sufficient to supply water to the FGD scrubbers and ash (fly ash, bottom ash) systems for approximately 3 days of operation, without makeup. To maintain level, water is supplied to the holding/recycle dam from the SDD and raw water. During most periods, other than periods of high rainfall, the Holding/Recycle Dam will require raw water supplied from the Kendal water pipeline. The Holding/Recycle Dam is not designed to contain any storm water from station areas.

- ***Coal Stockyard***

The coal stockyard facility includes two 20,315 m^2 compartment for collected rainfall. The settling basin was based on an area of 5, 600 m^2. The contribution from direct rainfall on the basins however, is minute in comparison with the rainfall runoff flows, as is the case for all the drains dams. The CSY settling basin will be seized to contain all the stormwater runoff from the station dirty-dirty areas associated with the limestone building, coal storage yard, emergency ash area and other areas mentioned above during a 1:50 year rainfall event. The balance around the CSY is a simple in-minus-out calculation.

- ***Raw Water Reservoir***

The raw water reservoir rainfall and evaporation flows are based on an area of 114,746 sq. m (as provided by B&V civil engineer Stephen Reitz on May 17, 2010)

- ***Evaporation***

Evaporation values for the various basins and dams shown on the water balances are calculated by multiplying an annual lake evaporation rate of 1,270 mm/yr. by surface area of the basin or dam. The assumed lake rate was based on information from the South Africa DEAT website.

- ***Rainfall***

Three rainfall case water balances are presented. Water Balance 1B is a “No Rainfall” case. Water mass balance 2B is an “Average Annual Rainfall” case and is based on a total of 683 mm of rain fall in an average year. This value is divided by 365 days to get a per day rainfall amount.

Water mass balances 6B is a “1 Day, 50-year Rainfall” case and is based on 126 mm of rainfall received in one day.

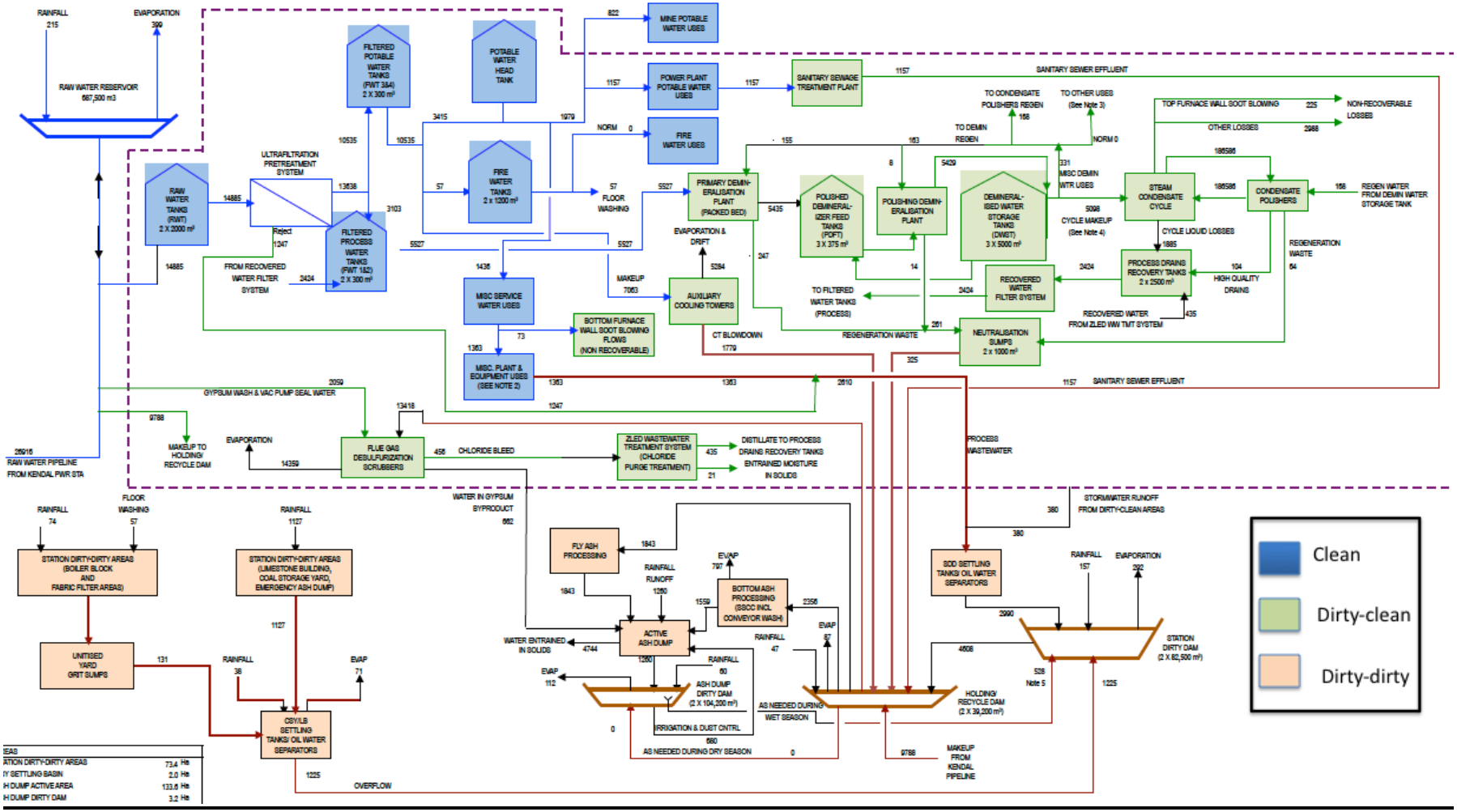


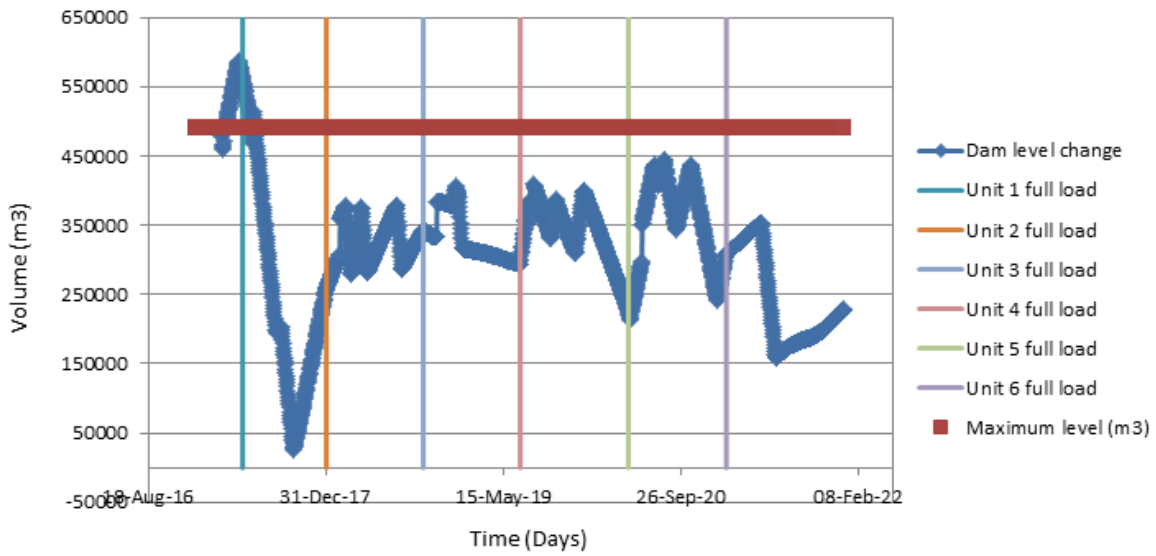
Figure Error! No text of specified style in document.**-1 Water Balance process at Kusile**

2. Construction and Commissioning phase

All values on the water balance were taken from the original design water balance. The only difference is the addition of the construction and commissioning activities:

- An average value of 2200 m3/day of waste water was generated during the construction and commissioning of Unit 1. This value was added to the water going to the pollution control dams. Then for 15 days during the commissioning period there were peak water usages. 50 ML for Boiler Chemical Clean and 80 ML for boiler blow through. These values were added to the 2200 m3/day.
- The future mitigation measures were also added to the water balance. The evaporator of 5000 m3/day was added and the oil pre-treatment plant of 2400 m3/day. Lead times were also considered in the addition of these mitigation measures.
- Raw water was slowly added during the times when the levels in the pollution control dams started dropping. This is to maintain the levels of the control dams for ash conditioning, dust suppression and FGD usage.

Below is the Graph showing the Water Levels in Pollution Control Dams during Construction and Commissioning of all six Units.



Water Levels in Pollution Control Dams
Water Level Reduction Mitigation Strategy Options:

- OPTION 1: Truck water off site.
- OPTION 2: Dust suppression on ash dump.

- OPTION 3: Install additional Oil/Water Separator at HRD.
- OPTION 4: Install Oil Pre-Treatment plant at Mobile Demineralized Water Plant
- OPTION 5: Install cannon-type evaporators at ADDD.
- OPTION 6: Controlled release of water into the environment. DWS must approve this option.
- OPTION 7: Add Shelly's dam and the Holding dam to the waste water management system