ZITHOLELE CONSULTING

KUSILE POWER STATION 60 YEAR ASH DISPOSAL FACILITY: WASTE MANAGEMENT FACILITY LICENCE APPLICATION REPORT

OPERATIONS PLAN

Report No.: JW007/14/D121 - Rev 1

JUNE 2014

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SYNOPSIS

This report presents the recommended operating methodology for the 60 year ash facility at Kusile Power Station.

The operation of the ash facility involves constructing the Starter Platform, controlling the geometry of the ash stack and managing storm water while ensuring that any adverse effects on the environment are minimised.

Monitoring and maintenance are fundamental requirements for operating a power station ash facility and are therefore also discussed.

CONTENTS PAGE

APPENDIXES

List of Tables

List of Figures

List of Drawings

D121-01-001	:	Layout of Facility at Full Development
D121-01-002	:	Layout of 5 year lined are including infrastructure
D121-01-003	:	Typical long sections & details
D121-01-004	:	Detailed layout of 5 year area
D121-01-005	:	Liner details
D121-01-006	:	Leachate collection layout
D121-01-007	:	PCD Layout and details
D121-01-008	:	Clean storm water management layout
D121-01-009	:	Capping layout
D121-01-010	:	Site office layout
D121-01-011	:	Final rehabilitation Plan
D121-01-012	:	0 to 30 Year development plan
D121-01-013	:	30 to 60 Year development plan
D121-01-014	:	Rehabilitation progress plan: Dust Suppression and Irrigation Layout
D121-01-015	:	Klipfontein River Diversion: Layout and details

Drawings are attached in Appendix B

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1. INTRODUCTION

1.1 Background

Kusile Power Station will be Eskom's twelfth base load coal-fired power station after construction is completed. The station will comprise of six 800 Megawatt units which will place it on par with the largest coal-fired power stations in the world. Anglo Coal's New Largo mine is located adjacent to Kusile on its eastern side and is likely to supply power station coal to Kusile over its expected 60 year life time.

Kusile will feature new super critical boilers which will operate at higher temperatures and pressures than older boilers providing better efficiency. The power station will burn approximately 1 850 tons of coal per hour over all six units, producing 900 tons of ash per hour. A total volume of over 530 million cubic meters of ash will be produced over the power station's 60 year life time. Therefore the ash storage facility forms an integral part of the power station's infrastructure.

The ash facility at Kusile Power Station will be the third of Eskom's power station ash facilities to be lined after Medupi and Kusile's Co-Disposal Facility.

The operation of the ash facility involves constructing the Starter Platform, controlling the geometry of the ash stack and managing storm water while ensuring that any adverse effects on the environment are minimised.

Monitoring and maintenance are fundamental requirements for operating a power station and are also discussed in addition to the operations plan of the facility.

1.2 Purpose

The purpose of this Operations Plan is to document procedures to be followed in carrying out specific tasks at the Kusile ash facility. The procedures for carrying out all the critical tasks on site are described. The plan also allows for continuity of operational procedures and practices thus minimising the risks in operating the facility.

1.3 References

Additional information describing how the ash facility was designed and how it will be rehabilitated can be found in:

Jones & Wagener (Pty) Ltd., February 2013. Kusile Power Station 60 year ash facility EIA – Engineering Detailed Concept Design Report. Report number JW140/13/D121.

Jones & Wagener (Pty) Ltd., February 2013. Kusile Power Station 60 year ash facility EIA – Rehabilitation Closure Plan. Report number JW008/14/D121.

1.4 Definitions and abbreviations

1.4.1 Commercial

J&W **J**ones **&** **W**agener (Pty) Ltd – Design Engineers

1.4.2 ***DEA*** *The **D**epartment of **E**nvironmental **A**ffairsTechnical*

Design:

ADF **A**sh **D**isposal **F**acility

CQA **C**onstruction **Q**uality **A**ssurance

CQC **C**onstruction **Q**uality **C**ontrol

CDF **C**o-**D**isposal **F**acility

HDPE **H**igh **D**ensity **P**oly**E**thylene

GM **G**eomembrane

GX **G**eotextile

GL **G**round **L**evel

LCS **L**eachate **C**ollection **S**ystem

LDS **L**eakage **D**etection **S**ystem

PCD **P**ollution **C**ontrol **D**am

TLB **T**ractor **L**oader **B**ackhoe

Other:

EIA **E**nvironmental **I**mpact **A**ssessment

EIR **E**nvironmental **I**mpact **R**eport

SED **S**afe **E**dge **D**istance

FS **F**ront **S**tack

1.4.3 Definitions

Back Stack: Ash stacked on top of the front stack (see **front stack**) behind the shiftable conveyor. The back stack is the final height of the facility.

Boom Conveyor: Cantilevered, slewable, luffable conveyor. Final delivery of ash onto the ash facility.

Crawler Mounted Stacker: Mechanised ash stacking machine connecting boom conveyor to the link conveyor.

Emergency Offload Platform: Concrete platform used for temporary ash storage if one or both stackers are out of commission.

Extendable Conveyor: Conveyor that is continuously extended as the ash stack advances. The extendable conveyor supplies ash to the shiftable conveyor and is supplied ash by the overland conveyor at the ash disposal facility transfer house.

First Ash: The first ash that is created by the power station after the first coal is burned.

Free Ash: Ash that is placed by a stacker which does not require further dozing.

Front Stack: Ash stacked from the level of the stacker to a lower level – either natural ground or lower ash stack. The front stack is placed in front of the shiftable conveyor.

Link Conveyor: Conveyor between the stacker and the tripper car.

Overland Conveyor: Conveyor that transfers ash from the power station to the ash disposal facility. The overland conveyor connects to the extendable conveyor at the ash facility at a transfer house.

Shiftable Conveyor: Conveyor that is shifted parallel to the direction of advancement or rotated radially about a fixed point. The shiftable conveyor supplies the tripper car with ash and also includes rails for the car to travel on. The shiftable conveyor is supplied ash by the extendable conveyor.

Transfer platform: A platform used to support a transfer point between two or more conveyors when a change in direction is required.

Tripper car: Mechanised machine used to transfer ash from the shiftable conveyor onto the link conveyor which leads to the stacker. The tripper car is able to move along the rails connected to the shiftable conveyor.

2. DESCRIPTION OF FACILITY

2.1.1 Site Layout

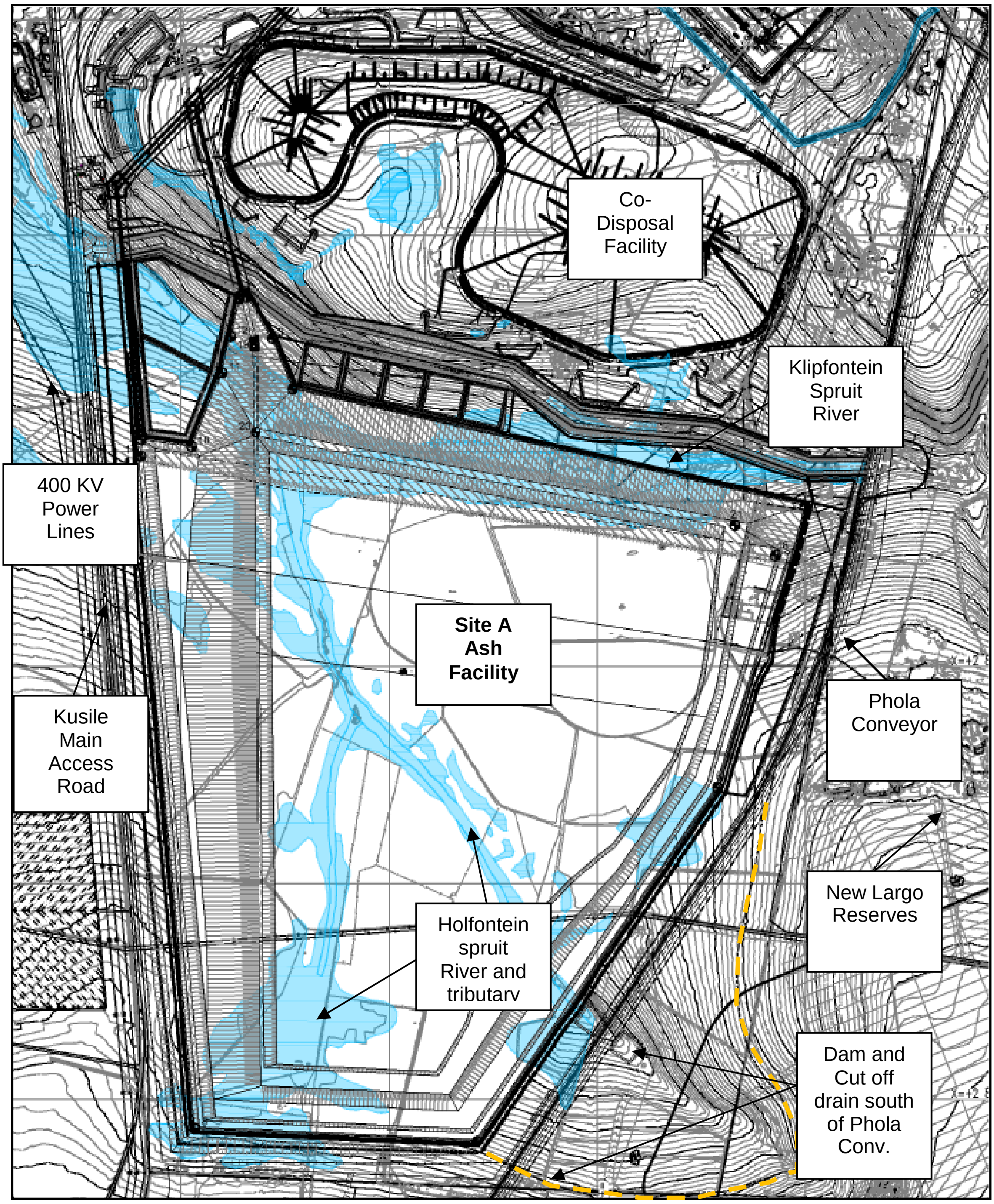


Figure 1: Site Layout

The site, as shown in Figure 1, is positioned south of the power station and the Co-disposal Facility. It is wedge shaped, starting wide in the north and becoming narrower as it develops southwards.

The space available for the facility is limited which leads to the ash stack requiring a substantial starter platform so that the stack is near final height at the commencement of stacking. The Starter Platform will be constructed from ash using a truck and haul operation. The platform will also need to be lined.

The site is characterised by a valley draining from the south-east to the north-west (forming the Holfonteinspruit). This valley will continue to lead clean storm water into the site for the duration of operations and therefore requires a combination of contour cut-off drains and clean storm water attenuation dams. A dam and a diversion canal system upstream of the New Largo Phola Conveyor will also be required.

A river diversion will also be required for the Klipfonteinspruit which is located along the northern side of the site.

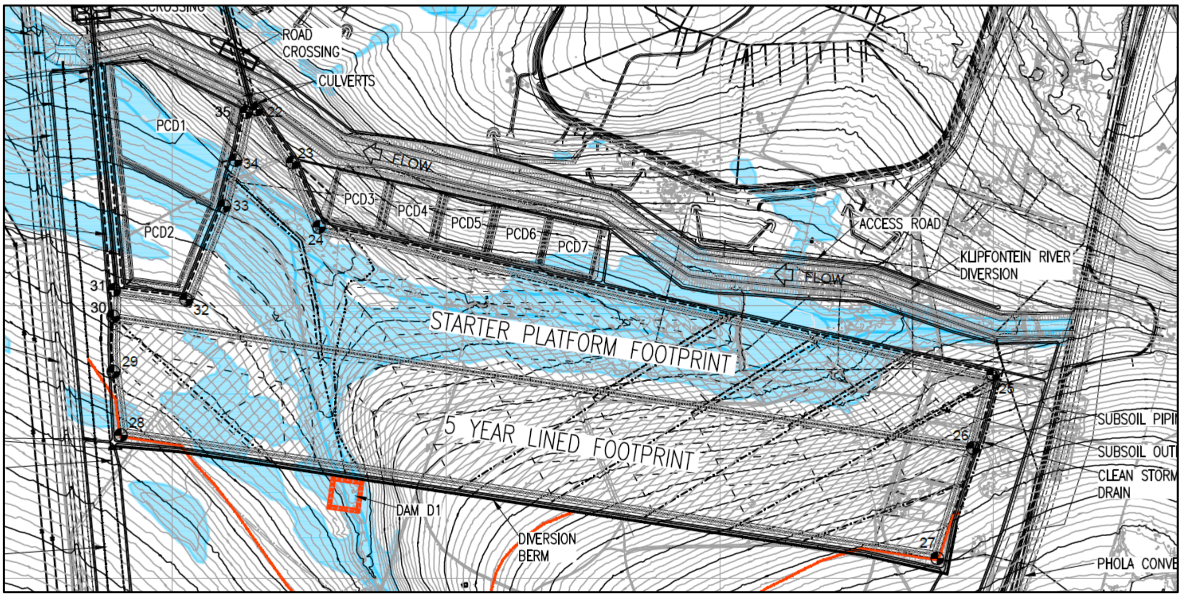


Figure 2: Starter platform and 5 year area footprints

The design of the ash facility is fully described in the Detailed Concept Design Report [Report JW-140].

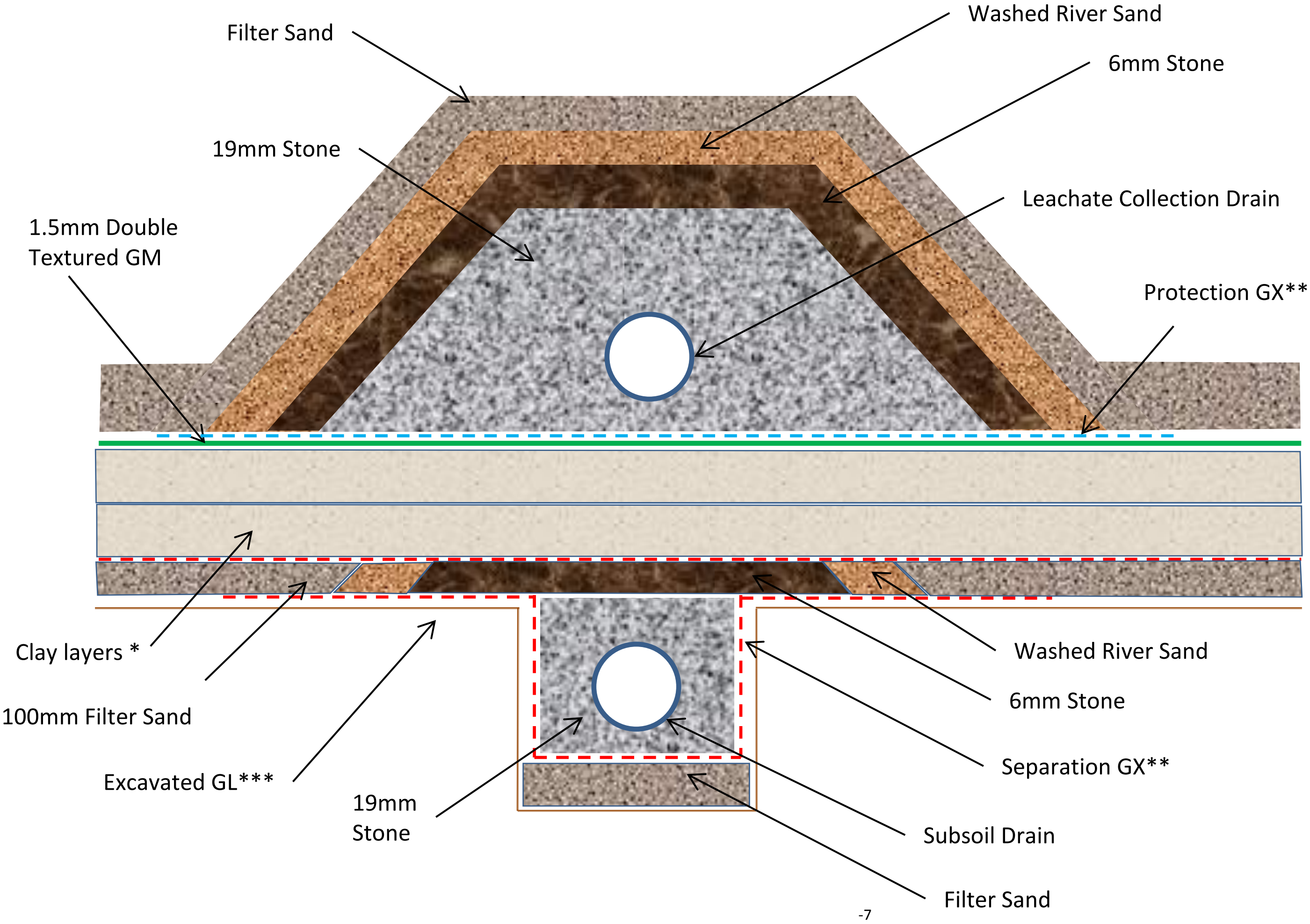
2.2 Waste classification

The ash is classified as a Type 3 waste (low hazard waste). Therefore the ash requires disposal on a landfill with a Class C barrier system.

The waste classification of the ash is represented in Report number JW030/13/D121 Rev 2.

2.3 The barrier system

The barrier is designed according to the National Norms and Standards for the Assessment of Waste for Landfill Disposal [2013]. The barrier has been designed according to the Class C lining specification.



*2 x 150mm Clay (tillite) Layers compacted to 98% Std. Proctor (k: $1x10^{-7}$ cm/s).
**GX = Geotextile
***GL = Ground Level

Figure 3: Barrier system applied to site conditions showing leachate and sub-soil conditions

The barrier system includes the following layers from excavation level upwards:

- Substrate preparation layer: The substrate will be ripped and re-compacted to 95% MOD AASHTO with a moisture content of -2 to +2% of optimum moisture content. Subsoil drains will be installed during this period. The detail of the subsoil drains is shown in Figure 3.
- Subsoil Drainage Layer: A 100mm layer of filter sand will be used as a subsoil drainage layer;
- Primary impermeable layer: 2 x 150mm layers of Tillite clay compacted to 98% Standard Proctor with a moisture content of +1 to +3% of optimum moisture content in order to have a permeability co-efficient (k) of less than $1x10^{-7}$cm/s.
- Primary geomembrane layer: 1.5mm HDPE double textured geomembrane layer;
- Leachate collection layer: 300mm layer of filter sand with HDPE pipe drainage network. The detail of the leachate collection drains is also shown in Figure 3.

The leakage detection system

The leakage detection system of the ash facility will drain to various manholes positioned on the sides of the ash facility. From these manholes the leakage will be pumped to the nearest contaminated trench which will drain to its respective pollution control dam.

The pumping system will contain a flow meter to record the volumes of leakage. A sampling point will also be included to sample the leakage for testing.

Steel grids, to allow easy inspection, will form the lids of the manholes. The grids will allow rainwater to enter the manholes, which may make the leakage seem excessive. Therefore the leakage volumes will need to be corrected for rainfall.

2.4 Construction Quality Control and Assurance during liner installation

It is essential that Construction Quality Control (CQC) and Assurance (CQA) take place during the installation of the lining system. These are defined as the following:

Construction Quality Control (CQC): A planned system of inspections that is used to directly monitor and control the quality of a construction project. Construction Quality Control shall be performed by the Lining Contractor or for natural soil materials by the Earthworks Contractor, and is necessary to achieve quality in the constructed or installed system. Construction Quality Control refers to measures taken by the installer or Contractor to determine compliance with the requirements for materials and workmanship as stated in the Drawings and Project Specifications.

Construction Quality Assurance (CQA): A planned system of activities that provides the Employer, Engineer and Permitting Authorities assurance that the facility was constructed as specified in the design. Construction Quality Assurance includes inspections, verifications, audits and evaluations of materials and workmanship necessary to determine and document the quality of the constructed facility. Construction Quality Assurance refers to measures taken by the Engineer to assess if the Lining Contractor is in compliance with the Drawings and Project Specifications. An independent third party CQA inspector may be appointed by the client to oversee the lining installation.

2.5 Effect of temperature on the lining system

Literature on the effect of elevated temperatures on geomembranes has indicated that the higher the temperature exposed to the geomembrane the less time it takes to reach its service life[1].

For example, a service life of 100 years at 30 degrees Celsius may be reduced to less than 10 years at 60 degrees Celsius. Temperatures much above 120 degrees will result in the melting of the geomembrane and complete failure of the lining system.

In an ash landfill site heat may be generated by the hydration of ash. Hydration is a function of the composition and amount of cementitious material in the ash and the water cement ratio of the mixture. For hydration to occur free lime (CaO) and Sulphates (SO3) are needed.

From the assessment of laboratory tests carried out on ash samples from Kendal Power Station during the design phase, the amount of free lime (CaO) and Sulphates (SO3) are expected to be low. Therefore the risk of hydration is currently low. However, the

[1] The service life of a geomembrane can be defined as the period of time for which the geomembrane performs in accordance with the design.

composition of the ash at the Kusile Power Station may be different to Kendal and will need to be tested when available.

The temperature of the geomembrane will also need to be continuously monitored throughout the facility's lifetime to ensure that it is within a specified range. Further information regarding temperature monitoring is provided in Section 6.5.

3. CONSTRUCTION OPERATIONS

The construction operations will consist of three phases:

- Phase 1: The construction of the Klipfontein River Diversion, the Starter Platform and conveyor access ramp:

  This will consist of the following activities:

  - The construction of the Klipfontein River Diversion including the stilling basin;
  - A haul road to the starter platform from Transfer House 9. This will later be converted into the conveyor platform for the Top Stackers Extendable Conveyor;
  - Contaminated Storm Water network around footprint;
  - Access roads and security fence up to the 20 year development line;
  - The construction of the terrace and lining system for the Starter Platform;
  - Pollution control dams 1 to 7 required for the Starter Platform;
  - Topsoil Stockpile area.
  - This phase is estimated to take 2.5 years. The first stage of this phase will take 15 months and will be required to be completed before ash is delivered to the facility.

- Phase 2: The construction of the first 5 year lined area:

  This will consist of the construction of the following activities:

  - Conveyor platforms to the facility including access roads and storm water canals along the conveyor;
  - Terrace and lining system for the first 5 years of operation;
  - Contaminated Storm Water network extensions;
  - Clean Storm Water Dam D1 and clean storm water contour cut-off trench;
  - The two emergency stockpile platforms;
  - This stage is estimated to take 2 years and will be required to be completed before ash is delivered to the facility via the conveyor system.

- Phase 3: The construction of the remaining footprint in 5 year lined area intervals:

  This phase consists of the construction of the following:

  - The terrace and lining system for each 5 year development;
  - Contaminated Storm Water network extensions;
  - Clean Storm Water Dams and contour cut-off dams required for each development;
  - Access roads and security fences when required.

The liner for the facility will be installed every five years. This is to reduce risk of damage due to exposure for long periods of time. As the liner is required to be installed before the ash facility reaches the capacity of the previously lined area, and due to the fact that the liner installation is a lengthy process, careful planning is required to ensure smooth development of the facility.

Construction processes required under various development periods are further listed in the Construction and Operations Table in Appendix A.

4. PHASE 1: STARTER PLATFORM OPERATIONS

The Starter Platform will be constructed using mobile equipment (trucks) for the initial 5 years of operations. After 5 years, the infrastructure for two stackers will be completed and the remainder of the facility will be constructed with the stackers (Phase 2 and Phase 3).

A haul road between the Starter Platform and Transfer House 9 will be constructed as part of the site preparations. The haul road will need to cross the Klipfontein Spruit River Diversion and requires its own storm water management infrastructure such as trenches for contaminated runoff. The haul road will be converted to an Overland Conveyor Platform for the operations of Phase 2.

The Starter Platform is designed such that it provides the walkout platforms for the upper and lower tier stackers.

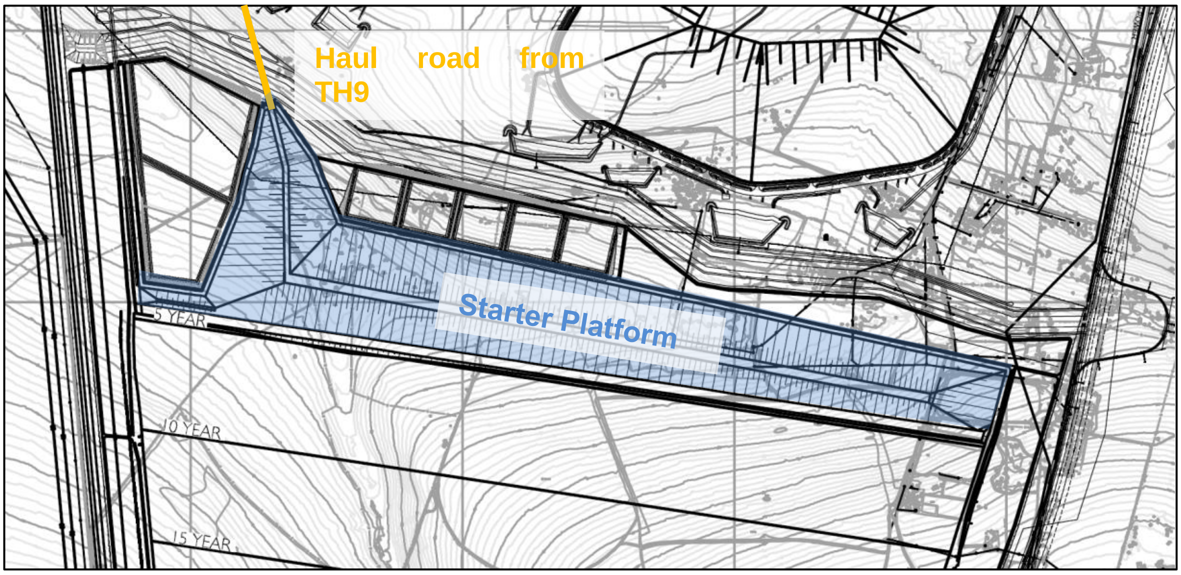


Figure 4: Final Starter Platform

The lined Starter Platform has a storage capacity of 5 years and has the following dimensions:

- Length: 3 500m
- Width: 380m
- Footprint area: 120.5ha
- Maximum Height: 73.5m
- Average Height: 29,7m
- Volume: 35.8 million cubic meters
- Side slopes: 1[v]:3[h] on the east, west and north sides,

1[v]:2.5[h] on the southern side due to the advancing face launching from this face.

4.1 Construction of the Klipfontein Spruit River Diversion

The Klipfontein Spruit River Diversion is the first section of infrastructure that needs to be constructed. The diversion will prevent further water entering the Starter Platform footprint which will allow construction of the footprint to commence as well as allow the material to dry.

4.2 Storm water management before large scale clear and grub

The contaminated storm water network must be constructed before large scale clear and grub activities commence. This is to ensure that storm water run-off from exposed soil is controlled and prevented from entering the environment. This run-off will likely have a large amount of suspended soil particles which will cause the turbidity of local streams to increase.

Instead of allowing the turbid storm water into the environment, it will be diverted to a settling pond which will likely be one of the partly constructed pollution control dams (a lining system will not be required at this time). The turbid water will be allowed to settle and the larger soil particles will deposit on the dam floor. Clear water will be removed from the top of the dam by either controlled overflowing through a spillway or by pumping water from the surface.

Colloidal particles will likely not settle under their own self weight. Options for dealing with colloidal particles are the following:

- Installing silt bags whereby turbid water is pumped through a water permeable fabric bag resting on a bed of washed aggregate;
- Using PAMs (Polyacrylamides) which are a large range of flocculants in liquid, powder and solid form to chemically bind sediment particles together and settle out. These need to be used at recommended levels to prevent aquatic organisms from being affected.

4.3 Development of the Starter Platform

The Starter Platform will be constructed in two stages so that the first stage is available for ash placement before the second stage is completed.

Assuming the first stage is limited to 600 000m^2 and using a liner installation production rate estimate of 5 000m^2 per day the construction period will be 120 days or 6 months. However, a certain amount of earthworks is required before the liner installation can commence. A fair assumption is that the earthworks will also take 6 months to complete. Therefore Stage 1 is estimated to take 12 months to construct.

Before the stage can be commissioned at least one pollution control dam will need to be constructed. Using the size of PCD 1 (approximately 150 000m^2) an additional 3 months would be required.

Therefore, the total construction time to commission the first stage is 15 months.

This estimate does not include the construction of conveyors as these would be required at the end of the construction of the Starter Platform when the ash stack begins which is assumed to be 4 to 5 years after first ash at the facility.

The remaining construction period, including the remaining 600,000m^2 liner installation for the Starter Platform and the 6 remaining dams of combined liner area 280 000m^2, results in a duration of approximately 8 months. Allowing 8 additional months for earthworks, gives a total of 16 months.

Therefore if a staged approach is taken, the first stage will be 15 months and the second 16 months resulting in a total of 31 months or just over 2.5 years. There is room for optimization during the basic and detailed design.

All these dates and durations are based on normal weather conditions and expected / assumed geotechnical conditions.

4.4 Placement of ash

Approximately 24 300m^3 of ash will need to be placed per day. Assuming Articulated Dump Trucks are used (ADTs) which can carry approximately 13m^3 of ash per load, 1870 loads will be required per day or 78 loads per hour.

Over the initial stage area of 600 000m^2, 150 000m^3 of ash will be required to place a layer 0.25m thick. Considering the deposition rate, it will take approximately 6 days to place one layer.

Sixteen months after construction of the first stage, the second stage of the Starter Platform will be available for placing ash. The deposition rate will then be split between the two stages resulting in a 0.25m thick layer taking 12 days to place.

In order to get to an average height of 29.7m, a total of approximately 120 lifts will be required. At 12 days per lift, the Starter Platform will take 1 440 days or 4 years to construct.

4.5 Compaction of ash

Compaction of the ash is required to ensure stability of the platform.

The platform must be:

- Constructed in horizontal layers over the full area;
- Constructed from the bottom of the liner terrace upwards;
- Constructed in layers not exceeding 250 mm thick (uncompacted).

Compaction will be according to an initial field compaction trial that determines a suitable “method specification” for all future compaction. The required compaction effort will be identified during the trial. A weekly routine test is required to cross check the ideal number of roller passes.

5. PHASE 2 & 3: ASH STACK OPERATIONS

5.1 Construction Water Requirements

Water is required to be added for compaction of liner and earthworks layers.

The area of the total lined footprint is used in the calculation of construction water requirements. The figure provided is for the facility over a 60 year life.

The water will need to be sourced from the Raw Water Reservoir at the power station or the pipeline from Kendal Power Station until any of the dams is constructed after which water will be sourced from local dams.

Table 1: Construction Water Requirements

Description:	Construction Water Requirements
Area (ha)	817.4
Depth (m)	0.45
Volume (m^3)	3,678,300
Mass of soil (t)	6,621,000
2% Moisture Content increase (m^3)	132,420

Assumptions:

- Bulk density of soil is 1 800kg/m^3
- In situ moisture content will require an average of 2% additional moisture during compaction

5.2 General Operations

Operations of conveyor systems and stackers:

Conveyors are used to transport the ash from the power station to the ash facility. At the power station, the ash is deposited onto an overland conveyor at a transfer house. The overland conveyor transports the ash to a transfer house at the ash disposal facility.

The transfer house at the ash facility either deposits the ash onto an extendable conveyor which leads onto the ash facility or onto a cross conveyor which will transport the ash to the transfer house of a second ash facility if required.

The extendable conveyor transports the ash from the transfer house to the starter platform where the shiftable conveyor is set up in the first shift position.

The stacker will do one complete cycle of placing ash in front of the shiftable conveyor followed by placing ash in the back stack behind the conveyor.

Once the first ashing cycle is complete, the shiftable conveyors will be shifted onto the newly placed ash. The extendable conveyors will be extended past the starter platform and onto the placed ash and the next shift's ashing cycle will commence.

Stack Arrangement:

A multi-level stacker setup, similar to the arrangement at Majuba Power Station, will be used.

The lined ash facility has a storage capacity of 55 years and has the following dimensions:

- Length: 3 350m
- Width: 2 825m
- Footprint area: 696.6ha
- Height (shown conceptually in Figure 5):
    - The bottom stacker front stack: 5m thick
    - The bottom stacker back stack: 12m thick
    - The top stacker front stack: Varies from a minimum of 30m to a maximum of 94m thick. The average thickness is 51.6m.
    - The top stacker back stack: 12m thick

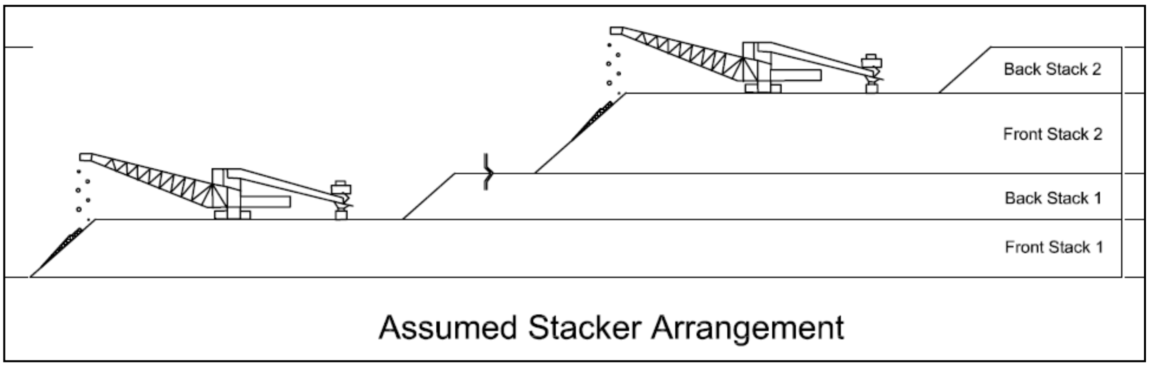


Figure 5: Multi Stacker Philosophy

- Volume:
  - 113.6 million cubic meters in the Bottom Stack (Volume Split: 23% of Total);
  - 385.3 million cubic meters in the Top Stack (Volume Split: 77% of Total).

<u>Stacker setup:</u>

Figures 6 and 7 show the connection of the crawler mounted stacker to the tripper car which runs along tracks on the shiftable conveyor:

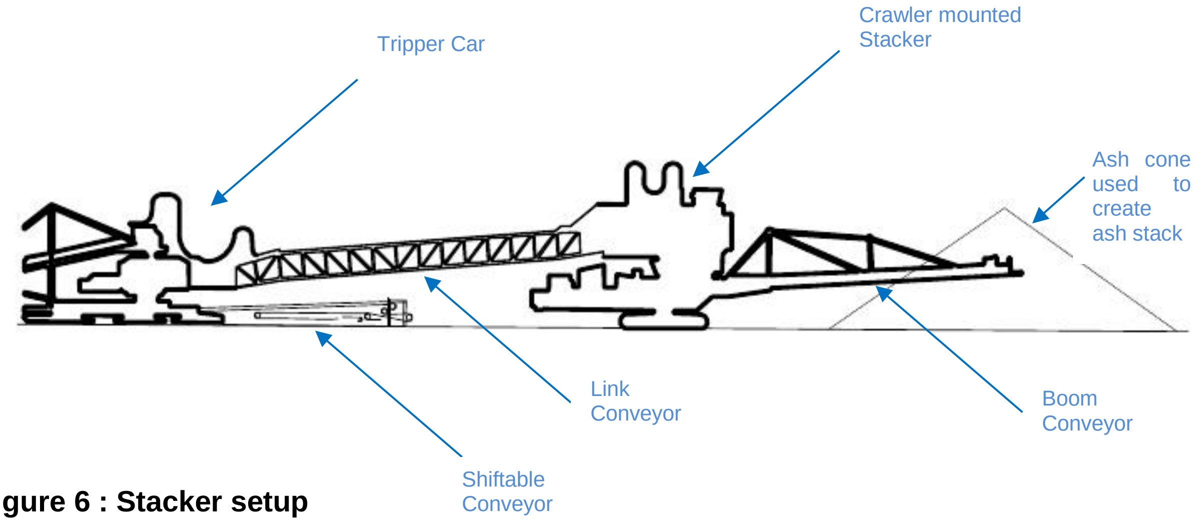


Figure 6 : Stacker setup

Figure 7: Stacker setup at Medupi Power Station

Mobile Equipment:

Where access for the stacker is limited, mobile equipment is used to place the ash and shape it according to the geometry shown on the drawings. The ashing system is arranged so that dozing is kept to a minimum while free ash is maximized. Free ash is defined as ash that is placed by the stacker which does not require further dozing.

Due to the ash being placed at the angle of repose, a large amount of shaping is required at the side slopes during rehabilitation. See the Rehabilitation Plan for more information.

Mobile equipment is also used to shift conveyors and carry out similar tasks.

The following mobile equipment is needed:

- **A dozer**: A dozer will be required to move ash to positions outside the reach of the stackers, carry out trimming and profiling of the ash surface, side slopes, and conveyor platforms and to move the head and tail stations during conveyor shifts.
- **D6 (or equivalent) dozer:** This dozer will be fitted with a rail shifting head frame which will be used to shift the shiftable conveyors.
- **Grader:** A grader will be used to do final levelling and shaping of the platforms, advancing front stack slope, side slopes, back stack and rehabilitation topsoil on the final surfaces of the ash stack. It will also be used for minor cleaning operations on the stacker working platforms as well as for grading of roads and excavation of clean storm water cut-off trenches.
- **Compaction Equipment:** A self-propelled or towed vibrating roller will be used to achieve nominal compaction of the ash stack surface in the stacker working areas as well as on the shiftable conveyor platforms. Compaction of the advancing front stack slope assists in the shifting operation of the shiftable conveyors.
- **Water bowser**: Water bowsers will be used for dust suppression of working areas, roads and, washing down of the mechanical plant. Water bowsers will also be used for dust suppression of advancing slopes where it is difficult to reach with sprinklers or for specific chemical dust suppression applications.
- **Dump Trucks:** Dump trucks will be used for hauling and placing topsoil and fill material on the ash facility.
- **Front End Loader:** Front end loaders will be used for loading dust suppression soil and fill material onto trucks, for general maintenance on and around the ash facility.
- **TLB:** A TLB (Tractor Loader Backhoe) will be used for cleaning concrete lined canals, digging holes for anchor plates and general maintenance on and around the ash facility.

5.3 The growth plan

The following growth plan is based on the volume and tonnage information shown in Table 2 below. It is also based on the assumption that all 6 units are operational when the 60 year ash facility is commissioned.

Table 2: Calculation of the required volume of the ash facility

Description:	Value:	Unit:
Rounded load	135	t/hr/unit

Daily Load per unit	3,240	t/day/unit
Monthly Load per unit	98,550	t/month/unit
Yearly Load per unit	1,182,600	t/year/unit
Total Load per unit (60 year life)	70,956,000	t/60yr/unit
Total Load of Power station	425,736,000	t/60yr/6units
Bulk Density	0.8	t/m^3
Total Volume	532,170,000	m^3

Additional information regarding the expected volume and tonnage is included in the Ash Facility Design Report.

A growth plan consists of three graphs:

- Time vs. Chainage: This graph indicates at what point in time the ash facility will reach a specific chainage.
- Time vs. Volume: This graph indicates at what point in time the ash facility will reach a specific volume.
- Volume percentage (%) vs. Chainage: This graph illustrates the relationship between the volume of the facility and its development in space. I.e. it reaches 50% of its volume after approximately 1 300m of development.

Starter
Platform
5yr

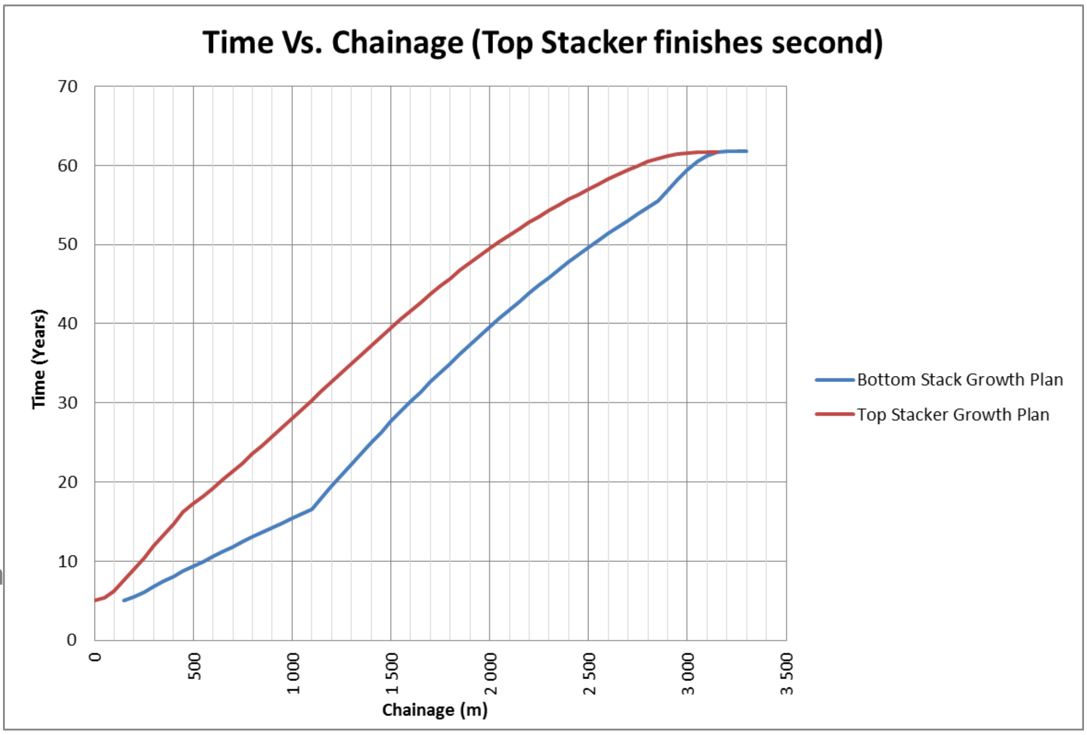


Figure 8: Growth Plan: Time Vs. Chainage (BS: Bottom Stacker TS: Top Stacker)

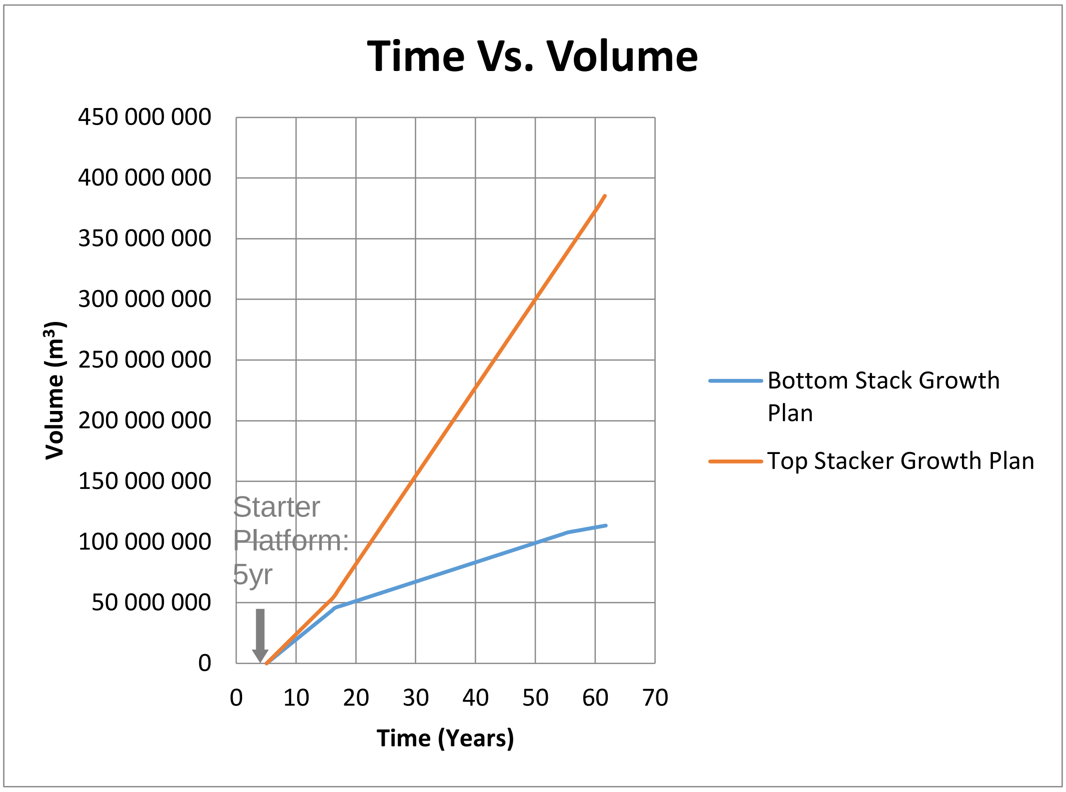


Figure 9: Growth Plan: Time vs. Volume

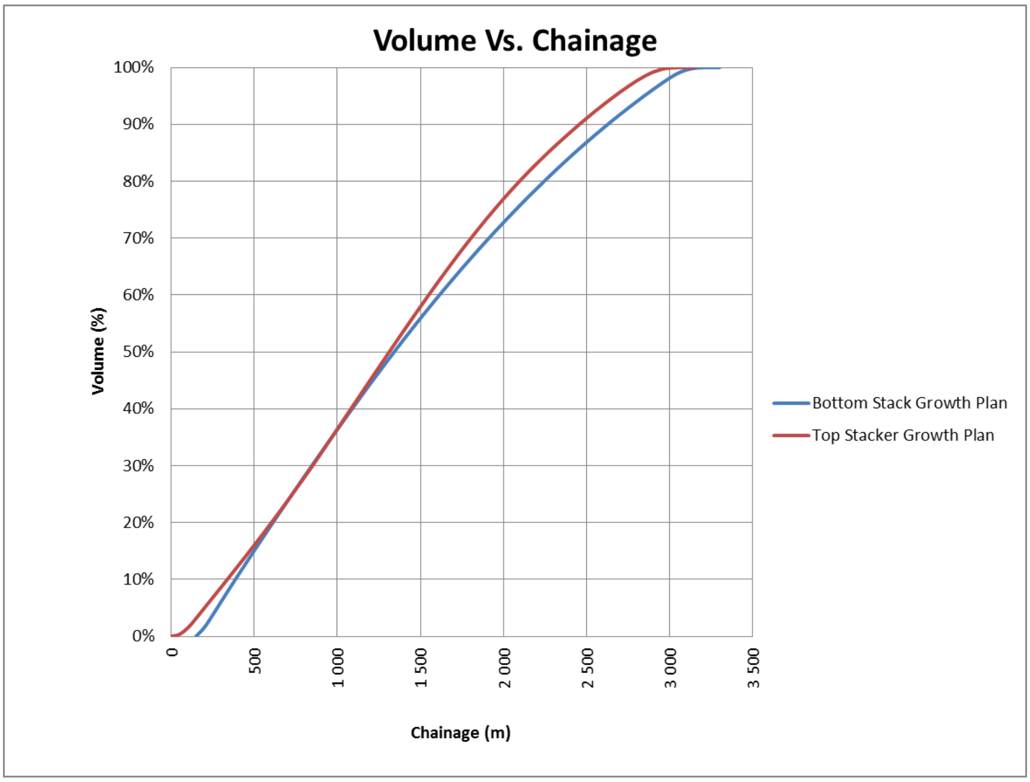


Figure 10: Growth Plan: Volume Percentage (%) Vs. Chainage (m)

Table 3 provides a summary of the accumulative volume stored over the lifetime of the facility.

Table 3: Growth Plan Summary for 5 year lined areas

Period:	Accumulated Ash Storage: (million m^3):	Lined Area per period: (Ha)	Accumulated Lined Area: (Ha)
Starter Platform	35.8	120.5	120.5
5 to 10 year	81.5	125.7	246.2
10 to 15 year	122.0	120.1	366.3
15 to 20 year	172.5	67.9	434.2
20 to 25 year	210.5	55.7	489.9
25 to 30 year	260.6	37.2	527.1
30 to35 year	301.8	48.9	576
35 to 40 year	349.8	55.8	631.8
40 to 45 year	388.8	51.1	682.9
45 to 50 year	437.2	46.5	729.4
50 to 55 year	478.9	48.2	777.6
55 to 60 year	534.8	39.8	817.4

The following table indicates the dates at which the percentage splits between the top stacker and bottom stacker change throughout the lifetime of the facility.

Table 4: Percentage splits for stacker over life of facility

Life:	Percentage Split	
0 – 3 years	100% truck and haul operation (Development of Starter Platform	
3 – 5 years	50% Truck and haul operation	50% Bottom Stacker
5 – 18 years	55 % Top Stacker	45 % Bottom Stacker
18 – 55.5 years	82 % Top Stacker	18 % Bottom Stacker
55.5 – 60 years	90 % Top Stacker	10 % Bottom Stacker

Cross over between the Starter Platform and the ash facility

Although the growth plan indicates that the starter platform will take four years to complete it is envisioned that there will be a cross over period where the bottom stacker may start ashing before the starter platform is complete. This will extend the life of the starter platform to 5 years as shown in Table 4.

5.4 Setting out of ash facility

Control beacons will be provided to the ash facility contractor by Eskom.

Setting-out details of the liner terrace and the ash facility will be shown on the working drawings.

The development and geometry of the facility will be audited annually using tacheometric audit surveys. These audits will ensure that the ash stack is within its tolerances. This will create a historic record of the ash stack's development.

Ground surveys taken before each shift, over the area since the last survey; will also indicate if an error is occurring when compared to the drawings.

Additional information will be obtainable from Eskom's Survey Department at Megawatt Park.

5.5 Conveyor and Shift details

The following table shows basic information regarding conveyor length and number of shifts:

Table 5: Conveyor and shift information

Description:	**Value:**
Overland Conveyor Length	1 250m
Extendable Conveyor – Top Stacker - Initial Length - Additional Length	 1 550m 2 906m
Extendable Conveyor – Bottom Stacker - Initial Length - Additional Length	 1 260m 2 990m
Shiftable Conveyor – Top Stacker - Length Range - Number of shifts	 460 to 2 347m 58
Shiftable Conveyor – Bottom Stacker - Length Range - Number of shifts	 686 to 3 083m 59

The following tables will need to be populated after the detailed design of the mechanical infrastructure is completed.

Table 6: Extendable Conveyor Characteristics

Belt width	
Belt speed	
Maximum continuous conveying rate	
Maximum design conveying rate	
Normal operating slope for conveyors (average)	
Maximum operating slope for conveyors	
Minimum radius for convex vertical curve	
Minimum radius for concave vertical curve	
Under normal operation the following is applicable for the extendible conveyors:	
Maximum slope across module	
Horizontal module deviation	
Vertical rail deviation	

Table 7: Shiftable Conveyor Characteristics

Belt widths	
Belt speed	
Maximum continuous conveying rate	
Maximum design conveying rate	
Normal operating slope for conveyors (average)	
Maximum operating slope for conveyors	

Under normal operation the following is applicable for the shiftable conveyors:	
Maximum slope across rails	
Horizontal rail deviation	
Vertical rail deviation	
During conveyor shifts the following is applicable for the shiftable conveyors:	
Maximum slope across rails	
Minimum horizontal radius	
Longitudinal curve length for shiftable conveyors through XX m radius curves during shifting operations	
Design ground bearing pressure under all conveyor bases	

Table 8: Tripper Car Characteristics

Length of tripper car	
Minimum distance from centre line of extendible conveyor to centre line of discharge onto the link boom	
Minimum distance from centre of discharge onto the link boom to the centre line of the pulley on the head end station	

Table 9: Stacker Characteristics

Crawler width (outside edge to outside edge)	
Crawler length	
Link boom length	
Discharge boom reach	
Link conveyor slewing angle	
Boom conveyor slewing angle	
Maximum luff angle	
Belt speed	
Maximum continuous conveying rate	
Maximum design conveying rate	
Maximum stacking height of cone	
Design ground bearing pressure under stacker crawlers	

The shifting procedure

The shift procedure involves the moving of the shiftable conveyor from the current position to new the shiftable conveyor position, which will be a distance of 50m approximately parallel to the current position.

Movement of the conveyor is made possible by the inclusion of tracks at the base of each conveyor unit. However, the conveyor cannot be moved in one continuous motion. It requires a “snaking” movement whereby a dozer is used to pull one unit into position at a time. Therefore the conveyor is “shifted” from one side to the other.

5.6 Safe Edge Distance

The Safe Edge Distance (SED) is defined as the zone near the crest of the front stack (FS) that is less stable due to over steepening as a result of the induced cohesion created by the conditioning water in freshly stacked ash.

The SED is calculated using the equation:

$$SED = \frac{1}{2} FS(\cot\phi - \cot\phi_s)$$

Where: SED = Safe Edge Distance

Φ = Angle of repose of ash (30°)

Φ_s = Over steepened angle of ash (40°)

The following table shows SED values for front stack heights in ten meter intervals.

The SED will not apply to mobile plant such as dozers that will be constantly used on the edge of the crest.

Table 10: Recommended SED vs. FS height based on profile geometry

FS (m)	10	20	30	40	50	60	70	80	90	100
SED (m)	3	6	9	11	14	17	19	22	25	28

5.7 Storm water management

Storm water infrastructure will be constructed before large scale clear and grub commences. See Section 4.2 for additional information.

Storm water that falls on the ash facility or conveyor platforms will be contaminated and will be kept separate from clean storm water as recommended in GN 704[2]. The site will have a network of contaminated storm water collection trenches which will surround the facility and gravity-drain towards seven PCDs located on the northern side of the ash facility.

Upstream clean storm water will be diverted around the ash facility by diversion berms and trenches. The clean storm water will be tested before being diverted into the environment downstream of the facility.

Where two Pollution Control Dams are located next to each other, the upstream dam will spill into the downstream dam which will in turn spill into the environment depending on the size of the rainfall event.

<u>Clean Storm Water Dams</u>

The site is characterised by three main valleys:

- The Klipfonteinspruit valley that runs along the northern edge of the facility;
- The Holfonteinspruit valley that runs northwards down the centre of the site;
- The tributary valley that runs towards the north west.

[2] GN 704 regulates the use of water for mining and related industries but serves as a guideline for storm water management at other waste facilities.

The last two valleys will be responsible for transporting storm water from the upstream catchments directly into the site. Therefore it will be essential to cut off as much water upstream as possible to reduce the water heading towards the site. There will always be a requirement for a clean water dam south and upstream of the ash facility.

As the ash facility develops southwards, the existing clean water dam will become redundant and will need to be demolished as it will be within the footprint of the future extension. Before it is demolished, a new dam will be required further upstream to take its place.

Figure 11 shows the 17 clean storm water dams that will be required over the life of the facility.

The volume in the clean storm water dams will be controlled by a pump system which will pump water to a contour cut-off drain which will drain to the environment.

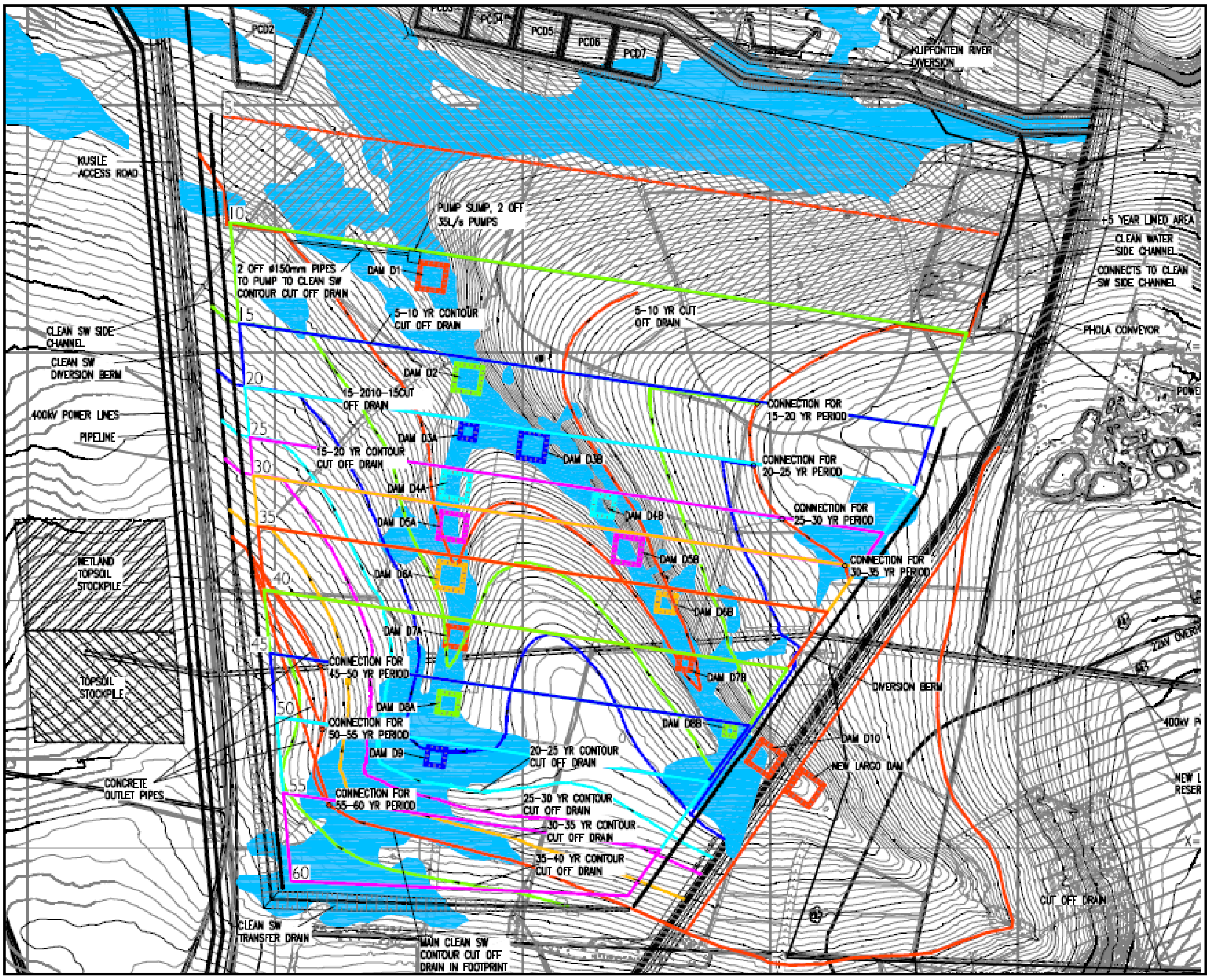


Figure 11: Layout of Clean Storm Water Dams and Pollution Control Dams

Table 11: List of clean water dams including sizes and catchments

Clean SW Dam List		
Description:	**Dam Size:**	**Catchment (ha):**
D1	30 000m^3 100 x 100 x 3m	103
D2	40 000m^3 115 x 115 x 3m	130
D3a	15 000m^3 70 x 70 x 3m	72.4
D3b	30 000m^3 100 x 100 x 3m	104.6
D4a	30 000m^3 100 x 100 x 3m	99
D4b	25 000m^3 90 x 90 x 3m	118
D5a	30 000m^3 100 x 100 x 3m	103
D5b	30 000m^3 100 x 100 x 3m	100.6
D6a	30 000m^3 100 x 100 x 3m	107.4
D6b	19 200m^3 80 x 80 x 3m	78.8
D7a	25 000m^3 90 x 90 x 3m	99.8
D7b	10 800m^3 60 x 60 x 3m	54.9
D8a	25 000m^3 90 x 90 x 3m	95
D8b	7 500m^3 50 x 50 x 3m	32.8
D9	19 200m^3 80 x 80 x 3m	77
D10	30 000m^3 100 x 100 x 3m	116.6
New Largo Dam	30 000m^3 100 x 100 x 3m	100

5.8 Dust Suppression & Irrigation

Figure 12 shows the dust suppression system in operation at the Matimba Power Station. This is a similar dust suppression system to the design at Kusile Power Station. The ash arrives at the ash facility with a raised moisture content of approximately 10% as shown in Figure 13. The aim of the dust suppression system is to ensure that the moisture content is maintained to reduce dust blow. The source of the dust suppression and irrigation water will likely be sourced from the surrounding pollution control dams.

Figure 12: Dust suppression system at Matimba Power Station

The rate of irrigation and dust suppression is shown in Table 12.

The operations requirement is approximately 900% more volume than the construction requirements as these areas will continuously need to be wetted during operations whereas the area during construction will only require wetting during a single period during construction of the compacted soil layers.

Table 12: Operations Water Requirements

Description:	Operations Water Requirements
No of days of operations (60 yr life)	21,900 days
Exposed Area (requires dust suppression)	2 000 000m^2
Current Rehabilitation Area (requires irrigation – width of facility multiplied by 100m [2 shifts])	316,000m^2
Dust Suppression	3,333m^3/day
Irrigation	1,896m^3/day
Total Dust Suppression over 60 years	73,000,000m^3
Total Irrigation over 60 years	41,500,000m^3

Assumptions:

- Dust suppression and irrigation requirements are 5.0 and 6.0mm/day respectively;
- Dust suppression occurs once every three days for a specific area. The sprinklers are used for a duration of 4 hours;
- Irrigation occurs once a day and the sprinklers are used for a duration of 1.5 hours.
- The area for dust suppression is based on the following assumptions:
  - Rehabilitation has reached 2 shifts behind the advancing face of the Top Stack (shift length 50m);
  - There is a 533m spacing between the top stacker and the toe of the bottom stack;

- The worst case scenario of the width of ash facility during the 5 to 10 year development area is used (3 160m).

- The area for irrigation is based on the following assumptions:
    - The ash facility is irrigated for 2 shifts width behind the extent of rehabilitation (shift length 50m);
    - The worst case scenario of the width of ash facility during the 5 to 10 year development area is used (3 160m).

Figure 13: Moisture condition (typically 10%) of ash at arrival at the ash facility (Matimba Power Station)

5.9 Progressive Topsoil Management

Figure 14 shows the method of progressive topsoil management. The topsoil of the Starter Platform and the first 5 years lined area (5 to 10 year development) is stockpiled for later use near the end of the facility.

The topsoil in the footprint of the 10 to 15 year development is used to rehabilitate the initial development of ash facility. This process then repeats itself until the last area (55 to 60 year development). The topsoil in the stockpile is then used to rehabilitate the last area.

There may be a need for additional topsoil during the rehabilitation of the facility. This is logical as the surface area of the facility will be larger than the footprint of the facility. Also, due to the wedge shape of the facility, preceding lined areas are larger than subsequent areas resulting in a reducing availability of topsoil. For these reasons, there may be a topsoil shortage and later areas will need to be covered from a commercial source of topsoil.

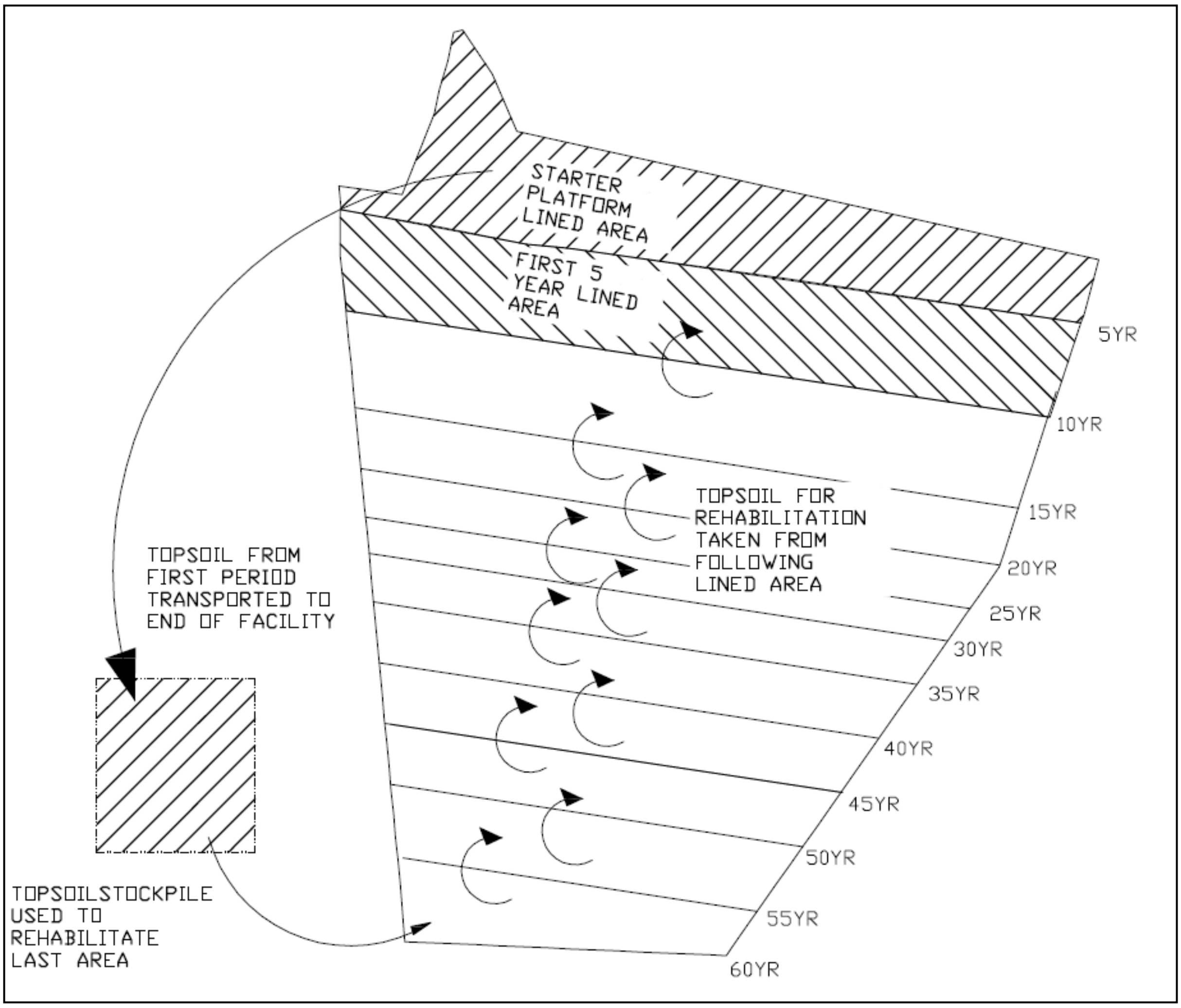


Figure 14: Method of progressive topsoil management

5.10 Emergency off loading facility

If one or both stackers are out of commission, ash will temporarily be offloaded onto the emergency ash platform situated after the additional transfer houses required for the overland conveyor.

The overland conveyors are connected to a moving head system which can extend past the transfer point and deposit ash onto the emergency platform. The extended length is supported by a wall which also retains the ash until it can be moved by mobile equipment.

No additional hardening to cater for mechanical track wheels will be included in the design of the slab on the emergency platform. Therefore only plant with conventional tyre wheels should be used.

The ash is transferred onto the extendable conveyor with the use of small plant such as a skid steer vehicle (bobcat type loader) or a TLB.

5.11 Construction and operation chart

The construction and operation chart is attached in Appendix A.

5.12 Site Office

The Site Office is located in the north western corner of the facility.

The following site facilities are available:

- **Site office:** The office includes three offices, one 10 seat meeting room, a kitchenette and a dining hall. Male and female ablutions are also provided.
- **Workshop and Store:** A workshop and store, both 6 x 10m in size, with vehicle access, are provided. An oil spillage sump outlet to outside containment facilities is included.
- **Vehicle maintenance:** A service bay and wash bay with oil trap facilities.
- **Contractor Yard**: 50 x 50m yard including one Site Agent Office, kitchenette with attached dining hall and male & female ablutions.

5.13 Access Roads

The site entry gate will be on the north western side of the site near the Site Office. Leading from the gate will be the service roads along the conveyors and the ash facility. Patrol roads are located parallel to the facility's security fence.

At certain points along the patrol road will be roads that branch off toward infrastructure such as storm water trenches, the Klipfontein River diversion or the pollution control dams.

Access roads that run on either side of the facility also provide access to leakage detection outlets of the liner system.

Roads will be used for access to carry out maintenance, inspections, material delivery and construction.

There are three service roads on the Overland Conveyor Platform: one on either side of the two conveyors and one that runs between the conveyors. The service roads along the conveyors lead to the Starter Platform and then onto the conveyor corridor on the ash facility.

Access to the rehabilitated back stacks of the facility will be from the eastern or western end of the Starter Platform.

On the rehabilitated back stacks, access roads are included on the eastern and western edges with crossroads every fourth shift (200m).

The roads that are included in the design of the Ash Disposal Facility (ADF) and the ash conveyor platforms will be designed according to best practice.

Best practice at other ash and waste facilities involves the use of a combination of competent gravel materials (G5 and G7 in TRH04) as a base and wearing course. Due to the low traffic expected on these roads, the cost of higher specified pavements as specified in TRH04, is not warranted.

5.14 Security Fence

A security fence surrounds the facility on the West, South and East sides. On the northern side, the fence connects to the security fence of the co-disposal facility.

5.15 Rehabilitation

For information regarding the rehabilitation of the 60 year Ash Facility please refer to the following Rehabilitation Plan:

- Jones & Wagener (Pty) Ltd., February 2013. Kusile Power Station 60 year ash facility EIA – Rehabilitation Closure Plan. Report number JW008/14/D121.

5.16 Ash as a resource

There are various alternative uses for ash including combining it with cement in concrete and using it as a filler in plastic production. If at any point during the operation of the facility there are commercial interests to use ash as a resource, access to specific areas of the facility will be made available.

Co-ordination between the collection parties and the facility operation personnel must exist so that no damage to lined areas or disturbance of rehabilitated areas occurs and that collection is carried out in a safe manner.

6. MONITORING AND MAINTAINANCE

6.1 Inspection Frequency

The following inspections should be carried out:

Fortnightly

Monthly

Yearly

5-yearly

The fortnightly and monthly inspections are to be carried out by Eskom staff, whilst the yearly inspections are to be carried out by a professionally registered civil engineer.

Monitoring should occur at the following frequency:

Table 13: Monitoring Frequency

Description:	Frequency:
Rainfall	Daily
Volume and constituents of water in pollution control dams and clean water storage dams	Monthly
Pumping systems are operational	Weekly
Borehole network	Monthly
Seepage at toe of ash facility	Continuous (minimum daily)
Exposed liner damage, penetrations and anchor trenches	Monthly
Liner temperatures Ash sampling for hydration constituents	Continuous (minimum weekly) Bi-annually
Leakage into detection sumps	Continuous (minimum weekly)
Repair work (Including date and nature of repair)	When Required
Damage (Including date and nature of damage)	When Required

6.2 General maintenance

Maintenance will take place throughout the entire facility. Checklists will be used to ensure that the facility is being developed according to the design and specification, by highlighting areas that may need remedial works as required.

Maintenance work must be well planned and cost effective. For some cases, a more costly alternative can be used if it is proved that the solution will be durable as opposed to short-lived less expensive alternatives.

6.3 Maintenance Frequency

Maintenance frequency will be based on the monitoring frequency discussed in Section 6.1. After monitoring has taken place items that require maintenance will be highlighted and should be maintained as soon as possible.

6.4 Barrier system

The barrier system is designed so that the geomembrane is minimally exposed. Where liner is exposed it should be carefully inspected for mechanical liner damage and for marked deterioration caused by exposure. Small crack patterns in the HDPE could indicate environmental stress cracking. Should this occur the advice of a specialist should be sought.

The liner anchor trenches should be inspected for signs of stress on the liner as well as the compaction of the fill material. Should the backfill to these trenches be insufficient, additional material is to be brought in and compacted. All anchors / penetrations of the lining system are to be inspected for failure and for stress on the liner.

Should damage to the geomembrane of the lining system occur it will need to be repaired by a specialist contractor.

Where the geomembrane has become exposed due to the removal of its cover material, the cover material should be replaced as to prevent prolonged exposure or damage.

6.5 Liner temperature monitoring

The barrier system will have a temperature monitoring system installed to take continuous readings of the temperature at the lining system. The monitoring system will include instrumentation such as thermo-couples.

Ad hoc measurements can also be taken using a handheld electric thermometer.

The ash is to be sampled and tested for chemical constituents (mainly free lime (CaO) and Sulphates (SO3)) to assess the possibility of hydration and temperature build-up occurring.

6.6 Leachate collection and leakage detection collection

Records of leakage volumes pumped from the sump must also be inspected as well as the pumping system, flow meters and sampling points.

Pumping systems that have failed will need to be repaired or replaced.

6.7 Pollution control dams

The water in the dams is to be tested for its constituents.

Long grass on the side of a dam leads to rodent habitation and will increase the risk of fire. Grass within 2m of the crest of the dam will need to be removed.

Trees' roots may cause piping in the dam embankment. All trees within 2 m of the toe of the embankment must be removed.

Bare patches on the sides of dam embankments must be reseeded.

The outlet of each dam must be kept clear of vegetation or other blockage material.

Pollution control dams may be filled with deposition over time. The geomembrane of the dam lining system is protected by a cement stabilised soil layer which will allow access into the dam for removal of the deposition.

6.8 Clean Water Storage Dams

The dam spillways must be monitored to ensure that there are no blockages.

The operation of the pumping systems that are used to drain the dams to the upstream contour drains are to be monitored. If the systems fail, the dams may become full and there will be a risk of spilling.

Pumping systems that have failed will need to be repaired or replaced.

6.9 Ash facility

The toe of the ash facility must be continuously checked for seepage. The cause of seepage must be investigated. If it is due to over wetting by irrigation or dust suppression systems these must be moved to a different area. If the cause is due to extensive rainfall; the advancing face must be specifically monitored until the seepage has dissipated through the barrier system drainage layers. If the cause is due to drainage system failure, the area of failure should be investigated for options to increase the drainage capacity.

Gullies on the ash body caused by erosion must be filled with ash before worsening.

The ash facility must also be inspected for subsidence, wall movement and undercutting.

6.10 Slope stability

Slopes must be continually checked for signs of slope failure such as the development of tension cracks at the crest and bulging of the sideslope. No water should be allowed to pond at the toe of the ash facility as this could lead to a reduction in the strength of the ash and failure could occur.

6.11 Storm water management

Storm water trenches will be inspected for erosion and surface damage. The position of occurrence will be noted.

Storm water trenches and berms must always be kept clear of material that can reduce conductivity such as deposited material or material that may cause a blockage such as branches or litter.

Pipes are to be kept clear of blockages.

Water planned for diversion to the environment must be tested regularly for its constituents and turbidity before release.

6.12 Rehabilitated areas

Erosion of rehabilitated areas may form gullies in the topsoil layer above the ash. These gullies must be refilled with topsoil immediately to avoid further contamination of rehabilitated areas.

6.13 Dust suppression

All excessive dust entrainment occurrences must be measured and monitored using dust monitors.

6.14 Erosion control

All erosion damage will be repaired and affected areas returned to their original state. All topsoil erosion must be reclaimed.

6.15 Access roads

All access roads will be inspected for depressions, potholes and erosion. The position of all depressions shall be indicated on the inspection form.

No standing water or ponding will be allowed and occurrence shall be noted.

6.16 Borehole network

The borehole network must be monitored on a monthly basis.

Damaged boreholes will need to repaired or reinstalled.

6.17 Tests and Analyses

Sampling points are included in the leakage detection systems of the ash facility and the pollution control dams.

Samples are also to be taken from the borehole network.

The samples taken are to be sent to a laboratory to test for the following constituents:

Table 14: Test requirements

pH
Electrical conductivity
Total Dissolved Solids
Total Alkalinity as $CaCO_3$
Nitrate as N
Chloride as Cl
Sulphate as SO_4
Sodium as Na
Potassium as K
Calcium as C
Magnesium as Mg

Samples of clean water should also be tested for turbidity.

6.18 Record keeping

The records of the following events are to be kept:

- Leakage volumes and constituents on the ash facility and the pollution control dams;
- Constituents of bore hole sampling;
- Constituents of clean water diversion systems;
- Leaching volumes measured at the toe of the facility and constituents of samples;

- Liner temperatures.

7. OPERATIONS PLAN UPDATES

This operations plan may serve as the base for the operations manual. The manual is seen as a dynamic or live document that is repeatedly updated depending on how the prescribed operations change over time.

The operations manual is also an effective training tool and experienced gained during operations should be added to future revisions so that if management hand over is required, the experience can be transferred.

Charl Cilliers
Project Manager
for Jones & Wagener

Danie Brink
Project Director

4 June 2014

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Document template: Normal.dotm

APPENDIX A

CONSTRUCTION AND OPERATIONS TABLE

	A	B	C	D	E	F	G	H	I	J
1	**Ash facility operation period:**	**Lined Area: (Ha)**	**Required Pollution Control Dams**	**Clean SW contour cut-off drains**	**Clean Storm Water Infrastructure**	**Access Road**	**Contaminated Storm Water Network**	**Rehabilitation**	**Other**	**Redundant Infrastructure**
2	Starter Wall: 0-5 year life	120.5	PCD 1 - 7	Main Clean SW Contour cut-off drain in footprint and east of Phola Conveyor	- Dam D10 - New Largo Dam - Klipfonteinspruit River Diversion incl. stilling basin - Clean water side drains - Clean water diversion berms	- Access Road around starter platform footprint and along fence up to 20 year development line (+15 yr) - Haul Road to Starter Platform	Northern, eastern and western sides.		- Topsoil Stockpile area	
3	5 – 10	127.5		5 -10 yr Clean SW Contour cut-off drain	- Dam D1	Access Road around footprint	Extend east and western sides	Rehabilitate Starter platform Rehabilitate 5 – 10 year development	- Conveyor platforms up to starter platform - Emergency Stockpile Platforms 1 and 2	
4	10 – 15	120.1		10 -15 yr Clean SW Contour cut-off drain	- Dam D2	Access Road around lined footprint	Extend east and western sides	Rehabilitate 10 – 15 year development		- Dam D1
5	15 – 20	67.9		15 -20 yr Clean SW Contour cut-off drain	- Dam D3A and D3B	Access Road around lined footprint	Extend western side	Rehabilitate 15 – 20 year development		- Dam D2
6	20 – 25	55.7		20 -25 yr Clean SW Contour cut-off drain	- Dam D4A and Dam D4B	Access Road around lined footprint and along fence up to 40 year development line (+35 yr)	Extend western side	Rehabilitate 20 – 25 year development		- Dam D3A and D3B
7	25 – 30	37.2		25 -30 yr Clean SW Contour cut-off drain	- Dam D5A and D5B	Access Road around lined footprint	Extend western side	Rehabilitate 25 – 30 year development		- Dam D4A and Dam D4B
8	30 – 35	48.9		30 -35 yr Clean SW Contour cut-off drain	Dam D6A and D6B	Access Road around lined footprint	Extend western side	Rehabilitate 30 – 35 year development		- Dam D5A and D5B
9	35 – 40	55.8		35 -40 yr Clean SW Contour cut-off drain	Dam D7A and D7B	Access Road around lined footprint		Rehabilitate 35 – 40 year development		Dam D6A and D6B
10	40 – 45	51.1		Main Clean SW Contour cut-off Outlet pipe 1.0m Diameter concrete pipe	Dam D8A and D8B	Access Road around lined footprint and along fence up to 60 year development line (+55 yr)		Rehabilitate 40 – 45 year development		Dam D7A and D7B
11	45 – 50	46.5		Main Clean SW Contour cut-off Outlet pipe 1.0m Diameter concrete pipe	Dam D9	Access Road around lined footprint		Rehabilitate 45 – 50 year development		Dam D8A and D8B
12	50 – 55	48.2		Main Clean SW Contour cut-off Outlet pipe 1.0m Diameter concrete pipe		Access Road around lined footprint		Rehabilitate 50– 55 year development		
13	55 – 60	39.8		Clean SW transfer drain		Access Road around lined footprint		Rehabilitate 55 – 60 year development		
14	Decommissioning	0				Access Road and security fence around entire existing facility		Carry out final rehabilitation		- PCD 2 and PCD 4 to 7

Note:

1. Infrastructure requirements for previous periods apply to subsequent periods unless included in Redundant Infrastructure (Column J)

APPENDIX B

DRAWINGS

APPENDIX B - Table of Contents

REPORT CHECKLIST

Job no:	
	23 January, 2014
Our Ref:	D121-00_REP-007_ccOperationsPlan_20140129.docx

ITEM	AUTHOR	REVIEWER	CORRECTED	COMMENTS
GENERAL				
Report number registered	X			
Correct template	X			
STRUCTURE				
Document approval record	X			Author, review, revision etc.
Revision / issue register	X			
Synopsis	X			
Table of contents	X			
References	X			
Sign and counter sign	X			
Appendices	X			
Drawings	X			
CONTENT				
Purpose	X			
Nature of the project	X			
Project information	X			Location, geology, topography
Engineering basis	X			Design, codes, assumptions etc
Analysis/Calculations/Review	X			
Discussions	X			
Recommendations	X			
Follow-up work required?	-			
Conclusions	-			
REVIEW				
Fulfils brief & purpose?				
Clarity?				Figures and tables?
Supporting data complete?				Forest & trees covered?
Recommendations logical?				Consistent with site conditions?
Recommendations practical?				Practicality
APPROVAL				
SIGNATURE				
DATE				

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Original	1		1	Unbound	
Archive Copy			1	Ring bound	
File Copy			1	Ring bound	
Project Manager					
Other					