

ZITHOLELE CONSULTING

**KUSILE POWER STATION 60 YEAR ASH DISPOSAL FACILITY:
WASTE MANAGEMENT FACILITY LICENCE APPLICATION
REPORT
CLOSURE & REHABILITATION PLAN**

Report No.: JW008/14/D121 - Rev 1

JUNE 2014






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DOCUMENT APPROVAL RECORD

Report No.: JW008/14/D121 - Rev 1

| ACTION | FUNCTION | NAME | DATE | SIGNATURE |
|---------------|------------------|----------------|--------------|-------------------------------------------------------------------------------------|
| Prepared | Project Manager | Charl Cilliers | 23 Jan 2014 |  |
| Reviewed | Project Director | Danie Brink | 04 June 2014 |  |
| Approved | Project Director | Danie Brink | 04 June 2014 |  |

RECORD OF REVISIONS AND ISSUES REGISTER

| Date | Revision | Description | Issued to | Issue Format | No. Copies |
|-------------|-----------------|--------------------|---------------------------------------|---------------------|-------------------|
| 07-03-2014 | A | First Draft | Mathys Vosloo Zitholele Consulting | Word Format | 1 |
| 23-03-2014 | 1 | Final Report | Mathys Vosloo Zitholele Consulting | Word Format | 1 |
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SYNOPSIS

Rehabilitation and closure of the ash disposal facility are included in the operations of the facility. Concurrent rehabilitation refers to rehabilitation that occurs during normal operations of the facility over areas where ash depositing has been completed. It includes reshaping the ash body and placing 300mm of topsoil cover, as the ash stack develops, so that the exposure of ash to the elements is continually minimised. Storm water falling on rehabilitated areas is considered clean. Therefore storm water management infrastructure is also continuously constructed over rehabilitated areas.

Closure occurs when the ash stack reaches the end of its life and the final exposed ash section is rehabilitated. Redundant infrastructure is then decommissioned.

This document discusses the rehabilitation and closure plan of the ash disposal facility.

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| D121-01-003 | Typical long sections and details |
| D121-01-009 | Capping layout |
| D121-01-011 | Final rehabilitation plan |
| D121-01-014 | Dust suppression & irrigation layout |

The drawings are available in Appendix A.



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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.

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.

Rehabilitation and closure of the ash stack are included in the operations of the facility. Concurrent rehabilitation is carried out as the ash stack develops so that the exposure of ash to the environment is minimised.

Rehabilitation and closure of the ash disposal facility are included in the operations of the facility. Concurrent rehabilitation refers to rehabilitation that occurs during normal operations of the facility over areas where ash depositing has been completed. It includes reshaping the ash body and placing 300mm of topsoil cover, as the ash stack develops, so that the exposure of ash to the environment is continually minimised. Storm water falling on rehabilitated areas is considered clean. Therefore storm water management infrastructure is also continuously constructed over rehabilitated areas.

Closure occurs when the ash stack reaches the end of its life and the final exposed ash section is rehabilitated. Redundant infrastructure is decommissioned and final storm water management infrastructure is constructed.

This document discusses the rehabilitation and closure plan of the facility.

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1.2 References

Additional information describing how the ash facility was designed and will operate 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 – Operations Plan. Report number JW007/14/D121.

1.3 Definitions and abbreviations

1.3.1 Commercial

| | |
|----------------|----------------------------------------------|
| J&W | Jones & Wagener (Pty) Ltd – Design Engineers |
| DEA | The Department of Environmental Affairs |

1.3.2 Technical

Design:

| | |
|-------------|--------------------------------|
| ADF | Ash Disposal Facility |
| CQA | Construction Quality Assurance |
| CQC | Construction Quality Control |
| CDF | Co-Disposal Facility |
| HDPE | High Density PolyEthylene |
| GM | Geomembrane |
| GX | Geotextile |
| GL | Ground Level |
| LCS | Leachate Collection System |
| LDS | Leakage Detection System |
| PCD | Pollution Control Dam |
| TLB | Tractor Loader Backhoe |

Other:

| | |
|------------|---------------------------------|
| EIA | Environmental Impact Assessment |
| EIR | Environmental Impact Report |
| SED | Safe Edge Distance |
| FS | Front Stack |

1.3.3 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

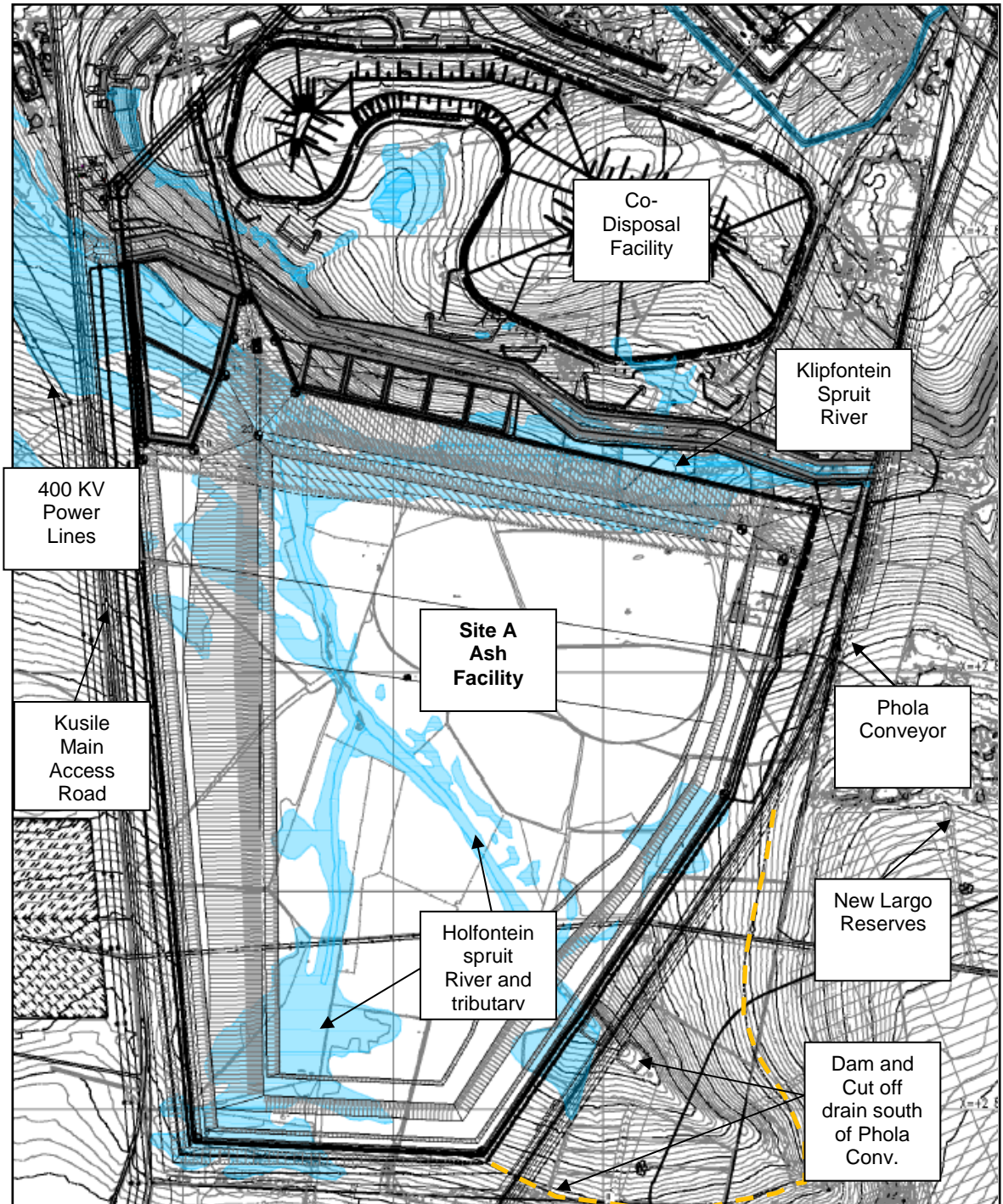


Figure 1: Site A Layout



The recommended 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 be appropriately lined in terms of the requirements of the DEA Norms and Standards series of documents.

The site is characterised by a valley draining from the south-east to the north-west (forming the Holfontein Spruit River). 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.

In addition, a river diversion will be required for the Klipfonteinspruit which is located along the northern side of the site.

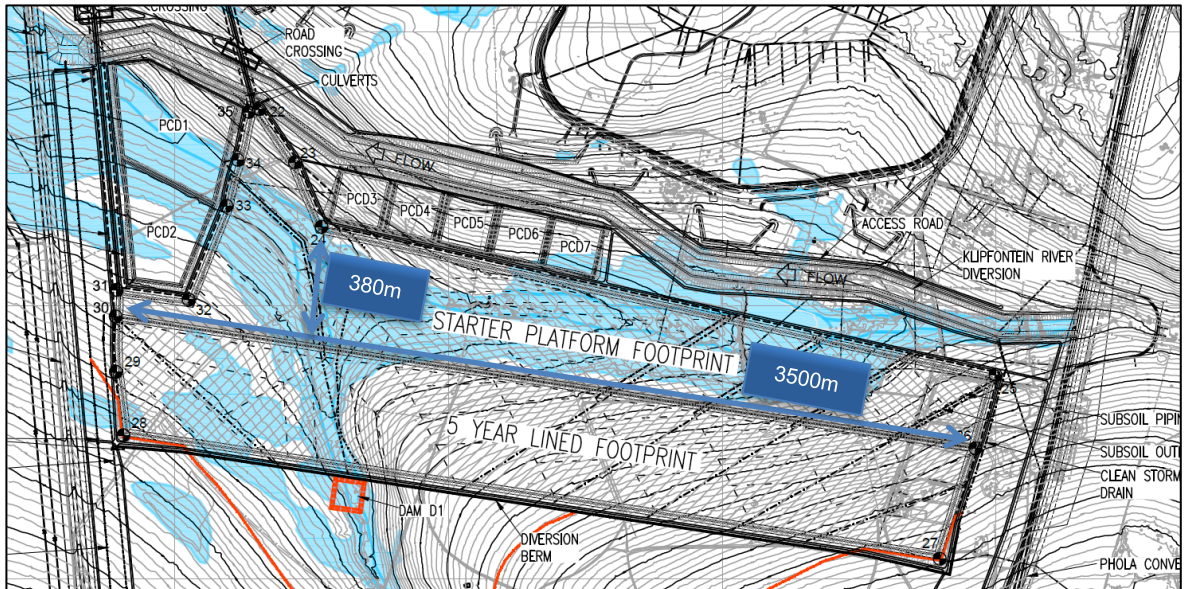


Figure 2: Starter platform and 5 year area footprints

The 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: 70m
- Volume: 35.8 million cubic meters

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 3):
 - 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

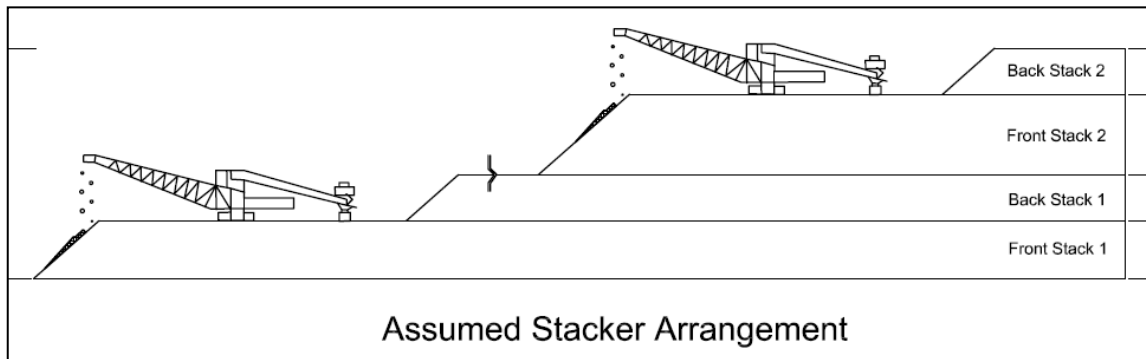


Figure 3: Multi Stacker Philosophy (Top Stacker and Bottom Stacker – refer to Operations Plan for more information on multi stacker and bottom stacker philosophy)

- 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).

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

3. **REHABILITATION**

Rehabilitation will take place concurrently as the ash stack develops. The extent of rehabilitation will be 2 shifts (approximately 100m) behind the advancing face of the top stack.

Rehabilitation includes the following activities which are further discussed below:

- Reshaping of the western slope;
- Placing topsoil cover;
- Installation of Storm Water measures;
- Maintenance of rehabilitated area.

3.1 **Reshaping**

Due to the nature of operations of the ash facility, the ash is stacked at its angle of repose or 1[v]:1.2[h] or 40° as shown in Figure 4. This occurs on the western side as well as the advancing face developing southwards. The western side will be reshaped immediately after the ash is placed as the conveyor corridors do not allow for later reshaping. This is illustrated in Figure 5.



Figure 4: Typical stacking ash at angle of repose (as seen at Kendal Power Station)

The steep angle of the slope has long term stability risk and therefore the eastern side slope of the facility needs to be reshaped to a more gentle slope of 1[v]:5[h]. Reshaping involves a cut to fill process whereby bulldozers are used to cut down the steeper crest to create an extended toe as shown in Figure 6.

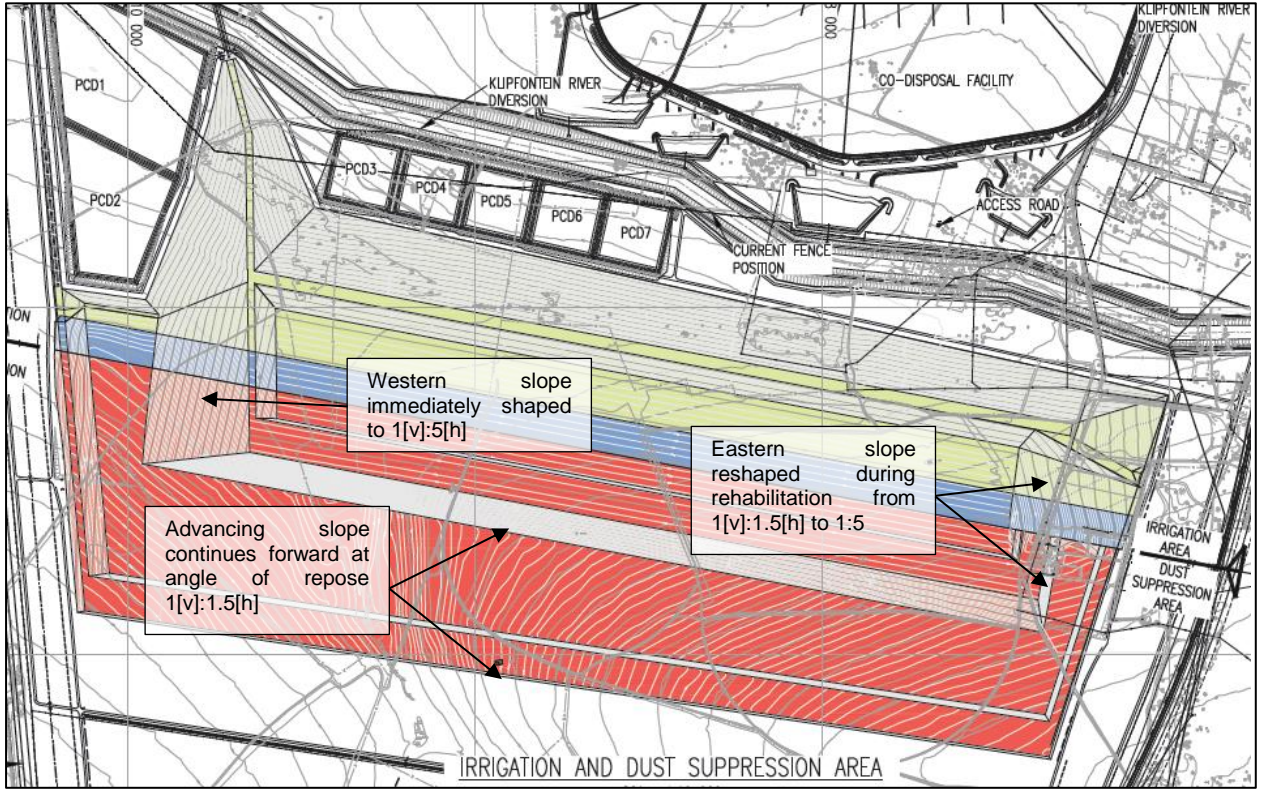


Figure 5: Reshaping on eastern side of facility

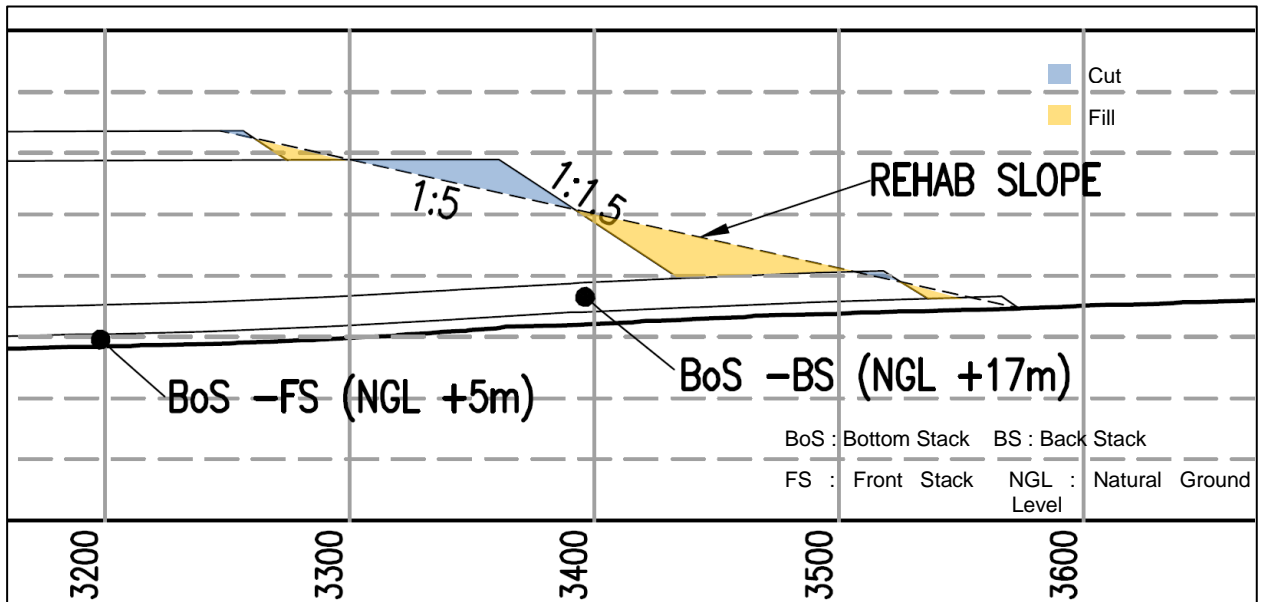


Figure 6: Reshaping side slopes from using a cut-to-fill process



3.2 Cover detail

The covering process includes placing two 150mm layers of topsoil above the reshaped ash. The topsoil is then scarified and fertilized in preparation for grassing. The grassing seed mix will include pioneer and long term grass seeds. The cover system is shown in Figure 7.

New trees and shrubs, or those that were previously existing in the facility footprint, will be transplanted to the covering layer.

An irrigation system is planned for the ash facility and will be operated as stated in the operating plan.

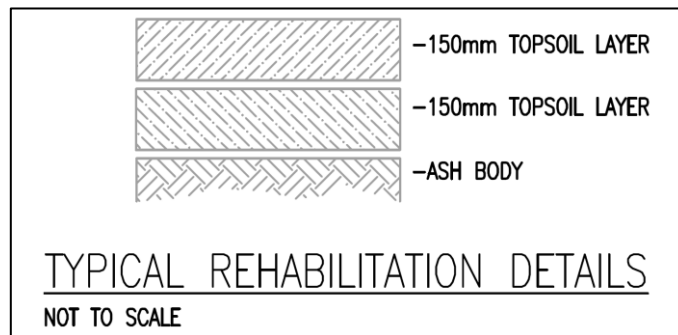


Figure 7: Cover detail

3.2.1 Progressive Topsoil Management

Figure 8 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 stockpile will be hydroseeded if required to ensure that vegetation establishes on it for the duration of its storage. This will ensure that the no excessive erosion of the stockpile takes place and that the topsoil does not lose its nutrients in the long term.

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.

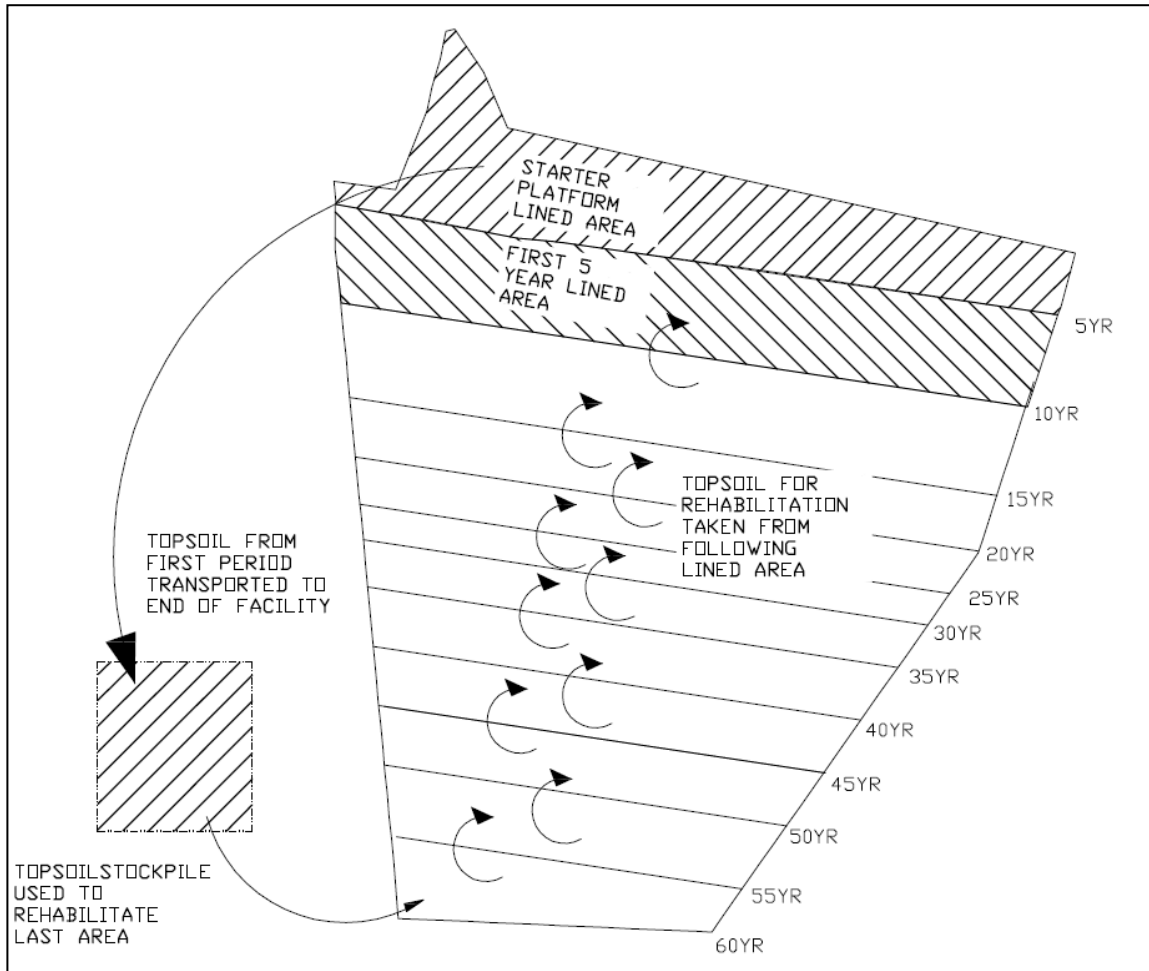


Figure 8: Method of progressive topsoil management

3.3 Installation of storm water measures

Stormwater measures include the construction of infrastructure such as down chutes, outlet channels, energy dissipaters, side slope berm trenches, shift berms and crest berms.

These are further expanded below in **Section 5**.

3.4 Rehabilitation schedule

Due to ash being trucked in to construct the Starter Platform (see operating plan for more information), it is assumed that the rehabilitation of the west, north and east faces of the Starter Platform can be done as the ash is trucked in. Therefore rehabilitation during the first five years will take place on the Starter Platform.

The development of further rehabilitation which takes place on the ash stack is illustrated in Figure 9. The extent of rehabilitation follows the advancing face of the top stack offset by 100m (2 shifts behind).

No rehabilitation of the ash stack takes place in the first few years of development as the first 100m of ash needs to be placed before rehabilitation can begin. During this time the final rehabilitation of the Starter Platform will take place.

The kink at the end of the rehabilitation curve is an effect of the time taken to finalise all rehabilitation after the ash stack has been completed. It is assumed that this period will take 5 years.

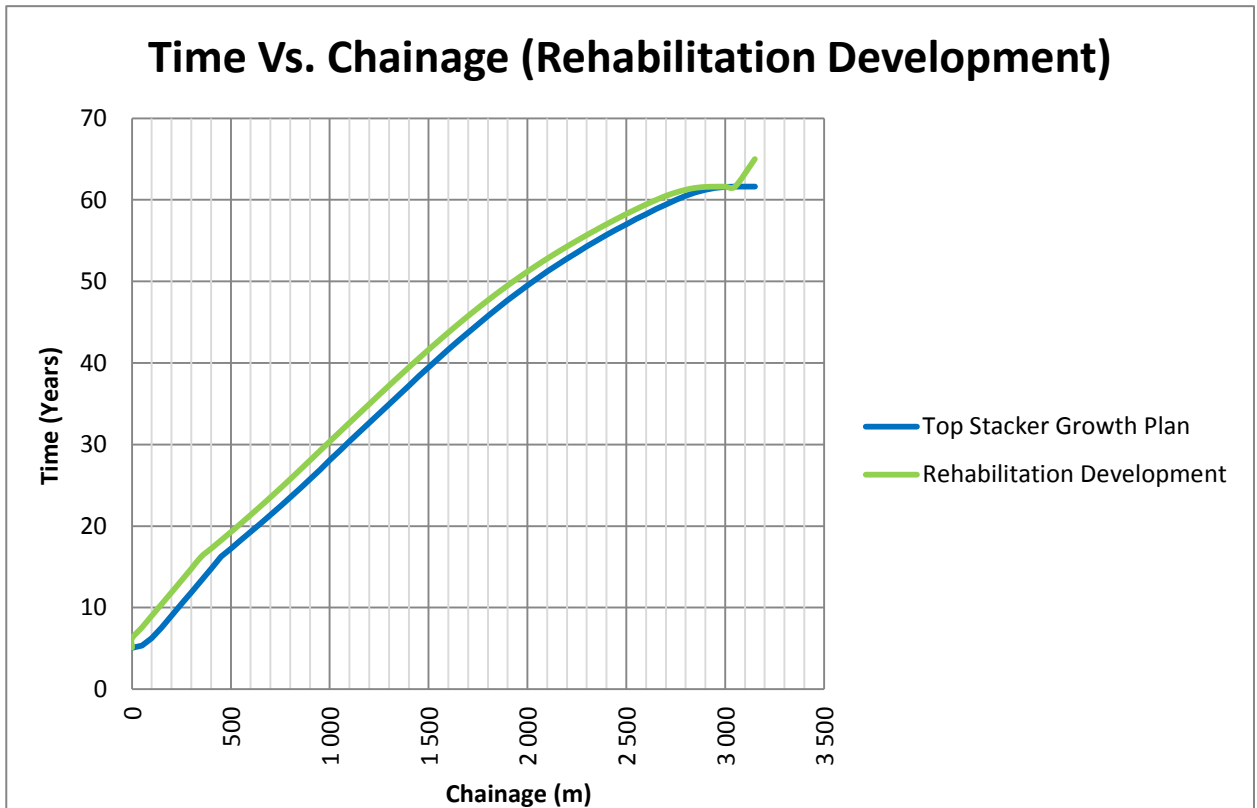


Figure 9: Rehabilitation development over time

The rehabilitation development for 5 year intervals is shown in Table 1.

Table 1: Rehabilitation Development for 5 year intervals

| Period: | Rehabilitation Development: (Chainage m): |
|------------------|--------------------------------------------------|
| Starter Platform | Starter Platform |
| 5 to 10 year | 135.03 |
| 10 to 15 year | 307.94 |
| 15 to 20 year | 464.60 |
| 20 to 25 year | 766.80 |
| 25 to 30 year | 1034.15 |
| 30 to 35 year | 1201.97 |
| 35 to 40 year | 1424.94 |
| 40 to 45 year | 1662.00 |
| 45 to 50 year | 1928.75 |
| 50 to 55 year | 2250.75 |
| 55 to 60 year | 2651.89 |
| 60 to 65 year | 3150.00 |

3.5 Maintenance of rehabilitated area

Exposure of the ash through the topsoil may occur due to stormwater erosion or burrowing animals. These exposed areas must be covered by topsoil when discovered as soon as possible to prevent further contamination of storm water.

An item for inspecting rehabilitated areas for exposed ash is included in the operating plan.

3.6 Equipment required for rehabilitation

The following mobile equipment is needed for rehabilitation:

- **A bulldozer:** A dozer will be required to move ash to positions outside the reach of the stackers, carry out trimming and profiling of the ash stack surface and side slopes.
- **Grader:** A grader will be used to do final levelling and shaping on rehabilitated areas where topsoil has been placed.
- **Dump Trucks:** Dump trucks will be used for hauling and placing topsoil and fill material on the ash stack.
- **Front End Loader:** Front end loaders will be used for loading topsoil onto trucks.

3.7 Handover of rehabilitated areas

As ash handling operations are carried out separately from previously rehabilitated and established areas, it is feasible to contractually hand responsibility for these areas over to Eskom. To avoid any conflict over these matters a procedure must be set up whereby both Eskom and the ash facility construction personnel agree to the handing over of a particular area.

The areas in question should be surveyed and inspected prior to their acceptance by Eskom and full records kept as handover of new areas progresses. A physical separation such as a low specification fence can be used to indicate areas handed over.

A standard form must be compiled and filled in, to record the details of the handover.

4. STORM WATER MANAGEMENT

Clean storm water management will also be required during rehabilitation of the facility. The system is needed to capture storm water falling on rehabilitated areas to ensure that it is discharged into the environment without getting contaminated or causing further erosion.

The infrastructure required for effective storm water management, as shown in Figure 10 and 11, is the following:

- Storm water collection canals on crest (black dashed lines);
- Canal Access and storm water diversion berms (magenta lines);
- Side slope bench drains (red lines);
- Down chutes (green lines);
- Toe collection drains (cyan lines – refer to drawing D121-01-011).

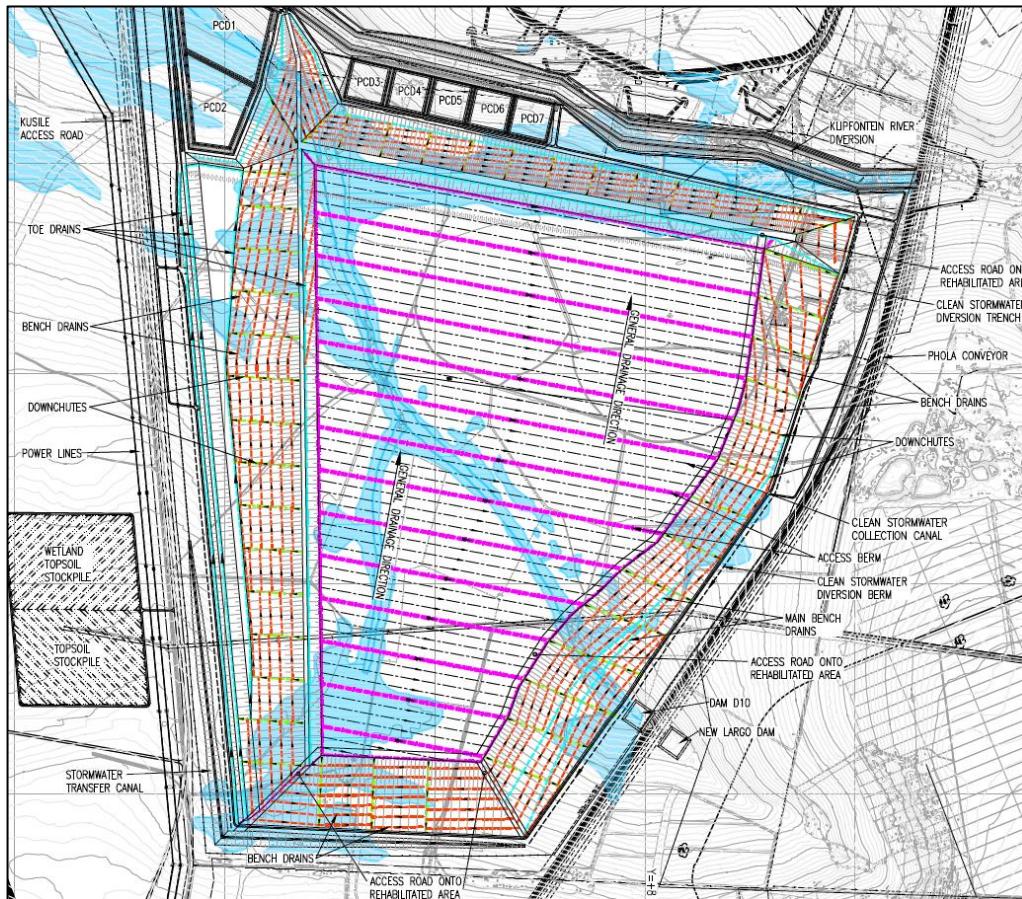


Figure 10: Stormwater infrastructure layout during rehabilitation

A zoomed view of the infrastructure is shown in Figure 11.

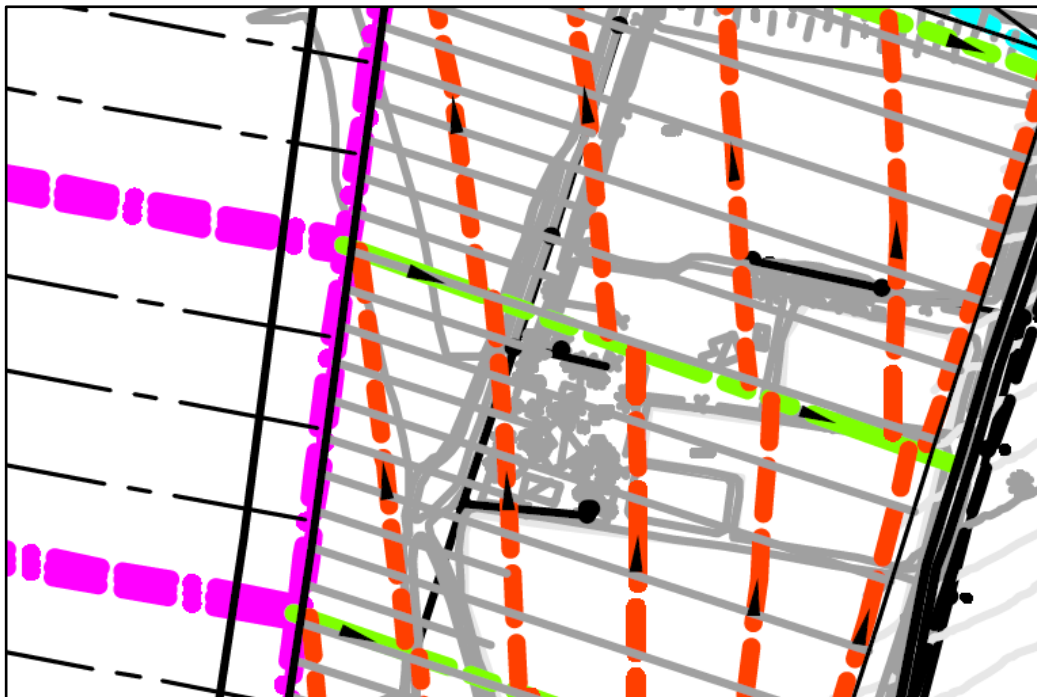


Figure 11: Close-up view of the storm water infrastructure required above rehabilitated areas.

Clean storm water falling on the rehabilitated area will be intercepted by the storm water canals that are placed above the rehabilitated layer at every shift. These canals lead to diversion berms at the crest which lead to down chutes on the side slopes. The down chute will transport the water down the side slope to the toe of the facility. There are benches included along the rehabilitated side slopes that form storm water collection trenches to collect slope run-off. These trenches also lead into the down chutes.

At the bottom of the down chute, energy dissipaters are positioned to reduce the energy of the water. The water then drains into toe collection drains which will have monitoring points for water contamination testing. Clean storm water will be discharged into the clean storm water collection trenches which divert water around the site and into the environment.

Existing infrastructure at Matimba Power Station is shown in Figures 12 and 13.

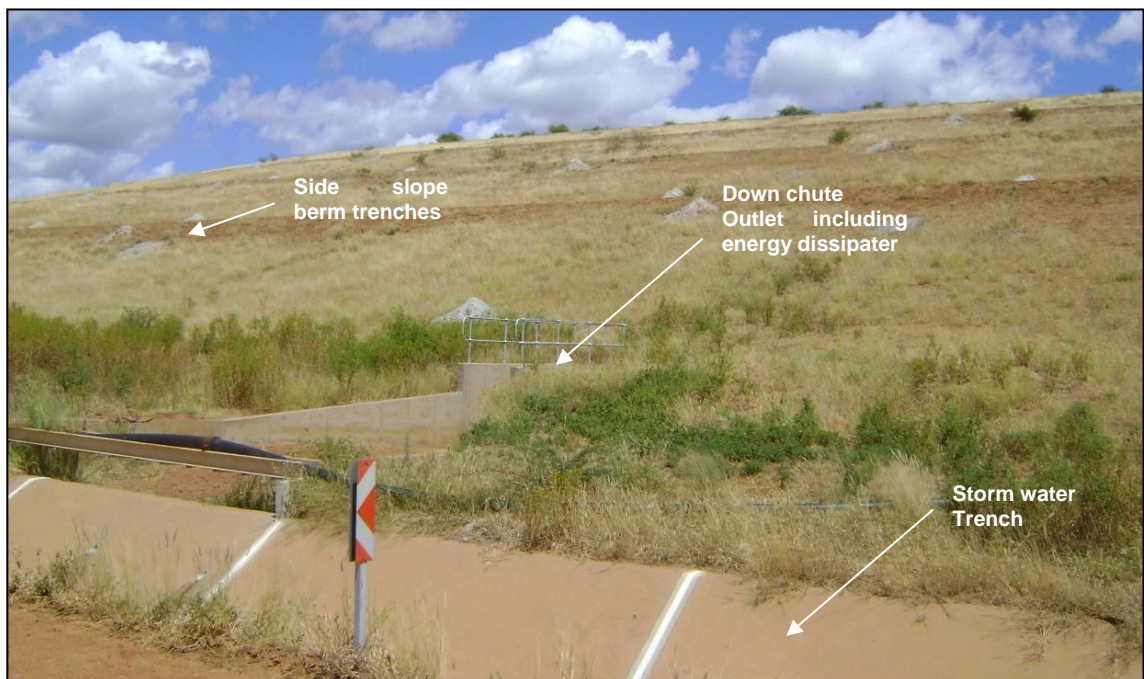


Figure 12: Rehabilitated ash stack at Matimba Power Station Ash Facility



Figure 13: Plan view of rehabilitated ash stack at Matimba Power Station Ash Facility

5. DECOMMISSIONING

After final closure some of the infrastructure required to operate the facility can be decommissioned.

This includes the following:

- Decommissioning the stackers and the conveyors;
- Decommissioning pollution control dams that are no longer required (this is assumed to be PCD 2 and PCD 4 to 7 as discussed in Table 2);
- Constructing required access roads for continuous maintenance and monitoring.

The decommissioning of the pollution control dams includes the following:

- The geomembrane and ballast layer of the lining system, along with any silt deposition, will be removed and taken to a landfill;
- Soil layers under the lining system will be tested for contamination and removed if necessary;
- The embankments will be dozed into the basin and additional fill material will need to be sourced if required in order to ensure that the final landform is free draining;
- A layer of topsoil will be placed over the footprint of the dam which will be hydroseeded after placement.

Table 2: Decommissioning of PCDs

| PCD: | Function: | Decommissioning: |
|-------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|
| PCD 1 | <p>Storage of contaminated storm water from the ash facility;</p> <p>Storage of seepage from seepage collection layer above geomembrane in ash facility;</p> <p>Dust suppression and irrigation water storage;</p> <p>Storage of makeup water pumped from the power station.</p> | PCD 1 will not be decommissioned at the end of the ash facility's life of 60 years but will be converted into a clean storm water attenuation dam. |
| PCD 2 | <p>Storage of contaminated storm water from the ash facility;</p> <p>Storage of seepage from seepage collection layer above geomembrane in ash facility;</p> | PCD 2 will not be decommissioned at the end of the ash facility's life of 60 years but will be converted into a clean storm water attenuation dam. |
| PCD 3 | <p>Storage of contaminated storm water from the ash facility;</p> <p>Storage of seepage from seepage collection layer above geomembrane in ash facility.</p> | PCD 3 will not be decommissioned but will be converted into a clean storm water attenuation dam. |
| PCD 4 to 7 | <p>Storage of contaminated storm water from the ash facility.</p> <p>Storage of seepage from seepage collection layer above geomembrane in ash facility.</p> | PCD 4, 5, 6 and 7 will be decommissioned at the end of the ash facility's life of 60 years. |

6. REHABILITATION PARTICULARS

The following is a table of pertinent information regarding the rehabilitation of the ash facility:

Table 3: Rehabilitation Particulars

| | |
|----------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
| Reshaping Side slopes | Eastern slope from 1[v]:1.5[h] to 1[v]:5[h] Final advancing face from 1[v]:1.5[h] to 1[v]:5[h] |
| Placing capping layer | 2 x 150mm layer of topsoil, hydro-seeded |
| Construction of Storm Water Management Infrastructure | Storm water collection canals on crest Canal Access and storm water diversion berms Side slope bench drains Down chutes Toe collection drains |
| Conversion of Pollution Control Dams to Clean Storm Water Dams | PCD 1, 2 and 3 |
| Decommissioning: | PCD 4, 5, 6 and 7 |



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4 June 2014

Document source: C:\Alljobs\D121 - Kusile\D121-01\REP\JW-008\D121-00_REP-008_r1_ccClosure&RehabPlan_20140603.docx
Document template: repGen_13r1.dotx

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APPENDIX A

DRAWINGS

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| D121-01-001 | Layout of facility at full development |
| D121-01-003 | Typical long sections and details |
| D121-01-009 | Capping layout |
| D121-01-011 | Final rehabilitation plan |
| D121-01-014 | Dust suppression & irrigation layout |



| REPORT CHECKLIST | | | | Job no: | D121-01 |
|------------------------------|--------|----------|-----------|----------------------------------|---------------------------------------------------|
| | | | | 5 March, 2014 | |
| | | | | Our Ref: | D121-00_REP-008_ccClosure&RehabPlan_20140123.docx |
| ITEM | AUTHOR | REVIEWER | CORRECTOR | 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 | | | | |
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| Purpose | X | | | | |
| Nature of the project | X | | | | |
| Project information | X | | | Location, geology, topography | |
| Engineering basis | X | | | Design, codes, assumptions etc | |
| Analysis/Calculations/Review | - | | | | |
| Discussions | X | | | | |
| Recommendations | - | | | | |
| 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 | | | | | |

| REPORT COPIES | | | | | | |
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| | TYPE | CD | PDF | HARDCOPY | COMMENTS | COMPLETED Date / Initials |
| | Client | | 1 | 3 | | |
| | Original | 1 | | 1 | Unbound | |
| | Archive Copy | | | 1 | Ring bound | |
| | File Copy | | | 1 | Ring bound | |
| | Project Manager | | | | | |
| | Other | | | | | |

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