ESKOM HOLDINGS LIMITED

PANEL B CONSULTANTS JOINT VENTURE

KUSILE POWER STATION

ASH DUMP TERRACE LAYER WORKS DESIGN

DETAIL DESIGN REPORT 5452-90-011 REV 5

Task Order Number: PBC JV TO#31

DECEMBER 2010

ESKOM HOLDINGS LIMITED

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CONTENTS

APPENDICES:

ESKOM HOLDINGS LIMITED

KUSILE POWER STATION

ASH DUMP No.1

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DECEMBER 2010

1   INTRODUCTION

The Panel B Consultants Joint Venture (PBCJV) has been appointed by ESKOM Enterprises under PO 4500 243 653 (TO # 31) to carry out civil design for the water licensing aspects of the Kusile coal-fired power station located near Witbank in the Mpumalanga province.   PBCJV is working in close liaison with ESKOM and their appointed design partners, Black and Veatch (B&V)

This report details the detail design of the No.1 Ash Dump terrace layer works and associated facilities (foundation drainage, lining system, clean and dirty stormwater facilities, dirty water storage dams, access roads, and general terraces).   It is currently decided that ash will be disposed for 5 years in dry form in co-disposal with gypsum from the station process (80:20 ash gypsum at approximately 15% moisture content).   Thereafter the No.1 Ash Dump will receive gypsum only for the balance of power station design life, to 60 years (i.e. for a further 55 years).   A second ash dump, to receive ash only for 55 years, will be developed on another site at a later stage.

The ash/gypsum in the first five years will be placed onto the dump using load and haul equipment.   The ash/gypsum will be placed in low height paddocks, until full design height is achieved.   A similar load/haul operation will apply for the gypsum only disposal over the remaining 55 years.

The construction of the ash dump facilities will be undertaken in phases. Phase 1 will include the footprint development for the first five years of deposition, together with all clean and dirty water management facilities designed to accommodate the ultimate development of the overall dump.

1.1 Background

Eskom is the principal supplier of electricity in South Africa. In order to meet the growing need for electricity, and in support of the growth and development strategy of national government, Eskom has embarked on an expansion programme to develop new power stations. Part of this expansion program includes the building of a number of coal-fired power stations. A proposed new 4,800 MW coal-fired power station (Kusile Power Station) near Kendal Power Station is one of the coal-fired power stations to be built. An extremely tight design and construction program is in place to achieve a first fire on coal date for the first boiler unit of July 2013. The project has been given National priority status. A preliminary version of this report (report 5492-90-011 Rev 1) was submitted in January 2009 with the Integrated Water Licence Application (IWULA) to the Department of Water Affairs (DWA). This final detail design report provides full detail of the ash dump final design, but has not deviated from the concept designs presented in the preliminary report.

1.2 General

The No.1 Ash Dump is located to the West of the main Kusile Power Station complex, as shown on the B&V Block Plan in **Appendix 1.**

The power station commissioning is currently scheduled as follows:

Date of first fire on coal: Unit 1: 1 July 2013
Date of first fire on coal: Unit 6: 1 November 2016

The ash dump will be constructed and commissioned in time to receive ash on 1 July 2013. Construction is scheduled to commence in August 2011.

1.3 Scope

The station ash dump, approximately 2500 m by 1000 m in plan extent (250 ha), is formed on sloping hill-top ground to the West of the station coal stockpile and its associated natural stream and stream diversion. The general location is shown on the Kusile site layout drawing in 1.2 above.

The following general drawings are presented in **Appendix 1**:

- Block Plan
- Ash Dump General Arrangement drawing K30300098/06-201
- Typical Ash Dump Cross-section drawing K30300098/06-207 Rev P1
  A list of all other drawings included in this report, together with a full schedule of all drawings associated with the Ash Dump, are included at the front of **Appendix 1.** The general arrangement drawings presented show the ultimate overall development of the dump. Accompanying detail drawings are for Phase 1 of the development only.

Clean and dirty water run-off from the ash dump terrace will be managed separately according to the DWA "Best Practice" series of publications.

The ash dump terrace layer works design is to address all relevant South African regulatory requirements, in particular:

- The National Water Act, No 36 of 1998
- Government Notice No.704, Regulations on use of water for mining and related activities aimed at the protection of water resources, in terms of the National Water Act (Act 36 of 1998)
- SANS 1200: Standardised Specifications for Civil Engineering Construction
- DWAF Minimum Requirements for Waste Disposal by Landfill (Second edition, 1998)

2 DESIGN PARAMETERS

2.1 General

The following basic parameters apply to the detail design of the no.1 Ash Dump:
- Ash and gypsum tonnages for disposal are as scheduled in **Appendix 2**
- Co-disposal Ash/gypsum for the 1st 5yrs: Storage Volume = 32.287 x 10^6 m^3
- Gypsum disposal for the next 55 yrs: Storage Volume = 49.788 x 10^6 m^3
- Total disposal for 60 yrs: Storage Volume = 82.075 x 10^6 m^3
- Top elevation of dump: 1540.00 m
- Dump height: Varies 33 to 51 m
- The dump will be developed to full height starting at the North end of the site, during the first 5 years of operation, and will progressively move forward at full height towards the south.

- The 5 year footprint will be developed to full height in two sections of coverage, the first over 3 years, the second over 2 years.

- All dump side slopes are at 1V to 5H. The advancing front face will also be benched to have an effective slope of 1V to 5H.

- Ash/gypsum co-disposal and gypsum disposal will be disposed by a load/haul operation in successive paddock of suggested size 200m by 200m, developed in 2mlifts, built to full height of the dump as quickly as possible. In this way dust suppression and irrigation water would be minimized and haul-truck distances reduced.

- The alternating paddock development approach will take approximately 5 years, in two sub-phases, to develop ash dump to full height along the full 5 year footprint face. Thereafter the entire ash dump face will develop progressively towards the south.

- Dust suppression of the top dump area will be controlled by a 100 mm permeable blanket layer of gravel, followed by top soiling and grassing.

- Storage volume / dump size derived for the first 5 years assumes that the six boiler units are commissioned, one every 8 months over 4 years, plus a further year at full production.

- Active area of the dump will be equivalent to the advancing face plus a 50 m section extending behind the advancing face of the dump.

- Rehabilitation establishment will take 3 years, developed progressively as each section of the dump is finalised. Irrigation will be provided for 1 year behind the active dump site. Thereafter no irrigation will be applied.

- All stormwater runoff collected from the active face, the active deposition zone and the active rehabilitation zone will be discharged to the dirty water system.

- Assumed tonnages per boiler unit for the ash dump volume calculations are:
  - Ash: 150 t/hr *0.9 load factor and 0.9 availability factor = 121.5 t/hr * factor of safety 1.1= 135 t/hr
  - FGD: 19.33 t/hr* 0.9 load factor and 0.9 availability factor = 15.66 t/hr*factor of safety 1.1 = 17.4 t/hr

- The top dump surface at nominal elevation 1540.00 m will be graded to the short sides from the dump centreline at 1V to 200H to facilitate stormwater runoff.

- The dump footprint will be provided with a double HDPE liner system with leakage detection. (Note: The DWA "Minimum Standards" document requires a 3-layer lining system for a class Hh disposal site. As the Kusile dump is a dry dump, DWA have agreed to relax the requirement to a 2-layer liner (2*2 mm HDPE).

- The liner system will have a drainage layer above it to intercept any seepage through the dumped materials. Seepage will be discharged to the dirty water system.

- A groundwater drainage system will be provided under the liner system in areas where the natural water table is shallow. Collected groundwater will be discharged to the clean water system.

- A system of concrete lined dirty water culverts and pipes will channel the dirty stormwater runoff from the active part of the dump and from the area in the process of rehabilitation to the Ash Dump Dirty Water Dam.

- External Clean Water Diversion Drains
    - The 1:100 yr / 24 hr clean stormwater runoff will be kept separate from the dirty water runoff from the dump site.
    - Runoff from fully rehabilitated areas will be managed as clean water and discharged to the streams on either side of dump after passing through a series of retention/settling dams located around the ash dump perimeter.
    - The runoff from the incremental cleanwater catchments outside of the active footprint, flowing towards the active dump will be intercepted with temporary cut-off drains. These drains will divert the flow around the ash dump footprint, into the clean water system after passing through retention/settling dams.

- Ash Dump Dirty Water Dam (ADDD)
    - *Government Notice Regulation 704* specifies that a dirty water system may not spill into a clean water system more than once in 50 years, and that 800 mm freeboard be provided.
    - The ADDD will be designed to ultimately store the 1:50 yr / 8 day storm runoff from the active dump surface area and the 3 year rehabilitation zone at any time. To allow emptying and cleaning access one at a time
    - The ADDD storage is accommodated in two equal size compartments
    - A silt settling sub-compartment is provided at the dirty water inlet zone of each main compartment
    - Dust control and irrigation water will also be stored in the ADDD. The operating storage volume will be equivalent to 72 hours of dust control and irrigation water flow. The volume is based on the maximum pumping rate of 25 l/s for a period of 72 hours.
    - The ADDD will be operated at or below the irrigation water storage level, at the start of each wet season, thereby providing the capacity above this to store the 1:50 yr / 8 day storm runoff.
    - Dust control and irrigation water will be sourced primarily from accumulated stormwater in the ADDD, supplemented as necessary from the Station Holding / Recycle Dam.

–   Excess stormwater accumulated in the ADDD will be transferred by gravity to the Station Dirty Dams for re-use in the station system.

2.2   Ash and Gypsum Production

Based on the design parameters in 2 above, a detailed Ash and Gypsum production schedule has been developed. This is presented in **Appendix 2.**
The production of first ash from boiler unit 1 is schedule for 1 July 2013.

3   ASH/GYPSUM CLASSIFICATION

3.1   Classification of Ash and Gypsum

The specialist report "Classification and Environmental Evaluation of Kusile Power Station Ash and Gypsum in Terms of the Minimum Requirements: November 2008" is presented in **Appendix 5.**

The report concludes and classifies the ash and gypsum products as follows:

3.1.1   Ash

Using ARLP test (which is the appropriate, acceptable test for ash disposal), no element is leached above its acceptable risk limit and, therefore, the ash formally classifies as **non-hazardous**. As the ash is produced in large amounts ie 16700 t/day at full production, it can however still have a significant impact on the environment as it can increase salinity of water resources (specifically because the water table on the ash dump site is high). A dirty water and seepage management system is therefore required for disposal.
A GLB^+ site will be required.

3.1.2   Gypsum

The Gypsum is predominantly calcium sulphate dehydrate but it contains a number of minor elements, i.e. A1, 0,254%; Mg, 0.22%, P, 0.428%; plus of a number of trace elements (<0.10%), i.e. Fe, F, K, etc. The FGD Gypsum sample leached only fluoride at a concentration above it acceptable risk limit using both the TCLP and the ARLP tests. Fluoride is a moderate hazard according to the Minimum Requirements and, therefore, the gypsum formally classifies as a **moderate hazard waste**. A class Hh landfill will be required.

3.1.3 Ash/FGD Gypsum (6:1) Mixture

The Ash/ Gypsum (6:1) mixture leaches Mn, Pb and P concentrations above their acceptable risk limits using TCLP solution number 1. Because Mn and Pb are classified as high hazard species, the mixture classifies as high hazard waste. However, the mixture leaches only F at a concentration above its acceptable risk limit using the ARLP. As F classifies as a **moderate hazard** species, the **mixture classifies as moderate hazard waste**. The origin of the fluoride is mainly the gypsum and, therefore, the hazard rating of the ash is increased by mixing with gypsum. Co-disposal of the ash and gypsum will require a class HhLB$^+$ site.

3.2 DWAF Minimum Requirements for Waste Disposal by Landfill

The DWAF classification system [Ref1] is summarised as follows:

3.2.1 Classification System

G = General Waste	B$^-$ = No significant leachate produced
H = Hazardous Waste	B$^+$ = Significant leachate produced
H:h = Hazard Rating 3 + 4	
H:H = Hazard Rating 1 – 4 all waste types	
L = Large Landfill	
M = Medium Landfill	
S = Small Landfill	

Typical classifications may thus be:

GLB$^+$	or	HhLB$^+$	or	HHLB$^+$
GLB$^-$		HhLB$^-$		HHLB$^-$

3.2.2 Climatic Water Balance (CWB)
CWB is defined as B = R – E
B = Climatic water balance in mm of water
R = Rainfall in mm of water
E = Evaporation from soil surface in mm of water

If B is positive for more than one year in five for the years for which data is available,

- The site is classified B+

- There should be significant leachate generation

In the case of the Kusile ash disposal site, this is classified as B$^+$ (water excess).

3.2.3 Hazard Ratings

Hazard Rating 1: Extremely hazardous
Hazard Rating 2: High hazard
Hazard Rating 3: Moderate hazard
Hazard Rating 4: Low hazard

3.2.4 Kusile Classification

a) **Kusile Climatic Water Balance (CWB).** The CWB assessment and rainfall data for Kusile is presented in **Appendix 6** hereto.

b) **Overall Classification**. The Kusile Ash Dump classifies as follows, according to the DWAF Minimum Requirements document:

Ash only disposed	:	GLB$^+$
Gypsum only	:	H:hLB$^+$
Ash/Gypsum co-disposal	:	H:hLB$^+$

4   ASH DUMP NO.1 DESIGN

4.1   Design Parameters

Design assumptions and parameters are set out in Section 2 hereto.

4.2   Ash Dump Deposition Modelling

Three dimensional volumetric models have been developed for the storage of ash/gypsum in the first five years of co-disposal, and for gypsum only for the remaining 55 years of the power station life.

The modelling incorporates the build-up of ash/gypsum production tonnages as the boiler units are brought on line at eight month intervals, per the schedule in **Appendix 2.**

Some of the modelling outputs are presented in **Appendix 4** as used for stormwater run-off and irrigation assessments.

The volumetric modelling output is summarised as follows:

- Co-disposal Ash/gypsum for the 1st 5yrs: Storage Volume = 32.287 x 10^6 m^3
- Gypsum disposal for the next 55 yrs: Storage Volume = 49.788 x 10^6 m^3
- Total disposal for 60 yrs: Storage Volume = 82.075 x 10^6 m^3
- Top elevation of dump: 1540.00 m
- Dump height: Varies 33 to 51 m

4.3 Ash Dump Terrace Layer Works Description

4.3.1 Topography

The Ash Dump is located to the West of the main power station terrace, on sloping ground on a spur/hill crest between two stream courses. The dump will have a footprint size of approximately 2500 m by 1000 m (250 ha). The maximum ground slope of ash dump footprint on the hill side has been limited to 1v to 15 h to ensure overall stability. The topography is more fully described in reference1, presented in Section 7 hereto.

4.3.2 Basic Terrace Layer Works

In accordance with the ash/gypsum HhLB$^-$ classification Ref[1], the site layer works will be as follows:

The grass land site will be prepared as follows:
- Basic stripping and removal of vegetation.
- Topsoil will be removed and stockpiled for rehabilitation use. Topsoil depth is expected to be approximately 200 mm.
- The surface will be harrowed, raked to remove excess size stones and compacted to 95% Standard Proctor to receive the liner.
- Minor cut and fill adjustments to the terrace are required along the perimeter to ensure that clean stormwater runoff from the dump can pass over the concrete dirty water channel after rehabilitation has taken place.

- In the pan area located on high ground that is covered by the ash dump footprint, the following actions are specified:
  - The pan will be drained of standing water by means of a gravity trench excavated through the lip of the pan, into the central pan area
  - A capillary break/drainage layer incorporating a porous dump rock layer and a herring-bone type system of agricultural drains will be provided to intercept ground water and to relieve any excess pore pressures developed as the ash is stacked. (see dwgs K30300098/06-208 and -209 in **Appendix 1**.
- Similarly, a herringbone drainage system will be provided under the liner system in areas of the main dump footprint where the groundwater table is within 2 m of the natural ground level. (see dwg K30300098/06-211 in **Appendix 1**). These drains will be treated as clean drains and will discharge to the ash dump perimeter clean drain system.
- A double liner system with leak detection facilities to satisfy the requirements of the DWAF Minimum Requirements (see Section 4.4 below) will be placed over the entire 5 year dump footprint, (and later over the entire footprint). The liner system will include provision for accommodation of tensile stresses on the liner caused during ash/gypsum placement operations. The capillary break under drain system and the liner system will be installed in stages as the footprint extends over time.
- Details of the liner system are presented on drawings K30300098/06-220, -221 and -224 in **Appendix 1.**

4.4.   Ash Dump Liner Details

To prevent contamination to the underlying soil, the Ash Dump is required to be fully lined (see Section 3 above). The Ash Dump will be provided with a double liner, incorporating a leakage detection system, in accordance with the DWA document "Minimum Requirements for Waste Disposal by Landfill (1998)", as modified by agreement with DWA (see sub-report and correspondence in **Appendix 3**).

The sub-grade earthworks will entail removal of vegetation and topsoil to an approximate depth of 200 mm and preparation of a smooth surface, free from large or loose angular particles and vegetative matter, compacted to 95% Standard Proctor. The liner layer system will then be as follows, as depicted on drawings K30300098/06-220, 221 and -224 in **Appendix 1**:

- A grade A8 Geo-textile (or similar non-woven needled punched geo-fabric) will be placed on the finished grade as a protective measure for the lower HDPE liner.

- A continuous 2.0 mm double-textured HDPE geo-membrane liner will be placed as the secondary (lower) liner.
- A second grade A8 geofabric will be placed over the lower HDPE sheet to provide protection from the drainage layer sand.
- A leakage detection layer comprising 100 mm clean river sand, screened to minus 3 mm, will be laid onto the geofabric, to facilitate leakage drainage to the leakage detection pipes reporting to the perimeter dirty water drain, should the primary liner have minor deficiencies.
- In area around the ash dump perimeter, where the ground slope steepens, a 35 mm or 50 mm high perforated, textured geocell retaining web (Neoweb or equal approved) will be imbedded in the sand layer to prevent migration of the sand down the slope.
- A 2.0 mm double textured HDPE geomembrane liner will be installed over the sand drainage layer as the primary (top) liner.
- Finally, an A8 grade geofabric will be laid over the top HDPE sheet to provide protection from the next gravel drainage layer.
- The liner system will then be covered with a 300 mm later of selected G5 gravel, to provide drainage for the stacked ash and gypsum. This layer will be provided with a herring-bone drainage collection system of agricultural drains, reporting to the dirty water drain.
- Drawing K30300098/06-221 in **Appendix 1** provides a schematic illustration of the liner system.

4.5 Dirty Water Drainage System: General

Dirty water run-off from the ash dump has been calculated using the 1:50 year / 24 hour storm hydrology applied to the calculated maximum exposed dirty areas as the dump develops over time. Details of the calculations are presented in Section 4.7.3 and in **Appendix 4**.

A dirty stormwater collection drain comprising rectangular concrete canal with removable precast concrete lids will be provided around the perimeter of the ash dam footprint as this is extended across the site during the various stages of development. The first phase of construction will provide for the first five years of ash/gypsum deposition. The concrete dirty stormwater channels, which also receive drainage from the leakage detection drains in 4.2 above will report to the dedicated ash dump dirty water storage dam (ADDD) via a system of dirty water drain pipes. Details of the dirty drains and pipes are provided on drawings K303000098/06-230 and -232 in **Appendix 1.**

The ADDD is separated into two operating compartments to allow cleaning. The dam will be fully lined with a double HDPE liner incorporating a leakage detection system. Access is provided to the concrete lined depressed operating storage compartment for silt removal. Stored dirty water will primarily be used for dust control and irrigation on the ash dump. Excess stored dirty water will be transferred to the Station Dirty Dams for re-use in the process.

The perimeter dirty water drainage canal comprises a rectangular concrete channel with pre-cast concrete lids. During the ash deposition stage when the ash is exposed, stormwater run-off will be collected into the open drain. Once rehabilitation of the exposed ash surfaces has been achieved by topsoiling and grassing, the dirty drain will be covered using the precast concrete lids, thereby allowing clean stormwater to flow over the covered drain, into the clean water drainage system.

The double HDPE liner on the ash dump footprint will be anchored to the upstream side of the dirty drain, with leakage outlet pipes from the leakage detection system discharging into the concrete dirty water drain at intervals.
Details of the concrete drain and the HDPE connection system are shown on the drawing K30300098/06-221 in **Appendix 1.**

The stormwater hydrology applying to the dirty water drains is presented in Section 4.7.3 hereto.

4.6   Clean Water Drainage System: General

Cleanwater run-off from the ash dump has been calculated using the 1:100 yr / 24 hour storm hydrology applied to the calculated maximum exposed clean areas as the dump develops over time. Details of the calculations are presented in Section 4.7.3 and in **Appendix 4**.

A system of temporary clean water drains will be developed outside the 5 year footprint to intercept and lead clean stormwater from undeveloped zones of the site, away from the ash dump footprint as the footprint extends with time over the site. The drains will discharge to silt retention dams before outlet to stream. Drawings K30300098/06-320 to -327 in **Appendix 1** show details

A series of clean water channels will also be provided around the perimeter of the ash dump, outside the concrete dirty water channel, to receive clean stormwater run-off from rehabilitated surfaces of the ash dump. These drains discharge through culverts under the perimeter access road, into a collector drain and then to a series of silt

retention dams, before final discharge to stream. Drawings of the clean water channels are presented in **Appendix 1**.(K303000098/06-303 and -304 refer)

All clean stormwater will be discharged after silt settlement to the existing streams to the East (stream diversion canal) and West of the ash dump.

The trapezoidal clean water drains are developed in short sections of variable depth, to maintain a 1:200 gradient on the steep perimeter slopes of the ash dump footprint thereby controlling the flow regime. The drains discharge through culverts under the perimeter access road, to a further trapezoidal collector drain outside the perimeter access road and then to a series of stormwater retention/silt dams located at intervals around the ash dump perimeter. These dams have perforated outlets which will allow discharge of intercepted stormwater to stream after primary silt settling has taken place.

The collector drain outside the perimeter access road together with the silt retention dams will be constructed as a first priority, to serve as construction phase stormwater and erosion control facilities.

Drawings K30300098/06-303 and -304 in **Appendix 1** show details of the ash dump clean water system.

The stormwater hydrology applying to the clean water drains is presented in Section 4.7.3 hereto.

4.7   Ash Dump Dirty Water Dam (ADDD)

4.7.1   General

General Arrangement drawings for the ADDD are presented in **Appendix 1** (drawings K30300098/06-280 to -288 refer).

The derivation of storage capacity of the Ash Dump Dirty Water Dam (ADDD) is dependent on the maximum exposed area of un-rehabilitated ash that will apply during the deposition process, for derivation of dirty water run-off volumes.

Exposed areas have been calculated for Phase 1 of ash/gypsum deposition in the first 5 years of operation, which will involve progressive covering of the 5-year lined footprint.

The maximum exposed area for dirty water runoff derivation, occurs in the 4th year of deposition. Thereafter the dirty water catchment area decrease to a fairly constant area, during the gypsum deposition phase. During Phase 2, an additional 150 m of liner will be placed beyond the toe of the active face, every 5 years. This 150 m of liner corresponds with approximately 5 years of gypsum deposition. A cut-off berm will be developed in front of the extended liner to divert any upstream clean water run-off from entering the ash dump. This diverted water will be returned to the streams on the East and West sides of the ash dump.

The ADDD will be inter-connected to the Station Dirty Dam (SDD) by a supply line, allowing excess accumulated stormwater to be transferred from the ADDD to the SDD. The SDD is in turn connected by a pumping main to the station Holding and Recycle Dam (HRD) which in turn supplies water to the power station process. The HRD is also connected to ADDD by a gravity supply line. During drier periods of the year, irrigation and dust suppression water can be transferred to the ADDD from the HRD to supplement the operation (Refer to attached schematic **K5406/018 Rev 5** in **Appendix 1**).

4.7.2   Ash Dump Dirty Dam (ADDD) Philosophy

The ADDD storage capacity derivation is set out in Section 4.7.3c following.

An 800 mm of dry freeboard has been provided above the full supply capacity/spillway level.

It is expected that during a severe storm event such as the 1:50 yr / 24 hr storm, all the station holding dams on site will be at capacity. During this event, raw water make-up supply to the Raw Water Reservoir (RWR) will be shutdown. Water from the HRD will supplement the plant. The transfer pipeline, linking the SDD and HRD, has a capacity to empty the SDD in 7 days. During the 7 days, water can be transferred by gravity from the ADDD to the SDD. This indicates that the station has the capacity to draw down all the reservoirs during and after a major storm event. The seven day buffer storage capacity at the ADDD is derived from this rationale.

At times when there is insufficient stored stormwater in the ADDD, the storage can be supplemented by a pipeline from the station Holding/Recycle Dam (in turn supplied from the SDD).

4.7.3   Ash Dump Flood Hydrology

a)   Hydrology and Assumptions

- Rainfall data from station 0514618W at Wilge River
- Station Mean Annual Precipitation (MAP) = 655 mm
- Rainfall generally occurs between October and March. The 98 yrs of recorded data was analysed to determine the average weekly rainfall for these months.
- Maximum dust suppression and irrigation surface area = 854 191 m^2 (5-year co-disposal case).
- Calculated dust/irrigation water volume pumped per day = 854.19 m^3/day. This is based on 1 mm of water per day over the derived dust suppression and irrigation areas.
- Minimum storage required at the start of each month = 2 562.57 m^3 equivalent to 72 hrs of dust suppression and irrigation water.
- Maximum Installed Pump Capacity at ADDD = 25l/s. This equates to a 72 hr capacity of 6480 m^3. The operational demand storage for the ADDD will be set at 6480 m^3. Based on the actually maximum 72 hr demand, there is therefore a Factor of Safety of 2.52 on the operational storage.
- Maximum Dirty Catchment Area (5-year co-disposal case) = 1 100 000 m^2 (a catchment area of 1 603 743 m^2.is encountered during year 6. Area only occurs for a short period during year 6, therefore not considered in design).
- Coefficient of Discharge = 0.504 assumed for exposed Ash Dump. The runoff coefficient is based on surface slopes, permeability and vegetation.

Catchment description - Rural area (%)

Surface slopes		Permeability		Vegetation	
Lakes and pans	*0*	*Very permeable*	*0*	*Thick bush & forests*	*0*
Flat area	*15*	*Permeable*	*55*	*Light bush & cultivated land*	*0*
Hilly	*80*	*Semi-permeable*	*45*	*Grasslands*	*10*
Steep areas	*5*	*Impermeable*	*0*	*Bare*	*90*

- Stormwater runoff calculated using Rational Method (suitable for small catchment areas).
- Time of Concentration assumes overland flow down the active face and then defined channel flow along the edge of ash dump.
- Design Storm for the ADDD is the 1:50 yr / 24hr storm event. Design rainfall is 122 mm.
- Longest flowpath is the longest distance that water would follow from the furthest point in the catchment to the ADDD. This was divided into the three sections;

down the active face, along the front edge of the active face and then along the canal.

The flowrate (m³/s) is calculated according to the following equation:

$$Q = \frac{CIA}{3.6}$$

Where C   =Runoff Coefficient (-)
  I   =   Rainfall Intensity (mm/hr)
  A   =   Catchment Area (km²)

b) Stormwater Run-off

Clean Water Perimeter Drains

- The ash dump has been divided into a series of individual catchments, each contributing to an individual clean water canal, as defined by the topography along the canal routes.
- In order to maintain sub-critical flow conditions on the canals and to avoid large concrete drop structures, the catchment was divided into smaller sub-catchments, each served by an individual length of trapezoidal drain. This reduced the canal sizes. Each individual length of canal has its gradient restricted to a 1:200 maximum slope.
- The run-off generated from the sub-catchments will flow into separate lengths of canal, running along the perimeter of the ash dump.
- Typical clean water sub-catchments are also presented in **Appendix 4**.
- The run-off is based on a rehabilitated run-off co-efficient of 0.436.
- The total 1:100 yr / 24hr clean water run-off from the fully rehabilitated zone of the dump, will increase with time.
- The clean water drains running around the ash dump will be unlined trapezoidal canals with a 1.00 m base width, 1V: 3H side slopes.
- The clean water drain system is shown on drawings K30300098/06-303 and -304 in **Appendix 1**.
- Each section of drain will pass through 750 x 750 concrete box culverts, running under the perimeter access road, flowing into retention / settling dams. Each retention dam will store the volume of the 1:100/24hr. Storm arising from the part catchment delivering to that dam. The dams will be provided with a perforated outlet tower so that the dams will drain by gravity over a short period of time and will thus generally be empty. Each retention dam is also provided with emergency spillways designed to carry the

1:100/24hr. Peak flow. The stilled clean run-off will then flow back into the natural streams surrounding the ash dump.

- Details of the silt retention dams are presented in drawings K30300098/06-320 to -327 in **Appendix 1.**

Dirty Water Perimeter Drains

- The dirty water catchment of the ash dump comprises of the active dumping face, a 50 m section behind the active face, the 1-year irrigation zone and a further 2 year rehabilitation zone (based on co-disposal tonnages and rate of ash dump development).
- The run-off is based on a rehabilitated run-off co-efficient of 0.504.
- The 5 year ash dump footprint is developed in two phases; 1A and 1B. Phase 1A comprises the 1st three years of deposition, while Phase 1B consists of years 4 and 5. The phased development of the Ash dump is illustrated in **Appendix 4**.
- In an attempt to minimise the dirty catchment areas, a berm will be constructed along the top edge of ash dump at the end of Phase 1A.
- The berm will separate the two phases, allowing Phase 1A to be fully rehabilitated after 6 years of deposition.
- The establishing surface area is still considered dirty water catchment, if it encloses both irrigation and dust suppression areas. The runoff from the irrigation and dust suppressions areas will flow over the establishing area into the dirty water perimeter drains. The berm along the edge of Phase 1A will avoid this and will reduce the rehabilitation period of phase 1A.
- Phase 1B will be fully rehabilitated after 8 years of deposition.
- The catchment areas during disposal are shown in Table 4.1 below.

Table 4.1 : Dirty Water Catchments during Disposal

Years	Dust Suppression Area	Irrigation Area	Total Area
-	km^2	km^2	km^2
1	0.500	0.028	0.528
2	0.464	0.098	0.562
3	0.294	0.102	0.574
4	0.680	0.175	1.131
5	0.504	0.116	1.532
6	0.131	0.190	1.554
7	0.098	0.114	1.579
8	0.127	0.115	1.604

- The dirty water catchment area was divided into sub-catchments in an attempt to minimise the total runoff. Separate canals will collect runoff from Phase 1A and 1B.
- Phase 2 comprises the remaining 55 years of deposition. This catchment area will be divided into east and west sections, each with a separate canal.
- The calculated dirty runoff flow rates are summarised in
- Table 4.2 below.

Table 4.2: Peak dirty runoff Flowrates

Catchment Area		Flowpath	Time of Concentration	Precipitation (mm)	Intensity	Runoff C	Flowrate
	km^2	km	hrs	mm	mm/hr	-	m^3/s
Phase 1A	0.5105	1.7316	1.0212	122.0000	119.472	0.504	8.545
Phase 1B	0.7753	1.9489	1.1235	122.0000	108.591	0.504	11.796
Phase 2 East	0.1618	0.6889	0.4864	122.0000	250.842	0.504	5.687
Phase 2 West	0.2560	0.8749	0.5787	122.0000	210.804	0.504	7.562

- The dirty water drains will ultimately flow into the ADDD via a series of dirty water pipes.
- The rectangular concrete canals collecting runoff from Phases 1A and B will have a controlled gradient of 1:200 to maintain tranquil flow and will be 2.5 m wide with a flow depth of 2.0 m. The canal depths will vary from 2.2 to 2.7 m deep. The canals collecting from Phase 2 will be 2.5 m wide with a flow depth of 1.8 m and canal depths varying from 2.0 m to 2.5 m.
- Details of the dirty water drainage system are shown on drawings K30300098/06-230 and -232 in **Appendix 1.**

c)   **Ash Dump Stormwater Storage Volume in the ADDD**

- A graph has been produced to illustrate the ash disposal volume at the ash dump after specific disposal times. The graph is presented in **Appendix 4**.
- The stormwater storage capacity for the ADDD is 204 000 m^3, and corresponds with the 1:50 yr / 8 day storm event falling on the maximum dirty catchment area.

d)   **Dust Control & Irrigation Storage (Operating Storage)**

- Additional storage in the ADDD is provided for 72 hours of water for dust control and irrigation over the active disposal area and the rehabilitation establishment zone.

- During the Ash - Gypsum co-disposal phase, the dust control area comprises the advancing face and a 50 m section behind the face. The irrigation zone is located behind the dust control area and extends for a length equivalent to 1 year of disposal.
- During the Gypsum disposal phase, the dust control area comprises the advancing face and a 25 m section behind the face. The irrigation zone is located behind the dust control area and extends for 50 m.
- The dust control and irrigation storage volumes are based on 1 mm/day of equivalent rainfall. (1 mm/day is equivalent to 0.5*the average annual daily rainfall at Kusile Site).
- The dust control and irrigation volumes during disposal are shown in Table 4.3 below.

Table 4.3: Dust Control and Irrigation Volumes

Years	Dust Suppression Area	Irrigation Area	Daily Volume	72 hr Volume
-	km^2	km^2	m^3/day	m^3
1	0.500	0.028	527.865	1583.595
2	0.464	0.098	562.196	1686.589
3	0.294	0.102	395.403	1186.210
4	0.680	0.175	854.191	2562.573
5	0.504	0.116	620.522	1861.565
6	0.131	0.190	320.956	962.867
7	0.098	0.114	212.206	636.619
8	0.127	0.115	241.379	724.138

- The maximum 72 hr dust suppression and irrigation volume is approximately 2562 m^3. The maximum pumping capacity from the ADDD is 25l/s.
- Based on the maximum pumping capacity, the operating storage was set at 6480 m^3, which is equivalent to 72 hrs of pumping at 25l/s.
- **Appendix 4** includes system descriptions for the Dust Suppression and Irrigation Water, and Make-up Water.

e)   ADDD Storage Volume

- The ADDD storage volume is sufficient to store the dirty water run-off for 1:50 yr / 8 day storm event, and for 72 hours of dust control and irrigation.

- The required ADDD storage capacity is 210480 m^3 as shown in Table 4.4 below.

Table 4.4: ADDD Storage Volumes

Stormwater Volume	Dust and Irrigation Volume	**Total Required Volume**
m^3	m^3	**m^3**
204 000	6480	**210480**

- The ADDD has a design total storage capacity of 227410 m^3, made up as follows:
  - Operating storage in depressed sumps in each compartment of the dam, for the irrigation and dust control operations of 11,560m^3 total. This includes an allowance for silt accumulation
  - Stormwater storage of 215850 m^3, split between the two compartments.
  - The two stormwater storage compartments are each provided with a silt trap sub-compartment at the dirty water inlet zone of each main compartment. This sub-compartment has the same depressed floor level as the operating storage zone, to allow accumulation of settled silt. The sub-compartments are separated from the operating storage zone and the stormwater storage zone by low height perforated walls.

- The ADDD will be a double compartment storage structure located to the north of the ash dump.
- The ADDD will be approximately 600 m long and 90 m wide with a maximum depth of 4.8 m.
- Ash Dump Dirty Dam drawings are presented on drawings K30300098/06-280 to 288 in **Appendix 1**.

4.7.4   Water Mass Balance

Water Mass Balance diagrams for Kusile Power Station, including the Ash Dump and Ash Dump Dirty Dam, are presented in **Appendix 7** for the following cases:
- No rainfall case
- Annual average rainfall case
- 1-day, 50 year event

4.8 Site Geotechnical Investigation

4.8.1 Introduction

The geotechnical information supplied by Partridge Maud and Associates, report reference number 1-6/07 entitled *Project Bravo - Report on Geotechnical Investigations Undertaken for the Ash Dump by Partridge Maud and Associates (PMA), June 2008*[Ref.1] has relevance and gives the overall geotechnical conditions of the plant site.

The Local Geology from the Golder Associates Hydrogeological report is presented in **Appendix 1a,** together with an interpretation of the ground water depth profile, extracted from the test pit logs.

The following text is extracted from the PMA report conclusion:

i)   *We do not envisage any major soil problems in the areas of the site underlain by the Dwyka tillite and Rayton shale. Shale bedrock occurs at shallow depth (less than three metres) in the latter area, while the residual tillite under the Ash Dump is characterized by relatively high consistency and shear strength at an average depth of about two metres, and perhaps double that locally. The mechanical properties of the tillite are, in addition, well known on the basis of a large number of tests carried out on both the Power Station and Ash Dump sites. This will facilitate design of the relevant parts of the dump.*

ii)   *The problematical material from a founding point of view is the clayey residual diabase. This is a material of low strength, low density and high void ratio, which is susceptible to the occurrence of shear failures and significant settlements at relatively low imposed pressures. These problems should be carefully considered by the designers of the Ash Dump. Once again, a significant body of test data, from various parts of the total site, is available to underpin design decisions.*

iii)   *A major concern, at least during the wet 2007/2008 summer season, was the extent to which shallow and rapid water seepage was encountered in the test pits. In many cases it proved too dangerous to descend the pits to their full depth because of the collapse of their sides under the high prevailing hydrostatic pressures. This problem was not confined to low-lying areas: some of the most rapid seepage occurred near the crest of the ridge on which the Ash Dump will be sited. It is clear, therefore, that comprehensive underdrainage will have to be provided to ensure that pore water pressures*

dissipate sufficiently rapidly not to prejudice the stability of the dump as it is raised. The combined flow from the drains will be substantial, and this needs to be taken into account when planning both the treatment (where this is needed) and the disposal of this water.

Drawings K 30300098/06-202 to -205 attached in **Appendix 1** show the location and logs of the test pits excavated on the ash dump.

Soil types vary across the site, but the area has shallow topsoils with quartzitic stones and weathered shales or organic clay/silts. The topsoils are predominantly underlain by tillite and diabase, with shallow bedrock within the tillite to about 3 to 4 m depth and the deeper weathering in the diabase to depths to bedrock of about 5 m, with occasional areas in excess of 5 m.

4.8.2 Groundwater Conditions

Strong groundwater seepage was noted at relatively shallow depth in some of the test holes excavated by Partridge Maud and Associates[1] and by Knight Piésold. Hydro-geological studies undertaken by Knight Piésold indicate the presence of both a deep and a shallow water table in the area of the Ash Dump. The ground water contour drawing in **Appendix 1** shows the interpreted zones of the ash dump site that have shallow ground water table depths.

4.9 Ash Dump Stability

A detail Stability analysis report has been prepared for the ash dump. (reference in Section 7).

After feasibility appraisal of alternative ash stacking or placement methods for the 5-year duration when ash and gypsum will be placed at high rates onto the no.1 ash dump footprint (ie before the no.2 final ash dump is developed), it was concluded that the ash/gypsum co-disposal in the first 5 years on Ash Dump No.1 would be undertaken using conventional load and haul operations. The ash/gypsum will be placed into successive paddocks of suggested size 200m by 200m,placed in 2 m lifts. This enables good management and control over the side and front faces of the dump, which will all be maintained at a 1v to 5h slope.

The paddock method will also avoid the development of excess pore pressures in the foundation materials as the ash is stacked, which would apply in conventional stacking processes where the ash front face is advanced from the full final height of the dump onto the underlying foundation.

The ash/gypsum stacking operations will ultimately result in high stacked fills over the underlying liner system. The friction interfaces between the ash/gypsum and the liner and between the liner and the natural foundation are thus critical to the dump stability.

The ash dump footprint is located on high ground between two stream courses (convex surface as shown on the typical cross-sections on K30300098/06-207 in **Appendix 1**). The perimeter of the ash dump footprint has been defined by restricting it to ground slopes that are not in excess of 1v to 15h, in order to ensure acceptable stability factors of safety for the dump.

In-situ samples have been taken from the in-situ foundation materials (November 2008) for laboratory tri-axial testing to supplement the sampling and testing undertaken and presented in ref [1].

Ash/gypsum and soil friction interface properties with HDPE and the HDPE/sand/HDPE leakage detection sandwich layer have also been investigated by laboratory shear box testing.

The testing will be followed by rigorous slope stability assessments to determine the maximum allowable ash stacking height and dump bench heights/ overall effective dump slopes for maintenance of a safe stability regime during operation.

The detail stability analysis for the ash dump and the liner system is presented in a separate report as referenced in Section 7 hereto.

4.10   Seepage Analysis

The ash/gypsum will be dry–disposed at approximately 15% moisture content. However, the climatic water balance is assessed to be positive and irrigation for dust control also adds water to the ash dump system. The entire footprint is provided with a double HDPE liner system as defined in Section 3.6 hereto. A preliminary seepage assessment has been undertaken, using very early and incomplete hydrological data (Ref 7). The preliminary seepage analysis for the ash/gypsum dump, with an HDPE liner, shows a potential total footprint seepage varying from 69,6 to 72,9m^3/d in the period 5 to 50 years of operation.

5   CONSTRUCTION

5.1   Method

The construction of the Ash Dump layer works is presented in the following separate work method statement reports:

- WMS 5452-90-011.1: Ash Dump Layer Works, Work Method Statement
- WMS 5452-90-011.2: Ash Dump Wetland Pan Area
- WMS 5452-90-011.3: Ash Dump Dirty Dam

In order to comply with Environmental and Water Licence requirements for protection of the water in the adjacent stream beds, silt and erosion control facilities in the form of interception trenches and silt retention dams will be constructed as a first priority before the main works are commenced.

Details of the construction phase works are presented on drawings K30300098/06-215 and -216 in **Appendix 1**.

5.2   Specifications

All work will be undertaken in accordance with the drawings and the provisions of the SANS 1200 series of documents and Eskom Technical Specification P23A – Combustion Waste Terrace.

6   OPERATION

After study of alternative deposition systems and life cycle cost comparisons, it was decided to place the ash/gypsum onto the ash dump for the first 5 years of power station operation by a load and haul operation. Ash and gypsum will be delivered by conveyor to a radial stacker near the ash dump, for subsequent loading, hauling and placement into paddocks of suggested size 200m by 200m, developed in 2m lifts, spread initially over the ash dump 5-year half-footprint, to full design height on the ash dump, and then similarly over the second half of the footprint.

The power station comprises six boiler units and these will be commissioned one every eight months, commencing 1 July 2013. The full power station ash/gypsum output will thus only be effective in the 4th year of operation.

In years 6 to 60 of operation, gypsum only will be placed at significantly reduced tonnages onto the ash dump by the same, but much smaller, load and haul operation.

A second dump, to receive ash only is planned to be developed later on another site, still to be selected.

The ash/gypsum load and haul deposition system will enable the ash dump operators to place the ash/gypsum in such a manner as to be free draining in shape, with minimisation of any depression that will collect and retain stormwater run-off.

Temporary artificial channels will be deployed on the exposed ash surfaces to lead stormwater down the faces to the dirty water collection dams in a controlled manner thereby preventing erosion.

Irrigation of the exposed ash surfaces will take place to achieve dust control. Irrigation water volumes will be restricted as far as possible to limit any seepage potential arising from the irrigation waters.

Exposed ash surfaces will be finally shaped at 1:5 on the side slopes and at 1:200 on the top surfaces and rehabilitated as soon as practically possible by placement of selected topsoil and vegetation cover. These areas will be irrigated to promote and sustain the vegetation.

Spillages at ash transfer houses will be contained and removed in an effective manner.

Dirty stormwater run-off from the radial stacker terrace adjacent to the ash dump will be contained by perimeter ditches, and transferred to the ADDD.

7   REFERENCES

1. Project Bravo – Report on Geotechnical Investigations undertaken at the Ash Dump, No. 1-6/07, Partridge Maude and Associates, June 2008

2. En Chem – DR. David Baldwin: Kusile Power Station project: Classification and Environmental Evaluation of Ash and FGD Gypsum in Terms of the Minimum Requirements, November 2008

3. Government Notice No.704, Regulations on use of water for mining and related activities aimed at the protection of water resources, in terms of the National Water Act (Act 36 of 1998)

4. Minimum Requirements for Waste Disposal by Landfill, DWAF, 1998

5. The National Water Act, No 36 of 1998

6. SANS 1200: Standardised Specifications for Civil Engineering Construction

7. Panel B Consultants JV: Ash Dump Stability Analysis (Report 5452/10/019)

8. Eskom Technical Specification 100820-P23A –Combustion Waste Terrace.

9.   DOCUMENT CONTROL SHEET

CLIENT   :   ESKOM HOLDINGS LIMITED

PROJECT   :   KUSILE POWER STATION   **PROJECT No :   5452/50**

TITLE   :   –DESIGN REPORT 5452-50-006

	Prepared by	**Reviewed by**	**Approved by**
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APPENDIX 1

DRAWING SCHEDULES

DRAWINGS
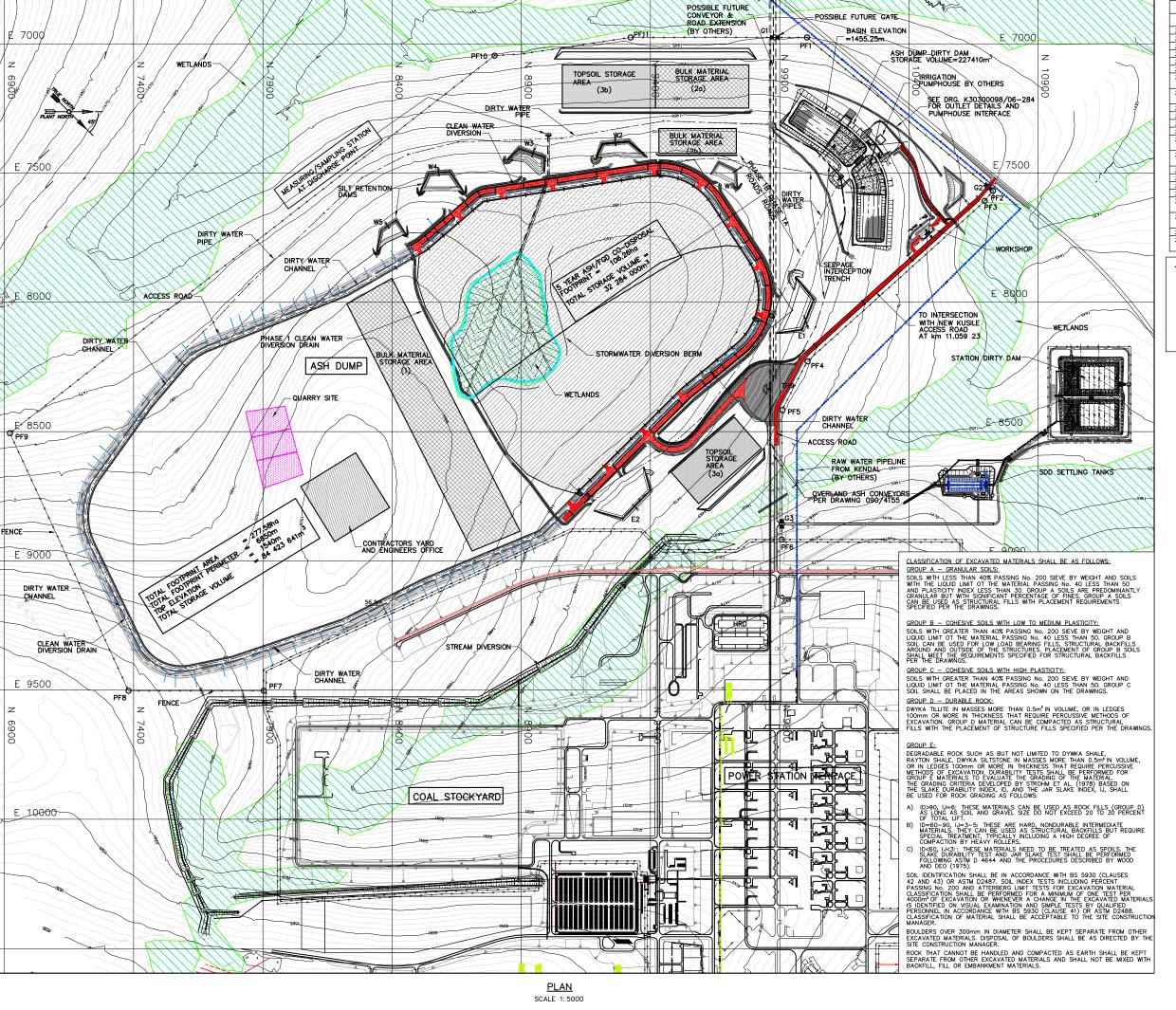
KUSILE POWER STATION
ASH DUMP SITE No. 1
DRAWING SCHEDULE

		Dwg No.	Title
			Ash Dump No. 1 - General
		200	Ash Dump No. 1 - Concept Plan
		201	Ash Dump No. 1 - General Arrangement Plan
		202	Ash Dump No. 1 - Geotechnical Plan
		203	Ash Dump No. 1 - Geotechnical Logs - Sheet 1 of 3
		204	Ash Dump No. 1 - Geotechnical Logs - Sheet 2 of 3
		205	Ash Dump No. 1 - Geotechnical Logs - Sheet 3 of 3
		206	Ash Dump No. 1 - Phase 1 General Arrangement & Setting Out Coordinates
		207	Ash Dump No. 1 - Typical Overall Sections
			Earthworks - Ash Dump No. 1 & Ancillary Structures
			Phase 1 Drawings
		208	Wetland / Pan Drainage Plan and Details
		209	Wetland / Pan Drainage - DN110 Kabelflex Longitudinal Section
		210	Footprint Site Preparation - Phase 1
		211	Footprint Site Preparation - Phase 1 Details
		213	Terracing of Radial Stacker - G. A. and Typical Sections
		215	Ash Dump Dirty Dam - Construction Phase Storm Water Management GA and Details
		216	Ash Dump No. 1 - Construction Phase Storm Water Management GA and Details
		217	Workshop Terrace - General Arrangement & Typical Sections
		218	Pump Station Terrace - General Arrangement & Typical Sections
		219	Ash Dump No. 1 - Storm Water Diversion Channels - Typical Sections & Details
			Civil Works - HDPE Liner
			Phase 1 Drawings
		220	HDPE Liner General Arrangement, Phase 1
		221	Sections and Details, Phase 1
		224	Drainage Above HDPE Liner - General Arrangement & Details, Phase 1
			Civil Works - Stormwater Management System
			Dirty Water Drains
		230	Dirty Water Management - General Arrangement
		231	Dirty Water Management - Phase 1 General Arrangement
			Phase 1 Drawings
		232	Dirty Water Drains - Concrete Details
		233	Dirty Water Drains - Typical Reinforcing
		234	Dirty Water Drains - Bending Schedule
		235	Dirty Water Drains - Plan and Profile, Sheet 1
		236	Dirty Water Drains - Plan and Profile, Sheet 2
		237	Dirty Water Drains - Plan and Profile, Sheet 3
		238	Dirty Water Drains - Plan and Profile, Sheet 4
			Dirty Water Pipes
			Phase 1 Drawings
		250	Dirty Water Pipes - Plan and Profile, Sheet 1
		251	Dirty Water Pipes - Plan and Profile, Sheet 2
		252	Dirty Water Pipes - Plan and Profile, Sheet 3
		253	Dirty Water Pipes - Radial Stacker Drop Inlet Details
		254	Dirty Water Pipes - Plan and Profile, Sheet 4
		256	Dirty Water Pipes - Typical Sections and Details
			Junction Boxes & Manholes
			Phase 1 Drawings
		260	Junction Box No. 1, 2 & 4 - Sections and Details
		261	Junction Box No. 1 - Reinforcing
		263	Junction Box No. 2 - Reinforcing
		264	Junction Box No. 3 - Sections and Details
		265	Junction Box No. 3 - Reinforcing
		267	Junction Box No. 4 - Reinforcing
		268	Junction Box No. 5 - Sections and Details
		269	Junction Box No. 5 - Reinforcing
		271	Junction Box Bending Schedule
		380	Manhole No. 1 - Details, G.A., Sections and Reinforcing
		381	Manhole No. 2 - Details, G.A., Sections and Reinforcing
		382	Manhole No. 3 - Details, G.A., Sections and Reinforcing
		383	Manhole No. 4 - Details, G.A., Sections and Reinforcing
		384	Manhole No. 5 - Details, G.A., Sections and Reinforcing
		385	Manhole No. 6 - Details, G.A., Sections and Reinforcing
		386	Manhole No. 7 - Details, G.A., Sections and Reinforcing
		387	Manhole No. 8 - Details, G.A., Sections and Reinforcing
		388	Manhole No. 9 - Details, G.A., Sections and Reinforcing
		389	Manhole No. 10 - Details, G.A., Sections and Reinforcing
		390	Manhole No. 11 - Details, G.A., Sections and Reinforcing
		391	Manhole No. 12 - Details, G.A., Sections and Reinforcing
		392	Manhole No. 13 - Details, G.A., Sections and Reinforcing
		393	Manhole No. 14 - Details, G.A., Sections and Reinforcing
		394	Manhole No. 15 - Details, G.A., Sections and Reinforcing
		395	Manhole No. 16 - Details, G.A., Sections and Reinforcing
		396	Manhole No. 17 - Details, G.A., Sections and Reinforcing
		397	Manhole No. 18 - Details, G.A., Sections and Reinforcing
		398	Manhole No. 19 - Details, G.A., Sections and Reinforcing
		399	Manhole No. 20 - Details, G.A., Sections and Reinforcing

			Ash Dump Dirty Dam
		280	ADDD - General Arrangement and Setting Out Coordinates
		281	ADDD - Sections and Details - Sheet 1 of 2
		282	ADDD - Sections and Details - Sheet 2 of 2
		283	ADDD - Compartment No. 1 Inlet General Arrangement
		284	ADDD - Compartment No. 1 Outlet General Arrangement
		285	ADDD - Spillway No.1 - GA & Typical Details
		286	ADDD - Spillway No.2 - GA & Typical Details
		287	ADDD - Energy Dissipator No. 1 - GA & Details
		288	ADDD - Leakage Detection Sump - GA & Details
		289	ADDD - Compartment No. 2 Inlet General Arrangement
		290	ADDD - Compartment No. 2 Outlet General Arrangement
		292	ADDD - Energy Dissipators No. 1 and 2 Reinforcing
		293	ADDD - Spillway No. 1 & 2 Concrete Reinforcing Details
		294	ADDD - Leakage Detection Sump Reinforcing Details
		295	ADDD - Basin Division Walls, Compartment No. 1
		296	ADDD - Basin Division Walls, Compartment No. 2
		297	ADDD - Compartment No. 1 Floor Slab Layout
		298	ADDD - Compartment No. 2 Floor Slab Layout
		404	ADDD - Energy Dissipator No. 2 - GA & Details
			Clean Water Drains
		300	Clean Water Management - General Arrangement
			Phase 1 Drawings
		301	Clean Water Management - Phase 1 General Arrangement
		303	Clean Water Drains, Sheet 1 of 6
		304	Clean Water Drains, Sheet 2 of 6
		310	Clean Water Drains - Culvert Cross-Sections
		311	Clean Water Drains - Wing walls / Apron slabs - Sections and Details, Sheet 1 of 2
		312	Clean Water Drains - Wing walls / Apron slabs - Sections and Details, Sheet 2 of 2
		313	Clean Water Drains - Wing walls / Apron slabs Reinforcing Details
			Clean Water Sediment Control Dams
			Phase 1 Drawings
		320	Bulk Material Storage Areas - General Arrangement and Setting Out Coordinates
		321	Clean Water Sediment Control Dam E1
		322	Clean Water Sediment Control Dam E2
		323	Clean Water Sediment Control Dam W1
		324	Clean Water Sediment Control Dam W2
		325	Clean Water Sediment Control Dam W3
		326	Clean Water Sediment Control Dam W4
		327	Clean Water Sediment Control Dam W5
		328	Clean Water Collection Channels - Long-Sections, West Channels
		329	Clean Water Collection Channels - Long-Sections, East Channels
			Ash Dump No. 1 - Access Roads
			Perimeter Access Road
		340	Perimeter Access Road - General Arrangement
			Phase 1 Drawings
		342	Perimeter Access Road - Profile, Sheet 1 of 7
		343	Perimeter Access Road - Profile, Sheet 2 of 7
		344	Perimeter Access Road - Profile, Sheet 3 of 7
		349	Perimeter Access Road - Access to Ash Dump
			Access Road 3 (From Kusile Access Road to Radial Stacker - Includes Workshop and Pumphouse
		370	Access Road 3 - General Arrangement and Setting Out Coordinates
		371	Access Road 3 - Plan and Profile
		372	Access Road 3 - Cross-Sections and Details

KUSILE POWER STATION
ASH DUMP No. 1
SCHEDULE OF DRAWINGS INCLUDED IN DESIGN REPORT 5452-90-011 Rev4

	Dwg No.	Rev No.	Title
			Ash Dump No. 1 - General
	201	1	Ash Dump No. 1 - General Arrangement Plan
	202	2	Ash Dump No. 1 - Geotechnical Plan
	203	1	Ash Dump No.1- Geotechnical Logs Sheet 1of 3
	204	1	Ash Dump No.1- Geotechnical Logs Sheet 2of 3
	205	2	Ash Dump No.1- Geotechnical Logs Sheet 3of 3
	206	2	Ash Dump No. 1 - Phase 1 General Arrangement & Setting Out Coordinates
	207	P	Ash Dump No. 1 - Typical Overall Dump Sections
			Earthworks - Ash Dump No. 1 & Ancillary Structures
	208	2	Wetland / Pan Drainage Plan and Details
	209	2	Wetland / Pan Drainage - DN110 Kabelflex Longitudinal Section
	210	2	Footprint Site Preparation - Phase 1
	211	2	Footprint Site Preparation - Phase 1 Details
	213	2	Terracing of Radial Stacker - General Arrangement Plan
	215	1	Ash Dump Dirty Dam - Construction Phase Storm Water Management GA and Details
	216	1	Ash Dump No. 1 - Construction Phase Storm Water Management GA and Details
	217	2	Workshop Terrace - General Arrangement & Typical Sections
	218	2	Pump Station Terrace - General Arrangement & Typical Sections
			Civil Works - HDPE Liner
	220	2	HDPE Liner General Arrangement, Phase 1
	221	2	Sections and Details, Phase 1
	224	1	Drainage Above HDPE Liner - General Arrangement & Details, Phase 1
			Civil Works - Stormwater Management System
			Dirty Water Drains
	231	1	Dirty Water Management - Phase 1 General Arrangement
	232	2	Dirty Water Drains - Concrete Details
			Ash Dump Dirty Dam
	280	2	ADDD - General Arrangement and Setting Out Coordinates
	281	2	ADDD - Sections and Details - Sheet 1 of 2
	282	2	ADDD - Sections and Details - Sheet 2 of 2
	283	2	ADDD - Inlet System - GA & Details
	284	2	ADDD - Outlet System - GA & Details
	285	2	ADDD - Spillway No.1 - GA & Details
	286	2	ADDD - Spillway No.2 - GA & Details
	287	2	ADDD - Energy Dissipator - GA & Details
			Clean Water Drains
	300	1	Clean Water Management - General Arrangement
	303	2	Clean Water Drains, Sheet 1 of 6
	304	2	Clean Water Drains, Sheet 2 of 6
			Clean Water Sediment Control Dams
	320	1	Clean Water Sediment Control Dam No. E1
	321	1	Clean Water Sediment Control Dam No. E2
	322	1	Clean Water Sediment Control Dam No. E3
	323	1	Clean Water Sediment Control Dam No.W1
	324	1	Clean Water Sediment Control Dam No. W2
	325	1	Clean Water Sediment Control Dam No W3
	326	1	Clean Water Sediment Control Dam No W4
	327	1	Clean Water Sediment Control Dam No W5
			Ash Dump No. 1 - Access Roads
			Perimeter Access Road
	340	2	Perimeter Access Road - General Arrangement
			Access Road 3
	370	2	Access Road 3 - General Arrangment and Setting Out Coordinates

KUSILE POWER STATION
ASH DUMP No. 1
GENERAL ARRANGEMENT PLAN

PLAN
SCALE 1:5000

DRG. No. K30300098/06-201

0.90/23330

REFERENCE DRAWINGS

DRAWING No.	TITLE
30300099/06-202	ASH DUMP NO. 1 - GEOTECHNICAL PLAN
30300099/06-208	WETLAND / PAN DRAINAGE PLAN AND DETAILS
30300099/06-209	WETLAND / PAN DRAINAGE - DN110 KABELFLEX LONGITUDINAL SECTION
30300099/06-210	FOOTPRINT SITE PREPARATION - PHASE 1
30300099/06-211	FOOTPRINT SITE PREPARATION - PHASE 1 DETAILS
30300099/06-213	TERRACING OF RADIAL STACKER - GENERAL ARRANGEMENT PLAN
30300099/06-215	ASH DUMP DIRTY DAM - CONSTRUCTION PHASE STORM WATER MANAGEMENT GA AND DETAILS
30300099/06-216	ASH DUMP NO. 1 - CONSTRUCTION PHASE STORM WATER MANAGEMENT GA AND DETAILS
30300099/06-217	WORKSHOP TERRACE - GENERAL ARRANGEMENT & TYPICAL SECTIONS
30300099/06-218	PUMP STATION TERRACE - GENERAL ARRANGEMENT & TYPICAL SECTIONS
30300099/06-220	HDPE LINER GENERAL ARRANGEMENT, PHASE 1
30300099/06-221	HDPE LINER SECTIONS AND DETAILS, PHASE 1
30300099/06-224	DRAINAGE ABOVE HDPE LINER - GENERAL ARRANGEMENT & DETAILS, PHASE 1
30300099/06-230	DIRTY WATER MANAGEMENT - GENERAL ARRANGEMENT AND SETTING OUT COORDINATES
30300099/06-232	DIRTY WATER DRAINS - CONCRETE DETAILS
30300099/06-280	ADDD - GENERAL ARRANGEMENT AND SETTING OUT COORDINATES
30300099/06-281	ADDD - SECTIONS AND DETAILS - SHEET 1 OF 2
30300099/06-282	ADDD - SECTIONS AND DETAILS - SHEET 2 OF 2
30300099/06-300	CLEAN WATER MANAGEMENT - GENERAL ARRANGEMENT AND SETTING OUT COORDINATES
30300099/06-301	CLEAN WATER MANAGEMENT - PHASE 1 GENERAL ARRANGEMENT
30300099/06-340	PERIMETER ACCESS ROAD - GENERAL ARRANGEMENT
30300099/06-370	ACCESS ROAD 3 - GENERAL ARRANGMENT AND SETTING OUT COORDINATES

ABREVIATIONS

I.L	INVERT LEVEL
c/c	CENTER TO CENTER
crs.	CENTERS
mm	MILIMETERS
m	METERS
m³	CUBIC METERS
m²	SQUARE METERS
ha	HECTARES
N.G.L	NATURAL GRADE LEVEL
T.O.C	TOP OF CONCRETE
DRG.	DRAWING
B&V	BLACK & VEATCH
N.T.S	NOT TO SCALE
OMC	OPTIMUM MOISTURE CONTENT
F.T.L	FINAL TERRACE LEVEL
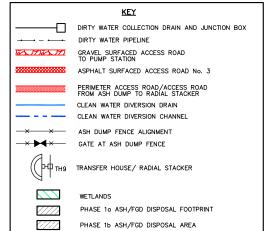
SETTING OUT CO-ORDINATES: GATES
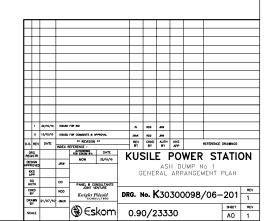
POINT NAME	N-COORDINATE	E-COORDINATE
G1	6974.949	9880.493
G2	7553.448	10707.136
G3	8856.685	9908.480
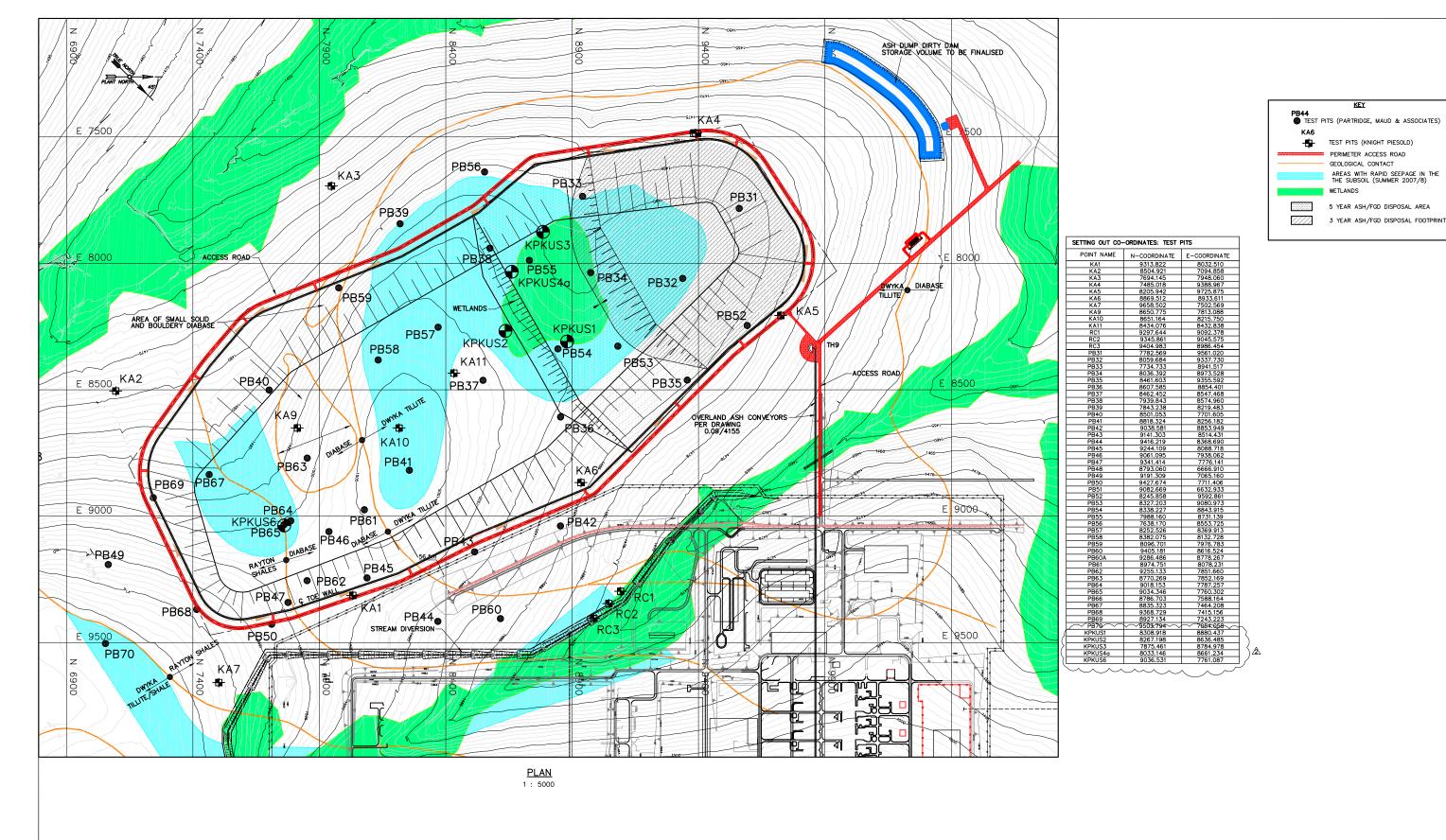
SETTING OUT CO-ORDINATES: PERIMETER FENCE

POINT NAME	N-COORDINATE	E-COORDINATE
PF1	6974.949	10005.839
PF2	7568.720	10725.650
PF3	7607.290	10693.505
PF4	8228.570	10007.842
PF5	8416.380	9911.163
PF6	8917.788	9908.480
PF7	9502.500	7903.147
PF8	9502.500	7380.007
PF9	8505.818	6921.105
PF10	7045.275	8796.921
PF11	6974.949	9323.271

GENERAL NOTES:

1. ALL DIMENSIONS GIVEN IN MILIMETERS, UNLESS OTHERWISE NOTED.
2. FOR FENCE AND GATE DETAILS, REFER TO B&V DRAWINGS OUYX-S3916, - S3916A THROUGH - S3916F. PERIMETER FENCE AND GATE SHOWN HERE ARE OF "OUTER BARRIER" CONFIGURATION.

KEY

- DIRTY WATER COLLECTION DRAIN AND JUNCTION BOX
- DIRTY WATER PIPELINE
- GRAVEL SURFACED ACCESS ROAD TO PUMP STATION
- ASPHALT SURFACED ACCESS ROAD No. 3
- PERIMETER ACCESS ROAD/ACCESS ROAD FROM ASH DUMP TO RADIAL STACKER
- CLEAN WATER DIVERSION DRAIN
- CLEAN WATER DIVERSION CHANNEL
- ASH DUMP FENCE ALIGNMENT
- GATE AT ASH DUMP FENCE
- TH9 TRANSFER HOUSE/ RADIAL STACKER
- WETLANDS
- PHASE 1a ASH/FGD DISPOSAL FOOTPRINT
- PHASE 1b ASH/FGD DISPOSAL AREA

CLASSIFICATION OF EXCAVATED MATERIALS SHALL BE AS FOLLOWS:

GROUP A - GRANULAR SOILS:

SOILS WITH LESS THAN 40% PASSING No. 200 SIEVE BY WEIGHT AND SOILS WITH THE LIQUID LIMIT OT THE MATERIAL PASSING No. 40 LESS THAN 50 AND PLASTICITY INDEX LESS THAN 30. GROUP A SOILS ARE PREDOMINANTLY GRANULAR BUT WITH SIGNIFICANT PERCENTAGE OF FINES. GROUP A SOILS CAN BE USED AS STRUCTURAL FILLS WITH PLACEMENT REQUIREMENTS SPECIFIED PER THE DRAWINGS.

GROUP B - COHESIVE SOILS WITH LOW TO MEDIUM PLASTICITY:

SOILS WITH GREATER THAN 40% PASSING No. 200 SIEVE BY WEIGHT AND LIQUID LIMIT OT THE MATERIAL PASSING No. 40 LESS THAN 50. GROUP B SOIL CAN BE USED FOR LOW LOAD BEARING FILLS, STRUCTURAL BACKFILLS AROUND AND OUTSIDE OF THE STRUCTURES. PLACEMENT OF GROUP B SOILS SHALL MEET THE REQUIREMENTS SPECIFIED FOR STRUCTURAL BACKFILLS PER THE DRAWINGS.

GROUP C - COHESIVE SOILS WITH HIGH PLASTICITY:

SOILS WITH GREATER THAN 40% PASSING No. 200 SIEVE BY WEIGHT AND LIQUID LIMIT OT THE MATERIAL PASSING No. 40 LESS THAN 50. GROUP C SOIL SHALL BE PLACED IN THE AREAS SHOWN ON THE DRAWINGS.

GROUP D - DURABLE ROCK:

DWYKA TILLITE IN MASSES MORE THAN $0.5m^3$ IN VOLUME, OR IN LEDGES 100mm OR MORE IN THICKNESS THAT REQUIRE PERCUSSIVE METHODS OF EXCAVATION. GROUP D MATERIAL CAN BE COMPACTED AS STRUCTURAL FILLS WITH THE PLACEMENT OF STRUCTURE FILLS SPECIFIED PER THE DRAWINGS.

GROUP E:

DEGRADABLE ROCK SUCH AS BUT NOT LIMITED TO DYWKA SHALE, RAYTON SHALE, DWYKA SILTSTONE IN MASSES MORE THAN $0.5m^3$ IN VOLUME, OR IN LEDGES 100mm OR MORE IN THICKNESS THAT REQUIRE PERCUSSIVE METHODS OF EXCAVATION. DURABILITY TESTS SHALL BE PERFORMED FOR GROUP E MATERIALS TO EVALUATE THE GRADING OF THE MATERIAL. THE GRADING CRITERIA DEVELOPED BY STROHM ET AL. (1978) BASED ON THE SLAKE DURABILITY INDEX, ID, AND THE JAR SLAKE INDEX, IJ, SHALL BE USED FOR ROCK GRADING AS FOLLOWS:

A) ID>90, IJ=6: THESE MATERIALS CAN BE USED AS ROCK FILLS (GROUP D) AS LONG AS SOIL AND GRAVEL SIZE DO NOT EXCEED 20 TO 30 PERCENT OF TOTAL LIFT.

B) ID=60>90, IJ=3-5: THESE ARE HARD, NONDURABLE INTERMEDIATE MATERIALS. THEY CAN BE USED AS STRUCTURAL BACKFILLS BUT REQUIRE SPECIAL TREATMENT, TYPICALLY INCLUDING A HIGH DEGREE OF COMPACTION BY HEAVY ROLLERS.

C) ID<60, IJ<3: THESE MATERIALS NEED TO BE TREATED AS SPOILS. THE SLAKE DURABILITY TEST AND JAR SLAKE TEST SHALL BE PERFORMED FOLLOWING ASTM D 4644 AND THE PROCEDURES DESCRIBED BY WOOD AND DEO (1975).

SOIL IDENTIFICATION SHALL BE IN ACCORDANCE WITH BS 5930 (CLAUSES 42 AND 43) OR ASTM D2487. SOIL INDEX TESTS INCLUDING PERCENT PASSING No. 200 AND ATTERBERG LIMIT TESTS FOR EXCAVATION MATERIAL CLASSIFICATION SHALL BE PERFORMED FOR A MINIMUM OF ONE TEST PER $4000m^3$ OF EXCAVATION OR WHENEVER A CHANGE IN THE EXCAVATED MATERIALS IS IDENTIFIED ON VISUAL EXAMINATION AND SIMPLE TESTS BY QUALIFIED PERSONNEL IN ACCORDANCE WITH BS 5930 (CLAUSE 41) OR ASTM D2488. CLASSIFICATION OF MATERIAL SHALL BE ACCEPTABLE TO THE SITE CONSTRUCTION MANAGER.

BOULDERS OVER 300mm IN DIAMETER SHALL BE KEPT SEPARATE FROM OTHER EXCAVATED MATERIALS. DISPOSAL OF BOULDERS SHALL BE AS DIRECTED BY THE SITE CONSTRUCTION MANAGER.

ROCK THAT CANNOT BE HANDLED AND COMPACTED AS EARTH SHALL BE KEPT SEPARATE FROM OTHER EXCAVATED MATERIALS AND SHALL NOT BE MIXED WITH BACKFILL, FILL OR EMBANKMENT MATERIALS.

Plan labels

POSSIBLE FUTURE CONVEYOR & ROAD EXTENSION (BY OTHERS)

POSSIBLE FUTURE GATE

BASIN ELEVATION =1455.25m

ASH DUMP DIRTY DAM STORAGE VOLUME=227410m³

IRRIGATION PUMPHOUSE BY OTHERS

SEE DRG. K30300098/06-284 FOR OUTLET DETAILS AND PUMPHOUSE INTERFACE

TOPSOIL STORAGE AREA (3b)

BULK MATERIAL STORAGE AREA (2a)

BULK MATERIAL STORAGE AREA (2b)

WETLANDS

CLEAN WATER DIVERSION

DIRTY WATER PIPE

MEASURING/SAMPLING STATION AT DISCHARGE POINT

SILT RETENTION DAMS

DIRTY WATER PIPE

DIRTY WATER CHANNEL

DIRTY WATER PIPES

WORKSHOP

SEEPAGE INTERCEPTION TRENCH

TO INTERSECTION WITH NEW KUSILE ACCESS ROAD AT km 11.059 23

DIRTY WATER CHANNEL

STATION DIRTY DAM

WETLANDS

ACCESS ROAD

DIRTY WATER PIPE

PHASE 1 CLEAN WATER DIVERSION DRAIN

5 YEAR ASH/FGD CO-DISPOSAL FOOTPRINT = 106.26ha TOTAL STORAGE VOLUME = 32 284 000m³

STORMWATER DIVERSION BERM

WETLANDS

ASH DUMP

BULK MATERIAL STORAGE AREA (1)

QUARRY SITE

DIRTY WATER CHANNEL

DIRTY WATER CHANNEL

ACCESS ROAD

RAW WATER PIPELINE FROM KENDAL (BY OTHERS)

SDD SETTLING TANKS

TOPSOIL STORAGE AREA (3a)

TOTAL FOOTPRINT AREA = 277.58ha
TOTAL FOOTPRINT PERIMETER = 6850m
TOE ELEVATION = 1540m
TOTAL STORAGE VOLUME = 84 423 641m³

CONTRACTORS YARD AND ENGINEERS OFFICE

OVERLAND ASH CONVEYORS PER DRAWING 090/4155

FENCE

CLEAN WATER DIVERSION DRAIN

STREAM DIVERSION

HRD

FENCE

POWER STATION TERRACE

COAL STOCKYARD

TRUE NORTH / PLANT NORTH 45°

E 7000, E 7500, E 8000, E 8500, E 9000, E 9500, E 10000
N 6900, N 7400, N 7900, N 8400, N 8900, N 9400, N 9900, N 10400, N 10900

PF1, PF2, PF3, PF4, PF5, PF6, PF7, PF8, PF9, PF10, PF11
G1, G2, G3
W1, W2, W3, W4, W5
E1, E2

Eskom

PANEL B CONSULTANTS JOINT VENTURE
Knight Piésold

PLAN
1 : 5000

KEY

PB44 ●	TEST PITS (PARTRIDGE, MAUD & ASSOCIATES)
KA6 ⊞	TEST PITS (KNIGHT PIESOLD)
	PERIMETER ACCESS ROAD
	GEOLOGICAL CONTACT
	AREAS WITH RAPID SEEPAGE IN THE THE SUBSOIL (SUMMER 2007/8)
	WETLANDS
	5 YEAR ASH/FGD DISPOSAL AREA
	3 YEAR ASH/FGD DISPOSAL FOOTPRINT

SETTING OUT CO-ORDINATES: TEST PITS

POINT NAME	N-COORDINATE	E-COORDINATE
KA1	9313.822	8032.510
KA2	8504.921	7094.858
KA3	7694.145	7948.060
KA4	7485.018	9388.967
KA5	8205.942	9725.875
KA6	8869.512	8933.611
KA7	9658.502	7502.569
KA9	8650.775	7813.088
KA10	8651.164	8215.750
KA11	8434.076	8432.838
RC1	9297.644	9092.378
RC2	9345.861	9045.575
RC3	9404.983	8986.454
PB31	7782.569	9561.020
PB32	8059.684	9337.730
PB33	7734.733	8941.517
PB34	8036.392	8973.528
PB35	8461.603	9355.592
PB36	8607.585	8854.401
PB37	8462.452	8547.468
PB38	7939.843	8574.960
PB39	7843.238	8219.483
PB40	8501.053	7701.605
PB41	8818.324	8256.182
PB42	9038.581	8853.949
PB43	9141.303	8514.431
PB44	9416.219	8368.690
PB45	9244.109	8088.718
PB46	9061.095	7938.062
PB47	9341.414	7776.141
PB48	8793.060	6666.910
PB49	9191.309	7065.160
PB50	9427.674	7711.406
PB51	9082.669	6632.933
PB52	8245.858	9592.861
PB53	8327.203	9080.973
PB54	8338.227	8843.915
PB55	7988.160	8731.139
PB56	7638.170	8553.725
PB57	8252.526	8369.913
PB58	8382.075	8132.728
PB59	8096.701	7976.783
PB60	9405.181	8616.524
PB60A	9286.486	8778.267
PB61	8974.751	8078.231
PB62	9255.133	7851.660
PB63	8770.269	7852.169
PB64	9018.153	7787.257
PB65	9034.346	7760.302
PB66	8786.703	7588.164
PB67	8835.323	7464.208
PB68	9368.729	7415.156
PB69	8927.134	7243.223
PB70	9503.794	7984.058
KPKUS1	8308.918	8880.437
KPKUS2	8267.198	8636.485
KPKUS3	7875.461	8784.978
KPKUS4a	8033.146	8661.234
KPKUS6	9036.531	7761.087

ASH DUMP DIRTY DAM
STORAGE VOLUME TO BE FINALISED

NOTES:
1. GEOLOGICAL CONTACTS, AREAS OF SMALL SOLID AND BOULDERY DIABASE AND AREAS WITH RAPID SEEPAGE IN THE SUBSOIL SHOWN HEREIN ARE REFERENCED FROM A "PRELIMINARY PLAN SHOWING SURFACE GEOLOGY AND TEST PITS" BY PARTRIDGE, MAUD & ASSOCIATES (MAY 2008)
2. GEOTECHNICAL LOGS OF TEST PITS SHOWN HEREIN ARE ILLUSTRATED ON DRAWING No. 5 K30300098/06-203 THROUGH K30300098/06-205

KUSILE POWER STATION
ASH DUMP No 1
GEOTECHNICAL PLAN

DRG. No. K30300098/06-202   REV 2

SCALE 0.90/23272   A0   REV 2

Eskom

Test Pit No. PB31 — Sheet 1 of 1 — PROJECT: BRAVO ASH DUMP — PROFILE DESCRIPTION

Test Pit No. PB32 — Sheet 1 of 1 — PROJECT: BRAVO ASH DUMP — PROFILE DESCRIPTION

Test Pit No. PB33 — Sheet 1 of 1 — PROJECT: BRAVO ASH DUMP — PROFILE DESCRIPTION

Test Pit No. PB34 — Sheet 1 of 1 — PROJECT: BRAVO ASH DUMP — PROFILE DESCRIPTION

Test Pit No. PB35 — Sheet 1 of 1 — PROJECT: BRAVO ASH DUMP — PROFILE DESCRIPTION

Test Pit No. PB36 — Sheet 1 of 1 — PROJECT: BRAVO ASH DUMP — PROFILE DESCRIPTION

Test Pit No. PB37 — Sheet 1 of 1 — PROJECT: BRAVO ASH DUMP — PROFILE DESCRIPTION

Test Pit No. PB38 — Sheet 1 of 1 — PROJECT: BRAVO ASH DUMP — PROFILE DESCRIPTION

Test Pit No. PB39 — Sheet 1 of 1 — PROJECT: BRAVO ASH DUMP — PROFILE DESCRIPTION

Test Pit No. PB40 — Sheet 1 of 1 — PROJECT: BRAVO ASH DUMP — PROFILE DESCRIPTION

Test Pit No. PB41 — Sheet 1 of 1 — PROJECT: BRAVO ASH DUMP — PROFILE DESCRIPTION

Test Pit No. PB42 — Sheet 1 of 1 — PROJECT: BRAVO ASH DUMP — PROFILE DESCRIPTION

Test Pit No. PB43 — Sheet 1 of 1 — PROJECT: BRAVO ASH DUMP — PROFILE DESCRIPTION

Test Pit No. PB44 — Sheet 1 of 1 — PROJECT: BRAVO ASH DUMP — PROFILE DESCRIPTION

Test Pit No. PB45 — Sheet 1 of 1 — PROJECT: BRAVO ASH DUMP — PROFILE DESCRIPTION

Test Pit No. PB46 — Sheet 1 of 1 — PROJECT: BRAVO ASH DUMP — PROFILE DESCRIPTION

Test Pit No. PB47 — Sheet 1 of 1 — PROJECT: BRAVO ASH DUMP — PROFILE DESCRIPTION

Test Pit No. PB48 — Sheet 1 of 1 — PROJECT: BRAVO ASH DUMP — PROFILE DESCRIPTION

Test Pit No. PB49 — Sheet 1 of 1 — PROJECT: BRAVO ASH DUMP — PROFILE DESCRIPTION

Test Pit No. PB50 — Sheet 1 of 1 — PROJECT: BRAVO ASH DUMP — PROFILE DESCRIPTION

KUSILE POWER STATION
ASH DUMP No. 1
GEOTECHNICAL LOGS
SHEET 1 OF 3

PANEL 8 CONSULTANTS JOINT VENTURE
Knight Piésold

DRG. No. K30300098/06-203

REV 1

0.90/23273

SHEET A0 — REV 1

Eskom

KUSILE POWER STATION
ASH DUMP No 1
GEOTECHNICAL LOGS
SHEET 3 OF 3

DRG. No. K30300098/06-205 REV 2

SCALE 0.90/23275 SHEET A0 REV 2

SETTING OUT CO-ORDINATES: TOE WALL

POINT NAME	N-COORDINATE	E-COORDINATE
A	8740.324	9111.488
B	8712.488	9016.434
C	8667.104	8924.295
D	8588.616	8850.324
E	8358.911	8724.418
F	7849.000	9433.447
G	7794.651	9585.718
H	7779.984	9696.247
I	7783.963	9742.789
J	7864.392	9793.002
K	8160.983	9730.186
L	7972.768	9573.110
M	8335.444	9517.212
N	8018.513	8528.786
O	7917.665	8496.948
P	7815.762	8505.424
Q	7800.078	8532.769
R	7610.361	8753.957
S	7511.432	9405.844
T	7644.671	9652.087
U	7766.316	9427.098

SETTING OUT LINE ON TOE WALL

SETTING OUT CO-ORDINATES: CONTRACTORS YARD

POINT NAME	N-COORDINATE	E-COORDINATE
CY1	8712.000	8046.000
CY2	8581.000	8258.000
CY3	8794.000	8390.000
CY4	8925.000	8177.000

SETTING OUT CO-ORDINATES: BULK MATERIAL STORAGE AREA 1

POINT NAME	N-COORDINATE	E-COORDINATE
BMS1a	8006.000	8225.000
BMS1b	7906.000	8398.000
BMS1c	8885.000	8895.000
BMS1d	8962.000	8710.000

SETTING OUT CO-ORDINATES: BULK MATERIAL STORAGE AREA 2(a)

POINT NAME	N-COORDINATE	E-COORDINATE
BMS2(a)a	7081.000	9419.000
BMS2(a)b	7081.000	9780.000
BMS2(a)c	7248.000	9780.000
BMS2(a)d	7248.000	9419.000

SETTING OUT CO-ORDINATES: BULK MATERIAL STORAGE AREA 2(b)

POINT NAME	N-COORDINATE	E-COORDINATE
BMS2(b)a	7327.000	9432.000
BMS2(b)b	7327.000	9732.000
BMS2(b)c	7423.000	9732.000
BMS2(b)d	7423.000	9432.000

SETTING OUT CO-ORDINATES: TOPSOIL STORAGE AREA 3(a)

POINT NAME	N-COORDINATE	E-COORDINATE
TS3(a)a	8656.000	9479.000
TS3(a)b	8443.000	9723.000
TS3(a)c	8564.000	9829.000
TS3(a)d	8778.000	9586.000

SETTING OUT CO-ORDINATES: TOPSOIL STORAGE AREA 3(b)

POINT NAME	N-COORDINATE	E-COORDINATE
TS3(b)a	7081.000	9058.000
TS3(b)b	7081.000	9419.000
TS3(b)c	7248.000	9419.000
TS3(b)d	7248.000	9058.000

KEY

GRAVEL SURFACED ACCESS ROAD TO PUMP STATION
ASPHALT SURFACED ACCESS ROAD No. 3
PERIMETER ACCESS ROAD/ACCESS ROAD FROM ASH DUMP TO RADIAL STACKER
WETLANDS
ASH DUMP FENCE ALIGNMENT
GATE AT ASH DUMP FENCE
NEW KUSILE PIPELINE
PHASE 1a
PHASE 1b

PHASE 1b
AREA = 543 120m²

PHASE 1a
AREA = 519 456m²

PLAN
SCALE 1:3000

TYPICAL SECTION A
SCALE 1:100

NOTE:
ALL DIMENSIONS ARE GIVEN IN MILIMETERS, UNLESS OTHERWISE NOTED.

KUSILE POWER STATION
ASH DUMP No 1
PHASE 1 GENERAL ARRANGEMENT
AND SETTING OUT CO-ORDINATES

DRG. No. K30300098/06-206 REV 2

Eskom

0.90/23331

PLAN
1 : 5000

PHASE 1

LATER PHASES

TRUE NORTH
PLANT NORTH
45°

E 7500 / E 8000 / E 8500 / E 9000 / E 9500
N 7400 / N 7900 / N 8400 / N 8900 / N 9400 / N 9000 / N 8000

SECTION A
HORIZONTAL SCALE 1:2500
VERTICAL SCALE 1:250

C ASH DUMP

1540

1:200   1:200

OVERALL SLOPE 1:5

OVERALL SLOPE 1:5

C ROAD
C CLEAN WATER TOE DRAIN
C DIRTY WATER CHANNEL
C TOE WALL

C TOE WALL
C DIRTY WATER CHANNEL
C CLEAN WATER TOE DRAIN
C ROAD

20m

10m

NGL

2m HIGH PADDOCKS
± 200x200m in size

1540 / 1535 / 1530 / 1525 / 1520 / 1515 / 1510 / 1505 / 1500 / 1495 / 1490 / 1485 / 1480 / 1475 / 1470

0 50 100 150 200 250 300 350 400 450 500 550 600 650 700 750 800 850 900 950 1000 1050 1100 1150 1200 1250

SECTION B
HORIZONTAL SCALE 1:5000
VERTICAL SCALE 1:500

ASH DUMP No. 1

1540

OVERALL SLOPE 1:5

OVERALL SLOPE 1:5

PHASE 1

NGL

NGL

ELEVATION

1547 / 1537 / 1527 / 1517 / 1507 / 1497 / 1487 / 1477 / 1467 / 1457

Datum 1447.0 amsl

C/L/ PEG LEVELS	0	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	2500	2600	2700	2800	2900	3000	3100	
GRADES	1475.52	1478.96	1482.74	1486.32	1489.58	1492.19	1492.60	1493.00	1493.00	1492.22	1490.87	1490.68	1491.96	1494.28	1497.00	1499.41	1501.78	1503.86	1505.43	1505.82	1506.20	1504.47	1502.40	1499.68	1496.85	1495.26	1495.04	1495.78	1497.57	1500.37	1504.26	1507.87	1509.88 3160.98
SUPERELEVATION																																	
HORIZONTAL CURVES								DIRECTION 330.46°																									
CHAINAGES																																	

KUSILE POWER STATION
ASH DUMP No. 1
TYPICAL OVERALL SECTIONS

PAREL B CONSULTANTS
JOINT VENTURE
Knight Piésold
CONSULTING

DRG. No. K30300098/06-207   REV P1

SHEET A0   REV P1

SCALE 0.90/

Eskom

PHASE 1b
AREA = 543 120m²

PHASE 1a
AREA = 519 456m²

PLAN
SCALE 1: 25000

TOPSOIL STOCKPILE AREA

EROSION CONTROL TRENCH

DIRTY WATER PIPE

PIPES TO PASS UNDER DIRTY WATER PIPE

PIPES TO PASS UNDER DRAINS AND ROAD

MEASURING/SAMPLING STATION AT DISCHARGE POINT
(SEE DRAWING K30300098/06-209 FOR DETAILS)

DIRTY WATER PIPE

STORMWATER DIVERSION BERM

CUT TO PROVIDE PERMANENT FALL TO WEST AT 1:150 MIN
(SEE DRAWING K30300098/06-210)

KABELFLEX

DRAINEX

LIMITS OF WETLAND/PAN

2/DN110 KABELFLEX

2/DN160 KABELFLEX

INITIAL DRAINAGE DITCH WITH DN 160 DRAINEX
(TO BE POSITIONED BY ENGINEER ON SITE)

WETLAND/PAN

STORMWATER DIVERSION BERM
2m CREST x 500mm HIGH

BULK MATERIAL STORAGE AREA

PLAN ON WETLAND/PAN
SCALE 1:2000

WETLAND DRAINAGE PROCEDURE

1. EXCAVATE INITIAL DRAINAGE DITCHES PROCEEDING FROM LOWER GROUND WEST OF THE PAN, TOWARDS THE PAN UNTIL FREE DRAINAGE OF PONDED SURFACE WATER IS ACHIEVED.
2. DRAIN THE PAN OF ALL STANDING WATER.
3. REMOVE LARGE VEGETATION AS FAR AS POSSIBLE. (BUSHES etc.)
4. INSTALL DRAINEX PIPES, GEOFABRIC AND STONE TO INITIAL DRAINAGE DITCHES.
5. TIP AND SPREAD A 150mm THICK LAYER OF -100mm DUMPROCK OVER THE PAN AREA, UNTIL REFUSAL IS REACHED AND DEFLECTION HAS STOPPED.
6. PLACE A 300mm THICK PERMEABLE GRANULAR SOIL COVER LAYER OVER THE DUMPROCK (G5 QUALITY).
7. CONSTRUCT SPINE DRAIN OUTLETS INTO THE SOIL LAYER AND CONNECT A SERIES OF FINGER DRAINS TO THE SPINE DRAINS (FINGER DRAINS TO COVER THE ENTIRE PAN WETLAND AREA).
8. (LAY A DOUBLE HDPE LINER SYSTEM WITH LEAKAGE DETECTION OVER THE DRAINS).
9. (PLACE A 300mm DRAINAGE AND PROTECTION LAYER OVER THE HDPE LINER).

SETTING OUT CO-ORDINATES: WETLAND/PAN

POINT NAME	E-COORDINATE	N-COORDINATE
W1	8194.754	9049.792
W2	8102.780	9007.659
W3	7895.106	8972.922
W4	7819.672	8906.268
W5	7808.428	8881.176
W6	7947.100	8705.771
W7	8083.900	8677.287
W8	8137.336	8633.026
W9	8340.246	8656.015
W10	8303.035	8791.012
W11	8301.386	8955.698

COMPACTED BACKFILLED WITH SELECTED GRANULAR SOIL FROM THE TRENCH EXCAVATION IN ACCORDANCE WITH SANS-2001-DP1 (FLEXIBLE PIPES)

HDPE LINER SYSTEM

200 GRANULAR SOIL COVER SPECIFIED AS FOLLOWS: GROUP A CLASSIFICATION SEE GENERAL NOTE 2)

DUMPROCK (-100mm) (MAX.STONE SIZE =100mm)

SECTION C
SCALE 1:10

PRE-FABRICATED DN 75 DRAINEX WRAPPED WITH 'FLOWNET' DRAINAGE CORE AND A4 GEOFABRIC TUBE (SEE NOTE 1)

DN110 KABELFLEX (PRE-FABRICATED PER NOTE 1)

200 GRANULAR SOIL COVER SPECIFIED AS FOLLOWS: GROUP A CLASSIFICATION (SEE GENERAL NOTE 2)

COMPACTED BACKFILLED WITH SELECTED GRANULAR SOIL FROM THE TRENCH EXCAVATION IN ACCORDANCE WITH SANS-2001-DP1 (FLEXIBLE PIPES)

DUMPROCK (MAX.STONE SIZE =100mm)

DN75 DRAINEX

INITIAL DRAINAGE DITCH

A6 GEOFABRIC

19mm STONE

DN160 DRAINEX

SECTION B
SCALE 1:10

NOMINAL EDGE OF PAN

25m TAPER SECTION

300 GRANULAR FILL

150 DUMP ROCK

INITIAL DRAINAGE DITCH SEE DETAIL

NGL

TYPICAL SECTION THROUGH PAN AREA
N.T.S

STORMWATER DIVERSION BERM

GROUP B OR GROUP C SOIL COMPACTED TO AT LEAST 93% MOD AASHTO AT OMC ± 2% (SEE GENERAL NOTE 2)

SECTION F
SCALE 1:20

INITIAL DRAINAGE DITCH DETAIL
SCALE 1:20
(SEE SECTION B FOR PERMANENT DRAIN INSTALLATION IN THE TRENCH)

DN160 KABELFLEX   DN110 KABELFLEX

FROM INITIAL DRAINAGE DITCH   FROM FINGER DRAIN OUTLETS

COMPACTED BACKFILLED WITH SELECTED GROUP A CLASSIFICATION SOIL FROM THE TRENCH EXCAVATION IN ACCORDANCE WITH SANS-2001-DP1 (FLEXIBLE PIPES) SEE GENERAL NOTE 2

SECTION A
SCALE 1:10

DN75 DRAINEX

DN110/75 REDUCER 45° Y-JUNCTION

DN110 KABELFLEX MAIN COLLECTOR

MAIN COLLECTION JUNCTION DN110/110 45° Y-JUNCTION

TYPICAL DETAIL ON FINGER DRAIN
NTS

SCHEDULE OF PIPE QUANTITIES

DN110 KABELFLEX	2900 m
DN75 DRAINEX	7000 m
DN110/75 45° REDUCER	90 No.
DN110/110 45° Y	3 No.
DN110 45° BEND	3 No.

SETTING OUT CO-ORDINATES: PIPES (to be confirmed on site)

POINT NAME	E-COORDINATE	N-COORDINATE
A	8224.8449	8637.5457
B	8365.5713	8687.9589
C	8302.1240	8881.4387
D	8260.7412	9017.6473
E	8004.3526	8738.7715
F	7958.4430	8839.9581
G	8077.8014	8932.8198
H	7844.3671	8888.1679
J	7522.7923	9009.0121
K	7350.2834	9005.2592
L	8022.8441	8690.1848

SETTING OUT CO-ORDINATES: STORMWATER DIVERSION BERMS

SD1	7783.012	9022.769
SD2	8204.858	9075.845
SD3	8326.392	8969.845
SD4	8392.819	8725.04
SD5	8170.29	8602.541
SD6	7820.647	8814.967

GENERAL NOTES:

1. ALL DIMENSIONS GIVEN IN MILIMETERS, UNLESS OTHERWISE NOTED.
2. REFER TO DRAWING K30300098/06-201 FOR DESCRIPTIONS OF MATERIAL GROUP CLASSIFICATIONS.
3. ALL DN75 AND DN110 DRAINEX PIPES TO BE SUPPLIED PRE-FABRICATED WRAPPED WITH A 'FLOWNET' DRAINAGE CORE AND AN A4 GEOFABRIC TUBE.

KUSILE POWER STATION
ASH DUMP No 1
WETLAND/PAN DRAINAGE
PLAN AND DETAILS

DRG. No. K30300098/06-208   REV 2

0.90/23300   SHEET A0   REV 2

PANEL B CONSULTANTS JOINT VENTURE
Knight Piésold

Eskom

LONGITUDINAL SECTION (D/208)
SCALE : HORIZONTAL 1:2000
VERTICAL 1:200

PAN ZONE

SEE DRG K30300098/06-210
FOR TERRACE CUT AND DISPOSE

350 LAYERWORKS
200

MIN. 1:200 FALL
IN TERRACE ZONE
(INITIAL DRAINAGE DETAILS AND
KABELFLEX OUTLET PIPES)

Ç ROAD
Ç CLEAN CHANNEL
Ç DIRTY WATER CHANNEL
Ç ASH DUMP TOE WALL

Ç CLEAN S/W DIVERSION TRENCH
Ç SAMPLING STATION
Ç DIRTY WATER PIPE

KABELFLEX PIPES UNDER
DIRTY/CLEAN CHANNELS
AND ROAD

300

KABELFLEX PIPES
UNDER DIRTY
WATER PIPE

TRENCH SECTION

LONGITUDINAL SECTION (E/208)
SCALE : HORIZONTAL 1:1000
VERTICAL 1:100

PAN ZONE

Ç DN110 KABELFLEX
350 LAYERWORKS
200
Ç DN110 KABELFLEX
Ç DN110 KABELFLEX
Ç DN110 KABELFLEX

INITIAL DRAINAGE TRENCH
INITIAL DRAINAGE TRENCH

400NB CLASS B HDPE PIPE
TO STORMWATER DIVERSION
TRENCH

Ç STORMWATER DIVERSION
TRENCH

1500

Ç MEASURING/SAMPLING
STATION

ø110 KABELFLEX — FROM FINGER DRAIN
ø110 KABELFLEX
ø160 KABELFLEX — FROM INITIAL DRAINAGE DITCH
ø160 KABELFLEX

PLAN
SCALE 1:10

GALVANISED RECTAGRID
TYPE RS80 WITH PERIMETER EDGING

BEARER BARS SPAN
900

NGL
NGL

BRICK WEIR

SECTION (F)
SCALE 1:10

MEASURING/SAMPLING STATION
FOR LOCATION SEE DRAWING K30300098/06-209

KUSILE POWER STATION
ASH DUMP No 1
WETLAND/PAN DRAINAGE
DN110 KABELFLEX LONGITUDINAL SECTION

DRG. No. K30300098/06-209   REV 2

0.90/ 23301   SHEET A0   REV 2

Eskom

PLANT NORTH 45°
TRUE NORTH

SETTING OUT CO-ORDINATES:
GROUNDWATER FINGER DRAIN OUTLET S.O.P

POINT NAME	N-COORDINATE	E-COORDINATE
GFD1	8736.274	9108.500
GFD2	8684.778	9163.711
GFD3	8633.281	9218.922
GFD4	8581.785	9274.133
GFD5	8530.289	9329.344
GFD6	8222.909	9661.787
GFD7	8175.676	9720.143
GFD8	8121.447	9774.108
GFD9	8050.967	9810.541
GFD10	7969.279	9823.069
GFD11	7893.810	9810.384
GFD12	7811.351	9766.589
GFD13	7748.112	9725.410
GFD14	7685.351	9684.543
GFD15	7624.296	9644.786
GFD16	7540.014	9182.914
GFD17	7551.299	9108.768
GFD18	7562.585	9034.622
GFD19	7573.870	8960.476
GFD20	7585.155	8886.330
GFD21	7604.626	8758.401
GFD22	7651.180	8698.403
GFD23	7700.071	8641.498
GFD24	7749.392	8584.091

TOPSOIL STORAGE AREA (3b)

BULK MATERIAL STORAGE AREA (2a)

SILT RETENTION DAMS

BULK MATERIAL STORAGE AREA (2b)

NEW KUSILE ACCESS ROAD N14/N12

SITE CLEARING AND TOPSOIL STRIPPING

E 7500

TERRACE FILL

FD7

FD8

FD9

FD10

PHASE 1b

EXISTING TREES

SETTING OUT LINE (SEE DRAWING K30300098/06-206 FOR CO-ORDINATES)

DIRTY WATER PIPES

STONE COLLECTOR TRENCH (SEE DRAWING K30300098/06-221 FOR DETAILS)

SEEPAGE INTERCEPTION TRENCH

FD5

CUT TO PROVIDE PERMANENT FALL TO WEST AT 1:150 MIN (SEE DRAWING K30300098/06-209)

PAN AREA (SEE DRAWING K30300098/06-208)

DIVIDE MOUND

E 8000

PHASE 1a

TERRACE EXCAVATION REQUIRED TO MATCH TOP OF DIRTY DRAIN (SEE SECTION)

FD4

SEE GROUNDWATER FINGER DRAIN DETAIL ON DRAWING K30300098/06-211

SITE CLEARING AND TOPSOIL STRIPPING

RADIAL STACKER TERRACE

TYPICAL ARRANGEMENT OF MAIN COLLECTORS (SIDE GROUNDWATER FINGER DRAIN COLLECTORS ONLY PARTIALLY SHOWN)

EXISTING TREES

FILL REQUIRED TO TOP OF DIRTY DRAIN (SEE SECTION)

FD3

E 8500

BULK MATERIAL STORAGE AREA (1)

TOPSOIL STORAGE AREA (3a)

FD2

CONTRACTORS YARD AND ENGINEERS OFFICE

ACCESS ROAD

END OF PHASE 1a

FD1

DIRTY WATER TRENCH
CLEAN WATER TRENCH

E 9000

S.O.L OF TOE WALL

KUSILE POWER STATION
STAGE 1 CONSTRUCTION (FIVE YEAR FOOTPRINT)
CONSTRUCTION SEQUENCE IN FOOTPRINT AREA TO MINIMISE CONSTRUCTION
(PHASE 1A AND 1B SEPARATE) STORMWATER SILT POLLUTION
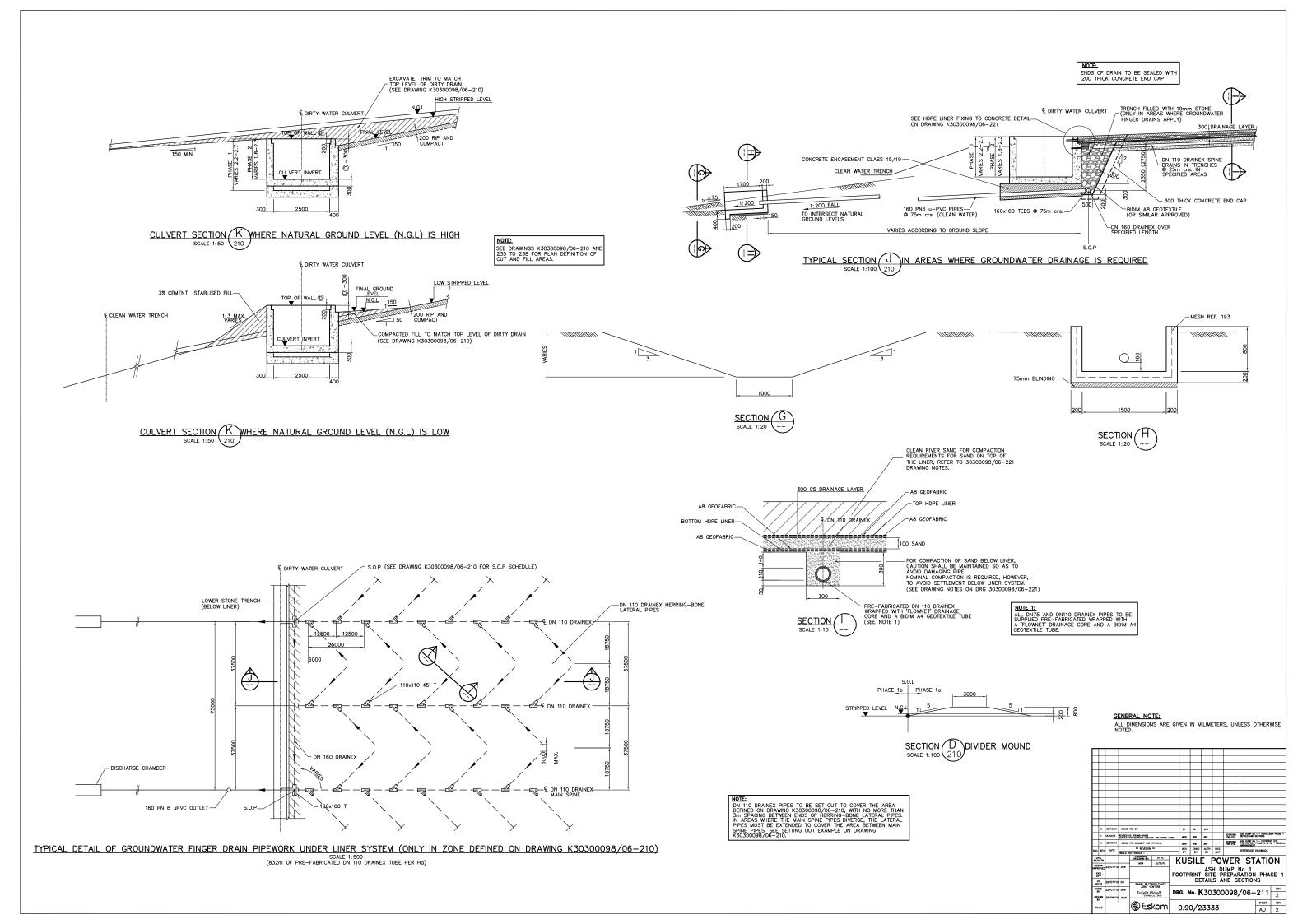
PHASE 1a AND 1b
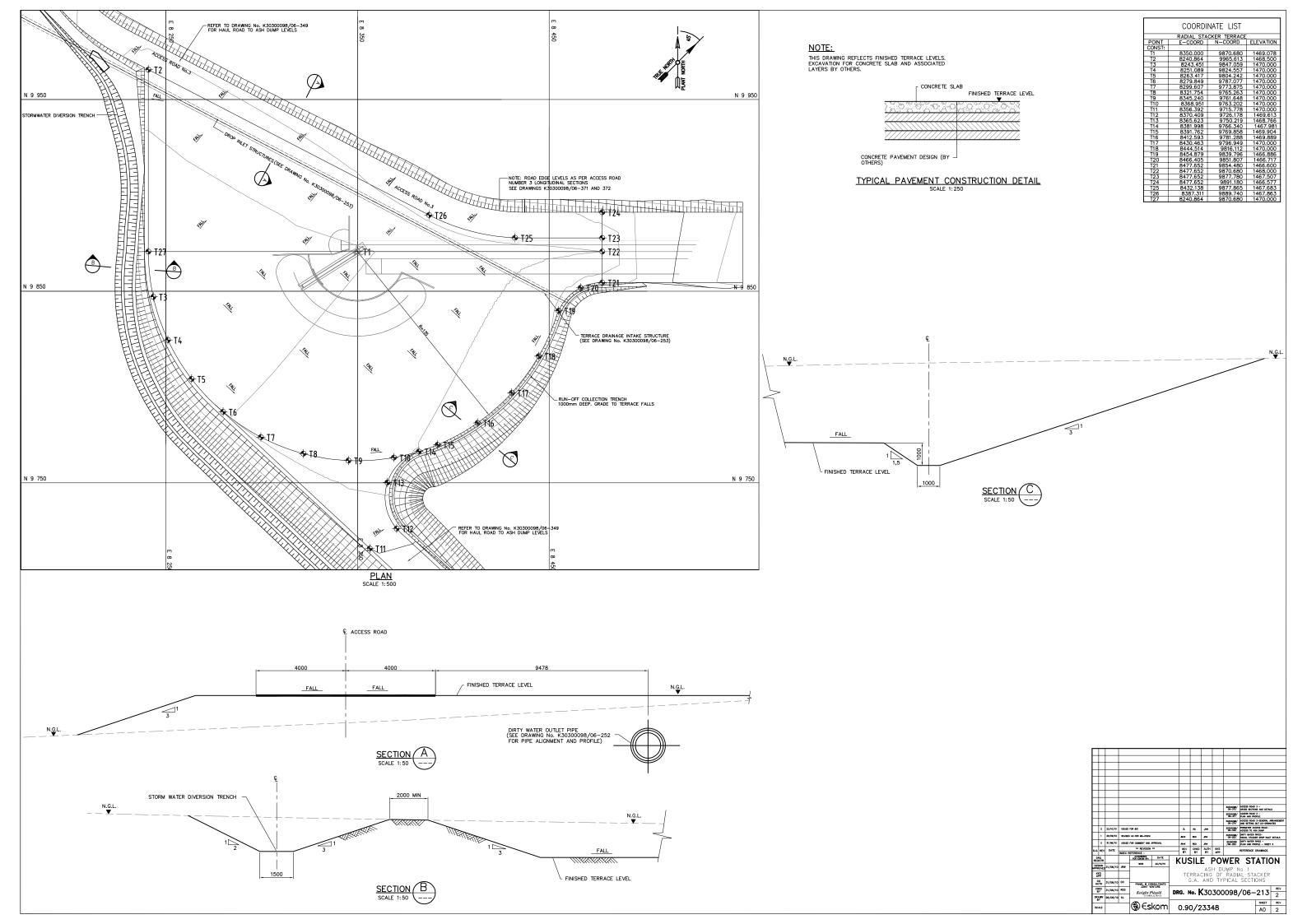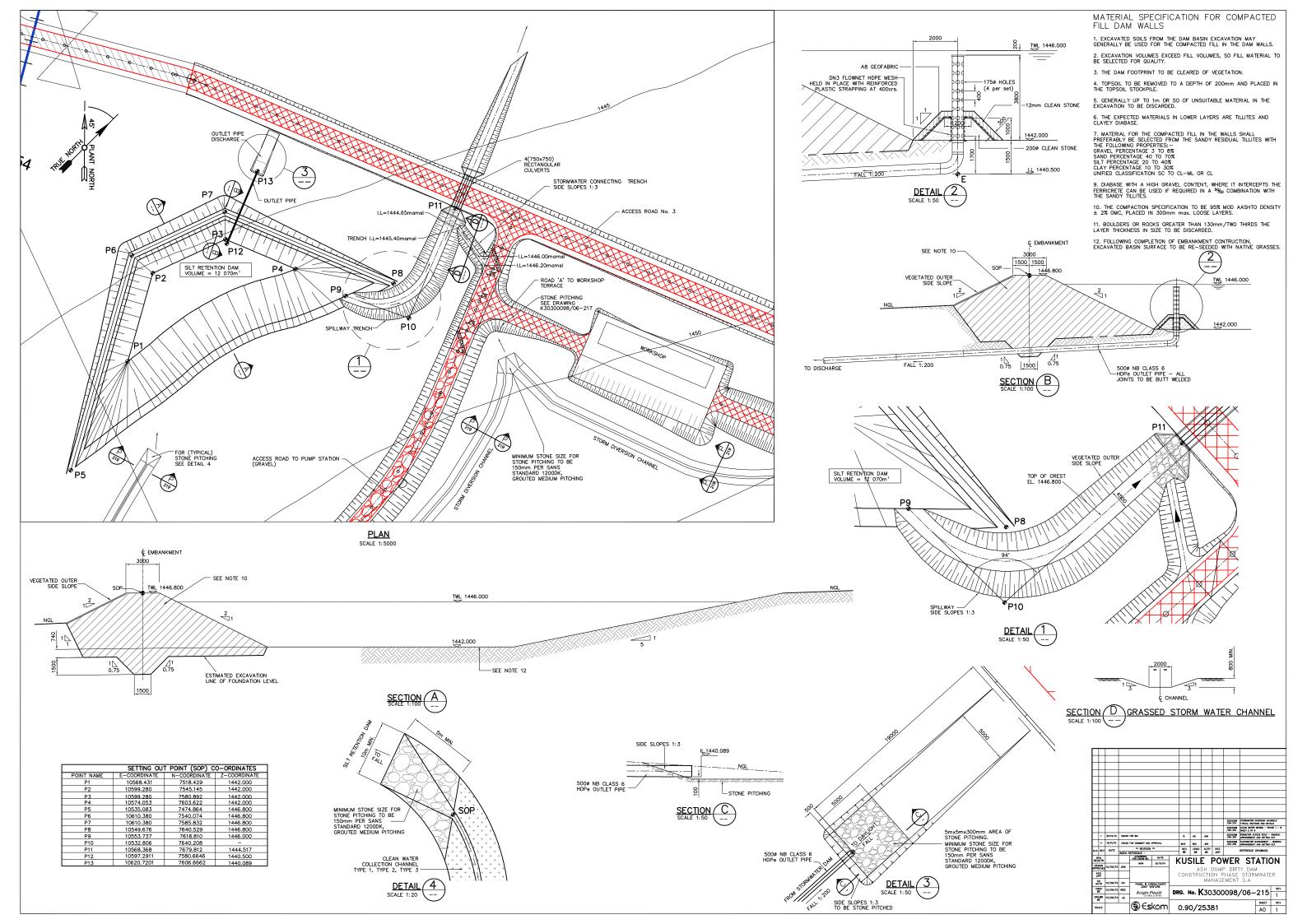
1. DRAWING K30300098/06-216 DEFINES CONSTRUCTION PHASE STORMWATER AND SILT CONTROL FACILITIES THAT ARE REQUIRED TO BE CONSTRUCTED BEFORE EACH PARTICULAR SECTION OF THE MAIN WORKS COMMENCES. THE GENERAL SEQUENCE WILL THEN BE AS FOLLOWS:

2. PREPARE STORMWATER DIVERSION AND CONTROL FACILITIES AT SOIL STOCKPILE AREAS AND CONTRACTORS YARD. THEN STRIP AND CLEAR.

3. STRIP, CLEAR AND REMOVE TOPSOIL IN FOOTPRINT AREAS OF PERIMETER SILT RETENTION DAMS.
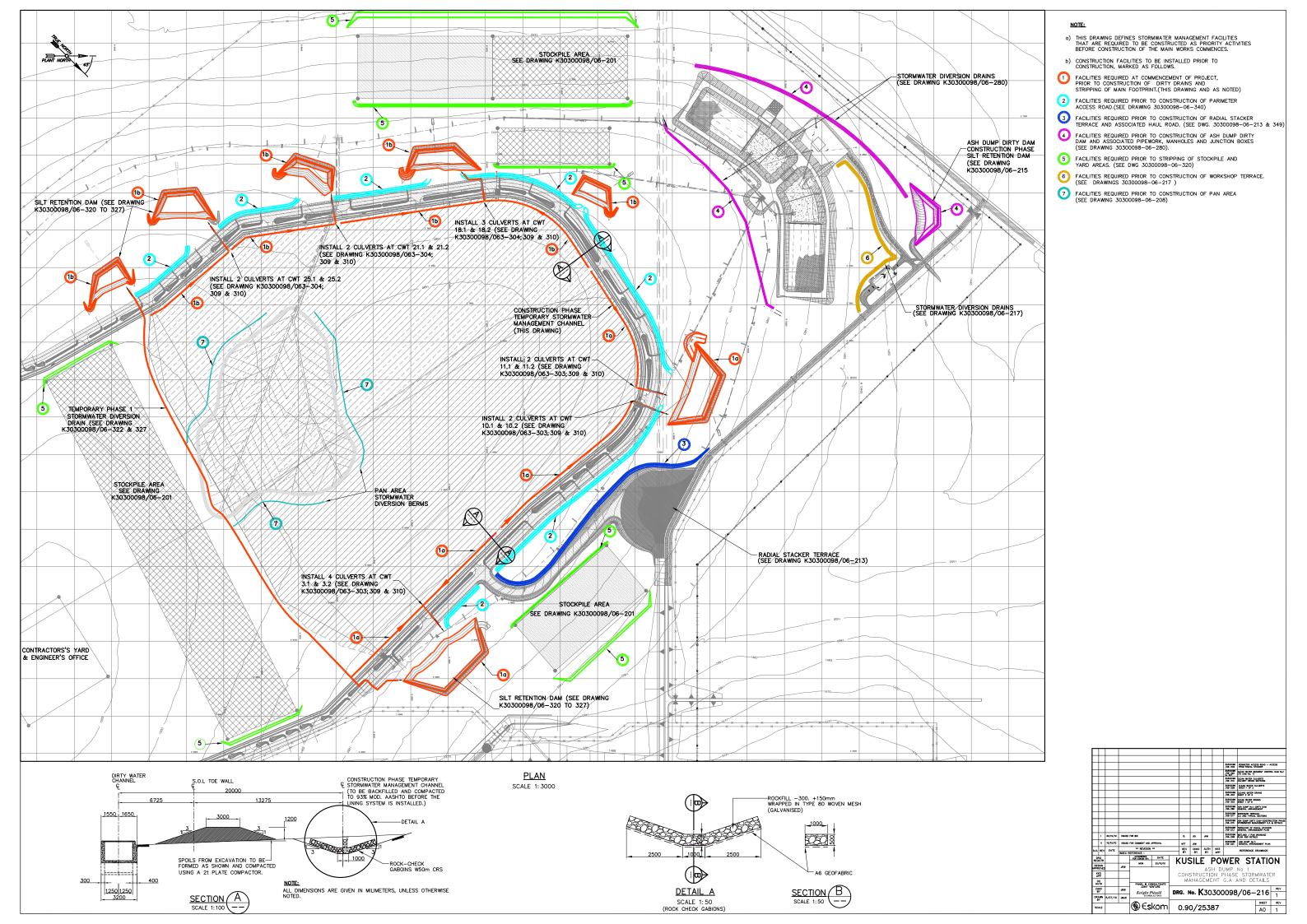
4. CONSTRUCT SILT RETENTION DAMS, INCLUDING PERFORATED OUTLET TOWERS. CONSTRUCT ASSOCIATED TEMPORARY PERIMETER STORMWATER CHANNELS TO SOUTH, EAST AND WEST OF MAIN FOOTPRINT. CONSTRUCT DEFINED CULVERTS PER DRAWING K30300098/06-216 UNDER THE PERIMETER ACCESS ROAD.

5. STRIP, CLEAR AND REMOVE TOPSOIL IN DIRTY DRAIN, ROAD BED AND CLEAN DRAIN AREAS, OVER 1000m LENGTHS AT A TIME, AND FORM EXTERNAL MITRE-CUT DRAINS WITH OUTLETS TO SILT RETENTION DAMS.

6. UNDERTAKE THE SPECIFIED STRIPPING, CLEARING AND DRAINAGE AND LAYER WORKS OF THE WETLAND/PAN AREA.

7. EXCAVATE AND LAY GROUNDWATER PAN AREA FINGER DRAIN OUTLET PIPES.

8. EXCAVATE AND CONSTRUCT THE DIRTY WATER CONCRETE CANAL IN 1000m LENGTHS AT A TIME. BACKFILL TRENCHES AFTER COMPLETION OF EACH SECTION.

9. CONSTRUCT PERIMETER ROAD BED AND BALANCE OF CULVERT CROSSINGS OVER 1000m LENGHTS AT A TIME.

10. EXCAVATE AND FORM CLEAN WATER DRAINS IN 1000m SECTIONS TOGETHER WITH CULVERTS AND CULVERT DISCHARGE TRENCHES TO SILT RETENTION DAMS.

11. COVER THE DIRTY WATER DRAIN CANALS WITH THE PRECAST LIDS IMMEDIATELY ON COMPLETION TO ALLOW SILTY STORMWATER TO PASS OVER THE CANAL.

12. TOPSOIL REMOVAL AND FOUNDATION PREPARATION IN 0.25km² SECTIONS OF THE ASH DUMP FOOTPRINT, MAY COMMENCE AFTER COMPLETION OF STEP 4, IN TIME TO RECEIVE THE LINER SANDWICH INSTALLATION (ALSO INSTALLED IN 0.25 km² SECTIONS LAID AT A TIME). THE FOOTPRINT STRIPPING MUST NOT BE UNDERTAKEN MORE THAN 1 MONTH BEFORE THE LINER IS SCHEDULED TO BE INSTALLED.

13. DELIVER, TIP AND SPREAD THE 300mm G5 GRANUL POETECTION LAYER OVER THE INSTALLED LINER AS SOON AS EACH 0.25km² SECTION IS COMPLETE.

14. FORM THE TOE WALL TO EACH LINER PANEL SECTION, INCLUDING DRAINAGE PIPES AT 75m INTERVALS FOR STORMWATER DISCHARGE TO THE SILT RETENTION DAMS.

15. SIMILAR CONSTRUCTION SEQUENCES ARE REQUIRED AT THE ASH DUMP DIRTY DAM, THE RADIAL STACKER TERRACE, AND THE WORKSHOP TERRACE TO PROVIDE STORMWATER AND SILT CONTROL FACILITIES AHEAD OF THE MAIN WORKS CONSTRUCTION (SEE DRAWING K30300098/06-216).

16. AFTER STEP No. 4, SUBSEQUENT STEPS CAN BE PERFORMED IN PARALLEL TO MEET THE CONSTRUCTION PROGRAM.

PLAN
SCALE 1:3000

KEY

— PERIMETER ACCESS ROAD

GROUNDWATER FINGER DRAIN ZONE UNDER LINER. (SEE DRAWING K30300098/06-211 FOR SECTION AND DETAILS.)

WETLAND PAN AREA

ASH DUMP FENCE

GATE AT ASH DUMP FENCE

NEW KUSILE PIPELINE

PHASE 1a

PHASE 1b

STONE COLLECTOR TRENCH

GROUNDWATER FINGER DRAINS (SEE DRAWING K30300098/06-211)

AREAS OF SITE CLEARING AND TOPSOIL STRIPPING

○ EXISTING STUCTURES

EXISTING ROADS

EXISTING FENCE

EXISTING POWER LINES

SITE CLEARING AND TOPSOIL STRIPPING

CULVERT SECTION K WHERE NATURAL GROUND LEVEL (N.G.L) IS HIGH
SCALE 1:50 (210)

EXCAVATE, TRIM TO MATCH TOP LEVEL OF DIRTY DRAIN (SEE DRAWING K30300098/06-210)
Ç DIRTY WATER CULVERT
N.G.L
HIGH STRIPPED LEVEL
TOP OF WALL D
FINAL LEVEL
200 RIP AND COMPACT
150 MIN
PHASE 1 VARIES 2.2-2.7
PHASE 2 VARIES 1.8-2.3
CULVERT INVERT
300 2500 400

CULVERT SECTION K WHERE NATURAL GROUND LEVEL (N.G.L) IS LOW
SCALE 1:50 (210)

3% CEMENT STABLISED FILL
Ç CLEAN WATER TRENCH
1:3 MAX. VARIES
TOP OF WALL D
FINAL GROUND LEVEL
N.G.L
LOW STRIPPED LEVEL
200 RIP AND COMPACT
COMPACTED FILL TO MATCH TOP LEVEL OF DIRTY DRAIN (SEE DRAWING K30300098/06-210)
CULVERT INVERT
300 2500 400

NOTE:
SEE DRAWINGS K30300098/06-210 AND 235 TO 238 FOR PLAN DEFINITION OF CUT AND FILL AREAS.

TYPICAL SECTION J IN AREAS WHERE GROUNDWATER DRAINAGE IS REQUIRED
SCALE 1:100 (210)

SEE HDPE LINER FIXING TO CONCRETE DETAIL ON DRAWING K30300098/06-221
Ç DIRTY WATER CULVERT
TRENCH FILLED WITH 19mm STONE (ONLY IN AREAS WHERE GROUNDWATER FINGER DRAINS APPLY)
300 DRAINAGE LAYER
CONCRETE ENCASEMENT CLASS 15/19
CLEAN WATER TRENCH
PHASE 1 VARIES 2.2-2.7
PHASE 2 VARIES 1.8-2.3
DN 110 DRAINEX SPINE DRAINS IN TRENCHES @ 25m crs. IN SPECIFIED AREAS
1700 200
±75
1:200
1:200 FALL TO INTERSECT NATURAL GROUND LEVELS
160 PN6 u-PVC PIPES @ 75m crs. (CLEAN WATER)
160x160 TEES @ 75m crs.
300 THICK CONCRETE END CAP
BIDIM A8 GEOTEXTILE (OR SIMILAR APPROVED)
DN 160 DRAINEX OVER SPECIFIED LENGTH
S.O.P
VARIES ACCORDING TO GROUND SLOPE

SECTION G
SCALE 1:20 --
VARIES
1:3 1:3
1000

SECTION H
SCALE 1:20 --
MESH REF. 193
75mm BLINDING
160
800
200 1500 200

SECTION I
SCALE 1:10 --
CLEAN RIVER SAND FOR COMPACTION REQUIREMENTS FOR SAND ON TOP OF THE LINER, REFER TO 30300098/06-221 DRAWING NOTES.
300 G5 DRAINAGE LAYER
A8 GEOFABRIC
TOP HDPE LINER
A8 GEOFABRIC
BOTTOM HDPE LINER
Ç DN 110 DRAINEX
A8 GEOFABRIC
100 SAND
FOR COMPACTION OF SAND BELOW LINER, CAUTION SHALL BE MAINTAINED SO AS TO AVOID DAMAGING PIPE. NOMINAL COMPACTION IS REQUIRED, HOWEVER, TO AVOID SETTLEMENT BELOW LINER SYSTEM. (SEE DRAWING NOTES ON DRG 30300098/06-221)
PRE-FABRICATED DN 110 DRAINEX WRAPPED WITH 'FLOWNET' DRAINAGE CORE AND A BIDIM A4 GEOTEXTILE TUBE (SEE NOTE 1)
300

NOTE 1:
ALL DN75 AND DN110 DRAINEX PIPES TO BE SUPPLIED PRE-FABRICATED WRAPPED WITH A 'FLOWNET' DRAINAGE CORE AND A BIDIM A4 GEOTEXTILE TUBE.

TYPICAL DETAIL OF GROUNDWATER FINGER DRAIN PIPEWORK UNDER LINER SYSTEM (ONLY IN ZONE DEFINED ON DRAWING K30300098/06-210)
SCALE 1:500
(832m OF PRE-FABRICATED DN 110 DRAINEX TUBE PER Ha)

Ç DIRTY WATER CULVERT
S.O.P (SEE DRAWING K30300098/06-210 FOR S.O.P SCHEDULE)
LOWER STONE TRENCH (BELOW LINER)
DN 110 DRAINEX HERRING-BONE LATERAL PIPES
12500 12500
25000
6000
110x110 45' T
Ç DN 110 DRAINEX
37500 37500
18750 18750 18750 18750
75000
DN 160 DRAINEX
VARIES
300Ø MAX.
Ç DN 110 DRAINEX MAIN SPINE
DISCHARGE CHAMBER
160 PN 6 uPVC OUTLET
S.O.P
160x160 T

NOTE:
DN 110 DRAINEX PIPES TO BE SET OUT TO COVER THE AREA DEFINED ON DRAWING K30300098/06-210, WITH NO MORE THAN 3m SPACING BETWEEN ENDS OF HERRING-BONE LATERAL PIPES. IN AREAS WHERE THE MAIN SPINE PIPES DIVERGE, THE LATERAL PIPES MUST BE EXTENDED TO COVER THE AREA BETWEEN MAIN SPINE PIPES, SEE SETTING OUT EXAMPLE ON DRAWING K30300098/06-210.

SECTION D DIVIDER MOUND
SCALE 1:100 (210)
S.O.L
PHASE 1b PHASE 1a
3000
STRIPPED LEVEL N.G.L
5 5
200
800

GENERAL NOTE:
ALL DIMENSIONS ARE GIVEN IN MILIMETERS, UNLESS OTHERWISE NOTED.

Title Block
KUSILE POWER STATION
ASH DUMP No 1
FOOTPRINT SITE PREPARATION PHASE 1
DETAILS AND SECTIONS
DRG. No. K30300098/06-211
PANEL B CONSULTANTS JOINT VENTURE
Knight Piésold CONSULTING
Eskom
0.90/23333
REV 2
SHEET A0 REV 2

NOTE:

THIS DRAWING REFLECTS FINISHED TERRACE LEVELS.
EXCAVATION FOR CONCRETE SLAB AND ASSOCIATED
LAYERS BY OTHERS.

CONCRETE SLAB
FINISHED TERRACE LEVEL

CONCRETE PAVEMENT DESIGN (BY OTHERS)

TYPICAL PAVEMENT CONSTRUCTION DETAIL
SCALE 1:250

REFER TO DRAWING No. K30300098/06-349
FOR HAUL ROAD TO ASH DUMP LEVELS

ACCESS ROAD No.3

STORMWATER DIVERSION TRENCH

DROP INLET STRUCTURES (SEE DRAWING No. K30300098/06-253)

NOTE: ROAD EDGE LEVELS AS PER ACCESS ROAD
NUMBER 3 LONGITUDINAL SECTIONS
SEE DRAWINGS K30300098/06-371 AND 372

TERRACE DRAINAGE INTAKE STRUCTURE
(SEE DRAWING No. K30300098/06-253)

RUN-OFF COLLECTION TRENCH
1000mm DEEP. GRADE TO TERRACE FALLS

REFER TO DRAWING No. K30300098/06-349
FOR HAUL ROAD TO ASH DUMP LEVELS

PLAN
SCALE 1:500

N.G.L.

FALL

FINISHED TERRACE LEVEL

SECTION C
SCALE 1:50

ACCESS ROAD

FALL   FALL

FINISHED TERRACE LEVEL

N.G.L.

DIRTY WATER OUTLET PIPE
(SEE DRAWING No. K30300098/06-252
FOR PIPE ALIGNMENT AND PROFILE)

SECTION A
SCALE 1:50

STORM WATER DIVERSION TRENCH

2000 MIN

N.G.L.

FALL

FINISHED TERRACE LEVEL

SECTION B
SCALE 1:50

KUSILE POWER STATION
ASH DUMP No 1
TERRACING OF RADIAL STACKER
G.A. AND TYPICAL SECTIONS

DRG. No. K30300098/06-213

Knight Piésold
PANEL B CONSULTANTS
JOINT VENTURE

Eskom

0.90/23348

MATERIAL SPECIFICATION FOR COMPACTED FILL DAM WALLS

1. EXCAVATED SOILS FROM THE DAM BASIN EXCAVATION MAY GENERALLY BE USED FOR THE COMPACTED FILL IN THE DAM WALLS.

2. EXCAVATION VOLUMES EXCEED FILL VOLUMES, SO FILL MATERIAL TO BE SELECTED FOR QUALITY.

3. THE DAM FOOTPRINT TO BE CLEARED OF VEGETATION.

4. TOPSOIL TO BE REMOVED TO A DEPTH OF 200mm AND PLACED IN THE TOPSOIL STOCKPILE.

5. GENERALLY UP TO 1m OR SO OF UNSUITABLE MATERIAL IN THE EXCAVATION TO BE DISCARDED.

6. THE EXPECTED MATERIALS IN LOWER LAYERS ARE TILLITES AND CLAYEY DIABASE.

7. MATERIAL FOR THE COMPACTED FILL IN THE WALLS SHALL PREFERABLY BE SELECTED FROM THE SANDY RESIDUAL TILLITES WITH THE FOLLOWING PROPERTIES:-
GRAVEL PERCENTAGE 3 TO 8%
SAND PERCENTAGE 40 TO 70%
SILT PERCENTAGE 20 TO 40%
CLAY PERCENTAGE 10 TO 30%
UNIFIED CLASSIFICATION SC TO CL-ML OR CL

8. DIABASE WITH A HIGH GRAVEL CONTENT, WHERE IT INTERCEPTS THE FERRICRETE CAN BE USED IF REQUIRED IN A 5‰ COMBINATION WITH THE SANDY TILLITES.

10. THE COMPACTION SPECIFICATION TO BE 95% MOD AASHTO DENSITY ± 2% OMC, PLACED IN 300mm max. LOOSE LAYERS.

11. BOULDERS OR ROCKS GREATER THAN 130mm/TWO THIRDS THE LAYER THICKNESS IN SIZE TO BE DISCARDED.

12. FOLLOWING COMPLETION OF EMBANKMENT CONSTRUCTION, EXCAVATED BASIN SURFACE TO BE RE-SEEDED WITH NATIVE GRASSES.

PLAN
SCALE 1:5000

OUTLET PIPE DISCHARGE

OUTLET PIPE

SILT RETENTION DAM VOLUME = 12 070m³

SPILLWAY TRENCH

FOR (TYPICAL) STONE PITCHING SEE DETAIL 4

ACCESS ROAD TO PUMP STATION (GRAVEL)

MINIMUM STONE SIZE FOR STONE PITCHING TO BE 150mm PER SANS STANDARD 1200DK, GROUTED MEDIUM PITCHING

STORM DIVERSION CHANNEL

WORKSHOP

ACCESS ROAD No. 3

STORMWATER CONNECTING TRENCH SIDE SLOPES 1:3

4(750x750) RECTANGULAR CULVERTS

I.L=1444.65mamsl
TRENCH I.L=1445.40mamsl
I.L=1446.00mamsl
I.L=1446.20mamsl

ROAD 'A' TO WORKSHOP TERRACE

STONE PITCHING SEE DRAWING K30300098/06-217

45° PLANT NORTH / TRUE NORTH / 45° PLANT NORTH

DETAIL 2
SCALE 1:50

A8 GEOFABRIC
DN3 FLOWNET HDPE MESH HELD IN PLACE WITH REINFORCED PLASTIC STRAPPING AT 400crs.
175⌀ HOLES (4 per set)
12mm CLEAN STONE
200⌀ CLEAN STONE
TWL 1446.000
FALL 1:200

SECTION B
SCALE 1:100

SEE NOTE 10
VEGETATED OUTER SIDE SLOPE
SOP
1446.800
TWL 1446.000
1442.000
NGL
TO DISCHARGE
FALL 1:200
500⌀ NB CLASS 6 HDPe OUTLET PIPE - ALL JOINTS TO BE BUTT WELDED

DETAIL 1
SCALE 1:50

SILT RETENTION DAM VOLUME = 12 070m³
TOP OF CREST EL. 1446.800
VEGETATED OUTER SIDE SLOPE
SPILLWAY SIDE SLOPES 1:3

SECTION D GRASSED STORM WATER CHANNEL
SCALE 1:100

SECTION A
SCALE 1:100

C EMBANKMENT
3000
VEGETATED OUTER SIDE SLOPE
SOP
TWL 1446.800
SEE NOTE 10
NGL
TWL 1446.000
1442.000
SEE NOTE 12
ESTIMATED EXCAVATION LINE OF FOUNDATION LEVEL

DETAIL 4
SCALE 1:20

SILT RETENTION DAM
10m MIN.
5m MIN.
TO FALL
SOP
MINIMUM STONE SIZE FOR STONE PITCHING TO BE 150mm PER SANS STANDARD 1200DK, GROUTED MEDIUM PITCHING
CLEAN WATER COLLECTION CHANNEL TYPE 1, TYPE 2, TYPE 3

SECTION C
SCALE 1:50

SIDE SLOPES 1:3
IL 1440.089
NGL
500⌀ NB CLASS 6 HDPe OUTLET PIPE
STONE PITCHING

DETAIL 3
SCALE 1:50

5mx5mx300mm AREA OF STONE PITCHING.
MINIMUM STONE SIZE FOR STONE PITCHING TO BE 150mm PER SANS STANDARD 1200DK, GROUTED MEDIUM PITCHING
500⌀ NB CLASS 6 HDPe OUTLET PIPE
FROM STORMWATER DAM
FALL 1:200
SIDE SLOPES 1:3 TO BE STONE PITCHED

SETTING OUT POINT (SOP) CO-ORDINATES

POINT NAME	E-COORDINATE	N-COORDINATE	Z-COORDINATE
P1	10568.431	7518.429	1442.000
P2	10599.280	7545.145	1442.000
P3	10599.280	7580.892	1442.000
P4	10574.053	7603.622	1442.000
P5	10535.083	7474.864	1446.800
P6	10610.380	7540.074	1446.800
P7	10610.380	7585.832	1446.800
P8	10549.676	7640.529	1446.800
P9	10553.737	7618.810	1446.000
P10	10532.806	7640.208	-
P11	10568.368	7679.812	1444.517
P12	10597.2911	7580.6646	1440.500
P13	10620.7201	7606.6662	1440.089

KUSILE POWER STATION
ASH DUMP DIRTY DAM
CONSTRUCTION PHASE STORMWATER MANAGEMENT G.A

DRG. No. K30300098/06-215

0.90/25381

Eskom

PANEL B CONSULTANTS JOINT VENTURE
Knight Piésold CONSULTING

NOTE:

a) THIS DRAWING DEFINES STORMWATER MANAGEMENT FACILITIES THAT ARE REQUIRED TO BE CONSTRUCTED AS PRIORITY ACTIVITIES BEFORE CONSTRUCTION OF THE MAIN WORKS COMMENCES.

b) CONSTRUCTION FACILITIES TO BE INSTALLED PRIOR TO CONSTRUCTION, MARKED AS FOLLOWS:

1 — FACILITIES REQUIRED AT COMMENCEMENT OF PROJECT, PRIOR TO CONSTRUCTION OF DIRTY DRAINS AND STRIPPING OF MAIN FOOTPRINT.(THIS DRAWING AND AS NOTED)

2 — FACILITIES REQUIRED PRIOR TO CONSTRUCTION OF PARIMETER ACCESS ROAD.(SEE DRAWING 30300098-06-340)

3 — FACILITIES REQUIRED PRIOR TO CONSTRUCTION OF RADIAL STACKER TERRACE AND ASSOCIATED HAUL ROAD. (SEE DWG. 30300098-06-213 & 349)

4 — FACILITIES REQUIRED PRIOR TO CONSTRUCTION OF ASH DUMP DIRTY DAM AND ASSOCIATED PIPEWORK, MANHOLES AND JUNCTION BOXES (SEE DRAWING 30300098-06-280).

5 — FACILITIES REQUIRED PRIOR TO STRIPPING OF STOCKPILE AND YARD AREAS. (SEE DWG 30300098-06-320)

6 — FACILITIES REQUIRED PRIOR TO CONSTRUCTION OF WORKSHOP TERRACE. (SEE DRAWINGS 30300098-06-217)

7 — FACILITIES REQUIRED PRIOR TO CONSTRUCTION OF PAN AREA (SEE DRAWING 30300098-06-208)

TRUE NORTH
PLANT NORTH 45°

STOCKPILE AREA SEE DRAWING K30300098/06-201

STORMWATER DIVERSION DRAINS (SEE DRAWING K30300098/06-280)

ASH DUMP DIRTY DAM CONSTRUCTION PHASE SILT RETENTION DAM K30300098/06-215

SILT RETENTION DAM (SEE DRAWING K30300098/06-320 TO 327)

INSTALL 3 CULVERTS AT CWT 18.1 & 18.2 (SEE DRAWING K30300098/063-304;309 & 310)

INSTALL 2 CULVERTS AT CWT 21.1 & 21.2 (SEE DRAWING K30300098/063-304; 309 & 310)

INSTALL 2 CULVERTS AT CWT 25.1 & 25.2 (SEE DRAWING K30300098/063-304; 309 & 310)

CONSTRUCTION PHASE TEMPORARY STORMWATER MANAGEMENT CHANNEL (THIS DRAWING)

INSTALL 2 CULVERTS AT CWT 11.1 & 11.2 (SEE DRAWING K30300098/063-303;309 & 310)

INSTALL 2 CULVERTS AT CWT 10.1 & 10.2 (SEE DRAWING K30300098/063-303;309 & 310)

STORMWATER DIVERSION DRAINS (SEE DRAWING K30300098/06-217)

TEMPORARY PHASE 1 STORMWATER DIVERSION DRAIN (SEE DRAWING K30300098/06-322 & 327)

STOCKPILE AREA SEE DRAWING K30300098/06-201

PAN AREA STORMWATER DIVERSION BERMS

RADIAL STACKER TERRACE (SEE DRAWING K30300098/06-213)

INSTALL 4 CULVERTS AT CWT 3.1 & 3.2 (SEE DRAWING K30300098/063-303;309 & 310)

CONTRACTORS'S YARD & ENGINEER'S OFFICE

STOCKPILE AREA SEE DRAWING K30300098/06-201

SILT RETENTION DAM (SEE DRAWING K30300098/06-320 TO 327)

PLAN
SCALE 1: 3000

DIRTY WATER CHANNEL

S.O.L TOE WALL

CONSTRUCTION PHASE TEMPORARY STORMWATER MANAGEMENT CHANNEL (TO BE BACKFILLED AND COMPACTED TO 93% MOD. AASHTO BEFORE THE LINING SYSTEM IS INSTALLED.)

20000
6725   13275
1550 1650
3000
1200
300   400
1250 1250
3200

3
3

DETAIL A

SPOILS FROM EXCAVATION TO BE FORMED AS SHOWN AND COMPACTED USING A 2t PLATE COMPACTOR.

ROCK-CHECK GABOINS W50m CRS

NOTE:
ALL DIMENSIONS ARE GIVEN IN MILIMETERS, UNLESS OTHERWISE NOTED.

1000

SECTION A
SCALE 1:100

ROCKFILL -300, +150mm WRAPPED IN TYPE 80 WOVEN MESH (GALVANISED)

1000
2500   1000   2500

A6 GEOFABRIC

DETAIL A
SCALE 1: 50
(ROCK CHECK GABIONS)

SECTION B
SCALE 1: 50

KUSILE POWER STATION
ASH DUMP No 1
CONSTRUCTION PHASE STORMWATER
MANAGEMENT G.A AND DETAILS

DRG. No. K30300098/06-216   REV 1

PANEL B CONSULTANTS JOINT VENTURE
Knight Piésold CONSULTING

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0.90/25387

ACCESS ROAD N°3

TO PLANT

B
B

A

ACCESS ROAD TO PUMP STATION

WORKSHOP FOOTPRINT

ROAD A

ROAD B

FALL

STONE PITCHING
(SEE NOTE 3)

GRAVEL

(SEE NOTE 5)

STORM WATER DIVERSION TRENCH

STORM WATER DIVERSION CHANNELS
SEE DRAWING K30300098/06-219
FOR TYPICAL SECTIONS AND 280
FOR SETTING OUT CO-ORDINATES

WORKSHOP TERRACE
SCALE 1:250

TRUE NORTH
PLANT NORTH

WORKSHOP ACCESS ROAD A

SCALES:
Horizontal 1:500
Vertical 1:50
Datum : 1445 m

ROAD-CENTRELINE
NGL-CENTRELINE

CUT / FILL		-1.094	-1.333	-1.230	-0.809	-0.209	0.149	0.056	0.025
ROAD	LEFT	1446.874	1446.614 1446.596	1446.652	1446.965	1447.596	1448.498	1449.175	1449.400
	CENTRELINE	1446.604 1446.544 1446.528	1446.582	1446.895	1447.526	1448.428	1449.105	1449.330	1449.330
	RIGHT	1446.534 1446.474 1446.512	1446.825	1447.456	1448.358	1449.035	1449.260	1449.260	
C/L GROUND LEVEL		1447.698 1447.796 1447.966	1448.125	1448.335	1448.637	1448.996	1449.274	1449.305	
DISTANCE (m)		0.000 3.000 4.815 8.000	13.000	20.000	30.000	40.000	50.000	50.971	
VERTICAL PROFILE		VCL=10 m K=0.9 1 IN -50 -2.0000%	1 IN 11.088 9.0187%	VCL=20 m K=2.2 LEVEL					
HORIZONTAL		PI 1	STRAIGHT 317° 58' 47"	PI 2					
SECTION PROFILE		Left: 2.0% Right: -2.0%							

WORKSHOP ACCESS ROAD B

SCALES:
Horizontal 1:500
Vertical 1:50
Datum : 1445 m

ROAD-CENTRELINE
NGL-CENTRELINE

CUT / FILL		-1.447	-1.742	-1.995	-2.012	-1.998	-1.837	-0.885	-0.678	-0.177	0.133	0.420	0.630
ROAD	LEFT	1449.740	1449.805	1449.953	1450.289	1450.330	1450.668	1451.445	1451.875	1451.583	1452.049	1452.254	
	CENTRELINE	1449.670	1449.735	1449.883	1450.199	1450.260	1450.598	1451.395	1451.513	1451.805	1451.979	1452.184	
	RIGHT	1449.600	1449.665	1449.813	1450.129	1450.190	1450.528	1451.345	1451.443	1451.735	1451.909	1452.034	1452.114
C/L GROUND LEVEL		1451.117	1451.477	1451.878	1452.211	1452.258	1452.435	1452.280	1452.191	1451.982	1451.846	1451.684	1451.554
DISTANCE (m)		0.000	10.000	20.000	30.000	31.523	40.000	60.000	62.939	70.261	75.261	80.261	84.261
VERTICAL PROFILE			VCL=20 m K=6.0 1 IN 153.846 0.6500%				1 IN 25.073 3.9883%		VCL=10 m K=5.0 1 IN 50			
HORIZONTAL		PI 3 STRAIGHT 317° 58' 42"		BCC	PI 4 R=20m		ECC	STRAIGHT PI 5 227° 58' 44"				
SECTION PROFILE		Left: 2.0% Right: -2.0%										

ROAD SETTING OUT DATA

PI No.	CH	E-COORD	N-COORD	RAD (m)	DA D M S	TL (m)	AL (m)
CONST:							
PI 1	0.000	7671.746	10526.269	WORK SHOP ACCESS RAMP A			
PI 2	50.971	7705.866	10488.402				

ROAD SETTING OUT DATA

PI No.	CH	E-COORD	N-COORD	RAD (m)	DA D M S	TL (m)	AL (m)
CONST:							
PI 3	0.000	7747.368	10442.342	WORKSHOP ACCESS RAMP B			
BC 4	31.523	7768.470	10418.924				
PI 4		7781.858	10404.066	20	90°00'00"	20.000	31.416
EC 4	62.939	7796.716	10417.454				
PI 5	84.261	7812.556	10431.727				

COORDINATE LIST

POINT CONST:	WORKSHOP TERRACE E-COORD	N-COORD	ELEVATION
WT1	7702.894	10485.725	1449.250
WT2	7718.124	10499.448	1449.353
WT3	7759.626	10453.388	1449.693
WT4	7744.400	10439.661	1449.590
WT5	7736.596	10432.636	1449.643
WT6	7695.094	10478.696	1449.303

COORDINATE LIST

POINT CONST:	WORKSHOP FOOTPRINT E-COORD	N-COORD	ELEVATION
WK1	7711.866	10487.162	1449.708
WK2	7719.433	10494.031	1449.708
WK3	7754.451	10455.454	1449.708
WK4	7746.858	10448.612	1449.708

TYPICAL SECTION A
SCALE 1:125

N.G.L
TERRACE
WORKSHOP
FALL 0.5%
RIP TO 200mm AND RECOMPACT AT 95% MOD AASHTO DENSITY
MIN. 0.5% SLOPE AWAY FROM STRUCTURE, ALL SIDES

SECTION B GRASSED STORM WATER CHANNEL
SCALE 1:100
800 MIN.
2000

NOTES:
1. ALL EMBANKMENT SLOPES AT 1:3 V:H.
2. MINIMUM SLOPE AWAY FROM WORKSHOP STRUCTURE IS 0.5%, ALL SIDES.
3. STONE PITCHING TO BE 4:1 SAND:CEMENT MORTAR MIX 150mm NOMINAL DIAMETER STONE (PER SANS 1200 DK, MEDIUM PITCHING) WHERE STORMWATER DIVERSION CHANNELS DISCHARGE.
4. WORKSHOP FOUNDATIONS BY OTHERS.
5. SEE SECTION A FOR ASPHALT SURFACE LAYERWORKS DETAILS.
   SEE SECTION B FOR GRAVEL SURFACE LAYERWORKS DETAILS.

KUSILE POWER STATION
ASH DUMP No 1
WORKSHOP TERRACE
GENERAL ARRANGEMENT & TYP. DETAILS

DRG. No. K30300098/06-217 REV 2

0.90/23329

SHEET A0 REV 2

PINEL & CONSULTANTS
JOINT VENTURE
Knight Piésold

Eskom

E 7 250 · N 10 300 · E 7 300 · N 10 350 · E 7 350 · N 10 400 · E 7 400 · N 10 400 · N 10 450 · E 7 450

ACCESS ROAD TO PUMP STATION
SEE DRAWING K30300098/06-372 FOR DETAILS

1452

A

P1B

P2

N 10 350

1453

N 10 250

PUMP STATION TERRACE

TRUE NORTH
PLANT NORTH
45°

P1A

R 25.00

1:50 FALL

1:50 FALL

P3

STORMWATER DIVERSION CHANNEL
SEE DRAWINGS K30300098/06-215, 217 AND 219

1452

1454

N 10 400

1453

PUMP STATION
(BY OTHERS)

P7 P6

P5 P4

E 7 500

ACCESS RAMP

ACCESS RAMP

1454

STONE PITCHING AT OUTLET
4:1 SAND: CEMENT MORTAR MIX
150mm ND STONE

STONE PITCHING AT OUTLET
4:1 SAND: CEMENT MORTAR MIX
150mm ND STONE

E 7 300

400mmØ SOLID, CLASS 4 HDPE
STORM WATER OUTLET PIPE
TO EXTEND MIN. 2m BEYOND
ACCESS RAMP SIDE SLOPE

STORM WATER
DIVERSION CHANNEL

400Ø HDPE STORM WATER OUTLET PIPE

N 10 200

1455

1456 200

GROUTED STONE PITCHING

1455

DIRTY WATER DAM WALL CREST @ 1463.30 mamsL

A

1457

1456

N 10 250

N 10 300

N 10 350

E 7 500

PLAN
SCALE 1:250

73,5
PUMP STATION TERRACE

GRAVEL SURFACE TO MATCH
THAT OF ACCESS ROAD TO
PUMP STATION

1463.300

ACCESS RAMP

1454.154

FALL 1:50

1455.645 1455.145

DIRTY WATER DAM
CONTAINMENT WALL

1456.290

GL

SELECTED CLASS B FILL MATERIAL COMPACTED IN
200mm THICK LAYERS TO 98% STANDARD
PROCTOR DENSITY @ 0% TO +2% O.M.C

RIP AND RECOMPACT 300mm DEEP
INSITU MATERIAL TO 95% PROCTOR

500 DEEP STORM WATER
DIVERSION CHANNEL

SECTION A
SCALE 1:250

NOTE:

1. ALL TERRACING AND ROADSIDE EMBANKMENT SLOPES AT 1:3 V:H.

2. MINIMUM SLOPE AWAY FROM PUMP STATION STRUCTURE
   IS 2%, ALL SIDES.

3. PUMP STATION FOUNDATIONS BY OTHERS.

4. SEE SECTION B/372 FOR GRAVEL SURFACE LAYER WORKS
   DETAILS.

COORDINATE LIST			
PUMP STATION TERRACE			
POINT	E-COORD	N-COORD	Z-COORD
CONST:			
P1A	7309.383	10267.857	1454.557
P1B	7310.156	10303.189	1454.164
P2	7390.095	10372.549	1454.100
P3	7403.346	10357.267	1454.150
P4	7422.639	10335.016	1454.224
P5	7415.302	10328.128	1454.370
P6	7332.011	10256.968	1454.734
P7	7325.106	10249.724	1454.797

SETTING OUT CO-ORDINATES: GEOCELL ZONE

POINT NAME	N-COORDINATE	E-COORDINATE
LD1	8678.315	8950.063
LD2	8003.498	9610.205
LD3	7830.114	9609.549
LD4	7621.04	9426.368
LD5	7717.837	8775.337
LD6	7943.475	8505.096

TOPSOIL STORAGE AREA (3b)

BULK MATERIAL STORAGE AREA (2a)

SILT RETENTION DAMS

BULK MATERIAL STORAGE AREA (2b)

DIRTY WATER PIPES

SEEPAGE INTERCEPTION TRENCH

ADDO

E 7500

E 8000

E 8500

N 10400

N 10900

PHASE 1b GEOCELL = 154 613m²

PHASE 1b LINER AREA = 543 120m²

LD4
LD5
LD6
LD3
LD2
LD1

SETTING OUT LINE (SEE DRAWING K30300098/06-206 FOR CO-ORDINATES)

DIVIDE MOUND

LINER SUB-PHASE 1a(2) LINER SUB-PHASE 1a(1)

ANCHOR TRENCH

PHASE 1a GEOCELL = 212 153m²

PHASE 1a LINER AREA = 519 456m²

BULK MATERIAL STORAGE AREA (1)

TEMPORARY EDGE TO LINER

CONTRACTORS YARD AND ENGINEERS OFFICE

TOPSOIL STORAGE AREA (3a)

ACCESS ROAD

DIRTY WATER TRENCH
CLEAN WATER TRENCH

CONNECTION TO CONCRETE DIRTY WATER DRAIN (SEE DRAWING K30300098/06-221 FOR DETAILS)

S.O.L OF TOE WALL

PLAN
SCALE 1:3000

ASH DUMP LINER INSTALLATION (SAND/GEOCELL)

1. THE LINER SYSTEM TO BE SUPPLIED AND LAID IN ACCORDANCE WITH GRI GM13/SANS 1526 AND SANS 10409.
2. ONLY TRAINED, EXPERIENCED STAFF TO BE USED FOR THE LINER SYSTEM INSTALLATION.
3. RIGID QC/QA PROCEDURES TO BE IN PLACE AT ALL TIMES.
4. THE LINER INSTALLATION AND PANEL WELD SEQUENCE MUST BE PLANNED TO MINIMIZE THE EFFECTS OF THERMAL SHRINKAGE (TENSILE STRESSES) AND EXPANSION (EXCESSIVE EXPANSION UNDULATIONS).
5. THE RIVER SAND/GEOCELL COVERING OVER THE LOWER LINER MUST BE PLACED AT THE COOLEST TIME OF DAY WHEN THERE IS LEAST BULGING/WRINKLING IN THE LINER.
6. RIVER SAND/GEOCELL COVERING OVER THE LINERS TO BE PLANNED TO MINIMIZE EXPOSURE TIME OF THE HDPE.
7. THE LINER/RIVER SAND/SOIL COVERING CONSTRUCTION SEQUENCE MUST BE PLANNED TO MINIMIZE CONSTRUCTION VEHICLE TRAFFIC ACROSS THE SYSTEM.
8. NO VEHICLE TRAFFIC PERMITTED ON AN UNPROTECTED HDPE LINER.
9. APPROPRIATE LOW IMPACT VEHICLES AND MACHINERY WITH A LOADED MASS OF LESS THAN 10 TONS AND TIRE CONTACT PRESSURE LESS THAN 50kPa MUST BE USED IN ALL LINER INSTALLATION OPERATIONS TO MINIMIZE DAMAGE POTENTIAL TO THE LINER.
10. VEHICLE ACCESS MUST BE PLANNED TO AVOID SHARP TURNS OR SUDDEN BRAKING.
11. VEHICLES MUST NOT BE OPERATED ON A LINER CONTAINING BULGES THAT WILL FOLD OVER TO FORM CREASES.
12. THE GEOCELL RETAINING LAYER IMBEDDED IN THE RIVER SAND IS TO BE LAID STRICTLY IN ACCORDANCE WITH THE SUPPLIERS SPECIFICATIONS AND WITHOUT DAMAGE TO THE LOWER LINER. THE SUPPLIER TO BE IN ATTENDANCE AT SITE.
13. RIVER SAND TO BE SPREAD IN SUCH A WAY THAT WRINKLES IN THE LINER ARE DISPERSED AND NOT FOLDED OVER.
14. EXTREME WRINKLES TO BE CUT AND SEAMED FLAT USING FULL QA/QC CONTROL PROCEDURES.
15. RIVER SAND MUST BE SPREAD OVER SEAMS IN THE DIRECTION OF SHINGLING SO THAT IT DOES NOT PENETRATE UNDER THE FLAP.
16. THE RIVER SAND LAYER TO BE PLACED BY CAREFULLY CONTROLLED TIP AND SPREAD OPERATIONS, USING APPROPRIATE MACHINERY, MACHINERY TO RIDE ONLY ON THE SAND LAYER.
17. THE TOP HDPE LINER AND THE 300mm G5 SOIL COVER TO BE INSTALLED UNDER THE SAME CONDITIONS AND CONTROLS AS SET OUT IN POINTS 1 TO 16 ABOVE.
18. THE CONTRACTOR SHALL SUBMIT A DETAILED WORK METHOD STATEMENT IN RESPECT OF EACH OF THE ABOVE OPERATIONS, COVERING ALL PROCEDURES TO BE ADOPTED FOR EACH SEPARATE LAYER INSTALLATION/COMPONENT OF THE LINER SYSTEM, ALL FOR APPROVAL BY THE ENGINEER BEFORE CONSTRUCTION COMMENCES.

SPECIFICATION FOR CELLULAR CONFINEMENT SYSTEM (GEOCELL) FOR ASH DUMP LEAKAGE DETECTION LAYER

SYSTEM PHYSICAL DESCRIPTION

PROPERTIES	DESCRIPTION
GEOCELLS	3D HONEYCOMBED SECTIONS EXTRUDED FROM POLYMERS INTO ULTRASONICALLY WELDED STRIPS, WHICH EXPAND TO FORM STIFF YET FLEXIBLE GEOCELL MATTRESS. WELDS SHALL NOT BE OBTAINED BY WEAVING, KNITTING OR THERMAL BONDING.
MATERIAL	POLYMERIC NONO-COMPOSITE ALLOY: EACH STRIP COMPRISES 3 LAYERS: 2 HIGH DURABILITY OUTER LAYERS AND 1 HIGH STRENGTH PERFORMANCE INNER LAYER.
FORMULATED DENSITY	0.965gr/cc
COLOR	BLACK OR GRAY
SURFACE TEXTURE	SLIGHTLY COARSE INDENTATIONS OVER ENTIRE STRIP AREA.
PERFORATIONS	9.5mm ±10% HOLES UP TO 2-7% OF CELL WALL AREA.
TENDONS	THICKNESS UP TO 8mm, THREADED THROUGH PERFORATIONS.
TRACEABILITY	EACH SECTION MARKED FOR FULL DETAILED TRACEABILITY.

CELL AND SECTION NOMINAL DIMENSIONS (±7%)

CELL WELD DISTANCE (SEAMS)	330mm
CELL WALL HEIGHTS	35mm (OR 50mm IF 35mm NOT AVAILABLE)
CELL DIMENSION (EXPANDED)	250x210mm
No. OF CELLS/m²	38
SECTION SIZE	2.5mx8.0m
SECTION AREA EXPANDED	20m²

MECHANICAL PROPERTIES – STIFFNESS AND STRENGTH

	DESCRIPTION	UNITS	TEST METHOD
STRENGTH AT YIELD	>17.0	kN/m	SEAM TO SEAM BETWEEN WELDS
ALLOWED STRENGTH FOR DESIGN (60 YEARS)	>6.20	kN/m	ASTM D-6992 (SIM)
CREEP REDUCTION FACTOR (60 YEARS)	<2.75	kN/m	ASTM D-6992 (SIM)

KEY

- GRAVEL SURFACED ACCESS ROAD TO PUMP STATION
- ASPHALT SURFACED ACCESS ROAD No. 3
- PERIMETER ACCESS ROAD/ACCESS ROAD FROM ASH DUMP TO RADIAL STACKER
- WETLANDS
- ASH DUMP FENCE ALIGNMENT
- GATE AT ASH DUMP FENCE
- NEW KUSILE PIPELINE
- CONNECTION TO CONCRETE DIRTY WATER DRAIN
- LEAKAGE DETECTION ZONE WITH 35mm NEOWEB OR EQUAL APPROVED GEOCELL + 5mm THICK SAND (REMAINDER OF FOOTPRINT TO HAVE 30mm SAND ONLY FOR LEAKAGE DETECTION)
- PHASE 1a
- PHASE 1b

NOTE:
SEE DRAWING K30300098/06-221 FOR LINER DETAILS.

SECTION E — AT TEMPORARY END OF PHASE 1
SCALE 1:25

S.O.L
FUTURE | PHASE 1
SAND BAGS AT 2m crs.
3000 MIN
300 DRAINAGE LAYER (SEE SPECIFICATION ON DRAWING K30300098/06-224)
TOP LINER
N.G.L
STRIPPED LEVEL
100 SAND
A8 GEOFABRIC
BOTTOM LINER

SECTION F — DIVIDER MOUND DETAIL BETWEEN PHASE 1a AND 1b
SCALE 1:50

S.O.L
PHASE 1b | PHASE 1a
DIVIDER MOUND
LINER TO EXTEND 3000
5500
3000
SAND BAGS AT 2m crs.
300 DRAINAGE LAYER (SEE SPECIFICATION ON DRAWING K30300098/06-224)
TOP LINER
N.G.L
STRIPPED LEVEL
A8 GEOFABRIC
BOTTOM LINER
ENDS OF TOP AND BOTTOM LINERS
GROUP B OR GROUP C MATERIAL COMPACTED TO AT LEAST 90% MOD AASHTO DENSITY AT OMC ±2% (SEE DRAWING K30300098/06-201 FOR MATERIAL DESCRIPTIONS)

SECTION B
SCALE 1:25

ANCHOR TRENCH
SAND BAGS AT 2.5m crs.
300mm G5 SOIL
RIVER SAND
TOP LINER
GEOCELL
1500
BOTTOM LINER

KUSILE POWER STATION
ASH DUMP No 1
HDPE LINER :
GENERAL ARRANGEMENT PHASE 1

DRG. No. K30300098/06-220 REV 2

0.90/23334

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SHEET A0 REV 2

FINGER DRAINS
(SEE DRAWING K30300098/06-221 FOR DETAILS)

TOE WALL
(SEE DRAWING K30300098/06-224)

DN 75 DRAINEX

6250
N.T.S

300 THICK SELECTED G5 GRAVELL (TOP 100mm STABILISED WITH 4% CEMENT UP TO TOEWALL)

PRECAST CONCRETE LIDS

S.O.P

75 NB TYPE 5 HDPE CLASS 10

WATER TIGHT COUPLING

M10x90mm -316L S/S BOLTS

BOLTS

WEDGE WELD

WEDGE WELD

CONCRETE SURFACE TOLERANCE > 2mm OVER
OVER 2000mm NB TOLERANCE AT CONSTRUCTION JOINTS

RIVER SAND TAPER

DETAIL 1

20 NB PVC DRAIN PIPE INSIDE 30 NB SLEEVE

VARIES 1800 (2300)

DIRTY WATER CULVERT

30 NB PVC PIPES @ 5m crs. CAST INTO CONCRETE

1000 WIDE PRE-PREPARED 2mm HDPE BOTTOM LAYER WITH TANK CONNECTOR

DETAIL 2

2075

A8 GEOFABRIC

300 THICK CONCRETE END CAP

S.O.L TOE WALL

3000
N.T.S

DN 110 DRAINEX GROUNDWATER DRAINS IN TRENCHES @ 25m crs. IN SPECIFIED AREAS

1250   400

2575 WIDE CUSPATED DRAINAGE SHEET

35 OR 50mm GEOCELL (NEOWEB OR EQUAL APPROVED) PLUS RIVER SAND BETWEEN HDPE LINERS

6725
N.T.S

STONE COLLECTOR TRENCH AS PER (J/211) (ONLY IN ZONES WHERE GROUNDWATER COLLECTOR DRAINS APPLY)

SECTION C HDPE LINER FIXING TO CONCRETE DETAIL
220
SCALE 1:50

---

90 NB PVC SLEEVE CAST INTO CONCRETE AT 75m crs.

S.O.P'S AS SHOWN ON DRAWING K30300098/06-235 TO 238

BACKFILL WITH G5 SOIL

300 G5 GRAVEL LAYER

300 G5 DRAINAGE LAYER
(SEE SPECIFICATION ON DRAWING K30300098/06-224)

DN 75 DRAINEX

150

S.O.P

75 NB TYPE 5 HDPE CLASS 10

DETAIL 3

TOP HDPE LAYER

WATER TIGHT COUPLING

TOP HDPE LAYER

A8 GEOFABRIC

S.O.L TOE WALL

50mm GEOCELL (NEOWEB OR HIGH PERFORATED, TEXTURED EQUAL APPROVED WHERE SPECIFIED)

63x63x6 316L S/S ANGLE WITH 15Ø HOLES @250 crs. (ONE LEG)

20 DIA.x50mm PVC TANK CONNECTORS @ 5m crs. (PRE-PREPARED ONTO HDPE SHEET)

250

CUSPATED DRAINAGE SHEET
A8 GEOFABRIC

CUSPATED DRAINAGE SHEET ("HI-DRAIN 500" OR EQUAL APPROVED)

3mm CLEAN RIVER SAND

550

3/65x5 SHORE A/30 SILICONE RUBBER GASKETS (CONTINUOUS, V DOVETAIL AT SPLICES)

BOTTOM HDPE LAYER

DETAIL 4

RIVER SAND

WEDGE WELD

100mm RIVER SAND

12x50 METRIC THREADED INSERT SLEEVE CAST INTO CONCRETE @ 250 crs. USING THE ANGLE IRON AS A TEMPORARY TEMPLATE

500 WIDE STRIP OF "BENTOFIX" GLC OR EQUAL

LONGITUDINAL TRENCH ALONG LENGTH OF THE CULVERT

WEDGE WELD

BOTTOM HDPE LAYER

12mm CLEAN STONE

1000 WIDE PRE-PREPARED 2mm HDPE BOTTOM LAYER

A8 GEOFABRIC

20 NB PVC DRAIN PIPE INSIDE 30 NB SLEEVE

50

250

1500 WIDE 1500u HDPE SHEET ANCHORED TO SIDE OF CONCRETE

2575 WIDE CUSPATED DRAINAGE SHEET (NO OVERLAP)

6725
N.T.S

DETAIL 1
SCALE 1:20

100

30 NB PVC PIPES @ 5m crs. CAST INTO CONCRETE

DETAIL 5

300

25mm CLEAN STONE

A8 GEOFABRIC

DETAIL 2
SCALE 1:25

---

20 NB PVC PIPE SOLVENT WELDED TO TANK CONNECTOR

20 DIA.x50 PVC TANK CONNECTOR WITH 20 DIA. PVC WELDED TUBE EXTENSION AT 5m crs.

CUSPATED DRAINAGE SHEET

TOP HDPE LAYER

BOTTOM HDPE LAYER

1500 WIDE 1500u HDPE SHEET ANCHORED TO SIDE OF CONCRETE

A8 GEOFABRIC

500 WIDE STRIP OF "BENTOFIX" GLC OR EQUAL

1500 WIDE 1500u HDPE SHEET ANCHORED TO SIDE OF CONCRETE

DETAIL 4
SCALE 1:10

30 NB SLEEVE IN CONCRETE

20 DIA. PVC TUBE EXTENSION

DETAIL 5
SCALE 1:10

NOTES:

1. FOR CONCRETE DETAILS OF THE DIRTY WATER CHANNEL SEE DRAWING K30300098/06-232.

2. HDPE LINERS TO BE 2mm DOUBLE TEXTURED (BLOWN FILM METHOD) IN ACCORDANCE WITH THE PROJECT TECHNICAL SPECIFICATION.

3. HDPE TO BE LAID USING PROCEDURES TO MINIMISE THE EFFORTS OF TEMPERATURE VARIATION LEADING TO CREASING AND EXCESSIVE DEFLECTION. (SPECIALIST CONTRACTOR TO SUBMIT A DETAILED WORKS METHOD STATEMENT FOR THIS).

4. RIVER SAND TO BE CLEAN, FREE FROM ORGANICS IN COMPLIANCE WITH SANS 1083:2006 AND BE SCREENED TO HAVE A MAXIMUM PARTICAL SIZE OF 3mm. NO MORE THAN 5% LESS THAN 75 MICRON SIZE.

5. 100mm THICK CLEAN RIVER SAND LAYER, MINUS 3mm SIZE WITH PARTICLE SIZE GRADING IN ACCORDANCE WITH SANS 1083 (NOT MORE THAN 5% MINUS 75 MICRON MATERIAL). SAND TO BE LAID BY THE "BAR" METHOD, WHEREBY SAY 5m WIDE, 400mm HIGH STRIPS OF SAND ARE LAID AT 15m crs. BY A CAREFULLY MANAGED TIP AND SPREAD OPERATION OVER THE 400mm SAND STRIP USING SELECTED DUMP TRUCKS WITH WIDE, LOW PRESSURE TYRES AND A MAXIMUM LOADED MASS OF 20t. VEHICLES TO RIDE ONLY ON THE SAND STRIP. SHARP TURNS AND SUDDEN STOPS TO BE AVOIDED. THE 400mm SAND LAYER THEN TO BE SPREAD SIDEWAYS TO ACHIEVE THE DESIRED 100mm FINAL LAYER DEPTH USING A LOW MASS LOADER SUCH AS A BOBCAT A300 (MAXIMUM OPERATION MASS 4.3 TONS), FITTED WITH WIDE, LOW PRESSURE PNEUMATIC TYRES AT LOW INFLATION PRESSURES. THE CONTRACTOR TO SUBMIT A DETAILED WORK METHOD STATEMENT THAT SATISFIES THE REQUIREMENTS TO MINIMIZE DAMAGE TO THE UNDERLYING 2mm HDPE LINER.

6. AFTER SPREADING, THE RIVER SAND LAYER TO BE WATERED AND LIGHTLY COMPACTED BY A SINGLE PASS OF A BOMAG 90 OR EQUIVALENT COMPACTOR.

7. ALL DIMENSIONS ARE GIVEN IN MILIMETERS, UNLESS OTHERWISE NOTED.

---

90 NB PVC SLEEVE CAST INTO CONCRETE AT 75m crs.

A8 GEOFABRIC

2mm DOUBLE TEXTURED HDPE

100mm SAND

50mm GEOCELL (NEOWEB OR HIGH PERFORATED, TEXTURED EQUAL APPROVED WHERE SPECIFIED)

300mm DRAINAGE LAYER (SELECTED G5 GRAVEL) (SEE SPECIFICATION ON ON DRAWING K30300098/06-224)

A8 GEOFABRIC

2mm DOUBLE TEXTURED HDPE

A8 GEOFABRIC

PREPARED FOUNDATION COMPACTED TO 95% MOD AASHTO

NOTE:
SAND TO BE SCREENED TO MINUS 3mm AND IN COMPLIANCE WITH SANS 1083:2006.

HDPE LINER SCHEMATIC DETAIL
SCALE 1:50

TOP HDPE LAYER

BOTTOM HDPE LAYER

CUSPATED DRAINAGE SHEET

A8 GEOFABRIC

1500 WIDE 1500u HDPE SHEET ANCHORED TO SIDE OF CONCRETE

DETAIL 3
SCALE 1:10

TRUE NORTH
PLANT NORTH 45°

N 8400
N 8800
N 9600
N 10400

TOPSOIL STORAGE AREA (3b)

BULK MATERIAL STORAGE AREA (2a)

SILT RETENTION DAMS

BULK MATERIAL STORAGE AREA (2b)

W3
W2
W4
W1

PHASE 1b
AREA = 543 120m²

W5

DIRTY WATER PIPES

SIDE COLLECTORS TO COVER ENTIRE AREA BETWEEN MAIN COLLECTORS

SEEPAGE INTERCEPTION TRENCH

ADDD

SETTING OUT LINE
(SEE DRAWING K30300098/06-206 FOR CO-ORDINATES)

DIVIDE MOUND
(SEE DRAWING K30300098/06-210 FOR DETAIL)

E1

DETAIL Y

BULK MATERIAL STORAGE AREA (1)

PHASE 1a
AREA = 519 456m²

TEMPORARY EDGE TO LINER
(SEE DRAWING K30300098/06-211)

TOPSOIL STORAGE AREA (3a)

CONTRACTORS YARD AND ENGINEERS OFFICE

TYPICAL ARRANGEMENT OF MAIN COLLECTORS
(SIDE COLLECTORS ONLY PARTIALLY SHOWN)

ACCESS ROAD

CONNECTION TO CONCRETE DIRTY WATER DRAIN
(SEE DRAWING K30300098/06-221 FOR DETAILS)

DIRTY WATER TRENCH
CLEAN WATER TRENCH
E2

S.O.L OF TOE WALL

PLAN
SCALE 1:3000

SECTION L
SCALE 1:5

BACKFILLED WITH SELECTED RIVER SAND
ASH
300 DRAINAGE LAYER (SELECTED G5)
200
300
200
HDPE LINER SYSTEM
PRE-FABRICATED DN 75 DRAINEX WRAPPED WITH 'FLOWNET' DRAINAGE CORE AND A BIDIM A4 GEOTEXTILE

SIDE COLLECTORS TO COVER ENTIRE AREA BETWEEN MAIN COLLECTORS

MAIN COLLECTOR
SIDE COLLECTOR
SIDE COLLECTOR
45°
50000
25000
2500 MAX
VARIES
S.O.P
S.O.P
S.O.P
C DIRTY WATER CULVERT
UPPER STONE TRENCH (ABOVE LINER)
200 NB OUTLET PIPES INTO DIRTY WATER CULVERT AT 5m crs.
75000
75000

NOTE:
S.O.P'S FOR DRAINS AS SHOWN ON DRAWINGS K30300098/06-235 TO 238

TYPICAL DETAIL OF ASH DUMP DRAINAGE SYSTEM
SCALE 1:1000
(±420m OF DN 75 DRAINEX PER Ha)

KUSILE POWER STATION
SPECIFICATION FOR 300mm THICK PROTECTION/DRAINAGE LAYER OVER THE HDPE LINER.
THE PROTECTION/DRAINAGE LAYER SHALL HAVE THE FOLLOWING PROPERTIES:
1. GROUP A CLASSIFICATION BUT WITH A MAXIMUM PI OF 10 AND MAXIMUM LIQUID LIMIT OF 30.
2. G5 QUALITY, MAXIMUM SIZE = 63mm.
3. NO ANGULAR MATERIAL PERMITTED.
4. NO ORGANIC MATERIAL PERMITTED.
5. COMPACTION OF SINGLE 300 THICK LAYER TO BE 95% STANDARD PROCTOR AT OMC -1% TO +2%.

NOTES:
1. G5 DRAINAGE LAYER OVER THE LINER SYSTEM:
THE CONTRACTOR SHALL APPLY RIGID QA/QC PROCEDURES TO PROTECT THE LINER SYSTEM DURING PLACEMENT OF THE G5 DRAINAGE LAYER.
THE BASIC PROCESS FOR PLACEMENTS SHALL BE TIP AND SPREAD, WITH MACHINERY RIDING ONLY ON THE G5 LAYER.
APPROPRIATE SELECTION OF VEHICLES AND MACHINERY IS REQUIRED AND ONLY FULLY TRAINED PERSONNEL ARE TO BE USED FOR THIS PROCESS. MAX. LOADED VEHICLE MASS = 20 TONS.
THE CONTRACTOR SHALL SUBMIT A DETAILED WORK METHOD STATEMENT FOR ALL PROCEDURES TO BE ADAPTED FOR INSTALLATION OF THE G5 DRAINAGE LAYER, FOR APPROVAL BEFORE CONSTRUCTION COMMENCES.

C DIRTY WATER DRAIN
1650 5075
S.O.L TOE WALL
TOE WALL: GROUP A OR B MATERIAL FROM STOCKPILE, 93% MOD AASHTO COMPACTION AT OMC ±2% (SEE DRAWING K30300098/06-201 FOR MATERIAL DESCRIPTIONS)
450 ND CLASS 50D CONCRETE PIPE
WING WALL (SIMILAR COMPOSITION AND COMPACTION REQUIRED)
3000 6000
4% CEMENT STABILISER ZONE
1.75 1.75
300mm THICK G5 LAYER
LINER SYSTEM (SEE DRAWINGS K30300098/06-220 AND 221)

SECTION X
SCALE 1:100

C DIRTY WATER DRAIN
1650 5075
S.O.L TOE WALL
2x2.44m, 450 ND/50D CONCRETE INTERLOCKING JOINT PIPES @ 75m crs.
3000 4000
WING WALL @ 75m crs.
75 NB HDPE PIPE
C FINGER DRAIN
S.O.P FINGER DRAIN PIPE (SEE DRAWINGS K30300098/06-235 TO 238)

PLAN ON DETAIL 'Y'
SCALE 1:100

KEY
GRAVEL SURFACED ACCESS ROAD TO PUMP STATION
ASPHALT SURFACED ACCESS ROAD No. 3
PERIMETER ACCESS ROAD/ACCESS ROAD FROM ASH DUMP TO RADIAL STACKER
WETLANDS
ASH DUMP FENCE ALIGNMENT
GATE AT ASH DUMP FENCE
NEW KUSILE PIPELINE
AREAS OF CUT TO MATCH TOP OF DIRTY DRAIN
AREAS OF FILL TO MATCH TOP OF DIRTY DRAIN

KUSILE POWER STATION
ASH DUMP No 1
DRAINAGE LAYER ABOVE HDPE LINER
GENERAL ARRANGEMENT AND DETAILS

DRG. No. K30300098/06-224 REV 2

Knight Piésold CONSULTING
KNIGHT PIÉSOLD CONSULTANTS JOINT VENTURE

Eskom
0.90/23336
SHEET A0 2

TRUE NORTH
PLANT NORTH
45°

FUTURE DIRTY WATER CANAL
PHASE 1 DIRTY WATER CANAL
W5
W4
W3
W2
W1

SEE DRG.No. -238
SEE DRG.No. -237
SEE DRG.No. -236
SEE DRG.No. -235

PHASE 1-B
PHASE 1-A

PHASE 1B DIRTY WATER CANAL
PHASE 1A DIRTY WATER CANAL

ASH DUMP DIRTY DAM(ADDD)

E1

E2

PHASE 1 DIRTY WATER CANAL

FUTURE DIRTY WATER CANAL

PLAN
SCALE 1:3000

NOTES:
1. FOR DIRTY WATER PIPES, SEE DRG
   K30300098/06-250 TO 256
2. FOR PHASE 2 DIRTY WATER DRAIN SETTING OUT POINTS,
   SEE DRG No. K30300098/06-230.
3. FOR ASH DUMP DIRTY DAM GENERAL ARRANGEMENT,
   SEE DRG No. K30300098/06-280.

NOTE:
SETTING OUT POINTS FOR PHASE 1 CONCRETE DIRTY WATER DRAIN
SEE DRAWINGS K30300098/06-235 TO 238

KEY
GRAVEL SURFACED ACCESS ROAD TO PUMP STATION
ASPHALT SURFACED ACCESS ROAD No. 3
PERIMETER ACCESS ROAD/ACCESS ROAD FROM ASH DUMP TO RADIAL STACKER
TOE WALL
JUNCTION BOX AND DIRTY WATER PIPE
DIRTY WATER CANAL(C)
CLEAN WATER CHANNEL (C)
GATE AT ASH DUMP FENCE
ASH DUMP FENCE ALIGNMENT
NEW KUSILE RAW WATER PIPELINE

KUSILE POWER STATION
ASH DUMP No. 1
PHASE 1 DIRTY WATER MANAGEMENT
GENERAL ARRANGEMENT

DRG. No. K30300098/06-231

Eskom   0.90/25384

CONCRETE NOTES:

1. CONCRETE TO BE GRADE 35/19. (CAST IN-SITU AND PRECAST)
   MIX DESIGNS FOR CONCRETE TO BE SUBMITTED TO THE ENGINEER FOR APPROVAL PRIOR TO COMMENCEMENT OF CONCRETE WORK.
2. FINISHING:
   2.1 SMOOTH FINISH TO ALL SHUTTERED SIDES.
   2.2 WOODFLOAT TO TOPS OF WALLS AND TAMPED RIDGES @ 100mm CENTRES ON FLOOR SLABS.
   2.3 25x25mm CORNER FILLETS TO ALL EXPOSED EDGES.
3. TOLERANCES TO BE IN ACCORDANCE WITH SANS 1200G CLASS 1. (CAST IN-SITU AND PRECAST)
4. COVER TO REINFORCEMENT: AS INDICATED.
5. CURING OF ALL CONCRETE SURFACES TO BE DONE USING SAMSON'S WAX BASED WHITE PIGMENTED CURING COMPOUND.
6. ALL WORK TO BE CARRIED OUT IN CONFORMANCE WITH THE RELEVANT SANS 1200 / ESKOM SPECIFICATIONS.
7. ALL CONCRETE IS TO BE PROPERLY VIBRATED. HEAPING OF CONCRETE TO BE AVOIDED. CASTING OF CONCRETE MUST BE CONTINUOUS.
8. ALL WORK TO BE CHECKED BY SUPERVISING ENGINEER PRIOR TO POURING OF CONCRETE (MINIMUM 24 HOURS NOTICE.
9. AN ALLOWABLE FOUNDATION BEARING PRESSURE OF 200kPa ON COMPETENT SOIL IS ASSUMED UNLESS ADVISED DIFFERENTLY.
10. ALL DIMENSIONS TO BE CONFIRMED ON SITE.
11. ALL STRUCTURES SHALL BE CONSTRUCTED ON A SUB-FOUNDATION CARPET OF 15MPa/19mm BLINDING CONCRETE, NOT LESS THAN 75mm THICK.
12. FOR REINFORCEMENT SCHEDULE REFER TO DRW. No. K30300098/06-233
13. PRE-FABRICATED REINFORCEMENT CAGES TO BE USED FOR FLOOR AND WALLS TO REDUCE CONSTRUCTION TIME

TYPICAL PLAN ARRANGEMENT OF DIRTY WATER CULVERT
SCALE 1:50

30000 (EXPANSION JOINTS EVERY 30m - SEE DETAIL)

CONCEPTUAL LONG SECTION ALONG DIRTY WATER CULVERT
SCALE 1:50

SECTION C1
SCALE 1:10

PLAN ON PRECAST COVER SLAB
SCALE 1:10

NOTE:
COVER SLABS TO BE INITIALLY PLACED ON THE CULVERT, UNTILL THE ASH DUMP IS COMMISSIONED. THE COVER SLABS THEN TO BE REMOVED AND HELD IN STORE. FOR FINAL INSTALLATION ONLY AFTER ASH DUMP HAS BEEN TOPSOILED AND GRASSED.

PRECAST ROOF SLAB FRONT ELEVATION
SCALE 1:10

DIRTY WATER CHANNEL: DETAIL B
SCALE 1:5

DIRTY WATER CHANNEL: DRAINAGE DETAIL A
SCALE 1:5

SCENARIO A
SCALE 1:25

SCENARIO A1
SCALE 1:25

SCENARIO B
SCALE 1:25

SCENARIO B1
SCALE 1:25

SCENARIO C
SCALE 1:25

SCENARIO C1
SCALE 1:25

SCENARIO D
SCALE 1:25

SCENARIO D1
SCALE 1:25

DETAIL @ TOP OF EXPANSION JOINT AT METRIC THREADED INSERTS
SCALE 1:5

TYPICAL CROSS SECTION
SCALE 1:25

TYPICAL CROSS SECTION AT VEHICLE CROSSING
SCALE 1:25

WING WALLS AT CULVERT ROAD CROSSINGS. SEE PLAN AND SECTION.

TYPICAL CONSTRUCTION JOINT IN WALLS AND FLOOR @ 5m CRS
SCALE 1:5

TYPICAL EXPANSION JOINT IN WALLS AND FLOOR @ 30m CRS
SCALE 1:5

SECTION C2
SCALE 1:50

PLAN ON ROAD CROSSING
SCALE 1:50

KUSILE POWER STATION
ASH DUMP No 1
DIRTY WATER DRAINS
CONCRETE DETAILS

DRG. No. K30300098/06-232   REV 2

0.90/23343

KUSILE POWER STATION

COORDINATE LIST — PLANT GRID

ASH DUMP DIRTY DAM — COMPARTMENT No. 2

POINT CONST:	N-COORD	E-COORD
ADDD31	10278.057	7503.568
ADDD32	10296.359	7583.962
ADDD33	10291.129	7755.006
ADDD34	10209.181	7751.887
ADDD35	10214.395	7581.200
ADDD36	10211.890	7523.412
ADDD37	10250.382	7449.661
ADDD38	10291.168	7578.582
ADDD39	10218.973	7576.867
ADDD40	10198.899	7496.288
ADDD41	10236.303	7434.116
ADDD42	10268.591	7439.14
ADDD43	10275.863	7451.328
ADDD44	10310.914	7590.827
ADDD46	10303.462	7755.383
ADDD47	10290.663	7767.297
ADDD48	10208.714	7764.178
ADDD49	10196.887	7751.512
ADDD49	10199.676	7573.121
ADDD50	10183.493	7509.631
ADDD51	10181.576	7505.877
ADDD52	10185.607	7481.613
ADDD53	10281.125	7528.778
ADDD54	10182.684	7533.027
ADDD55	10189.653	7576.763
ADDD56	10182.487	7777.180

℄ ACCESS RAMP TO COMPART.No.2

AR2A	10250.134	7487.661
AR2B	10280.690	7459.983
AR2C	10288.388	7452.955
AR2D	10331.572	7418.970

COORDINATE LIST — PLANT GRID

ASH DUMP DIRTY DAM — COMPARTMENT No. 1

POINT CONST:	N-COORD	E-COORD
ADDD01	9992.879	7229.989
ADDD02	10115.226	7310.807
ADDD03	10181.490	7373.397
ADDD04	10133.178	7422.601
ADDD05	10070.273	7379.069
ADDD06	9947.863	7298.528
ADDD07	10134.321	7331.909
ADDD07A	10133.095	7323.917
ADDD08	10213.696	7406.191
ADDD09	10164.229	7453.927
ADDD10	10091.164	7387.991
ADDD10A	10084.992	7388.991
ADDD11	9982.594	7223.235
ADDD12	9999.738	7219.779
ADDD13	10109.336	7289.641
ADDD14	10215.789	7377.709
ADDD15	10229.128	7391.903
ADDD16	10228.162	7421.181
ADDD17	10177.978	7468.175
ADDD18	10149.709	7467.389
ADDD19	10145.432	7462.770
ADDD20	10062.183	7391.128
ADDD21	9941.248	7308.897
ADDD22	9937.584	7291.778
ADDD23	10133.477	7465.044
ADDD24	10123.674	7454.836
ADDD25	10074.341	7413.586
ADDD a	9911.679	7305.725

℄ ACCESS RAMP TO COMPART.No.1

AR1A	10179.586	7400.161
AR1B	10209.391	7371.227
AR1C	10216.604	7364.225
AR1D	10253.346	7328.558

COORDINATE LIST — PLANT GRID

ASH DUMP DIRTY DAM — STORMWATER DIVERSION CANAL

POINT CONST:	N-COORD	E-COORD
SDC01	10213.435	7842.565
SDC02	10145.605	7804.395
SDC03	10088.042	7579.921
SDC04	10041.527	7496.380
SDC05	9983.067	7432.814
SDC06	9878.596	7340.505
SDC07	9860.899	7294.370

SEEPAGE INTERCEPTION TRENCH

SIT01	10317.739	7833.873
SIT02	10167.115	7793.430
SIT03	10136.239	7734.835
SIT04	10153.192	7654.270
SIT05	10136.808	7523.825
SIT06	10133.312	7513.374
SIT07	10041.627	7414.847
SIT08	9889.440	7320.100
SIT09	9843.028	7201.058

TERRACE AT JUNCTION BOX 5

TR01	10132.908	7486.385
TR02	10108.440	7509.286
TR03	10107.973	7523.420
TR04	10118.372	7534.532
TR05	10128.473	7545.323
TR06	10142.247	7546.112
TR07	10164.964	7524.866

NOTES:

1. Ash Dump Dirty Dams Contract No. 71.0202
2. All works to be carried out in accordance with SANS 1200 D
3. All setting out shall be from tabulated points and levels or from dimensions given.
4. All levels indicated are to finished surface.
5. Co-ordinate system is PLANT

CONCRETE NOTES:
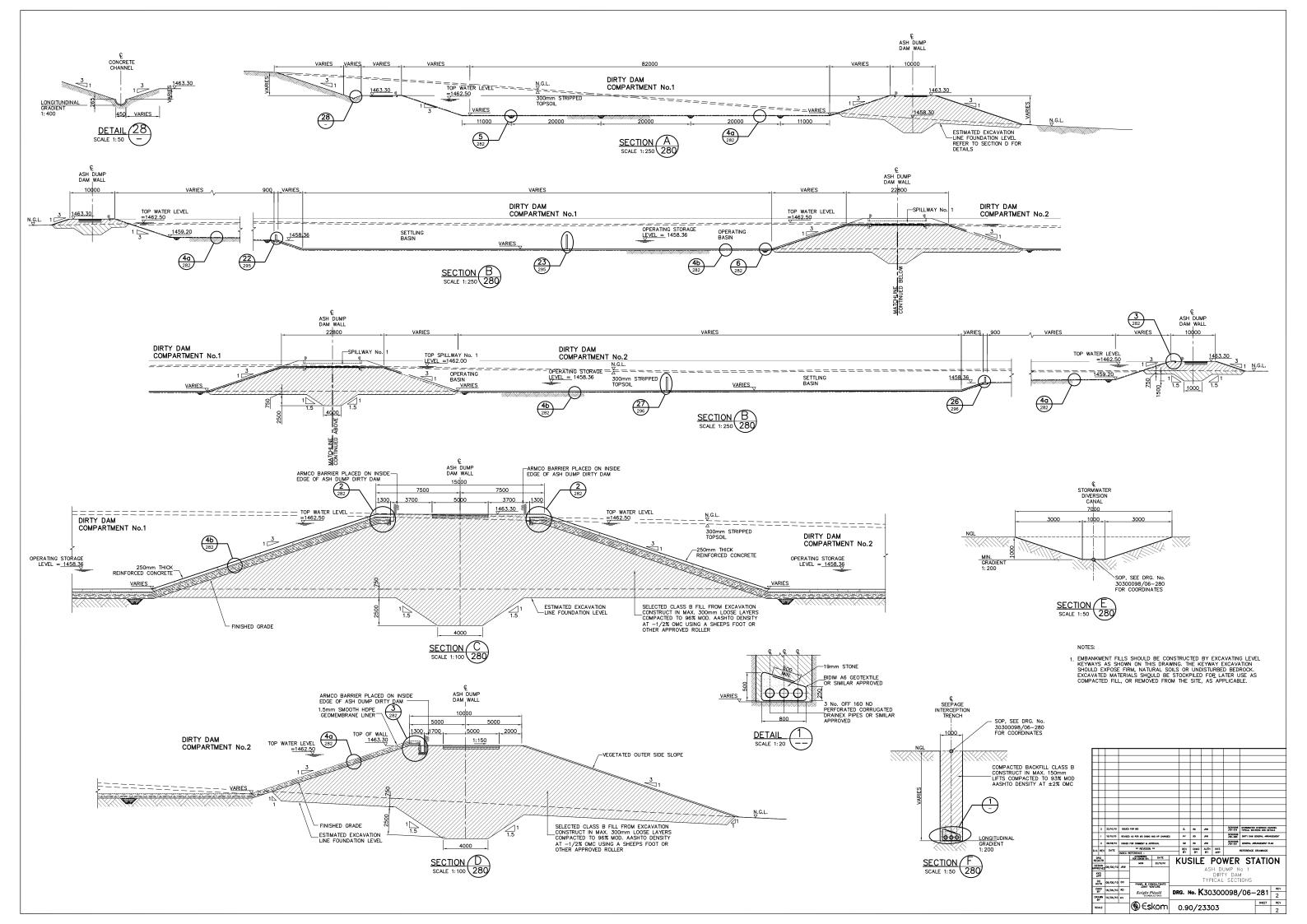
1. CONCRETE TO BE GRADE 35/19. MIX DESIGNS FOR CONCRETE TO BE SUBMITTED TO THE ENGINEER FOR APPROVAL PRIOR TO COMMENCEMENT OF CONCRETE WORK.
2. FINISHING:
   2.1 SMOOTH FINISH TO ALL SHUTTERED SIDES.
   2.2 WOODFLOAT TO TOPS OF WALLS AND SLABS.
   2.3 25x25mm CORNER FILLETS TO ALL EXPOSED EDGES.
3. TOLERANCES TO BE IN ACCORDANCE WITH SABS 1200G CLASS 1.
4. COVER TO REINFORCEMENT: AS INDICATED.
5. CURING OF ALL CONCRETE SURFACES TO BE DONE USING SAMSON'S WAX BASED WHITE PIGMENTED CURING COMPOUND OR ACCEPTABLE EQUAL.
6. ALL WORK TO BE CARRIED OUT IN CONFORMANCE WITH THE RELEVANT SABS 1200 SPECIFICATIONS.
7. ALL CONCRETE IS TO BE PROPERLY VIBRATED. HEAPING OF CONCRETE TO BE AVOIDED. CASTING OF CONCRETE MUST BE CONTINUOUS.
8. ALL WORK TO BE CHECKED BY SUPERVISING ENGINEER PRIOR TO POURING OF CONCRETE (MINIMUM 24 HOURS NOTICE).
9. AN ALLOWABLE FOUNDATION BEARING PRESSURE OF 300kPa ON COMPETENT SOIL IS REQUIRED. REMOVE AND REPLACE IN-SITU MATERIAL AS REQUIRED.
10. ALL DIMENSIONS TO BE CONFIRMED ON SITE.
11. ALL STRUCTURES SHALL BE CONSTRUCTED ON A SUB-FOUNDATION CARPET OF 15MPa/19mm BLINDING CONCRETE, NOT LESS THAN 75mm THICK.

KUSILE POWER STATION
ASH DUMP No 1
DIRTY DAM
GENERAL ARRANGEMENT

DRG. No. K30300098/06-280 REV 2

SCALE 1:1000

ASH DUMP DIRTY DAM GENERAL ARRANGEMENT

DETAIL 28
SCALE 1:50

SECTION A 280
SCALE 1:250

SECTION B 280
SCALE 1:250

SECTION B 280
SCALE 1:250

SECTION C 280
SCALE 1:100

SECTION D 280
SCALE 1:100

SECTION E 280
SCALE 1:50

SECTION F 280
SCALE 1:50

DETAIL 1
SCALE 1:20

NOTES:

1. EMBANKMENT FILLS SHOULD BE CONSTRUCTED BY EXCAVATING LEVEL
   KEYWAYS AS SHOWN ON THIS DRAWING. THE KEYWAY EXCAVATION
   SHOULD EXPOSE FIRM, NATURAL SOILS OR UNDISTURBED BEDROCK.
   EXCAVATED MATERIALS SHOULD BE STOCKPILED FOR LATER USE AS
   COMPACTED FILL, OR REMOVED FROM THE SITE, AS APPLICABLE.

KUSILE POWER STATION
ASH DUMP No 1
DIRTY DAM
TYPICAL SECTIONS

DRG. No. K30300098/06-281

0.90/23303

Row 1

DETAIL 1 — SCALE 1:25 — 283 289 295 296
TYPICAL CONCRETE DOWNSTAND AT HDPE INTERFACE
- 250mm THK REINFORCED CONCRETE CLASS 35/19
- 5MPa SOILCRETE BACKFILL
- 450 / 150 / 300 / 250 / 400 / 150

DETAIL 5 — SCALE 1:25 — 283 289 295 296
TYPICAL DRAIN DETAIL - UNDER LINER
(FOR GROUNDWATER INTERCEPTION)
- 300 OVERLAP
- 19mm WASHED STONE
- BIDIM A4 OR SIMILAR GEOTEXTILE
- 200 / 500

DETAIL 4a/4a — N.T.S — 281 286
TYPICAL HDPE LINER DETAIL
- 1.5mm SMOOTH HDPE GEOMEMBRANE LINER
- 1.5mm MONO TEXTURED HDPE GEOMEMBRANE LINER (TEXTURED SIDE DOWN)
- CUSPATED DRAINAGE LAYER (4mm "ABG LEAKDRAIN" OR SIMILAR APPROVED)
- A10 GEOTEXTILE (OR SIMILAR APPROVED)
- FINISHED GRADE
- SELECTED BEDDING LAYER 3mm PARTICLE SIZE
- LINER SYSTEM

ELEVATION Y-Y
- 220 270 160 270 220
- 900 min. / 450 / 220 / 150
- Ø160
- 50mm GRADE 15MPA/19mm BLINDING LAYER
- 65 220 1500 220 65
- O.G.L

Row 2

DETAIL 2 — SCALE 1:25 — 281 283 284 289
TYPICAL CONCRETE DOWNSTAND AT CREST EDGE
- ARMCO BARRIER PLACED ON INSIDE EDGE OF ASH DUMP DIRTY DAM
- SELECTED BACKFILL MATERIAL COMPACTED TO 93% MOD AASHTO
- 250mm THK REINFORCED CONCRETE CLASS 35/19
- T.W.L. 1462.500
- 1463.300
- R10 STIRRUPS @ 200 c/c
- SELECTED CLASS B FILL FROM EXCAVATION CONSTRUCT IN MAX. 300mm LOOSE LAYERS COMPACTED TO 96% MOD AASHTO DENSITY AT −1/2% OMC USING A SHEEPS FOOT ROLLER
- VARIES 300 300 1000 / 150 / 600

DETAIL 6 — SCALE 1:25 — 283 284 289 295 296
TYPICAL DRAIN DETAIL - UNDER SLAB
(FOR GROUNDWATER INTERCEPTION)
- 250mm THK REINFORCED CONCRETE CLASS 35/19
- 300 OVERLAP
- 19mm WASHED STONE
- BIDIM A4 OR SIMILAR GEOTEXTILE
- 160Ø CORRUGATED PERFORATED DRAINEX OR SIMILAR
- 500

DETAIL 4b — N.T.S — 281 285
TYPICAL HDPE LINER DETAIL UNDER SLAB
- CONCRETE SLAB
- A10 GEOTEXTILE (OR SIMILAR APPROVED)
- 1.5mm SMOOTH HDPE GEOMEMBRANE LINER
- 1.5mm MONO TEXTURED HDPE GEOMEMBRANE LINER (TEXTURED SIDE DOWN)
- CUSPATED DRAINAGE LAYER (4mm "ABG LEAKDRAIN" OR SIMILAR APPROVED)
- A10 GEOTEXTILE (OR SIMILAR APPROVED)
- FINISHED GRADE
- SELECTED BEDDING LAYER – 3mm PARTICLE SIZE
- LINER SYSTEM / 250 / 200

SECTION X — SCALE 1:25
- 1250 / 220 / 250
- BRICK ON EDGE COPING
- SAMPLE STATION REQUIRED AS PER DWAF SPECIFICATION
- 150 / 500 / VARIES
- 1% FALL
- V-DRAIN
- MESH REF 245
- 50mm GRADE 15MPA/19mm BLINDING LAYER
- 250 1000 220 75

Row 3

DETAIL 3 — SCALE 1:25 — 281
TYPICAL LINER ANCHOR DETAIL
- 15Ø POLYPROPYLENE SAFETY ROPE 30m LONG WITH KNOTS EVERY 2m @ 50m c/c
- ARMCO BARRIER PLACED ON INSIDE EDGE OF ASH DUMP DIRTY DAM
- BACKFILL ANCHOR TRENCH WITH SELECTED MATERIAL AND COMPACT TO 93% MOD AASHTO
- T.O.W. 1462.500 / 1463.300
- 10Ø STEEL BAR @ 50m c/c
- 10Ø STEEL BAR 500mm LONG @ 50m c/c
- SELECTED CLASS B FILL FROM EXCAVATION CONSTRUCT IN MAX. 300mm LOOSE LAYERS COMPACTED TO 96% MOD AASHTO DENSITY AT −1/2% OMC USING A SHEEPS FOOT ROLLER
- BURY LINER A MINIMUM OF 300mm INTO ANCHOR TRENCH
- 1000 300 VARIES / 600 / 300

PLAN VIEW W — SCALE 1:10
- ANCHOR TRENCH
- 10Ø STEEL BAR @ 50m c/c
- 15Ø POLPROPYLENE SAFETY ROPE 30m LONG WITH KNOTS EVERY 2m FASTENED TO STEEL BAR
- 500 STEEL BAR

DETAIL 11 — SCALE 1:5
- 40x40x6 RSA STAINLESS STEEL GRADE 316
- NOTE: EARTH ADJACENT TO CONCRETE TO BE COMPACTED. ALL CONCRETE CORNERS IN CONTACT WITH THE LINING TO BE CHAMFERED MIN. 25mm
- EXA 10/90 OR SIMILAR 316 S/S WEDGE ANCHORS AT MAXIMUM 160 c/c
- 40x6mm FULL FACE RUBBER GASKET
- 30x30mm CHAMFER
- REF 617 MESH
- 300 / 70 / 300 / 70

DETAIL 9 — SCALE 1:25 — 280
TYPICAL PLAN ON GROUNDWATER DRAIN OUTLET
- 1250 / 220 / 250
- 400 270 160 270 400
- 1500
- 1:3 min
- BRICKS CUT TO FIT OR CONCRETE INFILL
- ALLOW OPEN JOINTS IN BRICKWORK AS SPECIFIED FOR TRENCH DRAINAGE (IF REQUIRED)
- 220mm BRICKWORK
- 25 MPa CONCRETE APRON
- NOTES:
  1. ALL BRICKWORK TO BE ENGINEERING UNITS TO SANS 227.
  2. ALLOW EXPOSED CONCRETE TO BE STEEL TROWEL FINISH.

Row 4

SECTION VIEW — CONCRETE PIPE LINER PENETRATION
DETAIL 10 — SCALE 1:20 — 280
- LINER SYSTEM
- EARTH ADJACENT TO CONCRETE COLLAR TO BE WELL COMPACTED TO PREVENT FUTURE DIFFERENTIAL SETTLEMENT
- SIKAFLEX PRO-3 WF FLEXIBLE JOINT SEALANT IN 30 WIDE x 15 DEEP PRIMED GROVE
- 300 WIDE SIKADUR-COMBIFLEX BANDAGE
- REF 617 MESH
- STEEL TROWEL SURFACE FINISH
- 600 NB GRAVITY PIPELINE TO SDD – REFER TO B&V DRG. No. 146838-0UXC-S3387
- "SERVISTRIP AH25" OR EQUAL APPROVED EXPANSION JOINTING STRIP
- REINFORCED CONCRETE COLLAR – 3000 LONG
- SIKAFLEX PRO-3 WF FLEXIBLE JOINT SEALANT IN 30 WIDE x 15 DEEP PRIMED GROVE
- APPROXIMATE LOCATION OF BELLMOUTH
- LINER SYSTEM
- 1800 / 300 / 500 / 300 / 300
- 30 PIPE INVERT / 15

ELEVATION Z — SCALE 1:20
- Ç WEDGE ANCHORS / Ç PIPE 3000 / Ç WEDGE ANCHORS
- 300 / 300
- 600 NB GRAVITY PIPELINE TO SDD – BY OTHERS
- 40x40x5 ANGLE
- 300 THK CONCRETE COLLAR – 3000 WIDE WITH 2 LAYERS REF. 617 MESH (70 COVER)

LAYERWORKS DETAIL — TYPICAL AGGREGATE SURFACED ROAD (5m) — SCALE 1:10
- FINISHED ROAD LEVEL
- SURFACE / BASE / LOWER SELECTED
- 150 / 150 / 150
- G3 (GRADED CRUSHED STONE) DENSE-GRADED STONE AND SOIL BINDER: MAXIMUM SIZE 37.5mm; 98–100% MODIFIED AASHTO; SOIL FINES PLASTICITY INDEX < 6
- G4 (CRUSHED OR NATURAL GRAVEL) MINIMUM CBR – 80% @ 98% MODIFIED AASHTO; MAXIMUM SIZE 37.5mm; 98–100% MODIFIED AASHTO; PLASTICITY INDEX < 6; MAXIMUM SWELL 0.2% @ 100% MODIFIED AASHTO FOR CALCRETE PLASTICITY INDEX LESS THAN OR EQUAL TO 8.

DETAIL 14 — SCALE 1:10 — 287 404
TYPICAL ISOLATION JOINT IN FLOOR SLABS (I.J.)
- 300x2mm SIKADUR – COMBIFLEX SYSTEM OR SIMILAR APPROVED TO BE TRIMMED AROUND OUTLET PIPE
- SIKAFLEX PRO-3 WF FLEXIBLE JOINT SEALANT OR SIMILAR APPROVED
- 20 THK "SONDOR JOINTEX"
- NOTE: EARTH ADJACENT TO CONCRETE TO BE COMPACTED. ALL CONCRETE CORNERS IN CONTACT WITH THE LINING TO BE CHAMFERED MIN. 25mm
- VARIES / 250

DETAIL 15 — SCALE 1:5 — 287 404
- 5MPa SOILCRETE BACKFILL
- 6mm x 40mm 316 S/S BATTEN
- GEOMEMBRANE
- 40x6 mm RUBBER GASKET
- M24 STUDS OR SIMILAR S/S 316 AT MAXIMUM 160 c/c
- 75X75X5 L
- EXA 10/90 OR SIMILAR SED 316 S/S WEDGE ANCHORS AT MAXIMUM 160 c/c

Row 5

TYPICAL CONTRACTION (SAW-CUT) JOINT IN FLOOR SLABS (S.C.J.)
DETAIL 7 — SCALE 1:10 — 287 404
- NOTE: STOOLS MUST BE PROVIDED TO OBTAIN COVER WITH REINFORCING
- SAUSAGE 15Ø POLYURETHANE
- 8x40mm SAW CUT JOINT
- Ç JOINT
- REINFORCING REF 617 TOP AND BOTTOM 70mm COVER
- 40 / 250

TYPICAL CONSTRUCTION JOINT IN FLOOR SLABS (C.J.)
DETAIL 8 — SCALE 1:10 — 287 404
- SECOND CAST / FIRST CAST
- NOTE: 250mm THK CONCRETE CLASS 35/19
- OCTODOWELS AT 350mm c/c
- Ç JOINT
- REINFORCING REF 617 TOP AND BOTTOM 70mm COVER
- 200 WIDE EXTERNAL WATERSTOP
- 250

TYPICAL CONSTRUCTION JOINT IN FLOOR SLABS ON INCLINED SLOPE (C.J.)
DETAIL 12 — SCALE 1:10 — 283 284 287 289 404
- SECOND CAST / FIRST CAST
- OCTODOWELS AT 350mm c/c
- 100
- Ç JOINT
- MESH REF 617 TOP AND BOT 70mm COVER
- 200 WIDE EXTERNAL WATERSTOP
- 250

TYPICAL CONSTRUCTION JOINT IN FLOOR SLABS ON INCLINED SLOPE (C.J.)
DETAIL 13 — SCALE 1:10 — 283 284 289
- SECOND CAST / FIRST CAST
- OCTODOWELS AT 350mm c/c
- 100
- Ç JOINT
- MESH REF 617 TOP AND BOT 70mm COVER
- 200 WIDE EXTERNAL WATERSTOP
- 250

Title Block

REFER TO DRG. No. K30300098/06-280 FOR CONCRETE NOTES

KUSILE POWER STATION
ASH DUMP No 1
DIRTY DAM
TYPICAL DETAILS

DRG. No. **K30300098/06-282** — REV 2

Knight Piésold CONSULTING

0.90/23304 — SHEET A0 — REV 2

Eskom

MATCHLINE – CONTINUATION ON DRG. No. K30300098/06–284

1461.0
1:3   1:3
1:6
10000
AR1A
ASH DUMP
DIRTY DAM WALL
15000
C

1462.0
160 NB DRAINEX

6
282

TRUE NORTH
PLANT NORTH
45°

SPILLWAY No. 1
T.O.C. 1462.00m

1463.0
160 NB DRAINEX
72° LEAKAGE DETECTION
FALL

22
295
12
282
1:3

160 NB DRAINEX
1463.0

160 NB DRAINEX

5
282
A

INLET
DISSIPATOR
CHAMBER No.1
1464.0

B

WALL CREST
15.0m WIDE
TOP OF WALL =
1463.300m

ADDD04
ADDD09

B

C   C

ADDD10

1465.0

1
282

2
282

WALL CREST 10.0m WIDE
TOP OF WALL = 1463.300m

1466.0

A

EDGE OF
CONCRETE SLAB

ANCHOR TRENCH AND
ARMCO BARRIER

MATCHLINE (COMPARTMENT 2) – CONTINUATION ON DRG. No.
K30300098/06–289

GENERAL ARRANGEMENT OF COMPARTMENT No. 1
INLET SYSTEM
SCALE 1:250

30015
20515
9500
15000
C

N.G.L.
300mm STRIPPED TOPSOIL
1463.300

316 STAINLESS STEEL RAILEX CA–TM90
OR SIMILAR APPROVED.
2 No. 16∅ RAWL BOLTS PER STANCHION.
ALTERNATE: MENTIS INTERLINK HANDRAILING NT90

TOP WATER LEVEL
=1462.500

I.L. 1457.930
1456.800
VARIES

REFER TO DRG. No.
30300098/06–250
FOR OUTFALL PIPE
ALIGNMENT & INFO.

2
2250 ND
CLASS 100D
CONCRETE PIPE

1000

REFER TO DRG. No. 30300098/06–287
FOR DETAILS

SECTION A
SCALE 1:100

SIKAFLEX PRO–3 WF FLEXIBLE
JOINT SEALENT IN 30mm WIDE BY
15mm DEEP PRIMED GROOVE.

300mm WIDE
SIKADUR–COMBIFLEX
BANDAGE

CONCRETE COLLAR WITH 2 LAYERS
REF 617 MESH (70 COVER)

"SEVERSTRIP
AH25" OR EQUAL
APPROVED
EXPANSION
JOINTING STRIP

DETAIL 4
SCALE 1:25

"SERVISTRIP
AH25" OR EQUAL
APPROVED
EXPANSION
JOINTING STRIP

6

SIKAFLEX PRO–3 WF FLEXIBLE
JOINT SEALENT IN 30mm WIDE BY
15mm DEEP PRIMED GROOVE.

300mm WIDE
SIKADUR–COMBIFLEX
BANDAGE

CONCRETE COLLAR WITH 2 LAYERS
REF 617 MESH (70 COVER)

DETAIL 5
SCALE 1:25

"SERVISTRIP AH25" OR
EQUAL APPROVED
EXPANSION JOINTING STRIP

SIKAFLEX PRO–3 WF FLEXIBLE
JOINT SEALENT IN 30mm
WIDE BY 15mm DEEP PRIMED
GROOVE.

300mm WIDE
SIKADUR–COMBIFLEX
BANDAGE

CONCRETE COLLAR WITH 2
LAYERS REF 617 MESH
(70 COVER)

DETAIL 6
SCALE 1:10

CAST
AGAINST
EXCAVATION
SIDES

390
3300
2700
300
INITIAL
POUR

PIPE STRAPS TO
PREVENT FLOATING
DURING CONCRETE POUR

2700
OD PIPE

800   2700   800

SECTION C
SCALE 1:100

29250
7600
16950

N.G.L.   N.G.L.
300mm STRIPPED TOPSOIL

TOP WATER LEVEL
=1462.500

COMPARTMENT No. 1
OPERATING BASIN

REFER TO DRG. No.
30300098/06–295
FOR DETAILS

1459.610

COMPARTMENT No. 1
SETTLING BASIN

VARIES
1456.800

2250 ND CLASS 100D
CONCRETE PIPE

REFER TO DRG. No.
30300098/06–287
FOR DETAILS

REFER TO DRG. No.
30300098/06–295
FOR DETAILS

1459.610

SECTION B
SCALE 1:100

3

REINFORCED
CONCRETE COLLAR

4

D

5

300
3300
2700
300

8000

8000

REINFORCED CONCRETE
ENCASING INLET PIPE

D

DETAIL 2
SCALE 1:50

4000x16000 CONCRETE
COLLAR 300mm THK
2 LAYERS REF 617 MESH
(70 COVER)

C WEDGE ANCHORS   C WEDGE ANCHORS

40x40x5 ANGLE
(REFER TO DETAIL 3)

2700 OD PIPE

300   3400   300
4000

ELEVATION D
SCALE 1:50

NOTE:
EARTH ADJACENT TO CONCRETE
TO BE COMPACTED. ALL
CONCRETE CORNERS IN CONTACT
WITH THE LINIGN TO BE
CHAMFERED MIN. 25mm

30x30 CHAMFER

M24 STUDS AT
MAXIMUM 150 c/c

40x40x5mm
316 s/s ANGLE

CONCRETE SLAB
250 THK

40x6mm RUBBER
GASKET

GEOMEMBRANE

40x6mm RUBBER
GASKET

CONCRETE COLLAR
300mmTHK

EXA 10/90 316
S/S WEDGE ANCHORS
AT MAXIMUM 150 c/c

300 NTS

DETAIL 3
SCALE 1:2

REFER TO DRG. No. K30300098/06–280 FOR CONCRETE NOTES
AND CO–ORDINATE LIST

KUSILE POWER STATION
ASH DUMP DIRTY DAM
COMPARTMENT No. 1 INLET
GENERAL ARRANGEMENT

DRG. No. K30300098/06–283

PANEL B CONSULTANTS
JOINT VENTURE
Knight Piésold
CONSULTING

Eskom
0.90/23305

SHEET A0   REV 2

TRUE NORTH
PLANT NORTH
45°

LEAKAGE DETECTION SUMP
REFER TO DRG. No.
K30300098/06-288

AR1C
WALL CREST 10.0m WIDE
TOP OF WALL = 1463.300m

ANCHOR TRENCH
AND ARMCO BARRIER

AR1B

EDGE OF CONCRETE
SLAB

160 NB HDPE
160 NB DRAINEX

ADDD03
ADDD08
SUMP
OUTLET

75ø LEAKAGE DETECTION

WALL No. 1A (REFER TO
DRG. No. K30300098/06-295

160 NB DRAINEX

75ø LEAKAGE DETECTION

160 NB DRAINEX

WALL CREST 15.0m WIDE
TOP OF WALL =
1463.300m

SPILLWAY No. 1
T.O.C. 1462.000m

FALL

MATCHLINE — CONTINUATION ON DRG. No. K30300098/06-283

GENERAL ARRANGEMENT OF COMPARTMENT No. 1
OUTLET SYSTEM
SCALE 1:250

COMPARTMENT 2 - CONTINUATION ON DRG. No. K30300098/06-290

PLAN ON OUTLET SUMP
SCALE 1:25

300x2mm SIKADUR — COMBIFLEX SYSTEM OR SIMILAR APPROVED
75ø uPVC PN9 LEVEL INDICATOR PIPE REFER TO NOTE 1
VITAGRID 5 TYPE VE, MEDIUM DUTY, 40x5 FULLY BANDED ON ALL SIDES, GALVANISED MILD STEEL
SOP 01
OUTLET SUMP
ACCESS SLAB
OUTLET PIPE (REFER TO NOTE 1)

SECTION B
SCALE 1:25
VITAGRID 5 TYPE VE, MEDIUM DUTY, 40x5 FULLY BANDED ON ALL SIDES, GALVANISED MILD STEEL
SILT STORAGE
OUTLET PIPE (REFER TO NOTE 1)
75mm GRADE 15MPA/19mm BLINDING LAYER

PLAN ON SUMP
SCALE 1:25
300x2mm SIKADUR — COMBIFLEX SYSTEM OR SIMILAR APPROVED
VITAGRID 5 TYPE VE, MEDIUM DUTY, 40x5 FULLY BANDED ON ALL SIDES, GALVANISED MILD STEEL
SOP 02
ACCESS SLAB

SECTION D
SCALE 1:25
VITAGRID 5 TYPE VE, MEDIUM DUTY, 40x5 FULLY BANDED ON ALL SIDES, GALVANISED MILD STEEL
CONCRETE CLASS 35/19
50mm GRADE 15MPA/19mm BLINDING LAYER

WELDED/STRAPPED TO LEAKAGE OUTLET PIPE
HDPE PIPE BOOT
WELDED
DETAIL 15
SCALE 1:5

DETAIL 10
SCALE 1:25
300x2mm SIKADUR — COMBIFLEX SYSTEM OR SIMILAR APPROVED
SIKAFLEX PRO-3 WF FLEXIBLE JOINT SEALENT OR SIMILAR APPROVED
HARD FOAM

DETAIL 11
SCALE 1:25
300x2mm SIKADUR — COMBIFLEX SYSTEM OR SIMILAR APPROVED
SIKAFLEX PRO-3 WF FLEXIBLE JOINT SEALENT OR SIMILAR APPROVED
HARD FOAM
SILT STORAGE

NOTE :
EARTH ADJACENT TO CONCRETE TO BE COMPACTED. ALL CONCRETE CORNERS IN CONTACT WITH THE LINING TO BE CHAMFERED MIN. 25mm

RIVERSAND BACKFILL IN DEPRESSION
6mm x 40mm 304 S/S BATTEN
GEOMEMBRANE
40x6 mm RUBBER GASKET
EXA 10/90 OR SIMILAR 304 S/S WEDGE ANCHORS AT MAXIMUM 160 c/c
M24 STUDS OR SIMILAR 304 S/S AT MAXIMUM 160 c/c
75X75X5 L

DETAIL 12
SCALE 1:5

160 NB HDPE CLASS 10
160 NB PERFORATED DRAINEX OR SIMILAR APPROVED
COUPLING WITH SEAL RINGS
GROUNDWATER DRAIN OUTLET TO SUMP
PURPOSE-MADE HDPE PIPE BOOT, WELDED TO LOWER HDPE LINER, AND WELDED/STRAPPED TO LEAKAGE OUTLET PIPE. FULL QA/QC REQUIRED FOR THE PROCESS.
CLEAN RIVER SAND IN DEPRESSION

DETAIL 14 SECTION VIEW
SCALE 1:25

CONCRETE SLAB
CLEAN RIVER SAND IN DEPRESSION
160 NB DRAINEX OR SIMILAR APPROVED
SECTION C
SCALE 1:25

ASH DUMP DIRTY DAM WALL
SELECTED CLASS B FILL FROM EXCAVATION CONSTRUCT IN MAX. 300mm LOOSE LAYERS COMPACTED TO 96% MOD. AASHTO DENSITY AT -1/2% OMC USING A SHEEPS FOOT OR OTHER APPROVED ROLLER
TOP WATER LEVEL 1462.500
TOP WATER LEVEL 1463.300
ACCESS RAMP
PUMPSTATION TERRACE
N.G.L.
VARIES
OUTLET SUMP
REFER TO NOTE 1
CUT-OFF COLLAR
10000 10000
LEAKAGE DETECTION SUMP REFER TO DRG. No. 30300098/06-288 FOR DETAILS
SECTION A
SCALE 1:250

BACKFILL LAYER THICKNESS TO SUIT ROLLER USED TO ACHIEVE SPECIFIED DENSITY
OUTLET PIPE (REFER TO NOTE 1)
75ø OD (PVC-U NPQ) LEVEL INDICATOR PIPE (REFER TO NOTE 1)
COMPACTED FILL TO 98% STANDARD PROCTOR DENSITY, MOISTURE CONDITIONED TO PROCTOR OMC. 0 TO +2%
160ø GROUNDWATER DRAIN
75ø LEAKAGE DETECTION PIPE
IF HIGH WATER TABLE EXISTS DURING CONSTRUCTION, PROVIDE BIDUM A4 OR SIMILAR ALONG TRENCH SIDES (CONSTRUCTION PURPOSES ONLY)
EXCAVATION IN ROCK VARIES
INV (REFER TO NOTE 1)
BACKFILL MOISTURE CONDITIONED TO PROCTOR OMC. 0 TO +2% AND COMPACTED TO MIN. 98% STANDARD PROCTOR DENSITY
REINFORCED CONCRETE ENCASEMENT
CAST AGAINST IN-SITU ROCK IF PRESENT (TO BE CONFIRMED BY ENGINEER)
305 265 190
1350 MIN.
CONCRETING STAGES
CUT-OFF COLLAR
SECTION E AT UNDERWALL
SCALE 1:25

BACKFILL LAYER THICKNESS TO SUIT ROLLER USED TO ACHIEVE SPECIFIED DENSITY
OUTLET PIPE (REFER TO NOTE 1)
FLOOR SLAB
COMPARTMENT 1
160ø GROUNDWATER DRAIN
BACKFILL MOISTURE CONDITIONED TO PROCTOR OMC. 0 TO +2% AND COMPACTED TO MIN. 98% STANDARD PROCTOR DENSITY
EXCAVATION IN ROCK VARIES
INV (REFER TO NOTE 1)
CONCRETE STAGES
REINFORCED CONCRETE ENCASEMENT
305
1350 MIN.
SECTION F FROM SUMP TO WALL
SCALE 1:25

300
75mm GRADE 15MPA/19mm BLINDING LAYER
CUT-OFF COLLAR
REFER TO NOTE 1
DETAIL 13 SECTION AT CUT-OFF COLLAR
SCALE 1:25

300
500
REFER TO NOTE 1
SECTION G PLAN VIEW
SCALE 1:25

OUTLET PIPE (REFER TO NOTE 1)
160ø GROUNDWATER DRAIN
COMPACTED FILL 200mm LAYERS OF 98% STANDARD PROCTOR DENSITY UP TO APPROVED LEVEL
75ø OD (PVC-U NPQ) LEVEL INDICATOR PIPE (REFER TO NOTE 1)
75ø LEAKAGE DETECTION PIPE
CONCRETE STAGES
BACKFILL 6% SOIL CEMENT MIX BY WEIGHT, MOISTURE CONDITIONED TO PROCTOR OMC. 0 TO +2% AND AT MIN. 98% STANDARD PROCTOR DENSITY
INV (REFER TO NOTE 1)
CONCRETE ENCASEMENT CLASS 20/19
50mm BLINDING LAYER (PLASTER SAND/CEMENT)
19mm STONE
BIDIM A4
110ø DIA. DRAINEX CONSTRUCTION DRAIN CAPPED BEFORE SUMP (OUTLET TO DAYLIGHT BELOW DAM)
FOR DRAINAGE DURING CONSTRUCTION ONLY
SECTION E ALTERNATE SECTION IF WATER IS ENCOUNTERED IN TRENCH
SCALE 1:25

OUTLET PIPE (REFER TO NOTE 1)
160ø GROUNDWATER DRAIN
COMPACTED FILL 200mm LAYERS OF 98% STANDARD PROCTOR DENSITY UP TO APPROVED LEVEL
75ø OD (PVC-U NPQ) LEVEL INDICATOR PIPE (REFER TO NOTE 1)
75ø LEAKAGE DETECTION PIPE
CONCRETE STAGES
BACKFILL 6% SOIL CEMENT MIX BY WEIGHT, MOISTURE CONDITIONED TO PROCTOR OMC. 0 TO +2% AND AT MIN. 98% STANDARD PROCTOR DENSITY
INV (REFER TO NOTE 1)
CONCRETE ENCASEMENT CLASS 20/19
50mm BLINDING LAYER (PLASTER SAND/CEMENT)
19mm STONE
110ø DIA. DRAINEX CONSTRUCTION DRAIN CAPPED BEFORE SUMP (OUTLET TO DAYLIGHT BELOW DAM)
FOR DRAINAGE DURING CONSTRUCTION ONLY
SECTION E ALTERNATE SECTION FOR ENCASEMENT OF OVER EXCAVATED TRENCH
SCALE 1:25

COORDINATE LIST		
PLANT GRID		
POINT	N-COORD	E-COORD
CONST:		
ASH DUMP DIRTY DAM		
COMPARTMENT No. 1 - OUTLET SUMP		
SOP 01	10203.969	7404.418
COMPARTMENT No. 1 - SUMP		
SOP 02	10205.202	7400.232
SOP - SETTING OUT POINT		

NB.
EXCAVATION PER SITE CONDITIONS (SAFETY TRENCHING)

NOTE :
1. FOR PIPE DETAILS SEE BLACK & VEATCH DRAWING No. 146838-0UXC-S3387
2. PIPE TO BE TESTED FOR WATER PRESSURE AND LEAKS PRIOR TO BACKFILL WITH CONCRETE

REFER TO DRG. No. K30300098/06-280 FOR CONCRETE NOTES

KNIGHT PIÉSOLD CONSULTING

KUSILE POWER STATION
ASH DUMP DIRTY DAM
COMPARTMENT No. 1 OUTLET
GENERAL ARRANGEMENT

DRG. No. K30300098/06-284 REV 2

0.90/23306 SHEET 2 A0

Eskom

General Arrangement

ASH DUMP DIRTY DAM COMPARTMENT No. 1

ASH DUMP DIRTY DAM COMPARTMENT No. 2

C ASH DUMP DIRTY DAM WALL

22800

3900 | 7500 | 7500 | 3900
1000 | 300 | 6200 | 6200 | 300 | 1000
300 | 5900 | 6200
4200 | 2000 | 2000 | 4200

TRUE NORTH
PLANT NORTH
45°

300
5400
2100
4000
1:4.15
S.C.J.

1462.00 | 1462.00 | 1462.000 | 1462.000

S.C.J.
15000
12000 @ 4000 c/c
S.C.J. @ 4000 c/c
30000
SPILLWAY
41400
4600

SW01

S.C.J.
15000
12000 @ 4000 c/c
S.C.J. @ 4000 c/c

TOP OF SPILLWAY LEVEL = 1462.000m
TOP OF CONCRETE LEVEL = 1462.000m

S.C.J.
1:4.15
5400
4000
2100
300

1300 | 3700 | 5000 ROADWAY | 3700 | 1300
15000
T.O.W. = 1463.300m

300x600 ANCHOR TRENCH
SEE DETAIL '2'

GENERAL ARRANGEMENT OF SPILLWAY No. 1 (BETWEEN COMPARTMENTS 1 & 2)
SCALE 1:100

DETAIL 1

C ASH DUMP DIRTY DAM WALL

11400
3900 | 7500
1000 | 300 | 6200
300

250mm THK CONCRETE 35 MPa/19mm

T.O.W.=1463.300

1 : 3

4b / 282

T.O.C.=1462.00
1300
900
600
300

REINFORCING

250mm THK CONCRETE CLASS

50mm GRADE 15MPa/19mm BLINDING LAYER

2

DETAIL 1
SCALE 1:25

DETAIL 2

300x2mm SIKADUR – COMBIFLEX SYSTEM OR SIMILAR APPROVED

SIKAFLEX PRO-3 WF FLEXIBLE JOINT SEALENT OR SIMILAR APPROVED

5MPa SOILCRETE

300

250mm THK CONCRETE CLASS 35/19 WITH MESH REF 317

Y16

250
600
350

Y16

20 THK "SONDOR JOINTEX"

75mm GRADE 15MPa/19mm BLINDING LAYER

R10 STIRRUPS @ 200 c/c

300

BURY LINER A MINIMUM OF 300mm INTO ANCHOR TRENCH

300 | 300 | 50 MAX.

DETAIL 2
SCALE 1:10

DETAIL 3

250mm THK CONCRETE 35 MPa/19mm

300
1 : 4.15
400
600

LINE OF CONCRETE EDGE BEAM

75mm GRADE 15MPa/19mm BLINDING LAYER

DETAIL 3
SCALE 1:25

SECTION A

C ASH DUMP DIRTY DAM WALL
22800
15000
3900 | 7500 | 7500 | 3900
1000 | 300 | 6200

SPILLWAY LEVEL =1462.000
TOP OF WATER =1462.500
T.O.W.=1463.300
1300
LEVEL
T.O.C.=1462.000

CONCRETE 35 MPa/19mm

CONCRETE 35 MPa/19mm

1

SECTION A
SCALE 1:100

SECTION B

C SPILLWAY
42000 (NTS)
30000 (NTS)
900 | 5400 | 5400 | 900
300 | 300

CREST OF DAM WALL
T.O.W.=1463.300

TOP OF WATER =1462.500

T.O.C.=1462.000

4.15

250mm THK CONCRETE CLASS 35/19 REINFORCED

50mm GRADE 15MPa/19mm BLINDING LAYER

3 | 3

SECTION B
SCALE 1:100

REFER TO DRG. No. K30300098/06-280 FOR CONCRETE NOTES

COORDINATE LIST

PLANT GRID
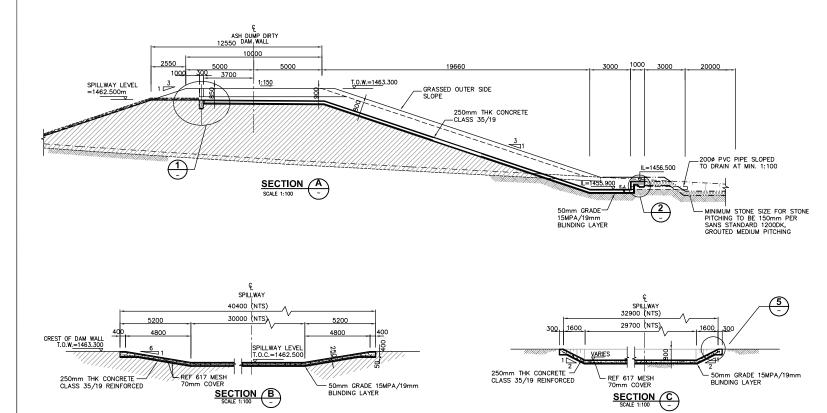
POINT	N-COORD	E-COORD
CONST:		
ASH DUMP DIRTY DAM		
SPILLWAY No. 1		
SW01	10208.218	7450.143

GENERAL ARRANGEMENT OF SPILLWAY No. 2 & ENERGY DISSIPATOR
SCALE 1:100

ASH DUMP DIRTY DAM COMPARTMENT No. 1

300x600 ANCHOR TRENCH SEE DETAIL '2' ON DRG. NO. K30300098/06-282

ASH DUMP DIRTY DAM WALL

TOE OF DAM WALL

TRUE NORTH / PLANT NORTH 45°

CONCRETE SLAB TO BE DETERMINED ON SITE

MINIMUM STONE SIZE FOR STONE PITCHING TO BE 150mm PER SANS STANDARD 1200DK, GROUTED MEDIUM PITCHING

S.C.J.
SPILLWAY
SW02
200ø PVC PIPE
FALL

TOP OF SPILLWAY LEVEL = 1462.500m
1462.450 1462.400
1455.900
1456.500
1462.500

T.O.W.=1463.300m

1:3
1300 1700 5000 ROADWAY 2000
10000

Dimensions: 2550 5000 5000 | 19660 (NTS) | 3000 1000 3000 20000
12550 | 22160 (NTS) | 9500 (NTS) S.C.J. @ 4750 c/c
4350 4350 | 2350 4000 2350 | 3160 4750 4750

900 2100 5100 4000 15000(NTS) 12000(NTS) 14850(NTS) 1500(NTS)
32900 (NTS) 14950 (NTS)

TOE OF DAM WALL

DETAIL 1
SCALE 1:25

CL ASH DUMP DIRTY DAM WALL

7550
2550 5000
3700
1000 300
1:150
T.O.W.=1463.300
T.O.C.=1462.500
FALL
E.J. 50
550 850
FALL
REF 617 MESH 70 COVER
250mm THK CONCRETE CLASS 35/19
50mm GRADE 15MPA/19mm BLINDING LAYER

DETAIL 3
SCALE 1:10

300x2mm WIDE SIKADUR-COMBIFLEX
20x10 THICK SIKAFLEX PRO-3 JOINT SEALANT
250mm THK CONCRETE CLASS 35/19
1500 MICRON HDPE LINER
250
BIDIM A4 GEOFABRIC (OR SIMILAR APPROVED)
REF 617 MESH 70mm COVER
20 THICK SONDOR JOINTEX OR EQUAL APPROVED
R10 STIRRUPS @ 200 c/c
Y16
300
50mm GRADE 15MPA/19mm BLINDING LAYER

DETAIL 4
SCALE 1:2.5

NOTE:
EARTH ADJACENT TO CONCRETE TO BE COMPACTED. ALL CONCRETE CORNERS IN CONTACT WITH THE LINING TO BE CHAMFERED MIN. 25mm

100
40
6mm x 40mm 304 S/S BATTEN
GEOMEMBRANE
40x6 mm RUBBER GASKET
EXA 10/90 OR SIMILAR 316 S/S WEDGE ANCHORS AT MAXIMUM 160 c/c

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SECTION A
SCALE 1:100

CL ASH DUMP DIRTY DAM WALL
12550
10000
2550 5000 5000
1000 300 3700
1:150
SPILLWAY LEVEL =1462.500m
T.O.W.=1463.300
GRASSED OUTER SIDE SLOPE
250mm THK CONCRETE CLASS 35/19
19660
3000 1000 3000 20000
3:1
200ø PVC PIPE SLOPED TO DRAIN AT MIN. 1:100
IL=1456.500
IL=1455.900
50mm GRADE 15MPA/19mm BLINDING LAYER
MINIMUM STONE SIZE FOR STONE PITCHING TO BE 150mm PER SANS STANDARD 1200DK, GROUTED MEDIUM PITCHING

DETAIL 2
SCALE 1:10

250mm THK CONCRETE CLASS 35/19
1000
O.G.L.
GROUTED STONE PITCHING, STONE: 100mm MAXIMUM, GROUT: 1 PART OPC TO 4 PARTS CLEAN RIVER SAND
±300
600
IL=1456.500
IL=1455.900
250
150 300
200ø PIPE
300
50mm GRADE 15MPA/19mm BLINDING LAYER
REF 617 MESH 70mm COVER

DETAIL 5
SCALE 1:25

300
400
REF 617 MESH 70 COVER

SECTION B
SCALE 1:100

CL SPILLWAY
40400 (NTS)
30000 (NTS)
5200 5200
CREST OF DAM WALL T.O.W.=1463.300
400 4800 4800 400
6:1
SPILLWAY LEVEL T.O.C.=1462.500
250mm THK CONCRETE CLASS 35/19 REINFORCED
REF 617 MESH 70mm COVER
50mm GRADE 15MPA/19mm BLINDING LAYER

SECTION C
SCALE 1:100

CL SPILLWAY
32900 (NTS)
29700 (NTS)
300 1600 1600 300
VARIES
250mm THK CONCRETE CLASS 35/19 REINFORCED
REF 617 MESH 70mm COVER
50mm GRADE 15MPA/19mm BLINDING LAYER

SECTION D
SCALE 1:100

CL SPILLWAY
32900 (NTS)
1500 14850 (NTS) 14850 (NTS) 1500
VARIES
710
300mm THK GROUTED STONE PITCHING
20m LONG SIDE SLOPE TRANSITION FROM 1:2 TO LEVEL WITH GROUND

COORDINATE LIST
PLANT GRID

POINT	N-COORD	E-COORD
CONST:		
ASH DUMP DIRTY DAM		
SPILLWAY No. 2		
SW02	10145.929	7310.541

REFER TO DRG. No. K30300098/06-280 FOR CONCRETE NOTES

PLAN ON COMPARTMENT No.1 ENERGY DISSIPATOR No. 1
SCALE 1:100

LINE OF MASS CONCRETE BELOW PIPE
150Ø PIPE (TYPICAL)
1456.800
2250Ø ND CLASS 100D CONCRETE PIPE

7600
5600
1000 / 1000
400 / 2270 / 1730 / 5150
400 / 3400 / 3400 / 400
1000 / 2800 / 4750 / 400
9550
2800 / 2800 / 2700 / 4500 / 7600
S.C.J. / C.J.

FOUNDATION PLAN

10850
1000 / 400 / 3000 / 1400 / 200 / 3400 / 1350 / 300
400 / 400
1400 / 200 / 3400 / 8400 / 3400 / 900
8600 / 5800
1400 / 900 / 500
1400 / 500 / 200 / 400
1900 / 7300 / 1650
10850
TRUE NORTH / PLANT NORTH / 45°

SECTION B
SCALE 1:100

316 STAINLESS STEEL RAILEX CA-TM90 OR SIMILAR APPROVED.
2 No. 16Ø RAWL BOLTS PER STANCHION.
ALTERNATE: MENTIS INTERLINK HANDRAILING NT90
Ø2250
VARIES
1456.800
CONCRETE FLOOR SLAB
50mm GRADE 15MPA/19mm BLINDING LAYER
7600 / 1000 / 5600 / 1000 / 400
150 / 4890 / 5340 / 300

SECTION C
SCALE 1:100

7600
400 / 850 / 565 / 850 / 2270 / 850 / 565 / 850 / 400
950
1456.800
VARIES I.J. / I.J.
CONCRETE FLOOR SLAB
50mm GRADE 15MPA/19mm BLINDING LAYER
770 / 600 / 2540 / 5340 / 200 / 400 / 1130 / 1150 / 300 / 1430 / 400 / 500

ELEVATION D
SCALE 1:100

7600
400 / 6800 / 400
3 No. OFF 150Ø PIPE OPENING AT 1700 CENTRES
1456.700 / 1456.800
CONCRETE FLOOR SLAB
50mm GRADE 15MPA/19mm BLINDING LAYER
2450 / 1700 / 1700 / 2450
1710 / 2200 / 3630 / 5340 / 1130 / 400 / 300 / 500

SECTION A
SCALE 1:100

316 STAINLESS STEEL RAILEX CA-TM90 OR SIMILAR APPROVED.
2 No. 16Ø RAWL BOLTS PER STANCHION.
ALTERNATE: MENTIS INTERLINK HANDRAILING NT90
300 THK REINFORCED CONCRETE COLLAR (SEE DETAIL No. 2 ON DRG. 30300098/06-283)
100x100 FILLET
N.G.L.
300mm STRIPPED TOPSOIL
LEVEL
IL:1457.930 / 1457.930
1456.800
CONCRETE FLOOR SLAB
VARIES
2250Ø ND CLASS 100D CONCRETE PIPE
MASS CONCRETE UNDER PIPE (4300 WIDE)
50mm GRADE 15MPA/19mm BLINDING LAYER
3 No. OFF 150Ø PIPE OPENING AT 1700 CENTRES
1000 / 3400 / 4850 / 300
9550
5340 / 400 / 300 / 5340
1900 / 1650

DETAIL 20
SCALE 1:25

TYPICAL ISOLATION JOINT IN FLOOR SLABS (I.J.)

SEE NOTE 1
50mm GRADE 15MPA/25mm BLINDING LAYER
"SERVISTRIP AH25" OR EQUAL APPROVED EXPANSION JOINTING STRIP
150 / 150 / 300 / 1100 / 800 / 150 KICKER (TYPICAL) / 400 / 50 / 700
400 / 1250 / 1650

DETAIL 21
SCALE 1:50

1730 / 1130 / 600 / 400
100x100 FILLET
600 / 1590 / 990 / 3140 / 200 / 1550 / 1550

DETAIL 22
SCALE 1:25

TYPICAL ISOLATION JOINT IN FLOOR SLABS (I.J.)

300x2mm SIKADUR - COMBIFLEX SYSTEM OR SIMILAR APPROVED
SIKAFLEX PRO-3 WF FLEXIBLE JOINT SEALENT OR SIMILAR APPROVED
20 THK "SONDOR JOINTEX"
SEE NOTE 1
50mm GRADE 15MPA/25mm BLINDING LAYER
"SERVISTRIP AH25" OR EQUAL APPROVED EXPANSION JOINTING STRIP
150 KICKER (TYPICAL)
500 / 400 / 500
1400
300 / 700

DETAIL 23
SCALE 1:25

TYPICAL ISOLATION JOINT IN FLOOR SLABS (I.J.)

MASS CONCRETE UNDER PIPE
INLET PIPE
300x2mm SIKADUR - COMBIFLEX SYSTEM OR SIMILAR APPROVED
SIKAFLEX PRO-3 WF FLEXIBLE JOINT SEALENT OR SIMILAR APPROVED
20 THK "SONDOR JOINTEX"
SEE NOTE 1
FLOOR OF DISSIPATOR
50mm GRADE 15MPA/25mm BLINDING LAYER
"SERVISTRIP AH25" OR EQUAL APPROVED EXPANSION JOINTING STRIP
150 KICKER (TYPICAL)
1000 / 400 / 500
1900
300 / 400 / 500 / 1200

NOTE:
1. CONSTRUCTION JOINT SURFACES TO BE SCABBLED AND CLEANED BEFORE NEXT LIFT IS CAST.

REFER TO DRG. No. K30300098/06-280 FOR CONCRETE NOTES

PLAN
SCALE 1:3000

LEGEND

- TOE WALL
- JUNCTION BOX AND DIRTY WATER PIPE
- DIRTY WATER CANAL (℄)
- CLEAN WATER CHANNEL (℄)
- PERIMETER ACCESS ROAD
- ASH DUMP FENCE ALIGNMENT

PHASE 1b

PHASE 1a

FUTURE PHASES

QUARRY SITE

CONTRACTORS YARD
AND ENGINEERS OFFICE

BULK MATERIAL
STORAGE AREA

BULK MATERIAL
STORAGE AREA

TOPSOIL
STORAGE
AREA

CLEAN WATER DRAINS
SEE DRG.No. -304

CLEAN WATER DRAINS
SEE DRG.No. -305

CLEAN WATER DRAINS
SEE DRG.No. -306

CLEAN WATER DRAINS
SEE DRG.No. -303

CLEAN WATER DRAINS
SEE DRG.No. -307

CLEAN WATER DRAINS
SEE DRG.No. -308

FUTURE DIRTY WATER PIPELINE

TRUE NORTH
PLANT NORTH
45°

PHASE 2

PHASE 1 - A

PHASE 1 - A

PHASE 1 - B

MATCH LINE
SEE DRG No. -304

E1

E2

SEE NOTES 1 & 3 FOR ALL CULVERTS AND POINTS OF DISCHARGE (TYPICAL)

CLEAN WATER COLLECTION CHANNEL (SEE NOTE 6)

SEE NOTE 4 FOR GROUND SLOPE REQUIREMENTS (TYP.)

FUTURE CULVERT (SEE NOTE 4)

PHASE 1A: CLEAN WATER TRENCH N° 1 (P1A / CWT 1)				
	N	E	G.L	I.L	DEPTH
CWT 1.1	8759.236	9164.142			
CWT 1.2	8743.441	9148.602	1481.516	1480.355	1.161m
CWT 1.3	8737.250	9142.511			
CWT 1.4	8772.969	9106.894	1482.263	1480.444	1.819m
LENGTH CWT 1.2 TO CWT 1.4 = 55.92m					
LENGTH OF CULVERT = 18 PORTALS x 1.220 LENGTH = 21.960m					
TOTAL TRENCH EXCAVATION = 425.71 m³					
DISTANCE ON PERIMETER ACCESS ROAD @ PIPE CROSSING = 127.427					

PHASE 1A: CLEAN WATER TRENCH N° 2 (P1 / CWT 2)				
	N	E	G.L	I.L	DEPTH
CWT 2.1	8753.543	9169.840			
CWT 2.2	8737.743	9154.286	1481.508	1480.515	0.993m
CWT 2.3	8732.264	9148.905			
CWT 2.4	8661.408	9219.909	1482.075	1481.040	1.035m
LENGTH CWT 2.2 TO CWT 2.4 = 104.932 m					
LENGTH OF CULVERT = 18 PORTALS x 1.220 LENGTH = 21.960m					
TOTAL TRENCH EXCAVATION = 519.19 m³					
DISTANCE ON PERIMETER ACCESS ROAD @ PIPE CROSSING = 135.481					

PHASE 1A: CLEAN WATER TRENCH N° 3 (P1A / CWT 3)				
	N	E	G.L	I.L	DEPTH
CWT 3.1	8651.653	9273.651			
CWT 3.2	8635.486	9256.035	1482.090	1481.090	1.000m
CWT 3.3	8628.989	9252.396			
CWT 3.4	8519.987	9362.627	1483.160	1483.160	1.270m
LENGTH CWT 3.2 TO CWT 3.4 = 160.55m					
LENGTH OF CULVERT = 19 PORTALS x 1.220 LENGTH = 23.180m					
TOTAL TRENCH EXCAVATION = 740 m³					
DISTANCE ON PERIMETER ACCESS ROAD @ PIPE CROSSING = 281.234					

PHASE 1A: CLEAN WATER TRENCH N° 4 (P1 / CWT 4)				
	N	E	G.L	I.L	DEPTH
CWT 4.1	8509.814	9413.777			
CWT 4.2	8493.877	9398.668	1482.928	1481.911	1.0160m
CWT 4.3	8488.299	9393.379			
CWT 4.4	8427.323	9454.482	1483.485	1482.360	1.1240m
LENGTH CWT 4.2 TO CWT 4.4 = 90.89 m					
LENGTH OF CULVERT = 18 PORTALS x 1.220 LENGTH = 21.960m					
TOTAL TRENCH EXCAVATION = 401.24 m³					
DISTANCE ON PERIMETER ACCESS ROAD @ PIPE CROSSING = 480.538					

PHASE 1A: CLEAN WATER TRENCH N° 5 (P1A / CWT 5)				
	N	E	G.L	I.L	DEPTH
CWT 5.1	8398.247	9526.402			
CWT 5.2	8381.723	9510.390	1482.929	1482.174	0.7550m
CWT 5.3	8375.973	9505.939			
CWT 5.4	8421.672	9460.145	1483.509	1482.520	0.9885m
LENGTH CWT 5.2 TO CWT 5.4 = 68.93 m					
LENGTH OF CULVERT = 19 PORTALS x 1.220 LENGTH = 23.180m					
TOTAL TRENCH EXCAVATION = 224.45m³					
DISTANCE ON PERIMETER ACCESS ROAD @ PIPE CROSSING = 639.283					

PHASE 1A: CLEAN WATER TRENCH N° 6 (P1A / CWT 6)				
	N	E	G.L	I.L	DEPTH
CWT 6.1	8321.679	9613.415			
CWT 6.2	8303.880	9600.559	1481.601	1480.591	1.010m
CWT 6.3	8297.616	9596.033			
CWT 6.4	8351.806	9529.840	1482.983	1481.040	1.943m
LENGTH CWT 6.2 TO CWT 6.4 =89.61 m					
LENGTH OF CULVERT = 18 PORTALS x 1.220 LENGTH = 21.960m					
TOTAL TRENCH EXCAVATION = 730.39 m³					
DISTANCE ON PERIMETER ACCESS ROAD @ PIPE CROSSING = 756.738					

PHASE 1A: CLEAN WATER TRENCH N° 7 (P1A / CWT 7)				
	N	E	G.L	I.L	DEPTH
CWT 7.1	8291.350	9650.477			
CWT 7.2	8274.276	9636.667	1480.470	1479.393	1.077m
CWT 7.3	8268.273	9631.875			
CWT 7.4	8288.573	9607.078	1481.628	1479.465	2.162m
LENGTH CWT 7.2 TO CWT 7.4 = 36.55 m					
LENGTH OF CULVERT = 18 PORTALS x 1.220 LENGTH = 21.960m					
TOTAL TRENCH EXCAVATION = 366.54 m³					
DISTANCE ON PERIMETER ACCESS ROAD @ PIPE CROSSING = 803.986					

PHASE 1A: CLEAN WATER TRENCH N° 8 (P1A / CWT 8)				
	N	E	G.L	I.L	DEPTH
CWT 8.1	8260.391	9688.293		–	
CWT 8.2	8243.419	9674.358	1479.390	1478.391	1.000m
CWT 8.3	8237.457	9669.517			
CWT 8.4	8261.018	9640.737	1480.598	1478.600	1.998m
LENGTH CWT 8.2 TO CWT 8.4 = 41.96 m					
LENGTH OF CULVERT = 18 PORTALS x 1.220 LENGTH = 21.960m					
TOTAL TRENCH EXCAVATION = 385.93 m³					
DISTANCE ON PERIMETER ACCESS ROAD @ PIPE CROSSING = 852.766					

PHASE 1A: CLEAN WATER TRENCH N° 9 (P1A / CWT 9)				
	N	E	G.L	I.L	DEPTH
CWT 9.1	8217.315	9740.909			
CWT 9.2	8200.328	9726.992	1478.090	1477.090	1.000m
CWT 9.3	8194.395	9722.145			
CWT 9.4	8231.122	9677.255	1479.703	1477.404	2.298m
LENGTH CWT 9.2 TO CWT 9.4 = 62.85 m					
LENGTH OF CULVERT = 18 PORTALS x 1.220 LENGTH = 21.960m					
TOTAL TRENCH EXCAVATION = 633.75 m³					
DISTANCE ON PERIMETER ACCESS ROAD @ PIPE CROSSING = 920.766					

PHASE 1A: CLEAN WATER TRENCH N° 10 (P1A / CWT 10)				
	N	E	G.L	I.L	DEPTH
CWT 10.1	8079.998	9847.717			
CWT 10.2	8071.725	9828.480	1476.338	1475.335	1.002m
CWT 10.3	8068.662	9821.363			
CWT 10.4	8186.709	9731.504	1478.095	1476.110	1.985m
LENGTH CWT 10.2 TO CWT 10.4 = 155.02 m					
LENGTH OF CULVERT = 17 PORTALS x 1.220 LENGTH = 20.740m					
TOTAL TRENCH EXCAVATION = 1070.51 m³					
DISTANCE ON PERIMETER ACCESS ROAD @ PIPE CROSSING = 1091.538					

PHASE 1A: CLEAN WATER TRENCH N° 11 (P1A / CWT 11)				
	N	E	G.L	I.L	DEPTH
CWT 11.1	8034.007	9862.559			
CWT 11.2	8029.016	9841.174	1476.666	1475.629	1.036m
CWT 11.3	8027.206	9833.418			
CWT 11.4	7950.446	9837.908	1478.066	1476.000	2.066m
LENGTH CWT 11.2 TO CWT 11.4 = 82.48 m					
LENGTH OF CULVERT = 18 PORTALS x 1.220 LENGTH = 21.960m					
TOTAL TRENCH EXCAVATION = 681.68 m³					
DISTANCE ON PERIMETER ACCESS ROAD @ PIPE CROSSING = 1137.877					

PHASE 1A: CLEAN WATER TRENCH N° 12 (P1A / CWT 12)				
	N	E	G.L	I.L	DEPTH
CWT 12.1	7933.032	9866.236			
CWT 12.2	7936.043	9844.484	1477.947	1476.934	1.013m
CWT 12.3	7937.040	9837.202			
CWT 12.4	7885.456	9824.179	1479.224	1477.230	1.994m
LENGTH CWT 12.2 TO CWT 12.4 = 58.04 m					
LENGTH OF CULVERT = 18 PORTALS x 1.220 LENGTH = 21.960m					
TOTAL TRENCH EXCAVATION = 457.83 m³					
DISTANCE ON PERIMETER ACCESS ROAD @ PIPE CROSSING = 1234.972					

PHASE 1A: CLEAN WATER TRENCH N° 13 (P1A / CWT 13)				
	N	E	G.L	I.L	DEPTH
CWT 13.1	7824.493	9828.853			
CWT 13.2	7835.950	9810.353	1479.835	1478.838	0.997m
CWT 13.3	7839.906	9803.978			
CWT 13.4	7786.104	9768.915	1481.177	1479.180	1.997m
LENGTH CWT 13.2 TO CWT 13.4 = 68.60 m					
LENGTH OF CULVERT = 18 PORTALS x 1.220 LENGTH = 21.960m					
TOTAL TRENCH EXCAVATION = 547.22 m³					
DISTANCE ON PERIMETER ACCESS ROAD @ PIPE CROSSING = 1345.441					

PHASE 1A: CLEAN WATER TRENCH N° 14 (P1A / CWT 14)				
	N	E	G.L	I.L	DEPTH
CWT 14.1	7755.622	9782.936			
CWT 14.2	7768.100	9766.369	1481.149	1480.153	0.997m
CWT 14.3	7772.795	9760.249			
CWT 14.4	7711.558	9720.373	1482.242	1480.540	1.702m
LENGTH CWT 14.2 TO CWT 14.4 = 77.0561 m					
LENGTH OF CULVERT = 17 PORTALS x 1.220 LENGTH = 20.740m					
TOTAL TRENCH EXCAVATION = 491.12 m³					
DISTANCE ON PERIMETER ACCESS ROAD @ PIPE CROSSING = 1427.173					

NOTES:

1. CLEAN WATER DRAINS TO DISCHARGE INTO COLLECTION CHANNELS OR SPECIFIED SILT RETENTION DAMS AS SHOWN ON DRAWINGS K30300098/06–320 THROUGH TO 328.

2. CLEAN WATER COLLECTION CHANNELS TO SERVE AS CONSTRUCTION PHASE STORM WATER RUNOFF COLLECTION CHANNELS AND WILL ROUTE WATERS TO SILT RETENTION DAMS. FOR SETTING OUT COORDINATES, REFER TO DRAWINGS K30300098/06–320 THROUGH TO 328.

3. FOR CLEAN WATER DRAIN CULVERT INFORMATION AND DETAILS, REFER TO DRAWINGS K30300098/06–309 AND 310.

4. GROUND SURFACE BETWEEN LIMITS OF THE CLEAN WATER DRAINS, ACCESS ROADS AND THE DIRTY CANALS SHALL BE SLOPED TO DRAIN INTO NEAREST CLEAN WATER DRAIN BASED ON SITE CONDITIONS AT TIME OF CONSTRUCTION.

5. CULVERTS SHOWN TO BE WITHIN LIMITS OF FUTURE PHASES ARE FOR ILLUSTRATIVE PURPOSES ONLY. ACTUAL LOCATIONS AND SIZES TO BE CONFIRMED BY ENGINEER.

6. FOR DETAILS REGARDING CLEAN WATER COLLECTION CHANNELS SEE DRAWINGS K30300098/06–320 to 329 AND 219.

KUSILE POWER STATION
ASH DUMP No.1
CLEAN WATER DRAINS
SHEET 1 OF 6

DRG. No. K30300098/06–303

REV 2

0.90/23327

Eskom

PHASE 1B: CLEAN WATER TRENCH N° 15 (P1B / CWT 15)

	N	E	G.L	I.L	DEPTH
CWT 15.1	7536.128	9628.044			
CWT 15.2	7552.106	9614.820	1480.505	1479.503	1.002m
CWT 15.3	7558.431	9609.564			
CWT 15.4	7678.641	9699.123	1482.314	1480.285	2.029m
LENGTH CWT 15.2 TO CWT 15.4 = 156.54m					
LENGTH OF CULVERT = 17 PORTALS x 1.220 LENGTH = 20.740m					
TOTAL TRENCH EXCAVATION = 1561.18 m³					
DISTANCE ON PERIMETER ACCESS ROAD @ PIPE CROSSING = 1693.439					

PHASE 1B: CLEAN WATER TRENCH N° 16 (P1B / CWT 16)

	N	E	G.L	I.L	DEPTH
CWT 16.1	7474.925	9525.677			
CWT 16.2	7495.481	9517.951	1478.655	1477.660	0.995m
CWT 16.3	7501.774	9515.567			
CWT 16.4	7533.121	9577.595	1480.138	1478.030	2.108m
LENGTH CWT 16.2 TO CWT 16.4 = 73.94 m					
LENGTH OF CULVERT = 18 PORTALS x 1.220 LENGTH = 21.960m					
TOTAL TRENCH EXCAVATION = 695.12 m³					
DISTANCE ON PERIMETER ACCESS ROAD @ PIPE CROSSING = 1810.294					

PHASE 1B: CLEAN WATER TRENCH N° 17 (P1B / CWT 17)

	N	E	G.L	I.L	DEPTH
CWT 17.1	7459.679	9437.953			
CWT 17.2	7481.636	9437.572	1478.132	1477.097	1.036m
CWT 17.3	7489.090	9437.433			
CWT 17.4	7499.616	9504.360	1478.973	1477.460	1.513m
LENGTH CWT 17.2 TO CWT 17.4 = 72.64 m					
LENGTH OF CULVERT = 18 PORTALS x 1.220 LENGTH = 21.960m					
TOTAL TRENCH EXCAVATION = 434.9184 m³					
DISTANCE ON PERIMETER ACCESS ROAD @ PIPE CROSSING = 1895.516					

PHASE 1B: CLEAN WATER TRENCH N° 18 (1B / CWT 18)

	N	E	G.L	I.L	DEPTH
CWT 18.1	7462.895	9388.126			
CWT 18.2	7484.607	9391.419	1478.295	1477.282	1.0120m
CWT 18.3	7492.194	9392.597			
CWT 18.4	7515.800	9237.499	1479.556	1478.090	1.466m
LENGTH CWT 18.2 TO CWT 18.4 =161.431 m					
LENGTH OF CULVERT = 18 PORTALS x 1.220 LENGTH = 21.960m					
TOTAL TRENCH EXCAVATION = 1020.08 m³					
DISTANCE ON PERIMETER ACCESS ROAD @ PIPE CROSSING = 1945.795					

PHASE 1B: CLEAN WATER TRENCH N° 19 (P1B / CWT 19)

	N	E	G.L	I.L	DEPTH
CWT 19.1	7493.127	9190.258			
CWT 19.2	7514.865	9193.376	1479.558	1478.556	1.002m
CWT 19.3	7522.350	9194.468			
CWT 19.4	7532.573	9127.296	1480.147	1478.920	1.227m
LENGTH CWT 19.2 TO CWT 19.4 = 72.573 m					
LENGTH OF CULVERT = 18 PORTALS x 1.220 LENGTH = 21.960m					
TOTAL TRENCH EXCAVATION = 353.06 m³					
DISTANCE ON PERIMETER ACCESS ROAD @ PIPE CROSSING = 2143.720					

PHASE 1B: CLEAN WATER TRENCH N° 20 (P1B / CWT 20)

	N	E	G.L	I.L	DEPTH
CWT 20.1	7516.842	9037.746			
CWT 20.2	7538.651	9040.320	1479.655	1478.651	1.004m
CWT 20.3	7545.699	9041.057			
CWT 20.4	7533.865	9118.810	1480.148	1479.067	1.081m
LENGTH CWT 20.2 TO CWT 20.4 = 82.937 m					
LENGTH OF CULVERT = 18 PORTALS x 1.220 LENGTH = 21.960m					
TOTAL TRENCH EXCAVATION = 352.30 m³					
DISTANCE ON PERIMETER ACCESS ROAD @ PIPE CROSSING = 2298.408					

PHASE 1B: CLEAN WATER TRENCH N° 21 (P1B / CWT 21)

	N	E	G.L	I.L	DEPTH
CWT 21.1	7522.298	8989.747			
CWT 21.2	7545.216	8993.224	1479.223	1478.227	0.996m
CWT 21.3	7552.802	8994.390			
CWT 21.4	7563.736	8922.554	1480.612	1478.610	2.002m
LENGTH CWT 21.2 TO CWT 21.4 =77.224 m					
LENGTH OF CULVERT = 19 PORTALS x 1.220 LENGTH = 23.180m					
TOTAL TRENCH EXCAVATION = 450.48 m³					
DISTANCE ON PERIMETER ACCESS ROAD @ PIPE CROSSING = 2346.243					

PHASE 1B: CLEAN WATER TRENCH N° 22 (P1B / CWT 22)

	N	E	G.L	I.L	DEPTH
CWT 22.1	7536.131	8906.943			
CWT 22.2	7557.911	8909.747	1480.836	1479.837	0.999m
CWT 22.3	7565.117	8910.777			
CWT 22.4	7575.702	8841.231	1482.278	1480.210	2.068m
LENGTH CWT 22.2 TO CWT 22.4 = 74.674 m					
LENGTH OF CULVERT = 18 PORTALS x 1.220 LENGTH = 21.960m					
TOTAL TRENCH EXCAVATION = 674.19 m³					
DISTANCE ON PERIMETER ACCESS ROAD @ PIPE CROSSING = 2430.415					

PHASE 1B: CLEAN WATER TRENCH N° 23 (P1B / CWT 23)

	N	E	G.L	I.L	DEPTH
CWT 23.1	7553.945	8798.008			
CWT 23.2	7574.484	8800.886	1482.543	1481.543	1.000m
CWT 23.3	7582.084	8802.001			
CWT 23.4	7589.755	8751.601	1483.179	1481.820	1.359m
LENGTH CWT 23.2 TO CWT 23.4 = 55.628 m					
LENGTH OF CULVERT = 17 PORTALS x 1.220 LENGTH = 20.740m					
TOTAL TRENCH EXCAVATION = 276.72 m³					
DISTANCE ON PERIMETER ACCESS ROAD @ PIPE CROSSING = 2540.665					

PHASE 1B: CLEAN WATER TRENCH N° 24 (P1B / CWT 24)

	N	E	G.L	I.L	DEPTH
CWT 24.1	7569.975	8730.280			
CWT 24.2	7588.648	8739.276	1483.187	1482.249	0.938m
CWT 24.3	7593.338	8741.597			
CWT 24.4	7624.982	8704.766	1484.505	1482.510	1.999m
LENGTH CWT 24.2 TO CWT 24.4 =52.270 m					
LENGTH OF CULVERT = 17 PORTALS x 1.220 LENGTH = 20.740m					
TOTAL TRENCH EXCAVATION = 390.40 m³					
DISTANCE ON PERIMETER ACCESS ROAD @ PIPE CROSSING = 2607.245					

PHASE 1B: CLEAN WATER TRENCH N° 25 (P1B / CWT 25)

	N	E	G.L	I.L	DEPTH
CWT 25.1	7609.393	8679.326			
CWT 25.2	7626.145	8691.553	1484.591	1483.586	1.005m
CWT 25.3	7632.427	8696.099			
CWT 25.4	7653.201	8671.920	1485.616	1483.770	1.846m
LENGTH CWT 25.2 TO CWT 25.4 = 37.062 m					
LENGTH OF CULVERT = 17 PORTALS x 1.220 LENGTH = 20.740m					
TOTAL TRENCH EXCAVATION = 264.30 m³					
DISTANCE ON PERIMETER ACCESS ROAD @ PIPE CROSSING = 2669.918					

PHASE 1B: CLEAN WATER TRENCH N° 26 (P1B / CWT 26)

	N	E	G.L	I.L	DEPTH
CWT 26.1	7654.945	8626.304			
CWT 26.2	7671.408	8638.899	1486.694	1485.689	1.005m
CWT 26.3	7677.541	8643.591			
CWT 26.4	7696.233	8621.834	1487.859	1485.860	1.999m
LENGTH CWT 26.2 TO CWT 26.4 = 33.6901 m					
LENGTH OF CULVERT = 17 PORTALS x 1.220 LENGTH = 20.740m					
TOTAL TRENCH EXCAVATION = 263.50 m³					
DISTANCE ON PERIMETER ACCESS ROAD @ PIPE CROSSING = 2739.561					

PHASE 1B: CLEAN WATER TRENCH N° 27 (P1B / CWT 27)

	N	E	G.L	I.L	DEPTH
CWT 27.1	7680.706	8596.296			
CWT 27.2	7696.438	8609.811	1488.016	1487.010	1.006m
CWT 27.3	7702.253	8614.827			
CWT 27.4	7722.602	8591.143	1489.334	1487.188	2.147m
LENGTH CWT 27.2 TO CWT 27.4 =35.790 m					
LENGTH OF CULVERT = 17 PORTALS x 1.220 LENGTH = 20.740m					
TOTAL TRENCH EXCAVATION = 328.88 m³					
DISTANCE ON PERIMETER ACCESS ROAD @ PIPE CROSSING = 2778.485					

PHASE 1B: CLEAN WATER TRENCH N° 28 (P1B / CWT 28)

	N	E	G.L	I.L	DEPTH
CWT 28.1	7710.027	8562.169			
CWT 28.2	7725.942	8575.468	1489.582	1488.594	0.989m
CWT 28.3	7731.829	8580.403			
CWT 28.4	7756.949	8551.166	1490.806	1488.810	1.996m
LENGTH CWT 28.2 TO CWT 28.4 = 43.216 m					
LENGTH OF CULVERT = 17 PORTALS x 1.220 LENGTH = 20.740m					
TOTAL TRENCH EXCAVATION = 349.55 m³					
DISTANCE ON PERIMETER ACCESS ROAD @ PIPE CROSSING = 2823.629					

PHASE 1B: CLEAN WATER TRENCH N° 29 (P1B / CWT 29)

	N	E	G.L	I.L	DEPTH
CWT 29.1	7740.289	8526.934			
CWT 29.2	7756.703	8539.648	1490.7480	1489.754	0.994m
CWT 29.3	7762.792	8544.365			
CWT 29.4	7785.189	8518.297	1491.571	1489.950	1.621m
LENGTH CWT 29.2 TO CWT 29.4 = 39.328 m					
LENGTH OF CULVERT = 17 PORTALS x 1.220 LENGTH = 20.740m					
TOTAL TRENCH EXCAVATION = 239.60 m³					
DISTANCE ON PERIMETER ACCESS ROAD @ PIPE CROSSING = 2870.493					

SEE DRG No. -305
MATCH LINE

FUTURE PHASES

PHASE 1 - B

PHASE 1 - A

SEE NOTE 4 FOR GROUND SLOPE REQUIREMENTS (TYP.)

2(750x750) RECTANGULAR CULVERTS

1(750x750) RECTANGULAR CULVERT

1(750x750) RECTANGULAR CULVERT

1(750x750) RECTANGULAR CULVERT

3(750x750) RECTANGULAR CULVERTS

CLEAN WATER COLLECTION CHANNELS (SEE NOTE 5)

FUTURE DIRTY WATER PIPE

SEE NOTES 1 & 3 TYP. FOR ALL CULVERTS AND POINTS OF DISCHARGE

PHASE 1A
PHASE 1B
SEE DRG No. -303 MATCH LINE

NOTES:

1. CLEAN WATER DRAINS TO DISCHARGE INTO COLLECTION CHANNELS OR SPECIFIED SILT RETENTION DAMS AS SHOWN ON DRAWINGS K30300098/06-320 THROUGH TO 328.

2. CLEAN WATER COLLECTION CHANNELS TO SERVE AS CONSTRUCTION PHASE STORM WATER RUNOFF COLLECTION CHANNELS AND WILL ROUTE WATERS SILT RETENTION DAMS. FOR SETTING OUT COORDINATES, REFER TO DRAWINGS K30300098/06-320 THROUGH TO 328.

3. FOR CLEAN WATER DRAIN CULVERT INFORMATION AND DETAILS, REFER TO DRAWINGS K30300098/06-309 AND 310.

4. GROUND SURFACE BETWEEN LIMITS OF THE CLEAN WATER DRAINS, ACCESS ROADS AND THE DIRTY CANALS SHALL BE SLOPED TO DRAIN INTO NEAREST CLEAN WATER DRAIN BASED ON SITE CONDITIONS AT TIME OF CONSTRUCTION.

5. FOR DETAILS REGARDING CLEAN WATER COLLECTION CHANNELS SEE DRAWINGS K30300098/06-320 TO 329 AND 219.

KUSILE POWER STATION
ASH DUMP No 1
CLEAN WATER DRAINS
SHEET 2 OF 6

DRG. No. K30300098/06-304

SETTING OUT POINT (SOP) CO-ORDINATES

POINT NAME	N-COORDINATE	E-COORDINATE	Z-COORDINATE
A	9789.319	7245.996	1462.750
B	9780.270	7254.018	1462.750
C	9419.414	7254.018	1463.500
D	9058.558	7254.018	1461.700
E	9049.508	7245.996	1461.700
F	9735.065	7429.266	1474.400
F1	9583.777	7429.265	1464.500
F2	9744.115	7421.244	1474.300
G	9432.488	7429.266	1474.300
H	9423.439	7421.244	1474.200
J	9726.191	8434.824	1473.600
K	9722.279	8437.030	1473.675
L	9597.985	8545.546	1474.500
M	9473.690	8654.063	1473.675
N	9469.563	8662.511	1473.600

FOR KEYPLAN SEE DRG 30300098/06 301
CLEAN WATER MANAGEMENT
PHASE 1 GA AND SETTING OUT

FOR CO-ORDINATES SEE DRG 30300098/06 206
PHASE 1 G.A AND SETTING OUT CO-ORDINATES

MINIMUM STONE SIZE FOR STONE PITCHING TO BE 150mm PER SANS STANDARD 1200DK, GROUTED MEDIUM PITCHING

STORMWATER COLLECTION CHANNEL

DETAIL 1
SCALE 1:20

BULK MATERIAL STORAGE AREA

BULK MATERIAL STORAGE AREA

TOPSOIL STORAGE AREA

FOR (TYPICAL) STONE PITCHING SEE DETAIL 1

STORMWATER COLLECTION CHANNEL

SILT RETENTION DAM (W2) VOLUME = 16 300m³

DIRTY WATER PIPE

N = 9779.934
E = 7244.524

N = 9734.820
E = 7419.772

N = 9432.824
E = 7419.772

N = 9058.893
E = 7244.524

FALL 1:200 MIN.

STORAGE AREAS STORMWATER CHANNEL ARRANGEMENT
SCALE 1:200

TOPSOIL STORAGE AREA

FOR (TYPICAL) STONE PITCHING SEE DETAIL 1

STORMWATER COLLECTION CHANNEL

DIRTY WATER PIPE

N = 9729.697
E = 8445.819

N = 9484.096
E = 8664.162

FALL 1:200 MIN.

STORAGE AREAS STORMWATER CHANNEL ARRANGEMENT
SCALE 1:200

KUSILE POWER STATION
ASH DUMP No.1
BULK MATERIAL STORAGE
STOCKPILE DIVERSION CHANNELS

DRG. No. K30300098/06-320

0.90/23381

KNIGHT PIÉSOLD CONSULTING

Eskom

MATERIAL SPECIFICATION FOR COMPACTED FILL DAM WALLS

1. EXCAVATED SOILS FROM THE DAM BASIN EXCAVATION MAY GENERALLY BE USED FOR THE COMPACTED FILL IN THE DAM WALLS.

2. EXCAVATION VOLUMES EXCEED FILL VOLUMES, SO FILL MATERIAL TO BE SELECTED FOR QUALITY.

3. THE DAM FOOTPRINT TO BE CLEARED OF VEGETATION.

4. TOPSOIL TO BE REMOVED TO A DEPTH OF 200mm AND PLACED IN THE TOPSOIL STOCKPILE.

5. GENERALLY UP TO 1m OR SO OF UNSUITABLE MATERIAL IN THE EXCAVATION TO BE DISCARDED.

6. THE EXPECTED MATERIALS IN LOWER LAYERS ARE TILLITES AND CLAYEY DIABASE.

7. MATERIAL FOR THE COMPACTED FILL IN THE WALLS SHALL PREFERABLY BE SELECTED FROM THE SANDY RESIDUAL TILLITES WITH THE FOLLOWING PROPERTIES:-
GRAVEL PERCENTAGE 3 TO 8%
SAND PERCENTAGE 40 TO 70%
SILT PERCENTAGE 20 TO 40%
CLAY PERCENTAGE 10 TO 30%
UNIFIED CLASSIFICATION SC TO CL–ML OR CL

9. DIABASE WITH A HIGH GRAVEL CONTENT, WHERE IT INTERCEPTS THE FERRICRETE CAN BE USED IF REQUIRED IN A 50/50 COMBINATION WITH THE SANDY TILLITES.

10. THE COMPACTION SPECIFICATION TO BE 95% MOD AASHTO DENSITY ± 2% OMC, PLACED IN 300mm max. LOOSE LAYERS.

11. BOULDERS OR ROCKS GREATER THAN 130mm/TWO THIRDS THE LAYER THICKNESS IN SIZE TO BE DISCARDED.

12. FOLLOWING COMPLETION OF EMBANKMENT CONTRUCTION, EXCAVATED BASIN SURFACE TO BE RE–SEEDED WITH NATIVE GRASSES.

SILT RETENTION DAM (E1) VOLUME = 28 300m³

OUTLET PIPE DISCHARGE
500⌀ OUTLET PIPE
OUTLET PIPE DISCHARGE
FENCE
RADIAL STACKER TERRACE
DIRTY WATER PIPE
SPILLWAY

CLEAN WATER COLLECTION CHANNEL SOP F–J (TYPE 2) (E1a)
CLEAN WATER COLLECTION CHANNEL SOP K–N (TYPE 3) (E1b)
CLEAN WATER COLLECTION CHANNEL SOP N–P (TYPE 1) (E1b)
FOR (TYPICAL) STONE PITCHING SEE DETAIL 4
HIGH POINT (E1a)
SOP(H) CONTINUED (W1)
TOPSOIL STORAGE AREA

CONTINUED ON DRG No. 30300098–06–323 TO W1a SILT RETENTION DAM

SILT RETENTION DAM E1 GENERAL ARRANGEMENT
SCALE 1:1000

SETTING OUT POINT (SOP) CO-ORDINATES

POINT NAME	N–COORDINATE	E–COORDINATE	Z–COORDINATE
CENTRE LINE OF CREST EMBANKMENT			
A	9965.506	7905.861	1473.000
B	10031.594	7988.678	1473.000
C	9986.037	8104.895	1473.000
D	9888.225	8119.683	1473.000
E	9994.302	8052.302	1468.000
E1	10007.912	8092.304	1467.878
CENTRE LINE OF CLEAN WATER CHANNEL BOTTOM			
F	9892.052	7975.394	1473.940
G	9875.731	7948.698	1474.657
H	9836.472	7824.595	1477.607
J	9751.512	7694.554	1479.864
K	9862.844	8081.172	1473.300
L	9774.729	8207.629	1474.381
M	9744.762	8231.749	1475.220
N	9571.227	8373.446	1479.792
P	9432.399	8507.809	1481.126

SETTING OUT POINT (SOP) CO-ORDINATES

POINT NAME	N–COORDINATE	E–COORDINATE	Z–COORDINATE
EMERGENCY SPILLWAY			
S1	9933.150	7878.540	–
S2	9990.425	7892.754	1472.000
S3	9960.972	7936.687	1472.200
S4	9967.092	7906.256	–
S5	9976.036	7889.270	–
S6	9950.333	7914.451	–

STORMWATER DIVERSION CANAL SIZES

TYPE	DEPTH (D)	WIDTH (W)	X
1	1300mm	8800mm	3900mm
2	1500mm	10000mm	4500mm
3	1700mm	11200mm	5100mm

FOR KEYPLAN SEE DRG 30300098/06 301 CLEAN WATER MANAGEMENT PHASE 1 GA AND SETTING OUT

SECTION B
SCALE 1:100

VEGETATED OUTER SIDE SLOPE
3000
1500 1500
1473.000
SEE NOTE 10
TWL 1472.200
NGL
TO DISCHARGE
FALL 1:200
1469.500
1500
500⌀ NB CLASS 6 HDPe OUTLET PIPE – ALL JOINTS TO BE BUTT WELDED
0.75 0.75
2 / 1

SECTION A
SCALE 1:200

VEGETATED OUTER SIDE SLOPE
3000
1473.000
SEE NOTE 10
TWL 1472.200
NGL
1469.500
SEE NOTE 12
ESTIMATED EXCAVATION LINE OF FOUNDATION LEVEL
750 1500
0.75
2 / 1

DETAIL 2
SCALE 1:50

2000
A8 GEOFABRIC
PIPE
TWL 1472.200
DN3 FLOWNET HDPE MESH HELD IN PLACE WITH REINFORCED PLASTIC STRAPPING AT 400crs.
175⌀ HOLES (4 per set)
12mm CLEAN STONE
200⌀ CLEAN STONE
1469.500
1468.000
FALL 1:200
200 / 400 / 300 / 1000 / 1700 / 1500 / 2500

DETAIL 4
SCALE 1:20

SILT RETENTION DAM
10m MIN. 5m MIN.
TO FALL
MINIMUM STONE SIZE FOR STONE PITCHING TO BE 150mm PER SANS STANDARD 1200DK, GROUTED MEDIUM PITCHING
SOP
CLEAN WATER COLLECTION CHANNEL TYPE 1, TYPE 2, TYPE 3
MINIMUM STONE SIZE FOR STONE PITCHING TO BE 150mm PER SANS STANDARD 1200DK, GROUTED MEDIUM PITCHING

DETAIL 1
SCALE 1:50

S2 1472.000
S5 S4
S1 S6
S3 1472.200
TOP OF CREST EL. 1473.000
VEGETATED OUTER SIDE SLOPE
SPILLWAY
SILT RETENTION DAM (E1) VOLUME = 28 300m³
MEDIUM STONE PITCHING FLOOR AND SIDES PER SANS 1200DK
SIDE SLOPES 1:3
R=150 R=1865

DETAIL 3
SCALE 1:100

500⌀ NB CLASS 6 HDPe OUTLET PIPE
TO DAYLIGHT FALL
FALL 1:200
FROM SILT RETENTION (E1)
E1
SIDE SLOPES 1:3 TO BE STONE PITCHED
5m×5m×300mm AREA OF STONE PITCHING.
MINIMUM STONE SIZE FOR STONE PITCHING TO BE 150mm PER SANS STANDARD 1200DK, GROUTED MEDIUM PITCHING

SECTION C
SCALE 1:50

SIDE SLOPES 1:3
IL1467.878
NGL
STONE PITCHING
500⌀ NB CLASS 6 HDPe OUTLET PIPE

KUSILE POWER STATION
ASH DUMP No.1
SILT RETENTION DAM (E1)
PLAN AND DETAILS

DRG. No. K30300098/06–321
SHEET 1
REV 1

Eskom
0.90/23382
A0

MATERIAL SPECIFICATION FOR COMPACTED FILL DAM WALLS

1. EXCAVATED SOILS FROM THE DAM BASIN EXCAVATION MAY GENERALLY BE USED FOR THE COMPACTED FILL IN THE DAM WALLS.

2. EXCAVATION VOLUMES EXCEED FILL VOLUMES, SO FILL MATERIAL TO BE SELECTED FOR QUALITY.

3. THE DAM FOOTPRINT TO BE CLEARED OF VEGETATION.

4. TOPSOIL TO BE REMOVED TO A DEPTH OF 200mm AND PLACED IN THE TOPSOIL STOCKPILE.

5. GENERALLY UP TO 1m OR SO OF UNSUITABLE MATERIAL IN THE EXCAVATION TO BE DISCARDED.

6. THE EXPECTED MATERIALS IN LOWER LAYERS ARE TILLITES AND CLAYEY DIABASE.

7. MATERIAL FOR THE COMPACTED FILL IN THE WALLS SHALL PREFERABLY BE SELECTED FROM THE SANDY RESIDUAL TILLITES WITH THE FOLLOWING PROPERTIES:-
GRAVEL PERCENTAGE 3 TO 8%
SAND PERCENTAGE 40 TO 70%
SILT PERCENTAGE 20 TO 40%
CLAY PERCENTAGE 10 TO 30%
UNIFIED CLASSIFICATION SC TO CL-ML OR CL

9. DIABASE WITH A HIGH GRAVEL CONTENT, WHERE IT INTERCEPTS THE FERRICRETE CAN BE USED IF REQUIRED IN A 5‰ COMBINATION WITH THE SANDY TILLITES.

10. THE COMPACTION SPECIFICATION TO BE 95% MOD AASHTO DENSITY ± 2% OMC, PLACED IN 300mm max. LOOSE LAYERS.

11. BOULDERS OR ROCKS GREATER THAN 130mm/TWO THIRDS THE LAYER THICKNESS IN SIZE TO BE DISCARDED.

12. FOLLOWING COMPLETION OF EMBANKMENT CONTRUCTION, EXCAVATED BASIN SURFACE TO BE RE-SEEDED WITH NATIVE GRASSES.

SILT RETENTION DAM E2 GENERAL ARRANGEMENT
SCALE 1:1000

DETAIL 4 — SCALE 1:20

DETAIL 2 — SCALE 1:50

DETAIL 1 — SCALE 1:50

DETAIL 3 — SCALE 1:100

SECTION A — SCALE 1:200

SECTION B — SCALE 1:100

SECTION C — SCALE 1:50

CONTINUED ON DRG No. 30300098-06-321 TO E1 SILT RETENTION DAM

CONTINUED ON DRG No. 30300098-06-327 TO W5 SILT RETENTION DAM

SILT RETENTION DAM (E2) VOLUME = 32 620m³

FOR KEYPLAN SEE DRG 30300098/06 301 CLEAN WATER MANAGEMENT PHASE 1 GA AND SETTING OUT

STORMWATER DIVERSION CANAL SIZES

TYPE	DEPTH (D)	WIDTH (W)	X
1	1300mm	8800mm	3900mm
2	1500mm	10000mm	4500mm
3	1700mm	11200mm	5100mm

SETTING OUT POINT (SOP) CO-ORDINATES

POINT NAME	N-COORDINATE	E-COORDINATE	Z-COORDINATE
CENTRE LINE OF CREST EMBANKMENT			
A	9373.611	8636.511	1479.000
B	9398.168	8727.142	1479.000
C	9292.693	8835.082	1479.000
D	9181.247	8805.812	1479.000
E	9330.748	8782.548	1474.500
E1	9346.612	8797.791	1474.443
CENTRE LINE OF CLEAN WATER CHANNEL BOTTOM			
F	9299.065	8660.239	1479.064
G	9298.828	8634.729	1479.834
H	9377.687	8555.804	1480.385
J	9284.780	8669.350	1479.343
K	9178.353	8766.297	1479.244
L	9166.430	8780.235	1479.079
M	9143.821	8788.042	1479.547
N	9077.629	8854.109	1480.133
P	9056.272	8853.294	1480.861
Q	9025.476	8821.847	1482.620
R	8936.451	8699.821	1488.464
S	8876.846	8635.114	1491.952
T	8829.531	8573.141	1495.000

SETTING OUT POINT (SOP) CO-ORDINATES

POINT NAME	N-COORDINATE	E-COORDINATE	Z-COORDINATE
EMERGENCY SPILLWAY			
S1	9379.147	8656.941	1478.200
S2	9407.853	8665.135	1478.000
S3	9388.857	8677.629	–
S4	9385.523	8655.368	–
S5	9402.270	8659.551	–

DIRTY WATER PIPES
SPILLWAY
CLEAN WATER COLLECTION CHANNEL (TYPE 2)
OUTLET PIPE DISCHARGE
500Ø OUTLET PIPE
FENCE
MINIMUM STONE SIZE FOR STONE PITCHING TO BE 150mm PER SANS STANDARD 1200DK, GROUTED MEDIUM PITCHING
CLEAN WATER COLLECTION CHANNEL TYPE 1, TYPE 2, TYPE 3
FOR (TYPICAL) STONE PITCHING SEE DETAIL 4
END OF PHASE 1 / PHASE 2
TO FALLS
TEMPORARY CLEAN WATER COLLECTION CHANNEL (TYPE 2)
TO FOLLOW SETTING OUT LINE SEE DRG No. 30300098-06-206 FOR CO-ORDINATES
TO BE ALIGNED WITH WETLAND PAN ON SITE
BULK MATERIAL STORAGE AREA
CWT1 CWT2 CWT3

N = 9320.447 E = 8647.285
N = 9067.414 E = 8841.431
N = 9168.252 E = 8822.149

TRUE NORTH / PLANT NORTH 45°

DETAIL 2 callouts:
AB GEOFABRIC
2000
175Ø HOLES (4 per set)
TWL 1478.200
DN3 FLOWNET HDPE MESH HELD IN PLACE WITH REINFORCED PLASTIC STRAPPING AT 400crs.
12mm CLEAN STONE
200Ø CLEAN STONE
1476.000
IL 1474.500
FALL 1:200

SECTION B callouts:
C EMBANKMENT
3000 / 1500 / 1500
SOP 1479.000
VEGETATED OUTER SIDE SLOPE
SEE NOTE 10
TWL 1478.200
1476.000
NGL
FALL 1:200
TO DISCHARGE
500Ø NB CLASS 6 HDPe OUTLET PIPE – ALL JOINTS TO BE BUTT WELDED
0.75 / 1500

DETAIL 1 callouts:
C EMBANKMENT
SPILLWAY
MEDIUM STONE PITCHING FLOOR AND SIDES PER SANS 1200DK
VEGETATED OUTER SIDE SLOPE
SIDE SLOPES 1:3
TOP OF CREST EL. 1479.000
SILT RETENTION DAM (E2) VOLUME = 32 620m³
S1 1478.200 / S2 1478.000 / S3 / S4 / S5
R=22.5m
26°

SECTION A callouts:
C EMBANKMENT
3000
VEGETATED OUTER SIDE SLOPE
SOP 1479.000
SEE NOTE 10
750
NGL
TWL 1478.200
1476.000
ESTIMATED EXCAVATION LINE OF FOUNDATION LEVEL
SEE NOTE 12
1500 / 0.75
5

DETAIL 3 callouts:
500Ø NB CLASS 6 HDPe OUTLET PIPE
5mx5mx300mm AREA OF STONE PITCHING.
MINIMUM STONE SIZE FOR STONE PITCHING TO BE 150mm PER SANS STANDARD 1200DK, GROUTED MEDIUM PITCHING
SIDE SLOPES 1:3 WITH STONE PITCHING
TO DAYLIGHT / TO FALL
FROM SILT RETENTION DAM (E2)
FALL 1:200
9500 / 5000 / 500

SECTION C callouts:
SIDE SLOPES 1:3
IL 1474.443
NGL
500Ø NB CLASS 6 HDPe OUTLET PIPE
STONE PITCHING

MATERIAL SPECIFICATION FOR COMPACTED FILL DAM WALLS

1. EXCAVATED SOILS FROM THE DAM BASIN EXCAVATION MAY GENERALLY BE USED FOR THE COMPACTED FILL IN THE DAM WALLS.

2. EXCAVATION VOLUMES EXCEED FILL VOLUMES, SO FILL MATERIAL TO BE SELECTED FOR QUALITY.

3. THE DAM FOOTPRINT TO BE CLEARED OF VEGETATION.

4. TOPSOIL TO BE REMOVED TO A DEPTH OF 200mm AND PLACED IN THE TOPSOIL STOCKPILE.

5. GENERALLY UP TO 1m OR SO OF UNSUITABLE MATERIAL IN THE EXCAVATION TO BE DISCARDED.

6. THE EXPECTED MATERIALS IN LOWER LAYERS ARE TILLITES AND CLAYEY DIABASE.

7. MATERIAL FOR THE COMPACTED FILL IN THE WALLS SHALL PREFERABLY BE SELECTED FROM THE SANDY RESIDUAL TILLITES WITH THE FOLLOWING PROPERTIES:-
GRAVEL PERCENTAGE 3 TO 8%
SAND PERCENTAGE 40 TO 70%
SILT PERCENTAGE 20 TO 40%
CLAY PERCENTAGE 10 TO 30%
UNIFIED CLASSIFICATION SC TO CL-ML OR CL

9. DIABASE WITH A HIGH GRAVEL CONTENT, WHERE IT INTERCEPTS THE FERRICRETE CAN BE USED IF REQUIRED IN A 5% COMBINATION WITH THE SANDY TILLITES.

10. THE COMPACTION SPECIFICATION TO BE 95% MOD AASHTO DENSITY ± 2% OMC, PLACED IN 300mm max. LOOSE LAYERS.

11. BOULDERS OR ROCKS GREATER THAN 130mm/TWO THIRDS THE LAYER THICKNESS IN SIZE TO BE DISCARDED.

12. FOLLOWING COMPLETION OF EMBANKMENT CONTRUCTION, EXCAVATED BASIN SURFACE TO BE RE-SEEDED WITH NATIVE GRASSES.

SILT RETENTION DAM W1 GENERAL ARRANGEMENT
SCALE 1:1000

FOR KEYPLAN SEE DRG 30300098/06 301
CLEAN WATER MANAGEMENT
PHASE 1 GA AND SETTING OUT

DETAIL 2 SCALE 1:50

SECTION B SCALE 1:100

DETAIL 4 SCALE 1:20

DETAIL 1 SCALE 1:50

SECTION A SCALE 1:200

DETAIL 3 SCALE 1:100

SECTION C SCALE 1:50

SETTING OUT POINT (SOP) CO-ORDINATES

POINT NAME	N-COORDINATE	E-COORDINATE	Z-COORDINATE
CENTRE LINE OF CREST EMBANKMENT			
A	9736.052	7554.291	1478.500
B	9729.126	7490.032	1478.500
C	9663.809	7459.435	1478.500
D	9633.397	7504.590	1478.500
E	9720.364	7497.391	1474.000
E1	9748.418	7478.177	1473.883
CENTRE LINE OF CLEAN WATER CHANNEL BOTTOM			
F	9668.369	7554.755	1478.500
G	9672.336	7574.664	1479.126
H	9751.512	7694.554	1479.834
J	9642.148	7535.948	1477.587
K	9632.625	7530.850	1477.517
L	9438.002	7452.384	1474.644

SETTING OUT POINT (SOP) CO-ORDINATES

POINT NAME	N-COORDINATE	E-COORDINATE	Z-COORDINATE
EMERGENCY SPILLWAY			
S1	9729.817	7574.493	–
S2	9753.169	7540.277	1477.500
S3	9721.297	7539.661	1477.700
S4	9724.219	7551.608	–
S5	9743.171	7554.947	–
S6	9734.507	7549.143	–

STORMWATER DIVERSION CANAL SIZES

TYPE	DEPTH (D)	WIDTH (W)	X
1	1300mm	8800mm	3900mm
2	1500mm	10000mm	4500mm
3	1700mm	11200mm	5100mm

KUSILE POWER STATION
ASH DUMP No.1
SILT RETENTION DAM (W1)
PLAN AND DETAILS

DRG. No. K30300098/06-323

Knight Piésold

Eskom   0.90/23384

SILT RETENTION DAM W2 GENERAL ARRANGEMENT
SCALE 1:1000

TOPSOIL STORAGE AREA — SEE DRG 30300098/06-230 FOR LAYOUT

SILT RETENTION DAM (W2) VOLUME = 16 300m³

CLEAN WATER COLLECTION CHANNEL (TYPE 2) (W2a)

CLEAN WATER COLLECTION CHANNEL (TYPE 2) (W2b)

FOR KEYPLAN SEE DRG 30300098/06 301 CLEAN WATER MANAGEMENT PHASE 1 GA AND SETTING OUT

CONTINUED ON DRG No. 30300098-06-323 TO W1 SILT RETENTION DAM

CONTINUED ON DRG No. 30300098-06-325 TO W3 SILT RETENTION DAM

DETAIL 2
SCALE 1:50

SECTION B
SCALE 1:100

DETAIL 4
SCALE 1:20

DETAIL 1
SCALE 1:50

DETAIL 3
SCALE 1:100

SECTION A
SCALE 1:200

SECTION C
SCALE 1:50

SETTING OUT POINT (SOP) CO-ORDINATES

POINT NAME	N-COORDINATE	E-COORDINATE	Z-COORDINATE
CENTRE LINE OF CREST EMBANKMENT			
A	9188.358	7442.969	1476.000
B	9214.672	7386.686	1476.000
C	9315.793	7378.248	1476.000
D	9387.314	7438.545	1476.000
E	9265.780	7393.004	1470.500
E1	9263.521	7365.592	1470.484
CENTRE LINE OF CLEAN WATER CHANNEL BOTTOM			
F	9238.361	7475.522	1476.470
G	9225.733	7480.196	1476.600
H	9028.244	7510.678	1477.556
J	9006.760	7512.573	1477.681
K	8999.320	7513.614	1477.721
L	9343.444	7455.098	1475.550
M	9360.448	7459.644	1475.700
N	9394.855	7454.436	1475.875
P	9419.889	7452.529	1476.025

SETTING OUT POINT (SOP) CO-ORDINATES

POINT NAME	N-COORDINATE	E-COORDINATE	Z-COORDINATE
EMERGENCY SPILLWAY			
S1	9176.999	7475.769	—
S2	9174.610	7433.260	1475.000
S3	9205.695	7438.358	1475.200
S4	9175.144	7442.774	—
S5	9196.522	7450.258	—
S6	9187.378	7442.107	—

STORMWATER DIVERSION CANAL SIZES

TYPE	DEPTH (D)	WIDTH (W)	X
1	1300mm	8800mm	3900mm
2	1500mm	10000mm	4500mm
3	1700mm	11200mm	5100mm

SILT RETENTION DAM W3 GENERAL ARRANGEMENT
SCALE 1:1000

FOR KEYPLAN SEE DRG 30300098/06 301
CLEAN WATER MANAGEMENT
PHASE 1 GA AND SETTING OUT

CONTINUED ON
DRG No. 30300098-06-324
TO W2 SILT RETENTION DAM

CONTINUED ON
DRG No. 30300098-06-326
TO W4 SILT RETENTION DAM

SILT RETENTION DAM (W3)
VOLUME = 14 200m³

DETAIL 2
SCALE 1:50

SECTION B
SCALE 1:100

SECTION A
SCALE 1:200

DETAIL 4
SCALE 1:20

DETAIL 1
SCALE 1:50

DETAIL 3
SCALE 1:100

SECTION C
SCALE 1:50

SILT RETENTION DAM (W3)
VOLUME = 14 200m³

SETTING OUT POINT (SOP) CO-ORDINATES			
POINT NAME	N-COORDINATE	E-COORDINATE	Z-COORDINATE
CENTRE LINE OF CREST EMBANKMENT			
A	8845.562	7447.783	1477.000
B	8892.464	7406.111	1477.000
C	8989.212	7438.256	1477.000
D	8989.215	7495.245	1477.000
E	8940.806	7436.399	1470.500
E1	8951.034	7406.074	1470.396
CENTRE LINE OF CLEAN WATER CHANNEL BOTTOM			
F	8897.276	7517.375	1478.500
G	8872.909	7535.240	1480.251
H	8754.582	7553.115	1480.500
J	8691.873	7589.620	1481.835
K	8912.048	7522.711	1478.500
L	8986.715	7516.072	1477.618

SETTING OUT POINT (SOP) CO-ORDINATES			
POINT NAME	N-COORDINATE	E-COORDINATE	Z-COORDINATE
EMERGENCY SPILLWAY			
S1	8831.334	7467.155	—
S2	8836.292	7435.263	1476.000
S3	8863.601	7446.666	1476.200
S4	8852.073	7453.986	—
S5	8835.104	7442.914	—
S6	8846.074	7444.646	—

STORMWATER DIVERSION CANAL SIZES			
TYPE	DEPTH (D)	WIDTH (W)	X
1	1300mm	8800mm	3900mm
2	1500mm	10000mm	4500mm
3	1700mm	11200mm	5100mm

KUSILE POWER STATION
ASH DUMP No.1
SILT RETENTION DAM (W3)
PLAN AND DETAILS

DRG. No. K30300098/06-325

0.90/23386

Eskom

MATERIAL SPECIFICATION FOR COMPACTED FILL DAM WALLS

1. EXCAVATED SOILS FROM THE DAM BASIN EXCAVATION MAY GENERALLY BE USED FOR THE COMPACTED FILL IN THE DAM WALLS.

2. EXCAVATION VOLUMES EXCEED FILL VOLUMES, SO FILL MATERIAL TO BE SELECTED FOR QUALITY.

3. THE DAM FOOTPRINT TO BE CLEARED OF VEGETATION.

4. TOPSOIL TO BE REMOVED TO A DEPTH OF 200mm AND PLACED IN THE TOPSOIL STOCKPILE.

5. GENERALLY UP TO 1m OR SO OF UNSUITABLE MATERIAL IN THE EXCAVATION TO BE DISCARDED.

6. THE EXPECTED MATERIALS IN LOWER LAYERS ARE TILLITES AND CLAYEY DIABASE.

7. MATERIAL FOR THE COMPACTED FILL IN THE WALLS SHALL PREFERABLY BE SELECTED FROM THE SANDY RESIDUAL TILLITES WITH THE FOLLOWING PROPERTIES:—
GRAVEL PERCENTAGE 3 TO 8%
SAND PERCENTAGE 40 TO 70%
SILT PERCENTAGE 20 TO 40%
CLAY PERCENTAGE 10 TO 30%
UNIFIED CLASSIFICATION SC TO CL—ML OR CL

9. DIABASE WITH A HIGH GRAVEL CONTENT, WHERE IT INTERCEPTS THE FERRICRETE CAN BE USED IF REQUIRED IN A 50/50 COMBINATION WITH THE SANDY TILLITES.

10. THE COMPACTION SPECIFICATION TO BE 95% MOD AASHTO DENSITY ± 2% OMC, PLACED IN 300mm max. LOOSE LAYERS.

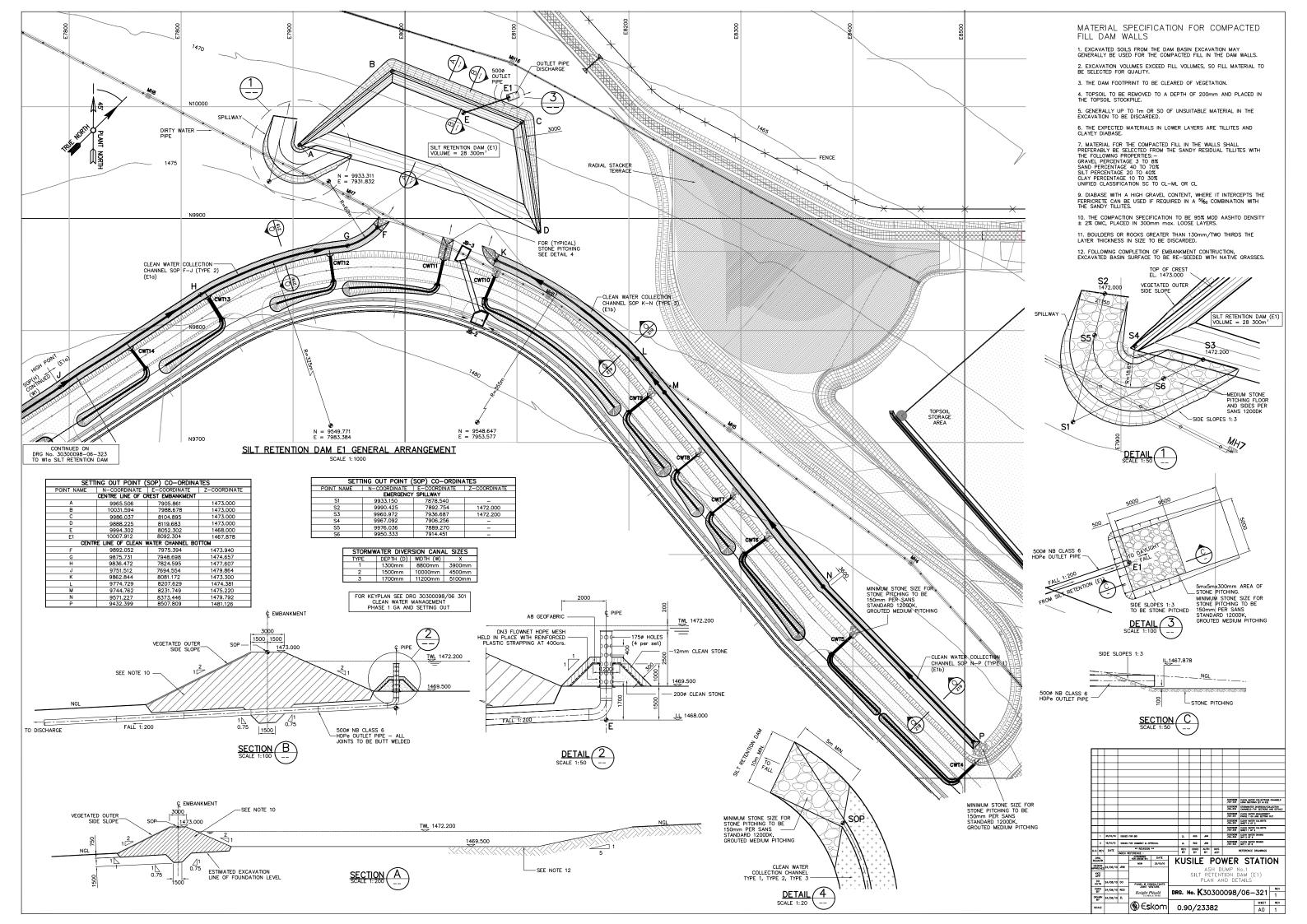11. BOULDERS OR ROCKS GREATER THAN 130mm/TWO THIRDS THE LAYER THICKNESS IN SIZE TO BE DISCARDED.

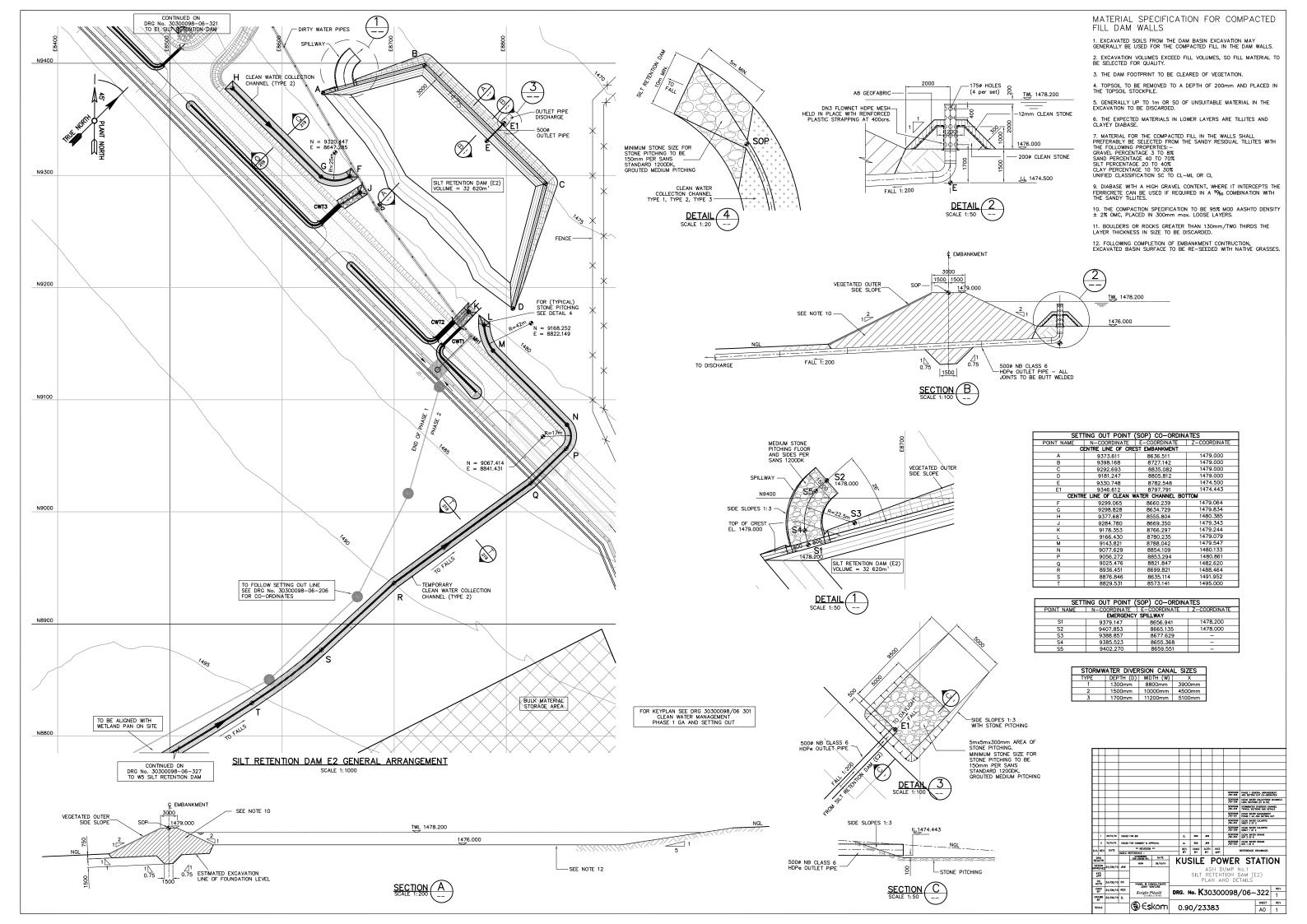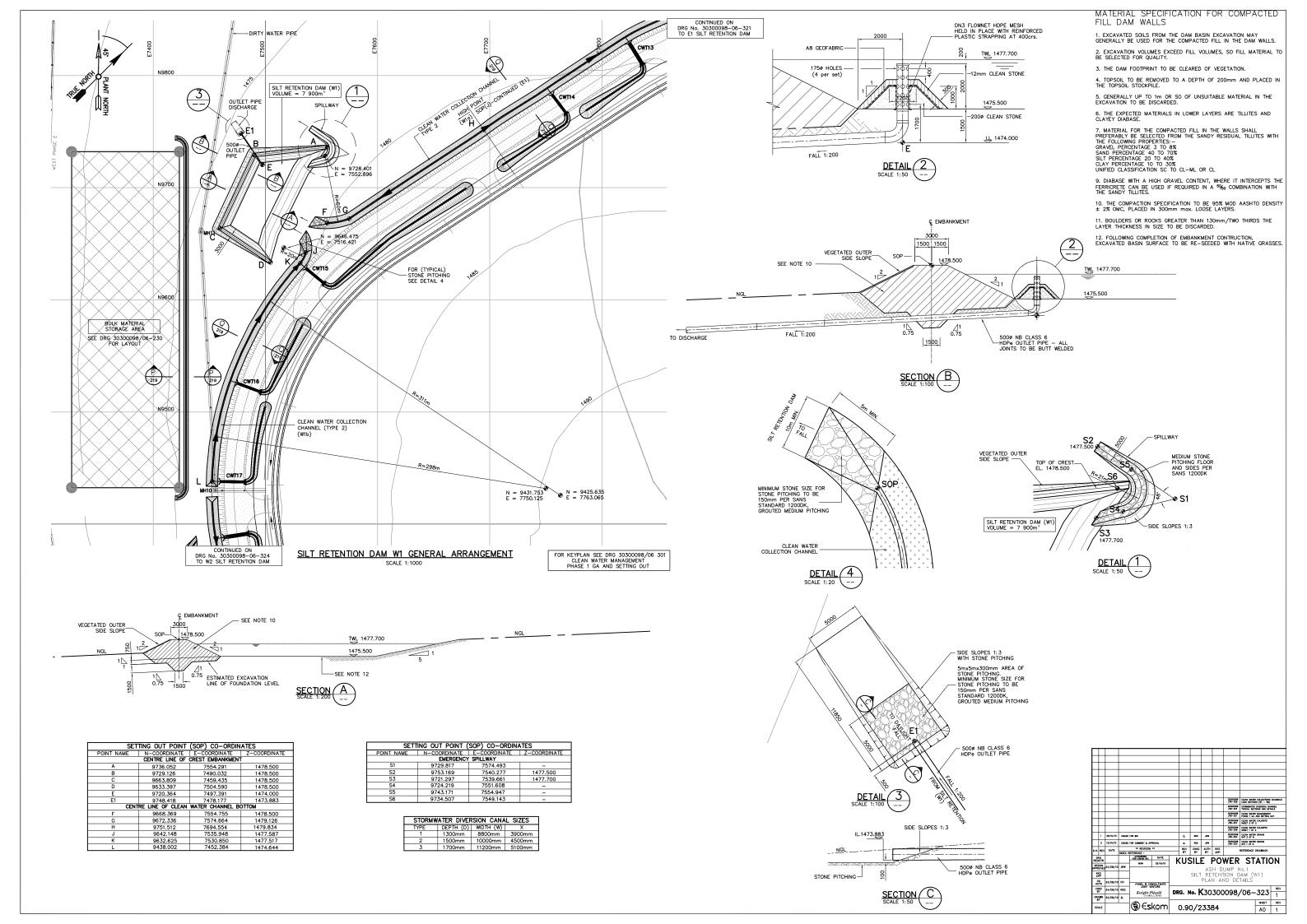12. FOLLOWING COMPLETION OF EMBANKMENT CONTRUCTION, EXCAVATED BASIN SURFACE TO BE RE-SEEDED WITH NATIVE GRASSES.

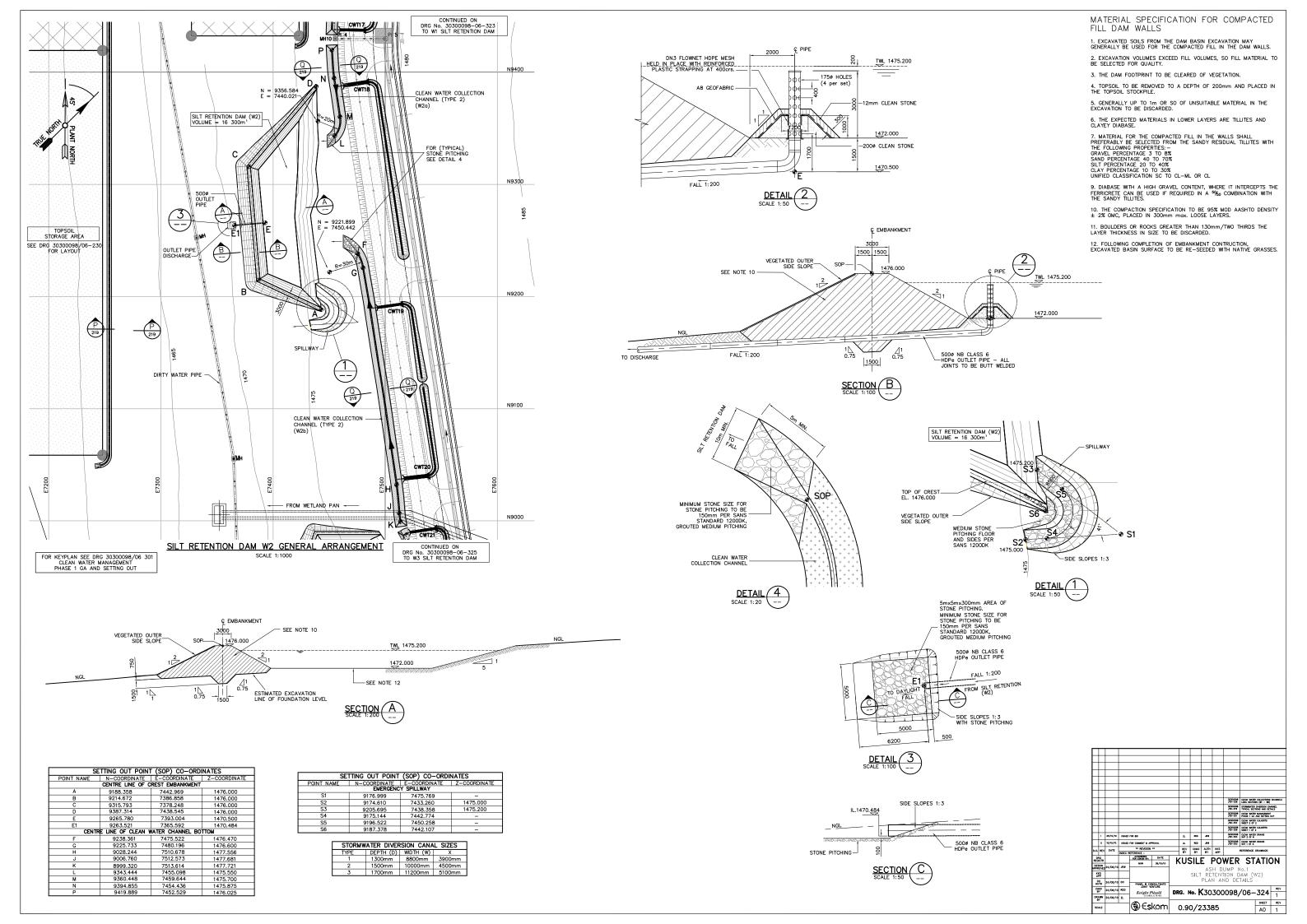## SILT RETENTION DAM W4 GENERAL ARRANGEMENT
SCALE 1:1000

FOR KEYPLAN SEE DRG 30300098/06 301
CLEAN WATER MANAGEMENT
PHASE 1 GA AND SETTING OUT

DETAIL 3
SCALE 1:50

SECTION B
SCALE 1:100

SECTION A
SCALE 1:200

DETAIL 1
SCALE 1:50

DETAIL 2
SCALE 1:50

DETAIL 5
SCALE 1:20

DETAIL 4
SCALE 1:100

SECTION C
SCALE 1:50

SETTING OUT POINT (SOP) CO-ORDINATES

POINT NAME	N-COORDINATE	E-COORDINATE	Z-COORDINATE
CENTRE LINE OF CREST EMBANKMENT			
A	8676.933	7572.014	1482.200
B	8623.575	7495.559	1482.200
C	8541.809	7502.578	1482.200
D	8509.239	7572.507	1482.200
E1	8581.344	7510.446	1476.700
E1	8579.094	7485.048	1476.650
CENTRE LINE OF CLEAN WATER CHANNEL BOTTOM			
F	8623.853	7645.419	1484.742
G	8602.572	7643.260	1484.843
H	8594.964	7672.505	1486.129
J	8499.403	7754.599	1489.548
K	8691.873	7589.620	1490.178
L	8671.770	7601.236	1482.711

SETTING OUT POINT (SOP) CO-ORDINATES

POINT NAME	N-COORDINATE	E-COORDINATE	Z-COORDINATE
EMERGENCY SPILLWAY			
S1	8686.301	7591.933	—
S2	8685.672	7548.624	1481.200
S3	8658.164	7566.891	1481.400
S4	8669.992	7577.418	—
S5	8685.986	7570.213	—
S6	8676.393	7570.274	—
S7	8502.559	7590.511	—
S8	8497.396	7556.542	1481.200
S9	8525.180	7568.211	1481.400
S10	8516.002	7577.259	—
S11	8499.726	7571.873	—
S12	8509.224	7570.457	—

STORMWATER DIVERSION CANAL SIZES

TYPE	DEPTH (D)	WIDTH (W)	X
1	1300mm	8800mm	3900mm
2	1500mm	10000mm	4500mm
3	1700mm	11200mm	5100mm

SILT RETENTION DAM W5 GENERAL ARRANGEMENT
SCALE 1:1000

MATERIAL SPECIFICATION FOR COMPACTED FILL DAM WALLS

1. EXCAVATED SOILS FROM THE DAM BASIN EXCAVATION MAY GENERALLY BE USED FOR THE COMPACTED FILL IN THE DAM WALLS.

2. EXCAVATION VOLUMES EXCEED FILL VOLUMES, SO FILL MATERIAL TO BE SELECTED FOR QUALITY.

3. THE DAM FOOTPRINT TO BE CLEARED OF VEGETATION.

4. TOPSOIL TO BE REMOVED TO A DEPTH OF 200mm AND PLACED IN THE TOPSOIL STOCKPILE.

5. GENERALLY UP TO 1m OR SO OF UNSUITABLE MATERIAL IN THE EXCAVATION TO BE DISCARDED.

6. THE EXPECTED MATERIALS IN LOWER LAYERS ARE TILLITES AND CLAYEY DIABASE.

7. MATERIAL FOR THE COMPACTED FILL IN THE WALLS SHALL PREFERABLY BE SELECTED FROM THE SANDY RESIDUAL TILLITES WITH THE FOLLOWING PROPERTIES:-
GRAVEL PERCENTAGE 3 TO 8%
SAND PERCENTAGE 40 TO 70%
SILT PERCENTAGE 20 TO 40%
CLAY PERCENTAGE 10 TO 30%
UNIFIED CLASSIFICATION SC TO CL-ML OR CL

9. DIABASE WITH A HIGH GRAVEL CONTENT, WHERE IT INTERCEPTS THE FERRICRETE CAN BE USED IF REQUIRED IN A 5‰ COMBINATION WITH THE SANDY TILLITES.

10. THE COMPACTION SPECIFICATION TO BE 95% MOD AASHTO DENSITY ± 2% OMC, PLACED IN 300mm max. LOOSE LAYERS.

11. BOULDERS OR ROCKS GREATER THAN 130mm/TWO THIRDS THE LAYER THICKNESS IN SIZE TO BE DISCARDED.

12. FOLLOWING COMPLETION OF EMBANKMENT CONTRUCTION, EXCAVATED BASIN SURFACE TO BE RE-SEEDED WITH NATIVE GRASSES.

DETAIL 3 — SCALE 1:50
SECTION B — SCALE 1:100
SECTION A — SCALE 1:200
DETAIL 1 — SCALE 1:50
SECTION 4 — SCALE 1:100
DETAIL 2 — SCALE 1:50
SECTION C — SCALE 1:50
DETAIL 5 — SCALE 1:20

SETTING OUT POINT (SOP) CO-ORDINATES

POINT NAME	N-COORDINATE	E-COORDINATE	Z-COORDINATE
CENTRE LINE OF CREST EMBANKMENT			
A	8453.039	7736.027	1490.000
B	8415.612	7682.579	1490.000
C	8358.877	7722.116	1490.000
D	8340.596	7803.542	1490.000
E	8388.582	7712.762	1485.300
E1	8375.952	7694.754	1485.267
CENTRE LINE OF CLEAN WATER CHANNEL BOTTOM			
F	8454.535	7774.499	1490.020
G	8463.115	7786.126	1490.791
H	8487.416	7834.085	1491.963
J	8488.513	7843.853	1492.285
K	8497.293	7962.481	1493.937
L	8522.699	8027.574	1494.765
M	8596.464	8168.999	1494.619
N	8662.838	8317.119	1496.000

SETTING OUT POINT (SOP) CO-ORDINATES
EMERGENCY SPILLWAY

POINT NAME	N-COORDINATE	E-COORDINATE	Z-COORDINATE
S1	8461.473	7750.961	—
S2	8457.065	7704.698	1489.000
S3	8441.257	7737.146	1489.200
S4	8446.682	7740.815	—
S5	8459.738	7733.009	—
S6	8450.990	7733.198	—
S7	8339.612	7827.778	1489.020
S8	8325.288	7792.078	1489.200
S9	8356.778	7783.999	1489.200
S10	8347.637	7807.311	—
S11	8331.392	7807.291	—
S12	8339.518	7804.046	—

STORMWATER DIVERSION CANAL SIZES

TYPE	DEPTH (D)	WIDTH (W)	X
1	1300mm	8800mm	3900mm
2	1500mm	10000mm	4500mm
3	1700mm	11200mm	5100mm

CONTINUED ON DRG No. 30300098-06-326 TO W4 SILT RETENTION DAM

CONTINUED ON DRG No. 30300098-06-322 TO E2 SILT RETENTION DAM

TO FOLLOW SETTING OUT LINE SEE DRG No. 30300098-06-206 FOR CO-ORDINATES

FOR KEYPLAN SEE DRG 30300098/06 301
CLEAN WATER MANAGEMENT PHASE 1 GA AND SETTING OUT

TRUE NORTH
PLANT NORTH
45°

SEE DRG.No. −344

PHASE 1−B

SEE DRG.No. −343

PHASE 1A ROADS
PHASE 1B ROADS

PI 5
PI 4
PI 7
PI 6
PI 8

PHASE 1 ROADS

FUTURE ROADS

SEE DRG.No. −345

PI 9

PHASE 1−A

SEE DRG.No. −342

PI 3

SEE DRG.No. −346

PI 10

PI 2

FUTURE PHASES

PI 11

FUTURE ROADS

PHASE 1 ROADS

PI 1

PI 16

SEE DRG.No. −348

SEE DRG.No. −347

PI 15

PI 12
PI 13
PI 14

N 7400
N 7900
N 8400
N 8900
N 9400
N 9900

E 7500
E 8000
E 8500
E 9000
E 9500

LEGEND

	TOE WALL
	JUNCTION BOX AND DIRTY WATER PIPE
	DIRTY WATER CANAL(C)_L
	CLEAN WATER CHANNEL (C)_L
	GRAVEL SURFACED ACCESS ROAD TO PUMP STATION
	ASPHALT SURFACED ACCESS ROAD No. 3
	PERIMETER ACCESS ROAD/ACCESS ROAD FROM ASH DUMP TO RADIAL STACKER
×—×—×	ASH DUMP FENCE ALIGNMENT
	NEW KUSILE PIPELINE

LEGEND:

- ASPHALT SURFACED ACCESS ROADS
- GRAVEL SURFACED ACCESS ROADS
- REINFORCED CONCRETE SLAB (SECTIONS AND DETAILS BY OTHERS)
- GRAVEL SURFACED HAUL ROADS

TRUE NORTH
PLANT NORTH

ACCESS ROAD No.3 — SETTING OUT DATA

PI No.	CH	EAST-COORD	NORTH-COORD	RAD (m)	DA D M S	TL (m)	AL (m)
CONST:							ACCESS ROAD No.3
PI 1	0.000	7521.649	10733.637				
BC 2	91.482	7591.925	10675.068				
PI 2		7597.412	10670.495	100	8°10'15"	7.142	14.261
EC 2	105.743	7602.193	10665.189				
BC 3	999.333	8200.361	10001.338				
PI 3		8212.521	9987.843	100	20°35'28"	18.165	35.938
EC 3	1035.271	8228.649	9979.487				
BC 4	1217.433	8390.393	9895.689				
PI 4		8412.028	9884.480	100	27°23'18"	24.367	47.802
EC 4	1265.235	8436.395	9884.480				
PI 5	1379.761	8550.921	9884.480				

ROAD SETTING OUT DATA

PI No.	CH	EAST-COORD	NORTH-COORD	RAD (m)	DA D M S	TL (m)	AL (m)
CONST:							PUMP HOUSE ROAD
PI 9	0.000	7394.484	10367.487				
BC 10	36.316	7421.922	10391.279				
PI 10		7452.820	10418.071	200	23°06'48"	40.896	80.680
EC 10	116.997	7491.755	10430.584				
BC 11	194.603	7565.640	10454.328				
PI 11		7606.468	10467.449	200	24°12'17"	42.885	84.490
EC 11	279.093	7638.327	10496.156				
PI 12	365.399	7702.444	10553.929				

WORKSHOP ACCESS ROAD A
WORKSHOP ACCESS ROAD B
WORKSHOP TERRACE (SEE DRAWING K30300098/06-217)

CROSS-FLOW AND SILT DAM SPILLWAY CULVERT 4(750x750) RECTANGULAR CULVERTS LENGTH OF CULVERT=13 PORTALS=15.86m

CROSS-FLOW CULVERT 1(750x750) RECTANGULAR CULVERT, TYPICAL LENGTH OF CULVERT=13 PORTALS=15.86m

ACCESS ROAD No.3

EXISTING START OF CONSTRUCTION
TIE INTO EXISTING ROAD LEVEL

REFER TO DRAWING 146536-0UGA-S3051 FOR TIE TO ROAD

CONSTRUCTION PHASE STORMWATER SILT ATTENUATION DAM (SEE DRG K30300098/06-215)

ACCESS ROAD TO PUMP STATION

PUMP STATION TERRACE (SEE DRAWING K30300098/06-220)

PUMP STATION
1:50 FALL
STORM WATER OUTLET PIPE

CONSTRUCTION PHASE STORMWATER DIVERSION CHANNEL

RADIAL STACKER TERRACE (SEE DRAWING K30300098/06-213)

ACCESS ROAD FROM RADIAL STACKER TO ASH DUMP

E1 Water Volume = 28 300cu.m
Cut Vol = 16 300cu.m
Fill Vol = 9 730cu.m

PERIMETER ACCESS ROAD

NOTE:
1. FOR PROFILE AND SETTING OUT COORDINATES OF ACCESS ROAD TO ASH DUMP, SEE DRG. No. K 30300098/06-349

APPENDIX 1A

ASH DUMP GEOLOGY AND SUB-SURFACE WATER DEPTH PROFILE

N·S BASELINE PLANT GRID · E 10,000
CL OF UNITS

X +2 867 630 (WG29)

RELOCATED 400 KV TRANSMISSION LINE

EXISTING 400 KV TRANSMISSION LINE

E·W BASELINE PLANT GRID · E 10,000
CL OF TURBINES & GENERATORS

X +2 869 000

LINEATION

PAN

AREAS OF SMALL SOLID & BOULDERY DIABASE OUTCROPS

GEOLOGICAL CONTACT

PB70   TEST PITS

AREAS WITH RAPID SEEPAGE IN THE SUBSOIL (SUMMER 2007/8)
(NOTE: SLOW SEEPAGE WAS NOTED IN MOST OTHER PITS)

GEOLOGICAL EXPLANATION

E   ECCA GROUP
DT   DWYKA TILLITE
D   DIABASE
RS   RAYTON SHALE

Interpretation by:
PARTRIDGE, MAUD & ASSOCIATES
Consultants in the Earth Sciences
P.O. BOX 1050, PARKLANDS,
JOHANNESBURG 2121, SOUTH AFRICA
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PRELIMINARY

Eskom

PROJECT BRAVO
ASH DUMP AND COAL STOCKYARD

PLAN SHOWING SURFACE GEOLOGY
AND TEST PITS

SCALE 1:5000	PLAN 0.90/36
MAY., 2008	

APPENDIX 2

ASH PRODUCTION SCHEDULES

Kusile Power Station: Waste Production
ASH/FGD PRODUCTION SCHEDULE

Unit Input Parameters

Ash Output (t/hr)	150.00	Ash S.G.	0.80	Ash Volume (m^3/hr)	187.50
Gypsum Output (t/hr)	19.33	Gypsum S.G.	1.00	Gypsum Volume (m^3/hr)	19.33

Ash Load Factor	0.90	Ash Availability Factor	0.90	Ash Factor of Safety	1.10
Gypsum Load Factor	0.90	Gypsum Availability Factor	0.90	Gypsum Factor of Safety	1.10

Adjusted Unit Output

Ash Output (t/hr)	133.65	Ash Volume (m^3/hr)	167.06	Monthly Ash Volume (m^3)	121956
Gypsum Output (t/hr)	17.22	Gypsum Volume (m^3/hr)	17.22	Monthly Gypsum Volume (m^3)	12573

Commissioning Schedule (relative to project time zero)   Co-Disposal Duration (months)   60

Feb 17 2017 (assume 2 week delay to March 1 2017)

Unit 1 (months):	0	July 1, 2013
Unit 2 (months):	8	March 1, 2014
Unit 3 (months):	16	November 1, 2014
Unit 4 (months):	24	July 1, 2015
Unit 5 (months):	32	March 1, 2016
Unit 6 (months):	40	November 1, 2016

Ash Dump No. 1 Production Schedule

Period (months) Start	End	Units Online	Inc. Ash (m³)	Inc. FGD (m³)	Total Ash (m³)	Total FGD (m³)	Total (m³)
0	4	1	487823	50291	487823	50291	538114
4	8	1	487823	50291	975645	100582	1076227
8	12	2	975645	100582	1951290	201165	2152455
12	16	2	975645	100582	2926935	301747	3228682
16	20	3	1463468	150874	4390403	452621	4843024
20	24	3	1463468	150874	5853870	603495	6457365
24	28	4	1951290	201165	7805160	804660	8609820
28	32	4	1951290	201165	9756450	1005825	10762275
32	36	5	2439113	251456	12195563	1257281	13452844
36	40	5	2439113	251456	14634675	1508737	16143412
40	44	6	2926935	301747	17561610	1810485	19372095
44	48	6	2926935	301747	20488545	2112232	22600777
48	52	6	2926935	301747	23415480	2413980	25829460
52	56	6	2926935	301747	26342415	2715727	29058142
56	60	6	2926935	301747	29269350	3017475	32286825
60	64	6	0	301747	29269350	3319222	32588572
64	68	6	0	301747	29269350	3620970	32890320
68	72	6	0	301747	29269350	3922717	33192067
72	76	6	0	301747	29269350	4224465	33493815
76	80	6	0	301747	29269350	4526212	33795562
80	84	6	0	301747	29269350	4827960	34097310
84	88	6	0	301747	29269350	5129707	34399057
88	92	6	0	301747	29269350	5431455	34700805
92	96	6	0	301747	29269350	5733202	35002552
96	100	6	0	301747	29269350	6034950	35304300
100	104	6	0	301747	29269350	6336697	35606047
104	108	6	0	301747	29269350	6638445	35907795
108	112	6	0	301747	29269350	6940192	36209542
112	116	6	0	301747	29269350	7241940	36511290
116	120	6	0	301747	29269350	7543687	36813037
120	124	6	0	301747	29269350	7845435	37114785
124	128	6	0	301747	29269350	8147182	37416532
128	132	6	0	301747	29269350	8448930	37718280
132	136	6	0	301747	29269350	8750677	38020027
136	140	6	0	301747	29269350	9052425	38321775
140	144	6	0	301747	29269350	9354172	38623522
144	148	6	0	301747	29269350	9655920	38925270
148	152	6	0	301747	29269350	9957667	39227017
152	156	6	0	301747	29269350	10259415	39528765
156	160	6	0	301747	29269350	10561162	39830512
160	164	6	0	301747	29269350	10862909	40132259
164	168	6	0	301747	29269350	11164657	40434007
168	172	6	0	301747	29269350	11466404	40735754
172	176	6	0	301747	29269350	11768152	41037502
176	180	6	0	301747	29269350	12069899	41339249
180	184	6	0	301747	29269350	12371647	41640997
184	188	6	0	301747	29269350	12673394	41942744
188	192	6	0	301747	29269350	12975142	42244492
192	196	6	0	301747	29269350	13276889	42546239
196	200	6	0	301747	29269350	13578637	42847987
200	204	6	0	301747	29269350	13880384	43149734
204	208	6	0	301747	29269350	14182132	43451482
208	212	6	0	301747	29269350	14483879	43753229
212	216	6	0	301747	29269350	14785627	44054977
216	220	6	0	301747	29269350	15087374	44356724
220	224	6	0	301747	29269350	15389122	44658472
224	228	6	0	301747	29269350	15690869	44960219
228	232	6	0	301747	29269350	15992617	45261967
232	236	6	0	301747	29269350	16294364	45563714
236	240	6	0	301747	29269350	16596112	45865462
240	244	6	0	301747	29269350	16897859	46167209
244	248	6	0	301747	29269350	17199607	46468957
248	252	6	0	301747	29269350	17501354	46770704
252	256	6	0	301747	29269350	17803102	47072452
256	260	6	0	301747	29269350	18104849	47374199
260	264	6	0	301747	29269350	18406597	47675947
264	268	6	0	301747	29269350	18708344	47977694
268	272	6	0	301747	29269350	19010092	48279442
272	276	6	0	301747	29269350	19311839	48581189
276	280	6	0	301747	29269350	19613587	48882937
280	284	6	0	301747	29269350	19915334	49184684
284	288	6	0	301747	29269350	20217082	49486432
288	292	6	0	301747	29269350	20518829	49788179
292	296	6	0	301747	29269350	20820577	50089927
296	300	6	0	301747	29269350	21122324	50391674
300	304	6	0	301747	29269350	21424071	50693421
304	308	6	0	301747	29269350	21725819	50995169
308	312	6	0	301747	29269350	22027566	51296916
312	316	6	0	301747	29269350	22329314	51598664
316	320	6	0	301747	29269350	22631061	51900411
320	324	6	0	301747	29269350	22932809	52202159
324	328	6	0	301747	29269350	23234556	52503906
328	332	6	0	301747	29269350	23536304	52805654
332	336	6	0	301747	29269350	23838051	53107401
336	340	6	0	301747	29269350	24139799	53409149
340	344	6	0	301747	29269350	24441546	53710896
344	348	6	0	301747	29269350	24743294	54012644
348	352	6	0	301747	29269350	25045041	54314391
352	356	6	0	301747	29269350	25346789	54616139
356	360	6	0	301747	29269350	25648536	54917886
360	364	6	0	301747	29269350	25950284	55219634
364	368	6	0	301747	29269350	26252031	55521381
368	372	6	0	301747	29269350	26553779	55823129
372	376	6	0	301747	29269350	26855526	56124876
376	380	6	0	301747	29269350	27157274	56426624
380	384	6	0	301747	29269350	27459021	56728371
384	388	6	0	301747	29269350	27760769	57030119
388	392	6	0	301747	29269350	28062516	57331866
392	396	6	0	301747	29269350	28364264	57633614
396	400	6	0	301747	29269350	28666011	57935361
400	404	6	0	301747	29269350	28967759	58237109
404	408	6	0	301747	29269350	29269506	58538856
408	412	6	0	301747	29269350	29571254	58840604
412	416	6	0	301747	29269350	29873001	59142351
416	420	6	0	301747	29269350	30174749	59444099
420	424	6	0	301747	29269350	30476496	59745846
424	428	6	0	301747	29269350	30778244	60047594
428	432	6	0	301747	29269350	31079991	60349341
432	436	6	0	301747	29269350	31381739	60651089
436	440	6	0	301747	29269350	31683486	60952836
440	444	6	0	301747	29269350	31985233	61254583
444	448	6	0	301747	29269350	32286981	61556331
448	452	6	0	301747	29269350	32588728	61858078
452	456	6	0	301747	29269350	32890476	62159826

456	460	6	0	301747	29269350	33192223	62461573
460	464	6	0	301747	29269350	33493971	62763321
464	468	6	0	301747	29269350	33795718	63065068
468	472	6	0	301747	29269350	34097466	63366816
472	476	6	0	301747	29269350	34399213	63668563
476	480	6	0	301747	29269350	34700961	63970311
480	484	6	0	301747	29269350	35002708	64272058
484	488	6	0	301747	29269350	35304456	64573806
488	492	6	0	301747	29269350	35606203	64875553
492	496	6	0	301747	29269350	35907951	65177301
496	500	6	0	301747	29269350	36209698	65479048
500	504	6	0	301747	29269350	36511446	65780796
504	508	6	0	301747	29269350	36813193	66082543
508	512	6	0	301747	29269350	37114941	66384291
512	516	6	0	301747	29269350	37416688	66686038
516	520	6	0	301747	29269350	37718436	66987786
520	524	6	0	301747	29269350	38020183	67289533
524	528	6	0	301747	29269350	38321931	67591281
528	532	6	0	301747	29269350	38623678	67893028
532	536	6	0	301747	29269350	38925426	68194776
536	540	6	0	301747	29269350	39227173	68496523
540	544	6	0	301747	29269350	39528921	68798271
544	548	6	0	301747	29269350	39830668	69100018
548	552	6	0	301747	29269350	40132416	69401766
552	556	6	0	301747	29269350	40434163	69703513
556	560	6	0	301747	29269350	40735911	70005261
560	564	6	0	301747	29269350	41037658	70307008
564	568	6	0	301747	29269350	41339406	70608756
568	572	6	0	301747	29269350	41641153	70910503
572	576	6	0	301747	29269350	41942900	71212250
576	580	6	0	301747	29269350	42244648	71513998
580	584	6	0	301747	29269350	42546395	71815745
584	588	6	0	301747	29269350	42848143	72117493
588	592	6	0	301747	29269350	43149890	72419240
592	596	6	0	301747	29269350	43451638	72720988
596	600	6	0	301747	29269350	43753385	73022735
600	604	6	0	301747	29269350	44055133	73324483
604	608	6	0	301747	29269350	44356880	73626230
608	612	6	0	301747	29269350	44658628	73927978
612	616	6	0	301747	29269350	44960375	74229725
616	620	6	0	301747	29269350	45262123	74531473
620	624	6	0	301747	29269350	45563870	74833220
624	628	6	0	301747	29269350	45865618	75134968
628	632	6	0	301747	29269350	46167365	75436715
632	636	6	0	301747	29269350	46469113	75738463
636	640	6	0	301747	29269350	46770860	76040210
640	644	6	0	301747	29269350	47072608	76341958
644	648	6	0	301747	29269350	47374355	76643705
648	652	6	0	301747	29269350	47676103	76945453
652	656	6	0	301747	29269350	47977850	77247200
656	660	6	0	301747	29269350	48279598	77548948
660	664	6	0	301747	29269350	48581345	77850695
664	668	6	0	301747	29269350	48883093	78152443
668	672	6	0	301747	29269350	49184840	78454190
672	676	6	0	301747	29269350	49486588	78755938
676	680	6	0	301747	29269350	49788335	79057685
680	684	6	0	301747	29269350	50090083	79359433
684	688	6	0	301747	29269350	50391830	79661180
688	692	6	0	301747	29269350	50693578	79962928
692	696	6	0	301747	29269350	50995325	80264675
696	700	6	0	301747	29269350	51297073	80566423
700	704	6	0	301747	29269350	51598820	80868170
704	708	6	0	301747	29269350	51900568	81169918
708	712	6	0	301747	29269350	52202315	81471665
712	716	6	0	301747	29269350	52504062	81773412
716	720	6	0	301747	29269350	52805810	82075160

APPENDIX 3

DWA LINER CORRESPONDENCE

KUSILE POWER STATION ASH DUMP
IWULA APPLICATION

DWA letter ref 16/2/7/B200/B174 refers.
I section B: Substansive Aspects, it is stated that the proposed liner system does not conform to the requirements of the DWA "Minimum Standards" document.

In this respect, discussions were held with Mr. F. Druits at the DWA offices in Pretoria on 6 August 2009.
The Minimum Standards document requires a 3-layer liner system comprising synthetic and clay layers with leakage detection, for a class H:h waste disposal facility. As there is no clay available in the Kusile Power station locality, it was agreed that the liner system for Kusile would be constructed using only synthetic materials (HDPE sheeting), with appropriate leakage detection facilities.

It was further proposed that because of the "dry" dumping nature of the Kusile ash dump, where ash and gypsum would be placed at only 15% moisture content, there was motivation to consider relaxation of the Minimum Standards liner requirements.

 Although the "Cautionary Principle" is understood and accepted, there is thus a view that the caution could be applied less rigorously in the case at Kusile (The ash is classified as non-toxic and the FGD Gypsum (USA sample) classifies as a moderate hazard waste. The 1:6 mix of FGD/Ash also classifies as a moderate hazard waste, but the dump is a dry dump so leachate is unlikely to be present).

It was thus proposed to DWA (Druits) that the Kusile ash dump be provided with a two layer liner system instead of the three layer requirement of the Minimum Standards document.

The motivation for only providing a 2-hdpe layer system is because of the high residual field capacity of the ash/gypsum after placement at 15% moisture content.

This means that it is highly unlikely that a seepage plume will ever develop in the ash dump, so seepage to the base drainage layer and leakage is unlikely. It is thus considered that a 2-layer system with seepage collection above the liner, will more than adequately provide a seal and leakage indication to cover this dry dumping case.

There is a technical paper on the subject of field capacity of South African ash dumps ; "Optimisation of Dry Ash Disposal Operations at Tutuka Power Station" by Dorman and Kreuiter. This states that if the initial moisture content of the ash does not exceed 25%, the ash dump can absorb and retain between $3.5m^3$ and $4.2m^3$ per $1m^2$ of dump surface area, for 20m and 40m high dumps respectively.(the Kusile dump will have an average height of 35m). The Authors further noted that a phreatic surface would only develop should uncontrolled irrigation take place continuously over a period of 2 to 3 months. At Kusile, a specific irrigation and dust control management plan will be in place to provide assurance that these aspects are strictly controlled. Furthermore there will not be any disposal of excess effluents from the power station to the ash dump.

DWA (F. Druits) has provided written approval to the proposes two-layer liner system for the Kusile ash dump, whereby the liners will each be 2mm HDPE with a cuspated HDPE leakage detection layer sandwiched in-between. The e-mail correspondence in this respect is attached over-leaf.

30300098/6/Reports
JRW 27 August 2009

PANEL B CONSULTANTS JOINT VENTURE

Rob Williamson

From:	Matlanato Suphic [SMatlanato@dwaf.gov.za] on behalf of Druyts Frans [DruytsF@dwaf.gov.za]
Sent:	Monday, August 17, 2009 11:43 AM
To:	Rob Williamson; Druyts Frans
Cc:	Douglas Dorren; Scott Rees; Kirkpatrick, Shelly K.; Michael Were
Subject:	RE: Kusile Ash Dump

Good day,

Your motivation is noted and accepted. Please include your reasoning in your formal application. I will recommend approval of the double (2) HDPE lining ash membrane having 2 minimum thickness of 2 mm.

Regards,

FRANS

From: Rob Williamson [mailto:jwilliamson@knightpiesold.com]
Sent: 12 August 2009 09:50 AM
To: Druyts Frans
Cc: Douglas Dorren; Scott Rees; Kirkpatrick, Shelly K.; Michael Were
Subject: Kusile Ash Dump

Dear Frans,

Thanks for seeing us last week and for the discussions.

The Client has requested that we review the necessity of a 3-hdpe layer requirement for compliance with the "Minimum Standards" document, because of the "dry" dumping nature of the facility. Although the "Cautionary Principle" is understood and accepted, there is a view that the caution could be applied less rigorously in this particular situation? (The ash is classified as non-toxic and the FGD Gypsum (USA sample) classifies as a moderate hazard waste. The 1:6 mix of FGD/Ash also classifies as a moderate hazard waste, but the dump is a dry dump so leachate is unlikely to be present)

The motivation for only providing a 2-hdpe layer system was because of the high residual field capacity of the ash/gypsum after placement at 15% m/c.

This means that it is highly unlikely that a seepage plume will ever develop in the ash dump, so seepage to the base drainage layer and leakage is unlikely. It is thus considered that a 2-layer system with seepage collection above the liner, will more than adequately provide a seal and leakage indication to cover this dry dumping case.

There is a paper on the subject of field capacity of South African ash dumps ; "Optimisation of Dry Ash Disposal Operations at Tutuka Power Station" by Dorman and Kreulter. This states that if the initial moisture content of the ash does not exceed 25%, the ash dump can absorb and retain between 3.5m3 and 4.2m3 per 1m2 of dump surface area, for 20m and 40m high dumps respectively.(the Kusile dump will have an average height of 35m). The Authors further noted that a phreatic surface would only develop should uncontrolled irrigation take place continuously over a period of 2 to 3 months.

We therefore request your re-consideration towards acceptance of the proposed 2-hdpe liner system with a single leakage detection layer i.e. for only partial compliance with the Minimum Standards.

We are happy to come to your office again to discuss the matter further.

Regards

....
JRG (Rob) Williamson
Technical Consultant
Knight Piésold (Pty) Ltd.
....

1

APPENDIX 4

STORMWATER HYDROLOGY AND HYDRAULIC CALCULATION RECORD

PANEL B CONSULTANTS JOINT VENTURE
Calculation Record

Client Name:	ESKOM	**Page:**	1	**of**	36

Project Name: Kusile Power Station **Job No:** 303-00098/06

Calculation Title: 10 yr Ash Dump Stormwater – Dirty and Clean Systems Hydrology and Hydraulic Calculations

Calculation No./File No.: V:\303-00098\04\A\CALCULATIONS\ASH DUMP - 10 YR\Hydraulic Design\Ash Dump Calculation Record 011010.doc

Calculation is: ☐ Preliminary ☒ Final

Objective: Detailed hydraulic design of the clean and dirty stormwater systems and the ash dump dirty dam including the energy dissipation structures.

Unverified assumptions requiring subsequent verification			
No.	**Assumption**	**Verified by**	**Date**
	None		

This section applies to computer generated calculations	
Program Name/Number:	**Version:**
Program Name/Number:	**Version:**
Evidence of or reference to computer program verification, if applicable:	
Bases or reference thereto supporting application of the computer program to the physical problem:	

Review and approval						
Rev	Prepared by	Date	Verified by	Date	Approved by	Date
0	Nicholas Pilz	October 2010				

PANEL B CONSULTANTS JOINT VENTURE	Client:	ESKOM			Computed by:	Nicholas Pilz
	Project:	Kusile Power Station	Component:	Ash Dump Hydraulics	Date:	October 2010
	Job no.:	303-00098/06	File no.:		Checked by:	Rob Williamson
	Title:	10 yr Ash Dump Stormwater – Dirty and Clean Systems Hydrology and Hydraulic Calculations			Date:	October 2010
					Page: 2 of 36	

1. PURPOSE:

To calculate the size of various unlined diversion canals conveying stormwater runoff around the Coal Stock Yard as well as the associated hydraulic structures such as the concrete drop structures.

2. REFERENCES:

1.	Ash Dump No.1 – General Arrangement Plan	30300098/06-201	Rev	1
2.	Ash Dump No.1 – Geotechnical Plan	30300098/06-202	Rev	1
3.	Ash Dump No.1 – Phase 1 GA & Setting Out Co-ordinates	30300098/06-206	Rev	2
4.	Ash Dump No.1 – Typical Overall Sections	30300098/06-207	Rev	0
5.	Wetland / Pan Drainage Plan and Details	30300098/06-208	Rev	2
6.	Wetland / Pan Drainage – DN100 Kabelflex Longitudinal Section	30300098/06-209	Rev	2
7.	Footprint Site Preparation – Phase 1	30300098/06-210	Rev	2
8.	Footprint Site Preparation – Phase 1 Details	30300098/06-211	Rev	2
9.	Terracing of Radial Stacker – General Arrangement Plan	30300098/06-213	Rev	2
10.	Ash Dump Dirty Dam – Construction Phase Storm Water Management GA	30300098/06-215	Rev	1
11.	Ash Dump No.1 – Construction Phase Storm Water Management GA	30300098/06-216	Rev	1
12.	Workshop Terrace – General Arrangement & Typical Sections	30300098/06-217	Rev	2
13.	Pump Station Terrace – General Arrangement & Typical Sections	30300098/06-218	Rev	2
14.	Ash Dump No. 1 – Storm Water Diversion/Collection Channels – Typical Sections & Details	30300098/06-219	Rev	1
15.	HDPE Liner General Arrangement, Phase 1	30300098/06-220	Rev	2
16.	Sections And Details, Phase 1	30300098/06-221	Rev	2
17.	Drainage above HDPE Liner – General Arrangement & Details, Phase 1	30300098/06-224	Rev	2
18.	Dirty Water Management – General Arrangement & Details, Phase 1	30300098/06-231	Rev	1
19.	Dirty Water Drains – Concrete Details	30300098/06-232	Rev	2
20.	ADDD – General Arrangement and Setting Out Co-ordinates	30300098/06-280	Rev	2
21.	ADDD – Sections And Details – Sheet 1 of 2	30300098/06-281	Rev	2
22.	ADDD – Sections And Details – Sheet 2 of 2	30300098/06-282	Rev	2
23.	ADDD – Compartment No. 1 Inlet – General Arrangement & Details	30300098/06-283	Rev	2
24.	ADDD – Compartment No. 1 Outlet – General Arrangement & Details	30300098/06-284	Rev	2
25.	ADDD – Spillway No.1 – General Arrangement & Details	30300098/06-285	Rev	2
26.	ADDD – Spillway No.2 – General Arrangement & Details	30300098/06-286	Rev	2
27.	ADDD – Energy Dissipator No. 1 – General Arrangement & Details	30300098/06-287	Rev	2
28.	ADDD – Leakage Detection Sump – General Arrangement & Details	30300098/06-288	Rev	1
29.	ADDD – Compartment No. 2 Inlet – General Arrangement & Details	30300098/06-289	Rev	1
30.	ADDD – Compartment No. 2 Outlet – General Arrangement & Details	30300098/06-290	Rev	1
31.	ADDD – Compartment No. 1 Basin Division Walls & Details	30300098/06-295	Rev	1
32.	ADDD – Compartment No. 2 Basin Division Walls & Details	30300098/06-296	Rev	1
33.	Clean Water Management – Phase 1 General Arrangement	30300098/06-301	Rev	1
34.	Clean Water Drains, Sheet 1 of 6	30300098/06-303	Rev	2
35.	Clean Water Drains, Sheet 2 of 6	30300098/06-304	Rev	2

PANEL B CONSULTANTS JOINT VENTURE	Client:	ESKOM			Computed by:	Nicholas Pilz
	Project:	Kusile Power Station	Component:	Ash Dump Hydraulics	Date:	October 2010
	Job no.:	303-00098/06	File no.:		Checked by:	Rob Williamson
	Title:	10 yr Ash Dump Stormwater – Dirty and Clean Systems Hydrology and Hydraulic Calculations			Date:	October 2010
					Page: 3 of 36	

36.	Ash Dump No. 1 – Bulk Material Storage Stockpile Diversion Channels	30300098/06-320	Rev	1
37.	Ash Dump No. 1 – Silt Retention Dam (E1) – Plan and Details	30300098/06-321	Rev	1
38.	Ash Dump No. 1 – Silt Retention Dam (E2) – Plan and Details	30300098/06-322	Rev	1
39.	Ash Dump No. 1 – Silt Retention Dam (W1) – Plan and Details	30300098/06-323	Rev	1
40.	Ash Dump No. 1 – Silt Retention Dam (W2) – Plan and Details	30300098/06-324	Rev	1
41.	Ash Dump No. 1 – Silt Retention Dam (W3) – Plan and Details	30300098/06-325	Rev	1
42.	Ash Dump No. 1 – Silt Retention Dam (W4) – Plan and Details	30300098/06-326	Rev	1
43.	Ash Dump No. 1 – Silt Retention Dam (W5) – Plan and Details	30300098/06-327	Rev	1
44.	Perimeter Access Road – General Arrangement	30300098/06-340	Rev	2
45.	Access Road No. 3 – General Arrangement and Setting Out Co-ordinates	30300098/06-370	Rev	2

3. ASSUMPTIONS

Clean Water Canals sized for the 1 : 100 year flood event
Dirty Water Canals sized for the 1 : 50 year flood event

Density of water =	1000 kg/m^3
Acceleration due to gravity =	9.81m/s^2
Sub-critical flow conditions require Froude Number	> 0.70
Allowance for groundwater seepage =	10%
Additional freeboard =	300 mm
Mannings' n-value for unlined canals =	0.023
Mannings' n-value for lined canals =	0.018
Mannings' n-value for concrete culverts =	0.012

Additional assumptions are listed in the detailed hydrology and hydraulic calculations, where applicable.

4. PROCEDURE/METHODOLOGY OF DESIGN:

4.1   Determine Catchment Areas
4.2   Calculate the 1 : 50 and 1 : 100 year flood peaks
4.3   Determine the location of the proposed surface canals
4.4   Calculate canal sizes for the given flowrates
4.5   Design associated structures such as energy dissipators and culverts
4.6   Calculate run-off volumes and determine the required ADDD storage capacity as well as clean water retention ponds.

5.   FLOOD HYDROLOGY CALCULATIONS

5.1   Catchment Characteristics

5.1.1   Dirty Catchment Area

Dirty water catchment area comprises:

- Active dumping face,
- a 50 m section behind the active face
- 1-year irrigation zone
- Further 2 years of rehabilitation zone

PANEL B CONSULTANTS JOINT VENTURE	Client:	ESKOM			Computed by:	Nicholas Pilz
	Project:	Kusile Power Station	Component:	Ash Dump Hydraulics	Date:	October 2010
	Job no.:	303-00098/06	File no.:		Checked by:	Rob Williamson
	Title:	10 yr Ash Dump Stormwater – Dirty and Clean Systems Hydrology and Hydraulic Calculations			Date:	October 2010
					Page: 4	of 36

5 year ash dump footprint is developed in two phases; 1A and 1B:

- – Phase 1A comprises the 1st three years of deposition;
- – Phase 1B consists of years 4 and 5 of deposition.

Phase 2 comprises the remaining 55 years of deposition.

The phased development of the Ash dump is illustrated in **Appendix 1**.

Phase 1A to be fully rehabilitated after 6 years of deposition and Phase 1B will be fully rehabilitated after 8 years of deposition. Establishing surface area is still considered dirty water catchment, if it encloses both irrigation and dust suppression areas.

The run-off from the catchment area surrounding the radial stacker is also considered dirty. This catchment area will remain dirty for the 60yr disposal period.

The catchment areas during dirty disposal are shown in Table 1 below.

Table 1 : Dirty Water Catchment Areas

Phase	Deposition Period	Total Area
-	Years	km^2
1A	1 – 3	0.511
1B	4 - 5	0.775
2 (East)	6 – 8*	0.162
2 (West)	6 – 8*	0.256
Radial Stacker	1 –	0.049

* The catchment areas in phase two will remain essentially constant for the remaining years of deposition i.e. to year 60.

5.1.2 Clean Catchment Area

Ash dump has been divided into a series of individual catchments, each contributing to an individual clean water canal, as defined by the topography along the canal routes. See **Appendix 2**.

5.1.3 Catchment Run-off Coefficients

The runoff coefficient is based on surface slopes, permeability and vegetation.

- – Run-off co-efficient of 0.504 is based on a rehabilitated dirty catchment areas;
- – Run-off co-efficient of 0.436 is based on a rehabilitated clean catchment areas;
- – Run-off co-efficient of 0.700 is based on a rehabilitated dirty catchment area and concrete surface for the radial stacker platform.

5.1.4 Time of Concentration

The Time of Concentration for overland flow conditions uses the equation shown below:

$$T_c = 0.604 \left(\frac{rL}{S^{0.5}} \right)^{0.467} \qquad \text{Equation 1}$$

Where T_c =   Time of Concentration (hrs)
   r =   Roughness coefficient
   L =   Longest Flowpath (m)
   S =   Catchment Slope (m/m)

The Time of Concentration for defined watercourses uses the equation shown below:

PANEL B	Client:	ESKOM			Computed by:	Nicholas Pilz
CONSULTANTS	Project:	Kusile Power Station	Component:	Ash Dump Hydraulics	Date:	October 2010
JOINT	Job no.:	303-00098/06	File no.:		Checked by:	Rob Williamson
VENTURE	Title:	10 yr Ash Dump Stormwater – Dirty and Clean Systems Hydrology			Date:	October 2010
		and Hydraulic Calculations			Page: 5	of 36

$$T_c = \left(\frac{0.87L^2}{1000S_{av}} \right)^{0.385}$$ Equation 2

Where T_c = Time of Concentration (hrs)
  L = Longest Flowpath (m)
  S_{av} = Average Catchment Slope (m/m)

Time of Concentration assumes overland flow down the active face and defined channel flow along the edge of ash dump.

Longest flowpath is the longest distance that water would follow from the furthest point in the catchment to the end of the flowpath.

5.1.5 Rainfall

Mean Annual Precipitation (MAP) = 655mm

The rainfall station 0514618W at Wilge Rivier was chosen as the most reliable due to the length of its record (98 years) as well as the fact that the station is still in operation.

Table 2 : Characteristics of Rainfall Station – 0514618W

Rainfall Station	Mean Annual Precipitation (mm)	Record (years)
0514618W	701	98

Table 3 : Design Rainfall for Station 0514618W

Duration (Days)	Return Period (years)						
	2	5	10	20	50	100	200
1 day	50	70	84	100	122	141	162
2 days	64	89	109	129	160	187	217
3 days	74	102	123	147	181	210	243
7 days	100	135	161	188	226	258	292

Recommended return period point precipitation:
  – 122 mm is used to determine the 50 year flood event (dirty water system);
  – 141 mm is used to determine the 100 year flood event (clean water system).

5.2 Flood Peak Determination

Small catchment areas therefore deterministic approach was adopted. Rational Method was used to determine flood peaks. Flood peaks calculated using following equation:

$$Q = \frac{C.I.A}{3.6}$$ Equation 3

Where Q = Peak Flow (m³/s)
  C = runoff coefficient
  I = Rainfall Intensity (mm/hr)
  A = Catchment Area (km²)

Intensity is the Point Precipitation divided by the Time of Concentration.

PANEL B CONSULTANTS JOINT VENTURE	Client:	ESKOM			Computed by:	Nicholas Pilz
	Project:	Kusile Power Station	Component:	Ash Dump Hydraulics	Date:	October 2010
	Job no.:	303-00098/06	File no.:		Checked by:	Rob Williamson
	Title:	10 yr Ash Dump Stormwater – Dirty and Clean Systems Hydrology and Hydraulic Calculations			Date:	October 2010
					Page: 6 of 36	

5.3 Stormwater Runoff

5.3.1 Dirty Water Runoff

The calculated dirty water runoff flowrates are summarised in Table 4 below.

Table 4 : 1:50 yr Dirty Water Runoff Flowrates

Catchment Area		Flowpath	Time of Concentration	Intensity*	Runoff C	Flowrate
	km^2	km	hrs	mm/hr	-	m^3/s
Phase 1A	0.511	1.732	1.021	119.472	0.504	8.545
Phase 1B	0.775	1.949	1.124	108.591	0.504	11.796
Phase 2 (East)	0.162	0.689	0.486	250.842	0.504	5.687
Phase 2 (West)	0.256	0.875	0.579	210.804	0.504	7.562
Radial Stacker	0.049	0.549	0.607	200.732	0.700	1.904

* Intensity based on 1:50 yr 24 hr Point Precipitation of 122 mm

5.3.1 Clean Water Runoff

The calculated clean water runoff flowrates for Phase 1A and 1B are summarised in Table 5 and Table 6 below.

Table 5 : 1:100yr Clean Water Runoff Flowrates (Phase 1A)

Catchment Area		Flowpath	Time of Concentration	Intensity*	Runoff C	Flowrate
Clean Catchment	km^2	Km	hrs	mm/hr	-	m^3/s
CWT1	0.034	0.674	0.645	218.463	0.436	0.890
CWT2	0.094	0.697	0.662	212.988	0.436	2.424
CWT3	0.124	0.688	0.659	214.091	0.436	3.215
CWT4	0.042	0.551	0.570	247.365	0.436	1.254
CWT5	0.030	0.531	0.556	253.617	0.436	0.922
CWT6	0.048	0.556	0.570	247.192	0.436	1.440
CWT7	0.019	0.458	0.493	285.844	0.436	0.675
CWT8	0.019	0.452	0.484	291.415	0.436	0.683
CWT9	0.028	0.466	0.486	289.970	0.436	0.975
CWT10	0.040	0.593	0.554	254.672	0.436	1.222
CWT11	0.015	0.386	0.251	560.908	0.436	1.001
CWT12	0.021	0.387	0.257	549.491	0.436	1.381
CWT13	0.024	0.355	0.237	594.294	0.436	1.725
CWT14	0.021	0.365	0.243	579.345	0.436	1.494
CWT15	0.017	0.455	0.300	470.140	0.436	0.956
CWT16	0.016	0.417	0.274	515.042	0.436	0.977

* Intensity based on 1:100 yr 24 hr Point Precipitation of 141 mm

PANEL B CONSULTANTS JOINT VENTURE	Client:	ESKOM			Computed by:	Nicholas Pilz
	Project:	Kusile Power Station	Component:	Ash Dump Hydraulics	Date:	October 2010
	Job no.:	303-00098/06	File no.:		Checked by:	Rob Williamson
	Title:	10 yr Ash Dump Stormwater – Dirty and Clean Systems Hydrology and Hydraulic Calculations			Date:	October 2010
					Page: 7 of 36	

Table 6 : 1:100yr Clean Water Runoff Flowrates (Phase 1B)

Catchment Area		Flowpath	Time of Concentration	Intensity*	Runoff C	Flowrate
Clean Catchment	km²	Km	hrs	mm/hr	-	m³/s
CWT17	0.030	0.437	0.459	307.220	0.436	1.130
CWT18	0.083	0.658	0.628	224.700	0.436	2.247
CWT19	0.034	0.562	0.571	246.818	0.436	1.028
CWT20	0.065	0.582	0.587	240.223	0.436	1.890
CWT21	0.045	0.609	0.611	230.651	0.436	1.271
CWT22	0.027	0.660	0.650	216.878	0.436	0.704
CWT23	0.032	0.598	0.611	230.847	0.436	0.883
CWT24	0.032	0.585	0.607	232.464	0.436	0.896
CWT25	0.038	0.585	0.610	231.090	0.436	1.074
CWT26	0.018	0.551	0.585	241.094	0.436	0.532
CWT27	0.025	0.605	0.614	229.767	0.436	0.685
CWT28	0.025	0.605	0.617	228.662	0.436	0.688
CWT29	0.032	0.617	0.627	225.002	0.436	0.868

* Intensity based on 1:100 yr 24 hr Point Precipitation of 141 mm

Table 7 : 1:100yr Clean Water Runoff Flowrates (Phase 2)

Catchment Area		Flowpath	Time of Concentration	Intensity*	Runoff C	Flowrate
Clean Catchment	km²	Km	hrs	mm/hr	-	m³/s

PANEL B CONSULTANTS JOINT VENTURE	Client:	ESKOM			Computed by:	Nicholas Pilz
	Project:	Kusile Power Station	Component:	Ash Dump Hydraulics	Date:	October 2010
	Job no.:	303-00098/06	File no.:		Checked by:	Rob Williamson
	Title:	10 yr Ash Dump Stormwater – Dirty and Clean Systems Hydrology and Hydraulic Calculations			Date:	October 2010
					Page: 8 of 36	

6. HYDRAULIC CALCULATIONS

6.1 Dirty Water Canals and Pipeline

Dirty canals designed to carry dirty water stormwater runoff plus leakage.

Canals sized for Phase 1A, Phase 1B and Phase 2 (East and West)

Dirty water design parameters:

- Concrete lined rectangular canals with a 2.50 m base width and vertical side slopes;
- Lined Canal Mannings' n = 0.018;
- Canal slopes = 1 : 250;
- Canal depth = flow depth + 10% allowance for groundwater + 300mm freeboard (Sub-critical flow conditions);
- Canal depth = flow depth + 2 * Energy Head (Super-critical flow conditions).

Flow depth was calculated using the Mannings' equation:

$$Q = \frac{AR^{2/3}S^{1/2}}{n}$$
Equation 4

Where Q =   Peak Flow (m^3/s)
       A =   Cross Section Flow Area (m^2)
       R =   Hydraulic Radius (m)
       S =   Canal Slope (m/m)
       n =   Mannings' n value (0.023)

Table 8 : Concrete Lined Rectangular Dirty Water Canal Sizes

Drain	Flow Rate	Flow Depth	Velocity	Energy Head	Froude No.	Total Depth
-	m^3/s	m	m/s	m	-	m
Canal 1	8.545	1.310	2.609	0.347	0.728	2.004
Canal 2	11.797	1.678	2.813	0.403	0.693	1.978
Canal 3	5.687	0.969	2.347	0.281	0.761	1.531
Canal 4	7.562	1.196	2.530	0.326	0.739	1.848

Rectangular concrete canals discharge into concrete pipes leading to the ADDD.

Pipe 1 – Phase 1A (Years 1 – 3 of deposition) to JB5 (Blue Line)
Pipe 2 – Phase 1B (Years 4 – 5 of deposition) to JB5 (Red Line)
Pipe 3 – JB5 to ADDD Compartment 2 (Yellow Line)
Pipe 4 – JB5 to ADDD Compartment 1 (Green Line)
Pipe 5 – Phase 2 (west) to JB5 (Purple Line)
Pipe 6 – Radial Stacker platform to JB5 (Orange Line)

The pipeline layout is shown in Figure 1.

PANEL B	Client:	ESKOM			Computed by:	Nicholas Pilz
CONSULTANTS	Project:	Kusile Power Station	Component:	Ash Dump Hydraulics	Date:	October 2010
JOINT	Job no.:	303-00098/06	File no.:		Checked by:	Rob Williamson
VENTURE	Title:	10 yr Ash Dump Stormwater – Dirty and Clean Systems Hydrology			Date:	October 2010
		and Hydraulic Calculations			Page: 9	of 36
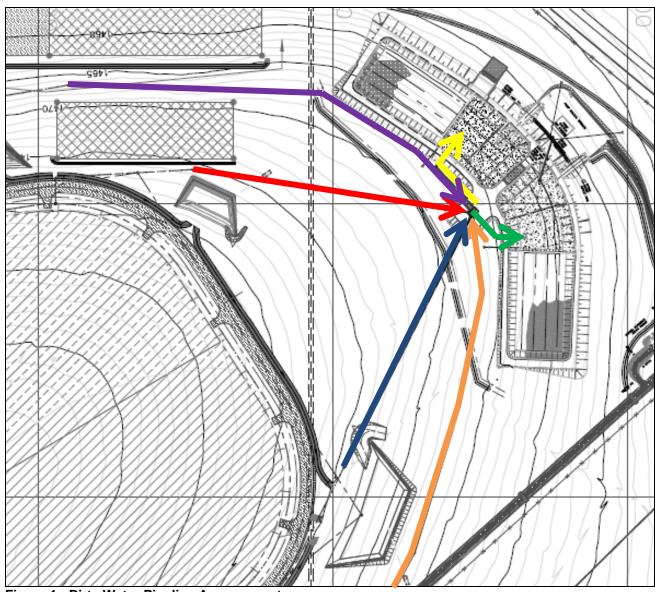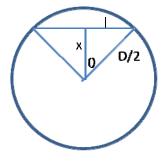
Figure 1 : Dirty Water Pipeline Arrangement

The following approach was taking in sizing the pipelines leading from the dirty water canals to the ADDD. A typical pipe sizing calculation is shown below.

Pipe flowing partially full:

Pipe 1 required capacity = 8.54 m^3/s
Assume optimal pipe efficiency at 75% full

Diameter	2.000	m
Pipe Gradient	0.005	m/m
Mannings' n	0.012	
x	0.500	m
l	0.866	m
2l	1.732	m
cos θ	0.5	
θ	60	degrees
2θ	120	degrees
Wetted Area	2.527	m^2

PANEL B CONSULTANTS JOINT VENTURE	Client:	ESKOM	Computed by:	Nicholas Pilz
	Project:	Kusile Power Station Component: Ash Dump Hydraulics	Date:	October 2010
	Job no.:	303-00098/06 File no.:	Checked by:	Rob Williamson
	Title:	10 yr Ash Dump Stormwater – Dirty and Clean Systems Hydrology and Hydraulic Calculations	Date:	October 2010
			Page: 10 of 36	

Wetted Perimeter   4.189   m
Hydraulic Radius   0.603   m

Velocity   4.208   m/s (based on Mannings' Formula)
Flowrate   10.634   m^3/s

The proposed 2.000 m diameter pipeline is sufficient to pass the design flow of 8.54 m^3/s under open channel flow conditions.

Pipe flowing full:

Design Flow   8.540   m^3/s
Headwater Level   1479.640   m
Tailwater Level   1470.500   m
Height Loss   9.140   m

Pipeline Length   1528.470   m
Minor Losses *   13.500
Pipe Roughness: 3.00E-04   m
K. Viscosity   1.14E-06   m^2/s

* Minor losses assumes and entrance loss coefficient of 0.5 and an exit loss coefficient of 1.0. Assuming inspection manholes at every 200m, Pipe 1 has 9 manholes.

The pipe diameter required to pass the design flow was calculated according to the Swamee – Jain equation:

$$f = \frac{0.25}{\left[\log_{10}\left(\frac{\varepsilon}{3.7D} + \frac{5.74}{\mathrm{Re}^{0.9}}\right)\right]^2} \qquad \text{Equation 5}$$

Where f =   Friction Factor
       ε =   Pipe roughness (m)
       D =   Pipe diameter (m)
       Re =   Reynolds Number

The Swamee – Jain equation was re-arranged to solve for the required pipe diameter, and through an iterative process, the 2.000 m diameter pipe has sufficient capacity to pass the design flow of 8.54 m^3/s under full flow conditions.

The required dirty water pipe diameters are summarised in Table 9.

Table 9 : Required Dirty Water Pipe Diameters

Pipeline	Required Flow Capacity	Required Pipe Diameter
-	m^3/s	mm
Pipe 1	8.54	2000
Pipe 2	11.79	2250
Pipe 3	22.23	2250
Pipe 4	22.23	2250
Pipe 5	7.56	2000
Pipe 6	1.904	1200

Pipes 3 and 4 will terminate at with an impact type energy dissipator. Sizing calculations for the energy dissipators are presented in **Appendix 4.**

PANEL B CONSULTANTS JOINT VENTURE	Client:	ESKOM			Computed by:	Nicholas Pilz
	Project:	Kusile Power Station	Component:	Ash Dump Hydraulics	Date:	October 2010
	Job no.:	303-00098/06	File no.:		Checked by:	Rob Williamson
	Title:	10 yr Ash Dump Stormwater – Dirty and Clean Systems Hydrology and Hydraulic Calculations			Date:	October 2010
					Page: 11 of 36	

Ash dump site requires pipes with the following internal diameters:

- 1200
- 2000
- 2250

Check was carried out to determine the flow velocities in the pipe sections for a range of flowrates. This was carried out to determine whether self-scouring velocities are achieved.

The flow velocities and the flowrates in each of the pipe sections is summarised in Table 10.

Table 10 : Flow Velocities at varying Flowrates

Flowrate	Flow Velocity in Pipeline (m/s)		
m^3/s	1200 Ø	2000 Ø	2250 Ø
0.10	1.22	1.14	1.12
0.25	1.60	1.50	1.48
0.50	1.96	1.85	1.82
1.00	2.38	2.27	2.24
1.50	2.64	2.55	2.52

Flow velocity in the pipes is greater than 1 m/s for all flows greater than 100 l/s. This can be assumed to be self scouring under the majority of flow conditions.

6.2   Clean Water Perimeter Drains

Design to maintain sub-critical flow conditions in the canals to avoid large concrete drop structures.

Each sub-catchments served by an individual length of trapezoidal drain terminating in a culvert running under Ash Dump perimeter road.

Clean water design parameters:

- Unlined trapezoidal drains with a 1.00 m base width, 1V: 3H side slopes;
- Unlined drain Mannings' n = 0.023;
- Drain slopes = 1 : 200;
- Drain depth = flow depth + 10% allowance for groundwater + 300mm freeboard (Sub-critical flow conditions).

Flow depth was calculated using the Mannings' equation:

$$Q = \frac{AR^{\frac{2}{3}}S^{\frac{1}{2}}}{n}$$

Equation 6

Where Q =   Peak Flow (m^3/s)
         A =   Cross Section Flow Area (m^2)
         R =   Hydraulic Radius (m)
         S =   Canal Slope (m/m)
         n =   Mannings' n value (0.023)

Table 11 : Unlined Trapezoidal Clean Water Drain Sizes (Phase 1A)

Drain	Flow Rate	Flow Depth	Velocity	Energy Head	Froude No.	Total Depth
-	m^3/s	M	m/s	m	-	M
CWT1	0.890	0.546	1.378	0.097	0.640	0.900
CWT2	2.424	1.025	1.763	0.159	0.623	1.427

PANEL B CONSULTANTS JOINT VENTURE

Client: ESKOM
Project: Kusile Power Station Component: Ash Dump Hydraulics
Job no.: 303-00098/06 File no.:
Title: 10 yr Ash Dump Stormwater – Dirty and Clean Systems Hydrology and Hydraulic Calculations

Computed by: Nicholas Pilz
Date: October 2010
Checked by: Rob Williamson
Date: October 2010
Page: 12 of 36

Drain	Flow Rate	Flow Depth	Velocity	Energy Head	Froude No.	Total Depth
-	m³/s	M	m/s	m	-	M
CWT3	3.215	1.216	1.883	0.181	0.619	1.637
CWT4	1.254	0.680	1.503	0.115	0.633	1.048
CWT5	0.922	0.559	1.391	0.099	0.639	0.915
CWT6	1.440	0.741	1.558	0.124	0.632	1.116
CWT7	0.675	0.457	1.280	0.084	0.643	0.803
CWT8	0.683	0.461	1.284	0.084	0.643	0.807
CWT9	0.975	0.579	1.411	0.102	0.638	0.937
CWT10	1.222	0.668	1.495	0.114	0.635	1.035
CWT11	1.001	0.589	1.421	0.103	0.638	0.948
CWT12	1.381	0.722	1.542	0.121	0.633	1.094
CWT13	1.725	0.830	1.628	0.135	0.629	1.213
CWT14	1.494	0.759	1.572	0.126	0.632	1.135
CWT15	0.956	0.572	1.404	0.101	0.639	0.929
CWT16	0.977	0.580	1.412	0.102	0.638	0.938

Table 12 : Unlined Trapezoidal Clean Water Drain Sizes (Phase 1B)

Drain	Flow Rate	Flow Depth	Velocity	Energy Head	Froude No.	Total Depth
-	m³/s	M	m/s	m	-	M
CWT17	1.130	0.636	0.636	0.636	0.636	0.999
CWT18	2.247	0.978	0.978	0.978	0.625	1.375
CWT19	1.028	0.599	0.599	0.599	0.637	0.959
CWT20	1.890	0.879	0.879	0.879	0.628	1.267
CWT21	1.271	0.685	0.685	0.685	0.634	1.054
CWT22	0.704	0.469	0.469	0.469	0.645	0.816
CWT23	0.883	0.544	0.544	0.544	0.639	0.898
CWT24	0.896	0.549	0.549	0.549	0.639	0.904
CWT25	1.074	0.616	0.616	0.616	0.637	0.978
CWT26	0.532	0.393	0.393	0.393	0.644	0.732
CWT27	0.685	0.462	0.462	0.462	0.643	0.808
CWT28	0.688	0.464	0.464	0.464	0.642	0.810
CWT29	0.868	0.537	0.537	0.537	0.641	0.891

Table 13 : Unlined Trapezoidal Clean Water Drain Sizes (Phase 2)

Drain	Flow Rate	Flow Depth	Velocity	Energy Head	Froude No.	Total Depth
-	m³/s	M	m/s	m	-	m

Clean water drains terminate at concrete culverts, running under the perimeter access road

Culverts sized to maintain flowrate without causing backwater in canal.

Culvert capacity calculated using Mannings' equation:

PANEL B	Client:	ESKOM			Computed by:	Nicholas Pilz
CONSULTANTS	Project:	Kusile Power Station	Component:	Ash Dump Hydraulics	Date:	October 2010
JOINT	Job no.:	303-00098/06	File no.:		Checked by:	Rob Williamson
VENTURE	Title:	10 yr Ash Dump Stormwater – Dirty and Clean Systems Hydrology			Date:	October 2010
		and Hydraulic Calculations			Page: 13 of 36	

$$Q = \frac{AR^{2/3}S^{1/2}}{n}$$ Equation 7

Where Q = Peak Flow (m³/s)
       A = Cross Section Flow Area (m²)
       R = Hydraulic Radius (m)
       S = Canal Slope (m/m)
       n = Mannings' n value (0.023)

Initially sized for 1No 750 x 750 culvert   → calculate flow depth
                                              → calculate velocity and energy head
                                              → check flow depth + energy head < 750mm

If not, add additional culvert and repeat process.

Table 14 : Clean Water Drain Culvert Sizing (Phase 1A)

Drain	Arrangement	Flow Rate	Flow Depth	Velocity	Energy Head	Total Depth
-	-	m³/s	m	m/s	m	m
CWT1	2No 750 x 750	0.890	0.287	2.066	0.218	0.505
CWT2	4No 750 x 750	2.424	0.329	2.456	0.307	0.636
CWT3	4No 750 x 750	3.215	0.343	3.125	0.498	0.841
CWT4	2No 750 x 750	1.254	0.363	2.303	0.270	0.633
CWT5	2No 750 x 750	0.922	0.294	2.090	0.223	0.517
CWT6	2No 750 x 750	1.440	0.399	2.407	0.295	0.694
CWT7	1No 750 x 750	0.675	0.239	3.764	0.722	0.961
CWT8	1No 750 x 750	0.683	0.241	3.780	0.728	0.969
CWT9	2No 750 x 750	0.975	0.305	2.131	0.232	0.537
CWT10	2No 750 x 750	1.222	0.356	2.288	0.267	0.623
CWT11	2No 750 x 750	1.001	0.311	2.145	0.235	0.546
CWT12	2No 750 x 750	1.381	0.388	2.373	0.287	0.675
CWT13	3No 750 x 750	1.725	0.326	2.351	0.282	0.608
CWT14	2No 750 x 750	1.494	0.41	2.430	0.301	0.711
CWT15	2No 750 x 750	0.956	0.301	2.117	0.228	0.529
CWT16	2No 750 x 750	0.977	0.306	2.129	0.231	0.537

Table 15 : Clean Water Drain Culvert Sizing (Phase 1B)

Drain	Arrangement	Flow Rate	Flow Depth	Velocity	Energy Head	Total Depth
-	-	m³/s	m	m/s	m	M
CWT17	2*750*750	1.130	0.338	2.228	0.253	0.591
CWT18	3*750*750	2.247	0.388	2.574	0.338	0.726
CWT19	2*750*750	1.028	0.317	2.162	0.238	0.555
CWT20	3*750*750	1.890	0.346	2.428	0.301	0.647
CWT21	2*750*750	1.271	0.366	2.315	0.273	0.639
CWT22	1*750*750	0.704	0.245	1.916	0.187	0.432
CWT23	2*750*750	0.883	0.286	2.059	0.216	0.502

PANEL B	Client:	ESKOM			Computed by:	Nicholas Pilz
CONSULTANTS	Project:	Kusile Power Station	Component:	Ash Dump Hydraulics	Date:	October 2010
JOINT	Job no.:	303-00098/06	File no.:		Checked by:	Rob Williamson
VENTURE	Title:	10 yr Ash Dump Stormwater – Dirty and Clean Systems Hydrology			Date:	October 2010
		and Hydraulic Calculations			Page: 14 of 36	

Drain	Arrangement	Flow Rate	Flow Depth	Velocity	Energy Head	Total Depth
-	-	m^3/s	m	m/s	m	M
CWT24	2*750*750	0.896	0.288	2.075	0.219	0.507
CWT25	2*750*750	1.074	0.326	2.197	0.246	0.572
CWT26	1*750*750	0.532	0.344	2.062	0.217	0.561
CWT27	1*750*750	0.685	0.221	4.134	0.871	1.092
CWT28	1*750*751	0.688	0.221	4.154	0.879	1.100
CWT29	2*750*752	0.868	0.282	2.051	0.214	0.496

Table 16 : Clean Water Drain Culvert Sizing (Phase 2)

Drain	Arrangement	Flow Rate	Flow Depth	Velocity	Energy Head	Total Depth
-	-	m^3/s	m	m/s	m	m

PANEL B	Client:	ESKOM			Computed by:	Nicholas Pilz
CONSULTANTS JOINT VENTURE	Project:	Kusile Power Station	Component:	Ash Dump Hydraulics	Date:	October 2010
	Job no.:	303-00098/06	File no.:		Checked by:	Rob Williamson
	Title:	10 yr Ash Dump Stormwater – Dirty and Clean Systems Hydrology and Hydraulic Calculations			Date:	October 2010
					Page: 15 of 36	

7. ASH DUMP DIRTY DAM STORAGE CAPACITY

7.1 Ash Dump Stormwater Storage Volume

The required stormwater storage capacity for the Ash Dump Dirty Dam (ADDD) is 204 000 m^3, and corresponds with the 1:50 yr / 24 hr storm event falling on the maximum dirty catchment area of 1 553 596 m^2. This volume was provided by Black & Veatch.

7.2 Dust Suppression & Irrigation Storage (Operational Storage)

ADDD is provided for 72 hours of operational storage for dust suppression and irrigation.

During Ash - FGD Co-disposal phase:

- Dust Suppression Area :   Advancing face and a 50 m section behind the face
- Irrigation Area :   Equivalent to 1 year of disposal behind Dust Suppression Area

During FGD disposal phase :

- Dust Suppression Area :   Advancing face and a 25 m section behind the face
- Irrigation Area :   Extends for 50 m behind the Dust Suppression Area

Dust control and irrigation storage volumes are based on 1 mm/day of equivalent rainfall.
1 mm/day is equivalent to 0.5*the average annual daily rainfall at Kusile Site.

The dust control and irrigation volumes during disposal are shown in Table 17 below.

Table 17 : Dust Control and Irrigation Volumes

Years	Dust Suppression Area	Irrigation Area	Daily Volume	72 hr Volume
-	km^2	km^2	m^3/day	m^3
1	0.500	0.028	527.865	1583.595
2	0.464	0.098	562.196	1686.589
3	0.294	0.102	395.403	1186.210
4	0.680	0.175	854.191	2562.573
5	0.504	0.116	620.522	1861.565
6	0.131	0.190	320.956	962.867
7	0.098	0.114	212.206	636.619
8	0.127	0.115	241.379	724.138

The maximum pumping capacity from the ADDD is 25l/s.

Based on the maximum pumping capacity, the Operational storage was set at 6480 m^3, which is equivalent to 72 hrs of pumping at 25l/s.

7.3 ADDD Storage Volume

ADDD storage volume is sufficient to store the maximum dirty water run-off for 1:50 yr / 24hr storm event, and for 72 hours of dust control and irrigation.

Table 18 : Required ADDD Storage Volume

Stormwater Volume	Dust and Irrigation Volume	Total Required Volume
m^3	m^3	m^3
204 000	6480	210480

ADDD has a design total storage capacity of 227410 m^3, which includes an allowance for silt accumulation in the sump.

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	Project:	Kusile Power Station	Component:	Ash Dump Hydraulics	Date:	October 2010
	Job no.:	303-00098/06	File no.:		Checked by:	Rob Williamson
	Title:	10 yr Ash Dump Stormwater – Dirty and Clean Systems Hydrology and Hydraulic Calculations			Date:	October 2010
					Page: 16 of 36	

8. CLEAN WATER RETENTION PONDS

Clean stormwater runoff flows into retention / settling dams.

Stilled clean run-off will then flow back into the natural streams surrounding the ash dump.

Catchment areas are small (<10km^2) therefore a triangular hydrograph can be used to determine the stormwater volume.

The shaded area under the graph represents the storm volume.
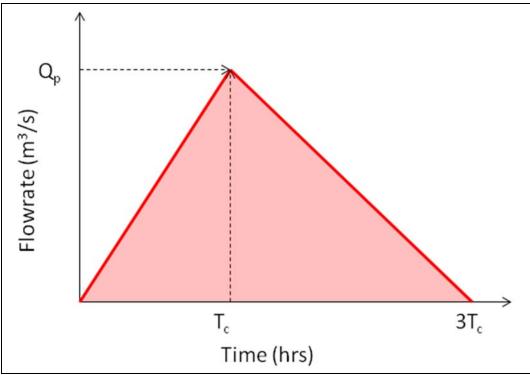
Figure 2: Triangular Hydrograph used to calculate the storm volume

Table 19 : Clean Stormwater Volumes (Phase 1A)

Drain	Flow Rate	Time of Concentration	Flood Volume
-	m^3/s	Hrs	m^3
CWT1	0.890	0.645	3100
CWT2	2.424	0.662	8665
CWT3	3.215	0.659	11435
CWT4	1.254	0.570	3860
CWT5	0.922	0.556	2767
CWT6	1.440	0.570	4437
CWT7	0.675	0.493	1797
CWT8	0.683	0.484	1785
CWT9	0.975	0.486	2560
CWT10	1.222	0.554	3652
CWT11	1.001	0.251	1358
CWT12	1.381	0.257	1914
CWT13	1.725	0.237	2210

PANEL B CONSULTANTS JOINT VENTURE	Client:	ESKOM			Computed by:	Nicholas Pilz
	Project:	Kusile Power Station	Component:	Ash Dump Hydraulics	Date:	October 2010
	Job no.:	303-00098/06	File no.:		Checked by:	Rob Williamson
	Title:	10 yr Ash Dump Stormwater – Dirty and Clean Systems Hydrology and Hydraulic Calculations			Date:	October 2010
					Page: 17 of 36	

Drain	Flow Rate	Time of Concentration	Flood Volume
-	m³/s	Hrs	m³
CWT14	1.494	0.243	1964
CWT15	0.956	0.300	1548
CWT16	0.977	0.274	1445

Table 20 : Clean Stormwater Volumes (Phase 1B)

Drain	Flow Rate	Time of Concentration	Flow Volume
-	m³/s	Hrs	m³
CWT17	1.130	0.459	2800
CWT18	2.247	0.628	7614
CWT19	1.028	0.571	3172
CWT20	1.890	0.587	5992
CWT21	1.271	0.611	4195
CWT22	0.704	0.650	2471
CWT23	0.883	0.611	2913
CWT24	0.896	0.607	2936
CWT25	1.074	0.610	3539
CWT26	0.532	0.585	1680
CWT27	0.685	0.614	2271
CWT28	0.688	0.617	2293
CWT29	0.868	0.627	2936

Table 21 : Clean Stormwater Volumes (Phase 2)

Drain	Flow Rate	Time of Concentration	Flow Volume
-	m³/s	Hrs	m³

PANEL B	Client:	ESKOM			Computed by:	Nicholas Pilz
CONSULTANTS	Project:	Kusile Power Station	Component:	Ash Dump Hydraulics	Date:	October 2010
JOINT	Job no.:	303-00098/06	File no.:		Checked by:	Rob Williamson
VENTURE	Title:	10 yr Ash Dump Stormwater – Dirty and Clean Systems Hydrology			Date:	October 2010
		and Hydraulic Calculations			Page: 18	of 36

9.1 TEMPORARY CLEAN WATER INTERCEPTION DRAINS

During construction of Phase 1, clean water interception drains will be constructed along the 5 yr footprint to prevent cleanwater from entering the open footprint.

Figure 3: Temporary Clean Water Drain Catchment Areas

Table 22 : 1:10yr Temporary Clean Water Runoff Flowrates

Catchment Area		Flowpath	Time of Concentration	Intensity*	Runoff C	Flowrate
Clean Catchment	km²	Km	hrs	mm/hr	-	m³/s
West (Orange)	0.145	1.073	0.812	103.509	0.436	1.819
East (Pink)	0.172	1.052	0.711	118.123	0.436	2.463

* Intensity based on 1:10 yr 24 hr Point Precipitation of 84 mm

9.2 TEMPORARY CLEAN WATER INCEPTION DRAIN SIZING

Design to maintain sub-critical flow conditions in the canals to avoid large concrete drop structures.

Each sub-catchments served by an individual length of trapezoidal drain terminating in a culvert running under Ash Dump perimeter road.

Clean water design parameters:

- Unlined trapezoidal drains with a 1.00 m base width, 1V: 3H side slopes;
- Unlined drain Mannings' n = 0.023;
- Drain slopes = 1 : 200;
- Drain depth = flow depth + 10% allowance for groundwater + 300mm freeboard (Sub-critical flow conditions).

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	Project:	Kusile Power Station	Component:	Ash Dump Hydraulics	Date:	October 2010
	Job no.:	303-00098/06	File no.:		Checked by:	Rob Williamson
	Title:	10 yr Ash Dump Stormwater – Dirty and Clean Systems Hydrology and Hydraulic Calculations			Date:	October 2010
					Page: 19 of 36	

Flow depth was calculated using the Mannings' equation:

$$Q = \frac{AR^{\frac{2}{3}}S^{\frac{1}{2}}}{n}$$ Equation 6

Where Q = Peak Flow (m³/s)
A = Cross Section Flow Area (m²)
R = Hydraulic Radius (m)
S = Canal Slope (m/m)
n = Mannings' n value (0.023)

Table 23 : Temporary Unlined Trapezoidal Clean Water Drain Sizes

Drain	Flow Rate	Flow Depth	Velocity	Energy Head	Froude No.	Total Depth
-	m³/s	M	m/s	m	-	m
West Drain	1.819	0.389	1.133	0.065	0.589	1.3
East Drain	2.463	0.470	1.261	0.081	0.598	1.4

9.3 TEMPORARY CLEAN WATER RETENTION PONDS
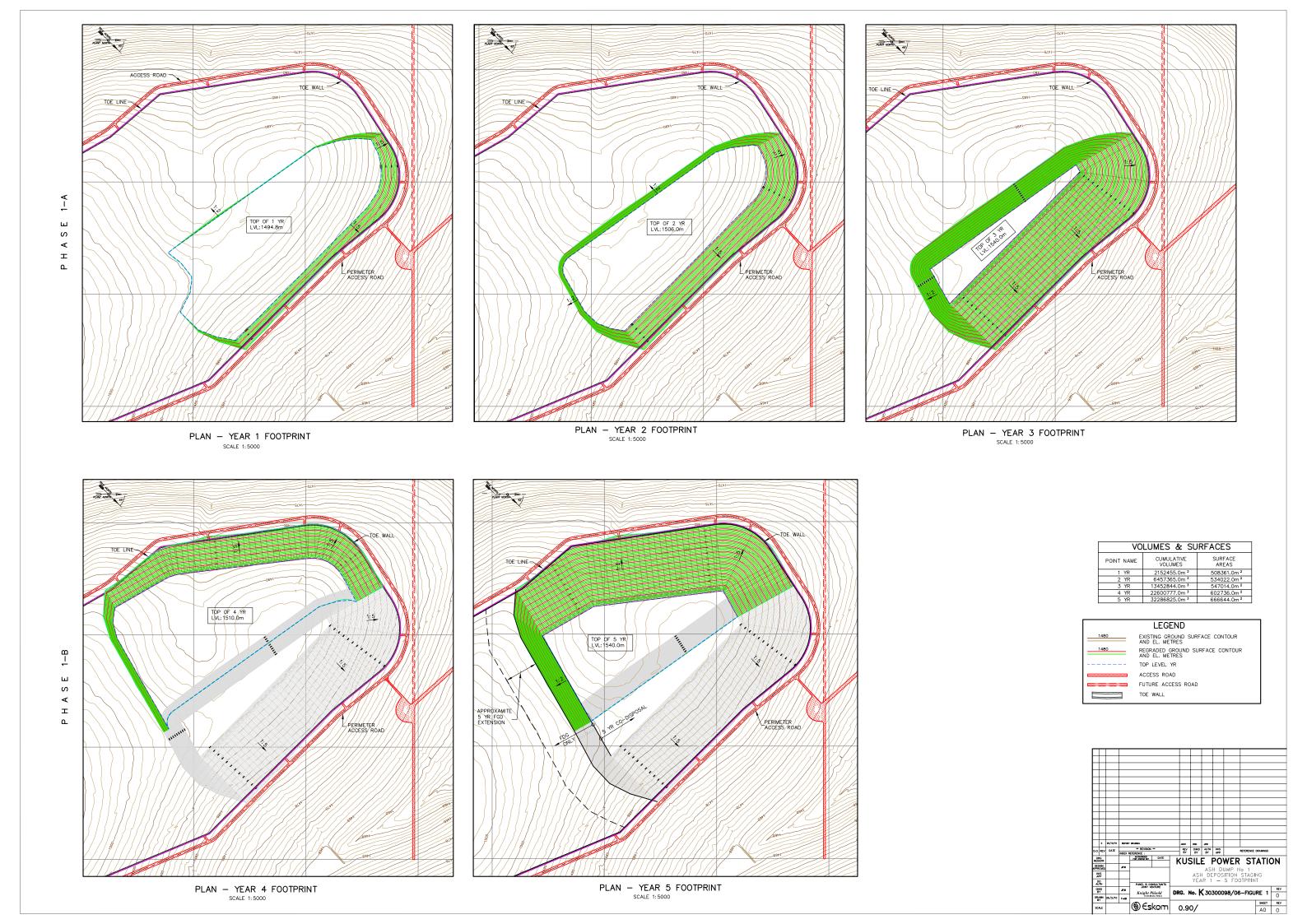
Table 24 : Temporary Clean Stormwater Volumes

Drain	Flow Rate	Time of Concentration	Flood Volume
-	m³/s	Hrs	m³
CWT1	1.819	1.073	7972
CWT2	2.463	1.052	9456

PANEL B CONSULTANTS JOINT VENTURE	Client:	ESKOM			Computed by:	Nicholas Pilz
	Project:	Kusile Power Station	Component:	Ash Dump Hydraulics	Date:	October 2010
	Job no.:	303-00098/06	File no.:		Checked by:	Rob Williamson
	Title:	10 yr Ash Dump Stormwater – Dirty and Clean Systems Hydrology and Hydraulic Calculations			Date:	October 2010
					Page: 20 of 36	

APPENDIX 1

Dirty Water Catchment Areas

PHASE 1-A

ACCESS ROAD
TOE WALL
TOE LINE
PERIMETER ACCESS ROAD

TOP OF 1 YR
LVL:1494.8m

1:5
1:2

PLAN – YEAR 1 FOOTPRINT
SCALE 1:5000

TOE LINE
TOE WALL
PERIMETER ACCESS ROAD

TOP OF 2 YR
LVL:1506.0m

1:5
1:2

PLAN – YEAR 2 FOOTPRINT
SCALE 1:5000

TOE LINE
TOE WALL
PERIMETER ACCESS ROAD

TOP OF 3 YR
LVL:1540.0m

1:5
1:2

PLAN – YEAR 3 FOOTPRINT
SCALE 1:5000

PHASE 1-B

TOE LINE
TOE WALL
PERIMETER ACCESS ROAD

TOP OF 4 YR
LVL:1510.0m

1:5
1:2

PLAN – YEAR 4 FOOTPRINT
SCALE 1:5000

TOE LINE
TOE WALL
PERIMETER ACCESS ROAD

TOP OF 5 YR
LVL:1540.0m

APPROXAMITE 5 YR FGD EXTENSION
FDG ONLY
5 YR CO-DISPOSAL

1:5
1:2

PLAN – YEAR 5 FOOTPRINT
SCALE 1:5000

VOLUMES & SURFACES

POINT NAME	CUMULATIVE VOLUMES	SURFACE AREAS
1 YR	2152455.0m³	508361.0m²
2 YR	6457365.0m³	534022.0m²
3 YR	13452844.0m³	547014.0m²
4 YR	22600777.0m³	602736.0m²
5 YR	32286825.0m³	666644.0m²

LEGEND

1480	EXISTING GROUND SURFACE CONTOUR AND EL. METRES
1480	REGRADED GROUND SURFACE CONTOUR AND EL. METRES
	TOP LEVEL YR
	ACCESS ROAD
	FUTURE ACCESS ROAD
	TOE WALL

PHASE 2

PLAN — YEAR 6 FOOTPRINT
SCALE 1:5000

TOP OF 6 YR
LVL:1540.0m

TOE LINE
TOE WALL
5 YR CO-DISPOSAL
FDG ONLY
APPROXAMITE 5 YR FGD EXTENSION
PERIMETER ACCESS ROAD

PLAN — YEAR 7 FOOTPRINT
SCALE 1:5000

TOP OF 7 YR
LVL:1506.0m

TOE LINE
TOE WALL
5 YR CO-DISPOSAL
FDG ONLY
APPROXAMITE 5 YR FGD EXTENSION
PERIMETER ACCESS ROAD

PLAN — YEAR 8 FOOTPRINT
SCALE 1:5000

TOP OF 8 YR
LVL:1540.0m

TOE LINE
TOE WALL
5 YR CO-DISPOSAL
FDG ONLY
APPROXAMITE 5 YR FGD EXTENSION
PERIMETER ACCESS ROAD

VOLUMES & SURFACES

POINT NAME	CUMULATIVE VOLUMES	SURFACE AREAS
6 YR	33192067.0m	115569.0m ²
7 YR	34097310.0m ³	109979.0m ²
8 YR	35002552.0m ³	109481.0m ²
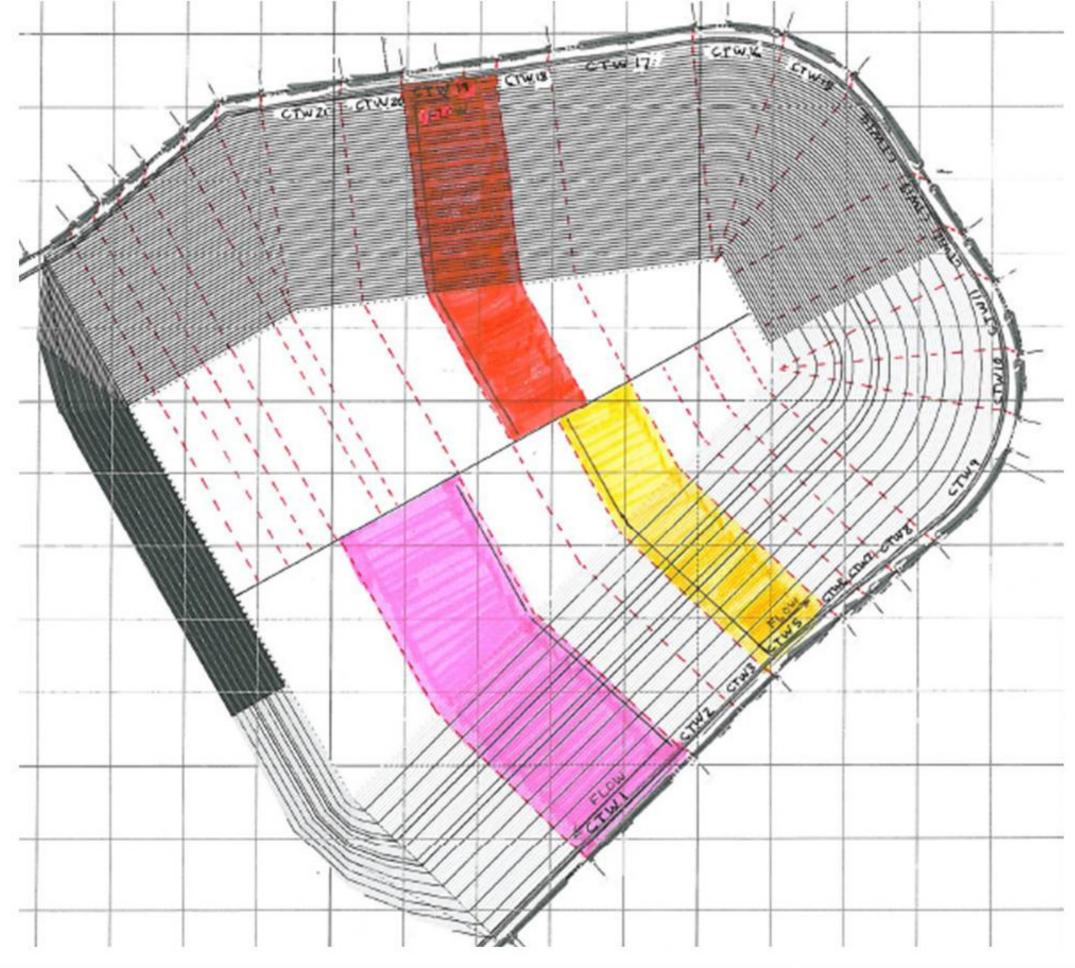
LEGEND

1480	EXISTING GROUND SURFACE CONTOUR AND EL. METRES
1480	REGRADED GROUND SURFACE CONTOUR AND EL. METRES
	TOP LEVEL YR
	ACCESS ROAD
	FUTURE ACCESS ROAD
	TOE WALL

PANEL B	Client:	ESKOM			Computed by:	Nicholas Pilz
CONSULTANTS	Project:	Kusile Power Station	Component:	Ash Dump Hydraulics	Date:	October 2010
JOINT	Job no.:	303-00098/06	File no.:		Checked by:	Rob Williamson
VENTURE	Title:	10 yr Ash Dump Stormwater – Dirty and Clean Systems Hydrology			Date:	October 2010
		and Hydraulic Calculations			Page: 21 of 36	

APPENDIX 2

Clean Water Catchment Areas

Canal	Catchment Area	Flowpath Length	Time of Concentration	Point Precipitation	Intensity	Runoff Coefficient	Flowrate
–	km²	km	hr	mm	mm/hr	–	m³/s
CTW1	0.998	0.6883	0.6586	141	214.091	0.436	2.59
CTW5	0.0195	0.4583	0.4933	141	285.844	0.436	0.67
CTW19	0.0455	0.6094	0.6113	141	230.651	0.436	1.27

PANEL B CONSULTANTS JOINT VENTURE

Client: ESKOM
Project: Kusile Power Station   Component: Ash Dump Hydraulics
Job no.: 303-00098/06   File no.:
Title: 10 yr Ash Dump Stormwater – Dirty and Clean Systems Hydrology and Hydraulic Calculations
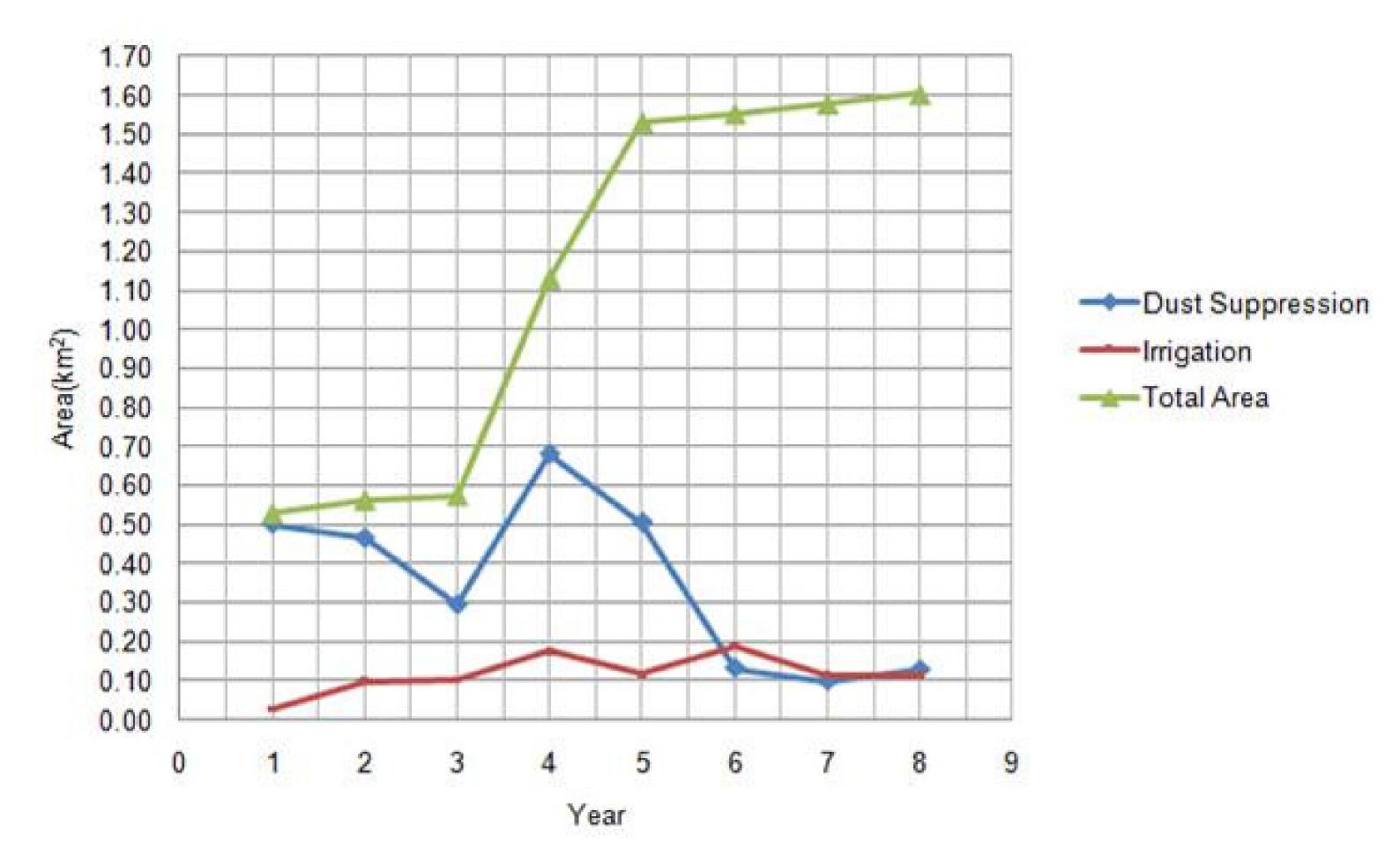
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Date: October 2010
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Date: October 2010
Page: 22   of   36

APPENDIX 3

Dirty Water Catchment Area Graph

PANEL B CONSULTANTS JOINT VENTURE

Client: ESKOM
Project: Kusile Power Station   Component: Ash Dump Hydraulics
Job no.: 303-00098/06   File no.:
Title: 10 yr Ash Dump Stormwater – Dirty and Clean Systems Hydrology and Hydraulic Calculations

Computed by: Nicholas Pilz
Date: October 2010
Checked by: Rob Williamson
Date: October 2010
Page: 22   of   36

PANEL B	Client:	ESKOM		Computed by:	Nicholas Pilz
CONSULTANTS	Project:	Kusile Power Station	Component: Ash Dump Hydraulics	Date:	October 2010
JOINT	Job no.:	303-00098/06	File no.:	Checked by:	Rob Williamson
VENTURE	Title:	10 yr Ash Dump Stormwater – Dirty and Clean Systems Hydrology		Date:	October 2010
		and Hydraulic Calculations		Page: 23 of 36	

APPENDIX 4

Energy Dissipator Design Calculations

PANEL B CONSULTANTS JOINT VENTURE	Client: ESKOM		Computed by: Nicholas Pilz
	Project: Kusile Power Station	Component: Ash Dump Hydraulics	Date: October 2010
	Job no.: 303-00098/06	File no.:	Checked by: Rob Williamson
	Title: 10 yr Ash Dump Stormwater – Dirty and Clean Systems Hydrology and Hydraulic Calculations		Date: October 2010
			Page: 24 of 36
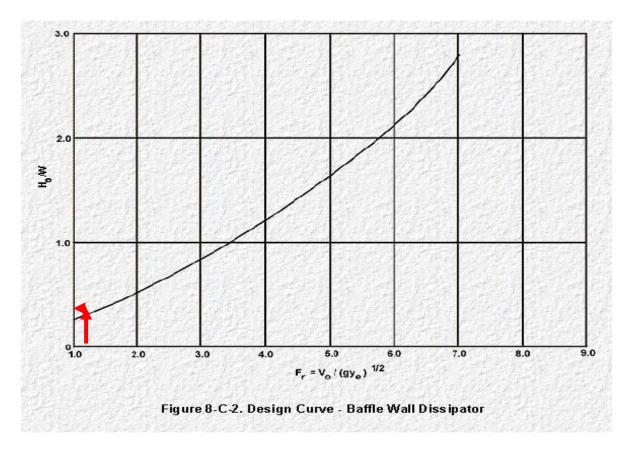
Pipe 3 and Pipe 4 Energy Dissipators

Inlet flow from Plant Terrace

Q =	22.23 m^3/s
Pipe Wetted Area 2250 Ø =	3.976 m^2
Velocity =	5.591 m/s
$y_e = (A/2)^{1/2}$ =	1.672 m
$Fr = u / \sqrt{gy_e}$ =	1.186
$H_0 = y_e + v^2/2g$ =	2.455 m

From Figure 8-C-2,

Figure 8-C-2. Design Curve - Baffle Wall Dissipator

H_0/W =	0.371
W =	6.800 m

The energy dissipator has the following dimensions based on Figure 8-C-1 :

h_1 =	5.04 m	w_2 =	2.27 m
L =	8.85 m	t_3 =	0.60 m
h_2 =	4.27 m	t_2 =	0.30 m
h_3 =	1.13 m	t_1 =	0.60 m
L_1 =	4.00 m	t_4 =	0.40 m
L_2 =	4.85 m	t_5 =	0.15 m
h_4 =	3.33 m	w_1 =	0.58 m

PANEL B CONSULTANTS JOINT VENTURE	Client:	ESKOM			Computed by:	Nicholas Pilz
	Project:	Kusile Power Station	Component:	Ash Dump Hydraulics	Date:	October 2010
	Job no.:	303-00098/06	File no.:		Checked by:	Rob Williamson
	Title:	10 yr Ash Dump Stormwater – Dirty and Clean Systems Hydrology and Hydraulic Calculations			Date:	October 2010
					Page: 25 of 36	

Figure 8-C-1. Baffle - Wall Energy Dissipator - USBR Type VI

PANEL B	Client:	ESKOM			Computed by:	Nicholas Pilz
CONSULTANTS	Project:	Kusile Power Station	Component:	Ash Dump Hydraulics	Date:	October 2010
JOINT	Job no.:	303-00098/06	File no.:		Checked by:	Rob Williamson
VENTURE	Title:	10 yr Ash Dump Stormwater – Dirty and Clean Systems Hydrology			Date:	October 2010
		and Hydraulic Calculations			Page: 26 of 36	

APPENDIX 5

System Descriptions

SYSTEM DESCRIPTION
DUST SUPPRESSION & IRRIGATION

1.1   System Identification

- System Name   Ash Dump Dust Suppression

- KKS Code   ETN

1.2   Function

The Dust Suppression & Irrigation System will supply recycle water at the required flows and pressures to the ash dump dust suppression sprinklers.

1.3   Process Description

A process flow diagram of the dust suppression & irrigation system is shown on 146838-0ETN-M2662D.

The Dust Suppression & Irrigation System will include the following major equipment and components:

- Two 50 percent Ash Dump Dust Suppression pumps.

- Ash Dump Dust Suppression sprinklers/water guns.

- Associated piping, valves, instruments, controls, and accessories.

The ash dump dust suppression pumps will draw recycle water from the Ash Dump Dam. The pumps will operate as needed to supply dust suppression water to the ash dump dust suppression sprinklers. Two primary pumps will be provided.

Initial pump operation will be manual with either pump running with the other pump on standby. The second pump will start automatically when the pressure in the discharge header drops below a set value. The pumps will be operated primarily at the local control panel, but will also be controllable from the DCS. Each pump has a local pressure indicator on the individual suction and discharge pipe to view the suction and discharge pressure of each pump. Pumps will be tripped by low level alarms from level transmitters in the Ash Dump Dam.

Adequate, constant pressure to the sprinklers via the supply line will be maintained by a combination of automatically starting and stopping the pumps and automatically modulating a recirculation control valve. The control valve will be automatically controlled by the pressure indicating transmitter in the supply header to provide a minimum flow for the pumps.

A magnetic flow meter will be installed in the supply header downstream of the ash dump dust suppression pump recirculation line to monitor the flow of the system.

SYSTEM DESCRIPTION
DUST SUPPRESSION & IRRIGATION

1.4 Basis for Design

Each pump will be sized to provide half of the required flow for the entire dust suppression sprinkler system. The total head required for the pumps will be determined by the piping and friction losses and the location and pressure requirements of the ash dump dust suppression sprinklers.

Piping will be galvanized carbon steel. All buried pipe will be PVC-M pipe. Butterfly valves will be used in all piping 80 mm nominal size and larger and will be constructed of cast iron. Ball valves will be used in all piping 65 mm nominal size and smaller and will be constructed of stainless steel. Check valves will be swing check type and constructed of carbon steel.

Temporary carbon steel cone strainers will be provided. These will be removed after start-up.

SYSTEM DESCRIPTION
ASH DUMP DAM MAKEUP WATER

1.1 System Identification

- System Name   Ash Dump Dam Makeup Water

- KKS Code   ETN

1.2 Function

The Ash Dump Dam Makeup Water System will supply recycle water at the required flow to the Ash Dump Dam to maintain a minimum liquid level and replenish water used for dust suppression.

1.3 Process Description

A process flow diagram of the ash dump dam makeup water system is shown on 146838-0ETN-M2662C.

The Ash Dump Dam Makeup Water System will include the following major equipment and components:

- Associated piping, valves, instruments, and controls.

The ash dump dam makeup water system will gravity feed recycle water from the Holding/Recycle Dam to the Ash Dump Dam. The system will automatically operate as needed to supply make-up water to the ash dump dam to maintain level. Two motorized open/close butterfly valves will be used to control levels in the two ash dump dam cells.

1.4 Basis for Design

One pipeline will be taken off each of the four supply lines from the Holding/Recycle Dam to the Holding/Recycle Dam Pump Suction Header. The four pipelines will be headered together and routed underground to the Ash Dump Dam Workshop. The header will then split to each of the Ash Dump Dam cells. Each of these pipelines will contain a motorized open/close butterfly valve. Each dam's valve acts automatically and independently to maintain level based on dam level transmitters. Each dam will have three redundant level transmitters.

Because the Ash Dump Dam cells are larger than the Holding/Recycle Dam cells, the Ash Dump Dam will also be used to drain the Holding/Recycle Dam for maintenance. Because of this, manual operation of the isolation valves will be allowed.

The Ash Dump Dam Makeup Water header will be sized to maintain the required makeup water flow to the ash dump dam. A change in pipe size will be required to maintain an appropriate flow to the Ash Dump Dam. The location of the change in pipe size will be determined to ensure the flow will remain relatively constant.

SYSTEM DESCRIPTION
ASH DUMP DAM MAKEUP WATER

Piping will be galvanized carbon steel. Butterfly valves shall be used in all piping 80 mm nominal size and larger and shall be constructed of cast iron. Ball valves shall be used in all piping 65 mm nominal size and smaller and shall be constructed of stainless steel.

APPENDIX 5

SPECIALIST REPORTS

Report: *Classification and Environmental Evaluation of Kusile Power Station Ash and FGD Gypsum in Terms of the Minimum Requirements: November 2008"*

Panel B Consultants Joint Venture

Kusile Power Station Project: Classification and Environmental Evaluation of Ash and FGD Gypsum in terms of the Minimum Requirements

November 2008

Report prepared for:

Linda Munro
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Executive Summary

The gypsum, which will be generated at the new Kusile Power Station that is being constructed near Witbank, would be formally classified as a waste product, because it is generated from a flue gas cleaning process, and, therefore, must be classified and the environmental risks assessed using the Minimum Requirements. It is estimated that each of the six scrubbing units at the Kusile Power Station will generate 464 tons/day of gypsum, i.e. once all six units are in operation in 2016, a total of 2784 tons/day will be generated.

En-Chem Consultants was requested by the Panel B Consultants Joint Venture to classify the gypsum product in terms of the requirements and to evaluate the utilisation, treatment and disposal options. As co-disposal with general waste and mono-disposal are both potential options for the gypsum both the Toxicity Characteristic Leaching Procedure and Acid Rain Leaching Procedure were used. One option is to dispose in the ash dam that will be constructed on site and a sample of ash plus a mixture of ash and gypsum have also been investigated. As the Kusile Power Station is just being built, samples of the ash were obtained from Kendal Power Station and the FGD gypsum from an overseas facility that uses the same process. Note that these materials will be sufficiently similar to those that will be generated from the new Kusile Plant to be able to determine the waste management requirements but, once the first Kusile unit is operational in 2013, samples must be obtained and the waste evaluation repeated.

The FGD Gypsum is predominantly calcium sulphate dihydrate but it contains a number of minor elements, i.e. Al, 0.254%; Mg, 0.22%; P, 0.428%; plus of a number of trace elements (<0.10%), i.e. Fe, F, K, etc. The FGD Gypsum sample leached only fluoride at a concentration above it acceptable risk limit using both the TCLP and the ARLP tests. Fluoride is a moderate hazard according to the Minimum Requirements and, therefore, the FGD gypsum formally classifies as a moderate hazard waste.

The Kendal Power Station Ash leaches Mn and Pb at a concentration above their acceptable risk limits using TCLP solution number 2 and, therefore, as both elements are classified as high hazards, the ash classifies as high hazard waste, if disposed with general waste. However, using the ARLP, no element is leached above its acceptable risk limit and, therefore, the ash formally classifies as non-toxic and, because it is also not-flammable, reactive or corrosive, it classifies as non-hazardous for disposal to a mono-disposal landfill or ash dam. The leaching of salts for the ash could, however, lead to an increase in the salinity of important water resources and, therefore, control of any leachate is required.

The Ash/FGD Gypsum (6:1) mixture leaches Mn, Pb and P concentrations above their acceptable risk limits using TCLP solution number 1. Because Mn and Pb are classified as high hazard species, the mixture classifies as high hazard waste if co-disposed with general waste. However, the mixture leaches only F at a concentration above its acceptable risk limit using the ARLP. As F classifies as a moderate hazard species, the mixture classifies as moderate hazard waste for disposal to a mono-disposal landfill. The origin of the fluoride is mainly the gypsum and, therefore, the hazard rating of the ash is increased by mixing with gypsum.

The results show that mono-disposal of the FGD Gypsum, either separately or with the ash would result in lower environmental risks that co-disposal with general waste. It may be more economic to dispose of the two wastes in two separate facilities, as the ash which is classified as non-hazardous and is produced in much higher amounts could be disposed to a facility with a lower grade liner than that required for the gypsum and ash/gypsum mixture. In addition,

disposing the FGD Gypsum its own mono-disposal facility would mean that, if required, the material could be recovered and utilised in the future. Treatment of the FGD Gypsum with lime or the use of excess lime in the gas cleaning process to reduce the leachability of the fluoride should be considered. The amount of excess lime, CaO or $Ca(OH)_2$, required would be about 2.5% by mass.

The actual choice of liners for the ash dam, a FGD gypsum mono-disposal site or a site that takes the mixed waste will depend on a number of other factors not considered in this report, e.g. the climatic water balance at the site and the presence of any groundwater that has to be protected.

When considering the environmental risks posed by most utilisation options, the analytical data presented in this report can be used to determine, at least initially, if it meets that standards required, e.g. in the manufacture of the various grades of cement from cement clinker; in the manufacture of bison board and as agricultural soil ameliorant. For agricultural use, the Waste Water Sludge Guidelines, which are based on the load of heavy metals and other potential pollutants that can be added to an agricultural soil, can be used to give an idea of the possible environmental impact of the gypsum. A brief comparison of the results obtained for the current sample of FGD Gypsum with the guidelines suggests that this option is worth pursuing further, although a separate in-depth study would have to be done.

A draft Material Safety Data Sheet that is required for handling, storage and transport of the FGD Gypsum has also been produced.

Table of Contents

1.   Introduction

Eskom has just started the construction of the new Kusile Power Station near Witbank, Mpumalanga. The 4 818-MW station will consist of six 803MW units; the first unit will enter commercial operation in 2013, with the subsequent five units being commissioned in eight-month intervals thereafter. Each unit will be fitted with a flue gas desulphurisation (FGD) facility, as an atmospheric-emission abatement technology to ensure compliance with new air quality standards.

The Flue Gas Desulphurisation scrubbing process injects a limestone or calcium oxide slurry into the gas stream, where it reacts with the sulphur dioxide to form calcium sulphite, which is then oxidised by air to produce calcium sulphate The suspended calcium sulphate dehydrate (gypsum) is separated and dried down to a moisture content of ~10%. Eskom opted for the water-intensive FGD route in a trade-off between adding to the plant's water footprint and reducing atmospheric emissions. It is estimated that each of the six scrubbing units will generate 464 tons/day of gypsum, i.e. once all six units are in operation in 2016, a total of 2784 tons/day will be generated.

The gypsum is formally classified as a waste product, because it is generated from a flue gas cleaning process, and, therefore, must be classified and the environmental risks assessed using the Minimum Requirements [1, 2]. However, depending on its purity, the FGD gypsum can be a valuable material and, in Europe, it is widely used in the building industry, as a substitute for natural gypsum and by heating to ~150°C to produce α- and β- calcium sulphate hemihydrates, which are used to make of plaster products. In addition, gypsum is used in significant quantities in the production of Portland Cement to control the setting rate.

Because at full operation more than a million tons of gypsum with be produced a year, Kusile must clearly look at all options for the utilisation and disposal of the gypsum.

En-Chem Consultants has been requested by the Panel B Consultants Joint Venture to classify the gypsum product in terms of the requirements and to evaluate the utilisation, treatment and disposal options. One option is to dispose in the ash dam that will be constructed on site and a sample of ash plus a mixture of ash and gypsum have also been investigated. As the Kusile Power Station is just being built, samples of the ash were obtained from Kendal Power Station and the FGD gypsum from an overseas facility that uses the same process. Note that these materials will be sufficiently similar to those that will be generated from the new Kusile Plant to be able to determine the waste management requirements but, once the first Kusile unit is

operational in 2013, samples must be obtained and the waste evaluation repeated.

In this report, an overview of the current Minimum Requirements and the classification system used for waste is included in section 2; the analytical procedures used are presented in section 3; and the classification of the three materials, the gypsum, the ash and the ash/gypsum mixture and their disposal in section 4. Section 5 briefly discusses the waste utilisation options for the gypsum and the conclusions of the study are presented in section 6. A draft MSDS has been prepared for the product gypsum in terms of the requirements of the Occupational Health and Safety Act (Act 85 of 1993) and is included in appendix 1.

2.   Overview and Approach to Waste Classification.
2.1.   General Background

Until 2006, the Department of Water Affairs and Forestry was obliged in terms of the Environmental Conservation Act (73 of 1989) to control pollution from amongst others littering and waste disposal. Section 20/1 of the Act makes provision for the permitting of landfills and this aspect is administered and controlled by the Department via the "Minimum Requirements". During 2006, most of the functions concerning waste management were taken over by the Department of Environment Affairs and Tourism, e.g. permitting of landfills, classification and delisting of hazardous waste, etc. Currently, the three "Minimum Requirements" documents published by the Department of Water Affairs and Forestry are still used for assessing wastes:

- Minimum Requirements for the Classification, Handling and Disposal of Hazardous Waste [1]
- Minimum Requirements for Waste Disposal by Landfill [2] and the
- Minimum Requirements for Monitoring at Waste Management Facilities.

The Minimum Requirements documents were launched at the end of September 1994 and a second edition was published in October 1998. The approach used in the documents has brought South Africa into line with overseas methods for the control of solid and hazardous waste. They include the Integrated Waste Management approach that promotes waste avoidance, waste re-use, waste recycling and waste treatment in preference to disposal. Since 1994, more than 700 landfill sites in South Africa have been permitted and upgraded according to these documents and many more are in the process of applying for permits.

2.2.   Classification of Hazardous Waste

The Minimum Requirements for the Classification, Handling and Disposal of Hazardous Waste [1] considers any waste that contains or that can leach a potentially hazardous component as "probably" or potentially hazardous. The document contains an approach for the classification of these wastes either as a hazardous waste (see below) or a non-hazardous waste. A non-hazardous waste is one that has a similar or even lower pollution potential than a General Waste such as household waste.

Potentially hazardous wastes are identified by:

- The Industrial Group or Sector that generates the waste, e.g. Chemical and Allied Industries, Metallurgical Industry, etc,

- The processes that generate the waste, e.g. Petroleum Production, Production of Primary Chemicals and Feedstocks, etc,

- The Waste Stream, e.g. Ash and Slags, Oily Wastes, Organic Wastes, etc, and

- The hazardous characteristics of the waste, i.e. Corrosivity, Flammability, Reactivity and Toxicity

In South Africa, the primary classification of wastes in terms of their hazardous characteristics is accomplished by using the International Maritime Dangerous Goods (IMDG) Code, or SANS Code 10228:2003, i.e.

Class 1, Explosives
Class 2, Gases
Class 3, Flammable Liquids
Class 4, Flammable Solids
Class 5, Oxidising Substances and Organic Peroxides
Class 6, Toxic and Infectious Substances
Class 7, Radioactive Substances
Class 8, Corrosive Substances and
Class 9, Miscellaneous Dangerous Substances

The above code was primarily developed as a code for the transport of hazardous materials. Therefore, the approach used to classify class 6, Toxic and Infectious Substances, in this code is not adequate for the determination of the impact of hazardous waste on the environment.

The Minimum Requirements [1], therefore, outline a comprehensive approach to the classification of the toxic or poisonous characteristic of a hazardous waste.

The Minimum Requirements classify waste streams in terms of their chronic toxicity (teratogenicity, mutagenicity, carcinogenicity), acute toxicity in terms of the mammalian toxicity, as measured by the LD_{50} mg/kg (oral, rat) and ecotoxicity in terms of its LC_{50} mg/l/96hr for fish preferably trout. Also taken into account is the biodegradability of the specific component, its persistency, bioaccumulation and mobility in the environment. The waste or the species of concern in the waste is assigned to a Hazard Group (HG) depending on its chronic toxicity, acute toxicity and its acceptable risk concentration or level (ARL). The ARL is equal to one tenth of the LC_{50} in ppm. In simple terms, the ARL is that concentration, which when added to a body of water will provide no risk or at least an acceptable risk, if consumed by a population. The hazard groups are defined as:

Hazard Group 1, (HG1): Extreme Hazard, e.g. Cr (VI), Hg and PCBs
Hazard Group 2, (HG2): High Hazard, e.g. Mn and Zn
Hazard Group 3, (HG3): Moderate Hazard, e.g. Ni and phenol
Hazard Group 4, (HG4): Low Hazard, e.g. Ethanol
Non-hazardous, e.g. fresh domestic waste

2.3.   Acceptable Load Calculations

Unlike most classification systems used in the world, the South African system allows for the calculation of the amount that can be disposed and a total load for a particular class of site. The load in grams per hectare per month is defined in the Minimum Requirements document as the ARL (in ppb) divided by 0.66. For example, for Mn which is hazard class 2 and has an ARL of 0.3 ppm, the load or dose that can be disposed to a hazardous waste site is 300/0.66 = 454.5 g/hectare/month [1]. For a waste with more than one hazardous component, that component that is the most hazardous determines the hazard group and that component at the highest concentration or leachable concentration is the one that determines the load. The maximum amount can be disposed on that 1 hectare of site for up to 100 months.

2.4.   Leaching Characteristics of Solid Wastes

Another innovation in the South African approach is that for a solid waste, the leachable concentration is used to calculate the impact on the environment. For a waste that is co-disposed with municipal waste, the United States Environmental Protection Agencies'

Toxicity Characteristic Leaching Procedure (TCLP) is used to determine the leachability of potentially hazardous components. The TCLP is also used, as a worse case scenario, if a waste is stored and transported off-site. Whereas, for a mono-disposal site, where one type of waste is being disposed, such as a Metallurgical slag or a power station ash disposal site, then the modified Acid Rain leaching procedure can be used. In the TCLP procedure, an acetic acid buffer is used as the leach solution, in order to simulate the chemical and physical characteristics of the leachate from domestic waste sites. In the Acid Rain test, the solution is a weak carbonic acid and nitric acid solution to simulate Acid Rain.

The leachability of a material depends on a multitude of factors, the most important of which are:

a) The pH of the leach solution and the acid neutralisation capacity.

b) Basic chemical equilibria, which for inorganic wastes involves:

- The "hydrolysis" reaction, where the metal ion reacts with water,

- The reaction in the interstial space within the solid – re-precipitation can occur that could prevent further leaching.

- The formation of new ionic or neutral species in solution

c) The presence of readily soluble species such as chromium (VI), vanadium (V), sodium, potassium, sulphate and chloride.

d) The presence of degrading organic matter, which can have the following effects: production of dissolved organic compounds that can dissolve metal ions, the generation of CO_2 that has a neutralising effect and the development of reducing conditions.

e) The redox potential

f) The leaching solution used. For the TCLP procedure, 0.1M acetic acid or acetic acid buffer are used to simulate the type of leachate found in a domestic waste site. This solution favours the leaching of "hard" ions such Mn (II) and Fe (III). The Acid Rain test on the other hand contains carbon dioxide and thus one would anticipate elements that form relatively insoluble carbonates or basic carbonates to be of lower leachability than in the TCLP test, e.g. Ca, Ba (II) and Pb (II).

g) The leaching tests tend to be acidic thus any material that has a reasonable alkalinity, will

tend to neutralise the solution and pH values above about 8 will lead to low leachability of most metal ions. Exceptions tend to be the anionic compounds such as chromate and vanadate.

h) The physical nature of the waste, e.g. its particle size, the presence of water in the sample, etc.

i) The presence of calcium or other cations that can form relatively insoluble compounds compared to the equivalent sodium salts, e.g. calcium zincate, calcium sulphate and calcium fluoride.

2.5. Delisting of Hazardous Wastes

A hazardous waste can be delisted - that is can be downgraded in terms of its classification and hazardousness to the environment - if the Estimated Environmental Concentration (EEC), as determined from the actual concentration or leachable concentration of the main constituent of concern, is below the acceptable risk limit (ARL). In the Minimum Requirements for the Handling, Classification and Disposal of Hazardous Waste [1], the delisting concentrations are defined as:

HG1 → HG3/4 when the EEC is < ARL.

HG1 → General when the EEC is <ARL/10

HG2/3/4 → General when the EEC is < ARL

Also total load in g/ha/m = ARL in ppb/0.66

Note that a waste, even one containing an extreme hazard waste, can delist such that it can be disposed to a general waste site (G site), i.e. a site taking domestic waste or one that is constructed as a G site [1]. A delisted waste is still classified as hazardous but if it is delisted, it can be disposed in to a general site with a leachate management system; i.e. the site must be constructed as a GB$^+$ site [1, 2]: see section 2.7.

2.6. Landfill Restrictions

The Minimum Requirements prohibit the landfilling of wastes with certain characteristics, i.e.

- Class 1, Explosives
- Class 2, Compressed gases
- Class 3, Flammable Liquids with a flash point <61 °C

- Class 4, Solids that emit flammable or toxic gases
- Class 5, Strong Oxidising Substances and Organic Peroxides
- Class 6, Infectious Substances
- Class 7, Radioactive Substances
- Class 8, Corrosive Substances with a pH <6 or >12

The requirement is that, if possible, the waste is treated to remove that characteristic prior to disposal to landfill. Once the characteristic has been removed, the waste or any residues must then be classified according to its toxicity in class 6.1.

2.7. Landfill Classification

The classes of landfills according to the Department of Water Affairs and Forestry's Minimum Requirements for Waste Disposal to Landfill [2] are summarised in the table below. Note that hazardous wastes must be disposed to an H landfill (HH or Hh) according to the hazard ratings listed in the right hand column. However, hazardous wastes can be delisted, see section 2.5, and it is a policy decision from the Departments that disposal to a GMB$^+$ or GLB$^+$ landfill, i.e. one with a leachate management system, is required. The Department of Water Affairs and Forestry, in the past, allowed disposal of selected dry wastes to a GLB$^-$ landfill after careful motivation, but it is not known whether the Department of Environment Affairs and Tourism would also give such an approval.

Landfill Classification System

Waste Type	G General Waste				H Hazardous Waste	
Landfill Size	C Communal Landfill	S Small Landfill	M Medium Landfill	L Large Landfill	h Hazard Ratings 3 & 4	H Hazard Ratings 1 to 4
Climatic Water Balance	B$^-$ B$^+$	B$^-$ B$^+$	B$^-$ B$^+$	B$^-$ B$^+$		
Landfill Size Maximum Rate of Deposition	<25 ton/day	>25 < 150 tons/day	>150 <500 tons/day	>500 tons/day		

2.8. Revision of the Minimum Requirements

The Department of Water Affairs and Forestry is required in terms of the National Waste Management Strategy, which was completed in 1999, to revise the Minimum Requirements documents every five years and, therefore, the Department in collaboration with the Department of Environment Affairs and Tourism embarked on a process, which has lead to

the publication of draft 3rd editions of the three document discussed in section 2. The 3rd edition of the Minimum Requirements for the Handling, Classification and Disposal of Hazardous Waste has received considerable criticism from many quarters. The Department of Environment Affairs and Tourism has therefore decided not to publish a final document and to undertake a benchmarking exercise that will compare the South African approach to waste classification against those used internationally. This exercise is expected to start towards the end of 2008, but until such time that a revised approach is developed; the second edition of the Minimum Requirements documents must be used.

3. Analytical Procedures

Samples of the FGD Gypsum and the Coal Ash were forwarded to M and L Laboratory Services, Ormonde, Johannesburg by the environmental consultants from Panel B. The laboratory was requested to:

a) Prepare two composite samples S1: FGD Gypsum and S2: Ash

b) Prepare a sample S3: Mixed Waste, which is one part by mass of S1 and 6 parts by mass of S2;

c) Analyse S1 for moisture, 10%pH, a range of 35 elements (major & trace), sulphate, volatile and semi-volatile organic compounds. Although, no organic compounds are expected, the Department of Environment Affairs and Tourism would require the generator to analyse at least one sample for these species to demonstrate that none are present. This analysis was repeated because the first results reported by the laboratory were not correct.

d) An ARLP on S1, S2 and S3 and analysis of the leachate for the same 35 elements plus sulphate. In the estimate given below, it is assumed that no volatile and semi-volatile compounds are present but if they are identified in b), then they would also have to be analysed in the ARLP extract.

e) A TCLP on S1, S2 and S3 and analysis of the leachate for the same 35 elements plus sulphate.

A copy of the final certificate of analysis from M and L Laboratory Services is included in appendix 2.

4. Classification of the Waste Materials

The results for the FGD gypsum are discussed in section 4.1, the Ash in section 4.2 and the Ash/Gypsum Mixture in section 4.3.

4.1. Classification of the Sample S1: FGD Gypsum

The results, that were obtained by M and L Laboratory Services for the S1: FGD Gypsum, are presented in table 2 together with the hazard rating (HR) and acceptable risk limits (ARL, mg/l) of each component. In addition, the total concentrations for the major components calcium and sulphate (as percentages) and the minor and trace elements (in mg/kg) are given.

4.1.1. Composition of the FGD Gypsum

According to the results from M and L Laboratory Services, the FGD Gypsum, as would be expected, contains mainly Ca, 25.9%; Sulphate, 65.5% and Moisture 16.6%. The FGD Gypsum, as produced should be wet calcium sulphate dihydrate, $CaSO_42H_2O$. The moisture is the amount of water driven off at $110^{\circ}C$, whereas the dihydrate water is only partially removed above $150^{\circ}C$ to nominally form calcium sulphate hemihydrate, $CaSO_40.5H_2O$. The sulphate: calcium mass ratio in all these products should be 2.4, whereas the above analysis gives a value of ~2.53, which makes the sulphate value higher than stoichiometric. One component that would increase this ratio is magnesium sulphate.

The FGD Gypsum contains a number of minor elements, i.e. Al, 0.254%; Mg, 0.22%; P, 0.428%; plus of a number of traces elements (<0.10%), i.e. Fe, F, K, etc.

4.1.2. Primary Classification

The FGD Gypsum is not flammable (flash point $>61^{\circ}C$), reactive or corrosive (pH< 6 or >12) in terms of the Minimum Requirements. The waste could, however, be toxic and this characteristic is discussed below in section 4.1.3.

4.1.3. Toxicity Rating

The toxicity of a species considers, the chronic toxicity, i.e. the presence of carcinogens, etc. and the acute toxicity, which is determined by the acceptable risk limit of the species.

4.1.3.1. Chronic Toxicity

The FGD Gypsum does not contain any leachable species, which are classified as Teratogens, Mutagens or Carcinogens, at a concentration above 1%, i.e. 10,000mg/kg. Therefore, in terms of the Minimum Requirements, the FGD Gypsum is not considered a teratogen, mutagen or

14

carcinogen.

4.1.3.2. *Acute Toxicity*

(i)   Organic Compounds

The possible presence of volatile and semivolatile organic compounds in the TCLP extract were analysed by headspace GC. The first set of results indicated that part per billion concentrations of carbon tetrachloride, toluene, xylenes and 1,2,4-trimethylbenzene were present. However, as the FGD gypsum is generated from a coal combustion process at high temperature, the presence of carbon tetrachloride in particular would be very unlikely. Because of the sensitivity of the technique samples can become contaminated in the laboratory or a sample with high concentrations of these components was analysed in the sample before and one can get incorrect results. M and L Laboratory Services were requested to repeat this analysis and this time all compounds analysed for were below the detection limit of 0.005mg/kg.

Therefore, there are no organic compounds present at an environmentally significant concentration.

(ii)   Inorganic Species

The FGD Gypsum leaches only fluoride at a concentration above it acceptable risk limit in both the TCLP and the ARLP tests. Fluoride is a moderate hazard according to the Minimum Requirements and, therefore, the FGD gypsum classifies as a moderate hazard waste.

4.1.4.   Conclusion

In terms of the Minimum Requirements, the FGD Gypsum sample classifies as a moderate hazard waste both for co-disposal with general waste and when disposed in a mono-disposal facility: a class Hh landfill would be required: : see section 4.4.3.

4.2.   Classification of the Sample S2: Kendal Power Station Ash

The TCLP and ARLP results, that were obtained by M and L Laboratory Services for sample S2: Ash, are presented in table 2 together with the hazard rating (HR) and acceptable risk limits (ARL, mg/l) of each component. No organic compounds were analysed in the leach solution from the ash in this study, as it has been demonstrated on many occasions that the ash generated by Eskom Power Stations does not leach volatile or semi-volatile organic compounds [3].

Unfortunately, the Toxicity Characteristic Leaching Procedure on S2, Ash required the use of solution number 2, which is a 0.1M Acetic Acid solution, pH 2.80±0.05, whereas samples S1 and S3 required the use of TCLP solution number 1, which is a 0.1M Acetic Acid/Sodium Acetate buffer of pH 4.93±0.05. The procedure requires the use of solution number 2, when the sample has a high acid neutralisation capacity and clearly this leach solution does not represent the conditions under which the waste would be disposed to co-disposal landfill in South Africa, where permitted landfills tend to have a leachate pH of between 6.5 and 8.2. Because of the use of TCLP solution number 2, the results in table 2 for the ash are not directly comparable to the TCLP results obtained for the Gypsum or the Gypsum/Ash mixture, where TCLP solution number 1 was used.

4.2.1. Primary Classification

The Ash is not flammable (flash point >61°C), reactive or corrosive (pH< 6 or >12) in terms of the Minimum Requirements. The waste could, however, be toxic and this characteristic is discussed below.

4.2.2. Toxicity Rating

The toxicity of a species considers, the chronic toxicity, i.e. the presence of carcinogens, etc. and the acute toxicity, which is determined by the acceptable risk limit of the species.

4.2.2.1. *Chronic Toxicity*

The Ash does not contain any leachable species, which are classified as Teratogens, Mutagens or Carcinogens, at a concentration above 1%, i.e. 10,000mg/kg. Therefore, in terms of the Minimum Requirements, the FGD Gypsum is not considered a teratogen, mutagen or carcinogen.

4.2.2.2. *Acute Toxicity*

The Ash leaches Mn and Pb at a concentration above their acceptable risk limits using TCLP solution number 2 and, therefore, as both elements are classified as high hazards, the ash classifies as high hazard in terms of the Minimum Requirements [1].

However, using the ARLP, no element is leached above its acceptable risk limit and, therefore, the ash formally classifies as non-toxic and, because it is also not-flammable, reactive or corrosive, it classifies as non-hazardous. Note, however, that it does leach Pb and F at concentrations just below their acceptable risk limit and that the non-toxic calcium leaches at a concentration of 457mg/l in the TCLP and 128mg/l in the ARLP. As the ash is

produced in such large amounts, i.e. ~16 700 tons/day at full production, it can still have a significant impact on the environment as it can increase the salinity of water resources and a lined facility with a water management system is required for its disposal.

4.2.3. Conclusion

The Kendal Power Station Ash classifies as a high hazard, if co-disposed with general waste, but is classified as non-toxic and non-hazardous for disposal to a mono-disposal facility or ash dam. In the former case an HH landfill would formally be required but for the mono-disposal, a GB^+ or GB^- class facility would be required depending on the water balance in the area and the need to protect groundwater resources: see section 4.4.3.

4.3. Classification of the Sample S3: Ash/FGD Gypsum Mixture

One of the waste management scenarios is to dispose of the FGD Gypsum to the ash dam. It has been estimated that the gypsum will be generated at a rate of one sixth of the quantity of ash and, therefore, this scenario has been evaluated by leaching a 6:1 mixture of ash and the gypsum. The TCLP and ARLP results, that were obtained by M and L Laboratory Services for the S3: Ash/FGD Gypsum, are presented in table 2 together with the hazard rating (HR) and acceptable risk limits (ARL, mg/l) of each component.

4.3.1. Primary Classification

Sample S3 is not flammable (flash point >61°C), reactive or corrosive (pH< 6 or >12) in terms of the Minimum Requirements. The waste could, however, be toxic and this characteristic is discussed below.

4.3.2. Toxicity Rating

The toxicity rating of a waste depends on the chronic toxicity, i.e. the presence of carcinogens, etc. and the acute toxicity, which is determined by the acceptable risk limit of the species.

4.3.2.1. *Chronic Toxicity*

The FGD Gypsum and the Ash do not contain any leachable species, which are classified as Teratogens, Mutagens or Carcinogens, at a concentration above 1%, i.e. 10,000mg/kg. Therefore, in terms of the Minimum Requirements, the mixed waste is not considered a teratogen, mutagen or carcinogen.

4.3.2.2. *Acute Toxicity*

The Ash/FGD Gypsum mixture leaches Mn, Pb and P concentrations above their acceptable risk limits using TCLP solution number 1. Because Mn and Pb are classified as high hazard species, the mixture classifies as high hazard in terms of the Minimum Requirements [1]. P is classified as a low hazard.

However, the Ash/FGD Gypsum mixture leaches only F at a concentration above its acceptable risk limit using the ARLP. As F classifies as a moderate hazard species, the mixture classifies as moderate hazard in terms of the Minimum Requirements [1].

4.3.3. Conclusion

The Ash/FGD Gypsum mixture classifies as a high hazard if co-disposed with general waste and formally an HH landfill would be required. For mono-disposal, e.g. the FGD Gypsum and Ash would have to be disposed formally to an Hh site: see section 4.4.3.

4.4. Treatment and Disposal of FGD Gypsum

Two key chemical issues must be considered whatever landfilling option is chosen, i.e. the moisture content and the leachable non-toxic elements and these are discussed in sections 4.4.1 and 4.4.2, respectively.

4.4.1. Moisture Content

The free moisture content of the FGD gypsum is fairly low, i.e. 16.6%. The normal guideline is that a waste with a moisture content of greater than 40% will generate a leachate, when disposed to landfill, due to compaction and the pressure on the waste as the waste height is increased. Clearly, the field capacity of a waste for retaining moisture will depend on the nature of the material and, particularly if mono-disposal is used as the management option, it would be worthwhile determining the actual field capacity of the waste. The Civil Engineering Department at the University of the Witwatersrand is able to undertake these measurements. The experiment simply determines the moisture retention of the waste under gravity and then when subjected to external pressure that simulates the compaction normally achieved on landfilling. In addition, the permeability of the waste under these scenarios can be measured.

4.4.2. Non-toxic Pollutants

Synthetic gypsum is slightly soluble in water and, for the purposes of this report, it is assumed

that it is of the order of 2g/litre on a dry basis, i.e. Ca would be ~588mg/l and sulphate ~1420 mg/l. Note that the values achieved during the ARLP in table 2 are slightly higher that the theoretical values. The TCLP results obtained for calcium and sulphate are about 50% higher than the theoretical values due to the presence of the acetate anion in the extractant solution, which will increase the solubility of the calcium cation. The FGD gypsum, however, leaches relatively low amounts of the cations, K and Na plus the anions, chloride and fluoride. The FGD gypsum could increase the salinity of both surface and ground water resources, if incorrectly utilised on land or disposed to an inappropriate waste disposal facility. The Department of Environment Affairs and Tourism and Department of Water Affairs and Forestry would require the landfill facility to be lined and, if necessary, to have a leachate management system to prevent increasing the salinity of surface and ground water resources.

4.4.3. Disposal to Landfill

4.4.3.1. *Monodisposal*

A mono-disposal landfill is one that accepts a single type of waste and usually refers to one that accepts inorganic waste, e.g. the FGD Gypsum. In practice, a mono-disposal facility can accept a number of purely inorganic waste streams, e.g. gypsum and ash could be disposed in the same facility.

For mono-disposal, the ARLP is used to assess the leachability and hence to classify each waste stream and the mixed product, e.g. FGD Gypsum + Ash. As shown in sections 4.1 to 4.3., the ARLP tends to be less aggressive than the TCLP, particularly towards some elements such as Pb The leaching results thus suggest that disposal to a mono-disposal landfill would have less impact that if the FGD Gypsum was co-disposed with general waste.

According to the Minimum Requirements, the FGD classifies as a moderate hazard and, therefore, must be disposed to an HH or Hh landfill, although the waste can delist for a GB^+ Landfill provided the amount of fluoride that is disposed does not exceed the allowed load. For fluoride, the load or dose of fluoride is given by:

Amount = (ARL (ppb) ÷ 0.66) g/ha/m = 1515.2 g/ha/m

The amount of FGD Gypsum that can be mono-disposed is given by:

Amount = 1515.2 ÷ [ARLP Concentration, mg/l] = 1515.2 ÷ 6.2 $\cong$ 244 tons/ha/m

Note that formally very little of the gypsum, which is going to be produced in amounts of

about 2 784 tons/day or 83 520 tons/m, can be disposed to a landfill that is classified as a GB$^+$ that has an economically feasible area and, therefore, an Hh waste site will be required.

When disposed to an ash dam, the Ash/FGD Gypsum mixture would be expected to leach F, as shown by the ARLP results in table 2, i.e. it classifies as a moderate hazard waste. The gypsum also increases the amounts of calcium and sulphate ions that leach compared to the ash alone. The origin of the fluoride is mainly the FGD Gypsum, although the ash also makes a contribution.

It would appear that the FGD Gypsum would increase the potential environmental risk posed by the ash dam, and, the development of the ash dam as an Hh landfill would be required. *Note that as Witbank is a water deficit area and provided the ash and FGD Gypsum are disposed dry, the requirements for the liner and the leachate management system that are installed might be able to be reduced: a water balance calculation is required.*

Other issues that might be able to be taken into account, if the FGD Gypsum is to be mono-disposed, are:

- The possible treatment of the FGD Gypsum with lime or the use of excess lime in the gas cleaning process to reduce the leachability of the fluoride. Note that the pH of the FGD Gypsum is only 7.2 and this would encourage the leaching of fluoride. From the results in table 2, an excess of about 2.5% lime should be sufficient to reduce the leaching of fluoride to more acceptable levels.

- The ash gypsum mixture is classified as a moderate hazard, but the ash is classified as non-hazardous. It may, therefore, be more economic to dispose of the two wastes in separate facilities, as the ash which is produced in much higher amounts could be disposed to a facility lower grade liner than that required for the gypsum and ash/gypsum mixture.

- Disposing the FGD Gypsum to its own mono-disposal facility would mean that, if required, the material could be recovered and utilised in the future.

4.4.3.2. *Co-disposal with General Waste*

The amount of FGD Gypsum that can be co-disposed with general waste is given by:

$$\text{Amount} = 1515.2 \div [\text{TCLP Concentration, mg/l}] = 1515.2 \div 7.5 \cong 202 \text{ tons/ha/m}$$

Note that without treatment, the amounts of the gypsum that could be co-disposed are very

small compared to the 83 520 tons/m that will be generated when the Kusile Power Station is fully operational. Thus, disposal to a municipal or private co-disposal facility that is close to Witbank would not seem possible, because of the low amounts that can be disposed. Treatment with lime, say 2.5%, may decrease the leaching of fluoride and, thus, allow a higher amount to be co-disposed. Note that there may, however, be occasions, when co-disposal of relatively small amounts of the FGD Gypsum to a municipal or private landfill is required, e.g. after a transport accident.

Currently, the only two sites in Gauteng, Northwest, Limpopo and Mpumalanga Provinces that can currently accept delisted waste are the Ekurhuleni Metropolitan Municipality's 10ha Rietfontein GLB$^+$ Landfill and EnviroServ's 25ha Holfontein HH site, both are near Springs. The Holfontein HH Landfill has a special rate for delisted waste. Other sites that may be available in future include the EnviroServ's Rosslyn GLB$^+$ Landfill near Pretoria, although the permit is under urgent discussion with the Department of Environment Affairs and Tourism, plus various regional sites that appear to be in the planning stages, e.g. planning is underway by the Mpumalanga Department of Agriculture & Land Administration for three regional GLB$^+$ Landfills that will be located near Middelburg/Witbank, Secunda and Nelspruit.

5.   Utilisation of the Product Gypsum

When considering the environmental risks posed by most options, the analytical data given in table 2 can be used, e.g. in the manufacture of the various grades of cement from cement clinker; in the manufacture of bison board and as agricultural soil ameliorant.

The data given in table 2 for the total content of the FGD gypsum should be forwarded to one or more of the South African cement manufacturers for an assessment of its use in the production of cement, although they may request additional information.

For manufactured products that contain the gypsum as an ingredient, one approach to the assessment of the environmental risks is to compare the leaching characteristics of the product made with synthetic gypsum to that made with natural gypsum or the gypsum already used in the manufacturer. The leaching characteristics of the product manufactured with the synthetic gypsum should, at least, be equivalent to or preferably better than that made with the natural gypsum.

For agricultural use, the Waste Water Sludge Guidelines [4, 5 and 6], which are based on the

load of heavy metals and other potential pollutants that can be added to an agricultural soil, can be used to give an idea of the possible environmental impact of the gypsum. The Department of Agriculture requires that an environmental assessment be undertaken, before it will provide a license for any product that is to be used as a soil ameliorant.

Table 3 provides a comparison between the metal concentrations in the FGD Gypsum with the limits for sewage sludge. Note that a "Class a" sludge can be used in any amount on agricultural land, while there are some restrictions for "Class b" and "Class c".

Table 3: Comparison of the Analytical Data for the FDG Gypsum with the 2005 Sewage Sludge Guidelines, mg/kg^{dry}.

Analyte	Class a	Class b	Class c	FGD Gypsum
Metal Limits, mg/kg				
Arsenic (As)	<40	40-75	>75	<2
Cadmium (Cd)	<40	40-85	>85	<0.1
Chromium (Cr)	<1200	1200-3000	>3000	7.8
Copper (Cu)	<1500	1500-4300	>4300	2.8
Lead (Pb)	<300	300-840	>840	93
Mercury (Hg)	<15	15-55	>55	<1
Nickel (Ni)	<420	420	>420	6.8
Zinc (Zn)	<2800	2800-7500	>7500	<0.5
Benchmark Metal Values, mg/kg				
Antimony (Sb)	<1.1	1.1-7.0	>7.0	<1
Boron (B)	<23	23-72	>72	na
Barium (Ba)	<108	108-250	>250	17
Beryllium (Be)	<0.8	0.8-7.0	>7.0	36
Cobalt (Co)	<5	5-38	>38	8.2
Manganese (Mn)	<260	260-1225	>1225	7.1
Molybdenum (Mo)	<4	4-12	>12	0.79
Selenium (Se)	<5	5-15	>15	22
Strontium (Sr)	<84	84-205	>205	128
Thallium (Tl)	<0.03	0.03-0.14	>0.14	<0.9
Vanadium (V)	<85	85-430	>430	5

Note that the amounts present in the .FGD Gypsum in the most important metals limits category are all in Class "a" and, therefore, for these elements, the gypsum would have little impact if used on agricultural land. However, in the benchmark values section Co and Sr fall into Class "b", whereas Be, Se and Tl fall into Class "c". The actual impact will depend of course on many factors, not the least of which is the amount of gypsum that would be used on the land. There are also other elements that could impact on agricultural land that are not included in table 3, e.g. fluoride.

The initial results appear reasonable, although if utilisation of the FGD gypsum as an agricultural ameliorant is an option, a separate in depth study would have to be done.

6. Conclusions

The FGD Gypsum is predominantly calcium sulphate dihydrate but it contains a number of minor elements, i.e. Al, 0.254%; Mg, 0.22%; P, 0.428%; plus of a number of trace elements (<0.10%), i.e. Fe, F, K, etc. The FGD Gypsum sample leached only fluoride at a concentration above it acceptable risk limit using both the TCLP and the ARLP tests. Fluoride is a moderate hazard according to the Minimum Requirements and, therefore, the FGD gypsum formally classifies as a moderate hazard waste.

The Kendal Power Station Ash leaches Mn and Pb at a concentration above their acceptable risk limits using TCLP solution number 2 and, therefore, as both elements are classified as high hazards, the ash classifies as high hazard waste, if disposed with general waste. However, using the ARLP, no element is leached above its acceptable risk limit and, therefore, the ash formally classifies as non-toxic and, because it is also not-flammable, reactive or corrosive, it classifies as non-hazardous for disposal to a mono-disposal landfill or ash dam. The leaching of salts for the ash could, however, lead to an increase in the salinity of important water resources and, therefore, control of any leachate is required.

The Ash/FGD Gypsum (6:1) mixture leaches Mn, Pb and P concentrations above their acceptable risk limits using TCLP solution number 1. Because Mn and Pb are classified as high hazard species, the mixture classifies as high hazard waste if co-disposed with general waste. However, the mixture leaches only F at a concentration above its acceptable risk limit using the ARLP. As F classifies as a moderate hazard species, the mixture classifies as moderate hazard waste for disposal to a mono-disposal landfill. The origin of the fluoride is mainly the gypsum and, therefore, the hazard rating of the ash is increased by mixing with gypsum.

The results show that mono-disposal of the FGD Gypsum, either separately or with the ash would result in lower environmental risks that co-disposal with general waste. It may be more economic to dispose of the two wastes in two separate facilities, as the ash which is classified as non-hazardous and is produced in much higher amounts could be disposed to a facility with a lower grade liner than that required for the gypsum and ash/gypsum mixture. In addition, disposing the FGD Gypsum its own mono-disposal facility would mean that, if required, the material could be recovered and utilised in the future. Treatment of the FGD Gypsum with lime or the use of excess lime in the gas cleaning process to reduce the leachability of the fluoride should be considered. The amount of excess lime, CaO or Ca(OH)$_2$, required would

23

be about 2.5% by mass.

The actual choice of liners for the ash dam, a FGD gypsum mono-disposal site or a site that takes the mixed waste will depend on a number of other factors not considered in this report, e.g. the climatic water balance at the site and the presence of any groundwater that has to be protected.

When considering the environmental risks posed by most utilisation options, the analytical data presented in this report can be used to determine, at least initially, if it meets that standards required, e.g. in the manufacture of the various grades of cement from cement clinker; in the manufacture of bison board and as agricultural soil ameliorant. For agricultural use, the Waste Water Sludge Guidelines, which are based on the load of heavy metals and other potential pollutants that can be added to an agricultural soil, can be used to give an idea of the possible environmental impact of the gypsum. A brief comparison of the results obtained for the current sample of FGD Gypsum with the guidelines suggests that this option is worth pursuing further, although a separate in-depth study would have to be done.

All the above results are based on an FGD Gypsum sample from a similar plant overseas and by using ash from Kendal Power Station. While these samples can provide guidance on the classification of the waste materials and the type of waste management facilities required, as soon as samples produced at the new Kusile Power Station become available, this study must be repeated.

7.   References

[1] Department of Water Affairs and Forestry, Minimum Requirements for the Handling, Classification, and Disposal of Hazardous Waste, 2nd edition, Pretoria, 1998

[2] Department of Water Affairs and Forestry, Minimum Requirements for Waste Disposal by Landfill, 2nd edition, 1998.

[3] En-Chem Consultants, Investigation into the Classification, Treatment and Disposal Options for Filter Bags from: Duhva, Hendrina, Majuba, and Arnot Power Stations, July 1999

[4] Water Research Commission, "Guidelines for the Utilisation and Disposal of Wastewater Sludge", Volume 1, "Selection of Management Options", Pretoria, 2005

[5] Water Research Commission, "Guidelines for the Utilisation and Disposal of Wastewater

Sludge", Volume 2, "Requirements for the Agricultural Use of Wastewater Sludge", Pretoria, 2005

[6] Water Research Commission, "Guidelines for the Utilisation and Disposal of Wastewater Sludge", Volume 3, "Requirements for the On-site and Off-site Disposal of Wastewater Sludge", Pretoria, 2007

Appendix 1: Draft MSDS for the FGD Gypsum

LOGO

Material Safety Data Sheet

Synthetic Gypsum

COMPANY DETAILS

Name:

Address:

Emergency: +27

Tel: +27

Fax: +27

E-mail:

SECTION 1 –PRODUCT AND COMPANY IDENTIFICATION

Trade name:	Synthetic Gypsum	CAS Number:	7778-18-9
Chemical Family:	Alkaline Earth Sulphate	NOISH Number:	Not available
Chemical Name:	Calcium Sulphate Dihydrate $CaSO_4 \cdot 2H_2O$	Hazchem Code:	Not available
Synonyms:	Gypsum, FGD Gypsum	UN Number:	Not regulated

SECTION 2 – COMPOSITION AND INFORMATION ON INGREDIENTS

Chemical Name	CAS No.	Percent	Hazardous[1]
Calcium Sulphate Dihydrate	7778-18-9	80 to 90%	Not Hazardous
Water (unbound)	7732-18-5	10 to 20%	Not Hazardous
Magnesium Oxide	1309-48-4	0.20 to 0.5%	Not Hazardous
Phosphorus Oxide	1314-56-3	0.80 to 1.20%	Low Hazard
Silicon Dioxide, Crystalline[3]	14808-60-7	0.5 to 1.5%	High hazard
Aluminium Oxide, Al_2O_3	1344-28-1	0.3 to 0.6%	Not Hazardous

1. Classification based on the South African Minimum Requirements, 2nd edition, 1998. Under acid leach conditions the product could leach environmentally significant concentrations of F and some heavy metals;
2. Contains a number of trace elements (<0.1%), e.g. Cl, F, Fe, K and Pb.
3. Contains silicon dioxide that has been assumed to be possibly crystalline.

SECTION 3 – HAZARDS IDENTIFICATION

Main hazard: Dust may cause irritation to the eyes, nose, throat and upper respiratory tract.

Flammability: Not Flammable

Chemical hazard: None

Biological hazard:	None known.
Reproduction hazard:	None known.
Eye Effects:	Exposure to dust can produce eye irritation
Health Effects – skin	No adverse effects expected.
Health Effects – ingestion	May be toxic if ingested due to release of iron and trace heavy metals
Health Effects – inhalation	Repeated inhalation can produce respiratory irritation or lung damage.
Carcinogenicity	May contain low amounts of crystalline silica: prolonged and repeated exposure to airborne free respirable crystalline silica can result in lung disease (i.e., silicosis) and/or lung cancer
Mutagenicity	None known.
Neurotoxicity	None known.

SECTION 4 – FIRST AID MEASURES

Product in Eye:	Check and remove any contact lenses. Flush thoroughly with plenty of water for at least 15 minutes. Obtain medical attention.
Product on Skin:	Wash skin with a mild soap and water. Remove and wash contaminated clothing and footwear. Obtain medical attention, if irritation develops.
Product Ingested:	Give water to drink if ingested. Never give anything by mouth to an unconscious person. Obtain medical attention.
Product Inhaled:	Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Obtain medical attention.

SECTION 5 – FIRE FIGHTING MEASURES

Fire:	The product is not a fire hazard.
Explosion:	No information found.
Extinguishing Media:	Use water or the appropriate means to extinguish a surrounding fire
Decomposition Products:	Above 1450º C calcium sulphate decomposes to calcium oxide (CaO) and sulphur dioxide (SO2).
Protective Clothing:	In the event of any fire, wear full protective clothing and an approved self-contained breathing apparatus.

SECTION 6 – ACCIDENTAL RELEASE MEASURES

Personal Precautions:	Keep unnecessary and unprotected persons away from the area of the spill. Wear protective clothing as detailed in section 8.

Environmental Precautions: As far as possible, prevent the material entering a watercourse or storm water channel.

Small and Large Spills: Carefully collect spilt material and place in suitable container, e.g. skip or drum, for reclamation or disposal. Any water that may be contaminated should preferably be discharged to sewer with permission of the Municipal Authority.

SECTION 7 – HANDLING AND STORAGE

Handling/Storage   Avoid dust contact with eyes. Wear the appropriate eye protection against dust (See Section 8). Minimise dust generation and accumulation. Avoid breathing dust. Wear the appropriate respiratory protection against dust in poorly ventilated areas and if TLV is exceeded (see Sections 2 and 8). Use good safety and industrial hygiene practices.

SECTION 8 – EXPOSURE CONTROLS AND PERSONAL PROTECTION

Occupational Exposure Limits: The South African Occupational limits are presented in the table below.

Chemical Name	TWA OEL-RL mg/m³	
	Total Inhalable	Respirable
Gypsum	10	5
Silica, Crystalline		0.4

Engineering Control Measures: Provide ventilation sufficient to control airborne dust levels. If user operations generate airborne dust, use ventilation to keep dust concentrations below permissible exposure limits. Where general ventilation is inadequate use process enclosures, local exhaust ventilation, or other engineering controls to decrease dust levels below the permissible exposure limits.

Personal Protection – Respiratory: Use dust masks in accordance with SANS 1455/EN and Government Gazette 1200. If exposure limit exceeded, a full-face piece respirator must be worn.

Personal protection – Eye: Use chemical safety goggles and/or full-face shield, where dusting is possible. Maintain eye wash fountain and quick drench facilities in work area.

Personal Protection – Skin: Impervious clothing should be worn, including boots, gloves, lab coat, apron, or overalls, as appropriate to avoid skin contact.

SECTION 9 – PHYSICAL AND CHEMICAL PROPERTIES

Appearance: White to Off-white Powder

Odour: None

pH 10% solution: Between 7 and 8

Specific Gravity: ~2.32

Boiling Point: Not known

Melting Point: Not known

Flash Point: Not applicable

Flammability:	Not flammable
Oxidising Properties:	Not applicable
Vapour Pressure:	Not applicable
Solubility in Water:	Low

SECTION 10 – STABILITY AND REACTIVITY

Stability:	Stable under normal conditions
Conditions to Avoid:	Incompatible Chemicals
Incompatible Chemicals:	Diazomethane, aluminium, phosphorus
Hazardous Decomposition Products:	Burning may produce sulphur dioxides

SECTION 11 – TOXICOLOGICAL INFORMATION

Acute Toxicity:	No acute toxicological data available. Expected to be of very low toxicity to humans and animals
Skin and Eye Contact:	No data available
Chronic Toxicity:	
Carcinogenicity:	Not carcinogenic
Mutagenicity:	No data available
Reproductive Hazards:	No data available

SECTION 12 – ECOLOGICAL INFORMATION

Aquatic Toxicity: Expected to be of low toxicity to aquatic life forms, except under acid conditions, when F and some heavy metals may leach.

Ingredient	LC_{50}, mg/l	Species	Duration	Hazard Rating
Calcium Fluoride	1000	Trout	96hrs	Moderate

Aquatic Toxicity:	Expected to be of low toxicity.
Degradability:	Will not degrade.
Bioaccumulation:	Will not bioaccumulate.
Mobility:	Not mobile except F may be mobilised under acid conditions.
Environmental Fate – Air:	Dust may be a nuisance factor

SECTION 13 – DISPOSAL CONSIDERATIONS

Disposal Methods:

The product classifies as a moderate hazard due to the leaching F using standard acid leach procedures according to the Department of Water Affairs and Forestry's Minimum Requirements. Dispose to a permitted hazardous waste landfill or delist in terms of the requirements and dispose to a permitted GB^+ Landfill.

Waste Classification:

Normally classifies as a moderate hazardous waste, when subjected to the leaching procedures required by the Department of Water Affairs and Forestry's Minimum Requirements but reasonable amounts can be delisted for disposal to a GB^+ Landfill.

UN Number: Not regulated

IMDG – Class: Not regulated

SANS 10228:   Not regulated

SECTION 15 – REGULATORY INFORMATION

UN Number: Not regulated

Substance Identity Number: Not applicable

IMDG – Class: Not regulated

IMDG Packaging Group: Not regulated

Risk/Safety Phrases:

    Harmful if swallowed or inhaled
    Do not get in eyes, skin or clothing
    Do not breathe dust
    Use only with adequate ventilation
    Wash thoroughly after handling
    Keep out of reach of children

SECTION 16 – OTHER INFORMATION

Other Special Considerations: None identified

History:
    Date of Issue: 18th November 2008

    Date of Previous Issue: None

    Validated by:

Notice to Reader:

The information and recommendations presented in this data sheet are to the best of our knowledge and belief accurate and reliable, but do not constitute a warranty. None of our representatives or agents are authorised to give any guarantee or warranty or make any representation in addition or contrary to the above, and we do not accept liability for claims of any kind for any loss, including, without limitation, consequential loss, injury or

damage arising from the use of the information or recommendations, or of the products, which are the subject matter hereof. The products are sold subject to our standard conditions of sale and tender, copies of which are available on request.

Appendix 2: Copy of the M and L Laboratory Services Certificate of Analysis

P.O. Box 82124,
Southdale, 2135,
South Africa.
TEL. (011) 496-2228
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Registration Number 1974/001476/07   Vat Number 4780103505
M and L Laboratory Services (Pty) Ltd
Consulting Industrial Chemists, Analysts & Samplers
CONFIDENTIAL

Ref.No.   :   08/12583L

Issued   :   Johannesburg
at
Date   :   2008.11.12

Page   :   1 of 13

COMPANY NAME	:	EN-CHEM CONSULTANTS CC
ADDRESS	:	PO BOX 2856, CRESTA, 2118
SUBJECT	:	ANALYSIS OF 3 SAMPLES OF GYPSUM AND ASH
MARKED	:	KUSILE and as below
INSTRUCTED BY	:	D.A. Baldwin
PROJECT NO.	:	P962/2008
RECEIVED ON	:	2008.09.23
LAB NO(S)	:	E50788,E50789,E51657
DATE ANALYSED	:	2008/10/19

Analysis on an as received basis: **KUSILE GYPSUM (S1)**

% Moisture, loss on dry @ 105^{0}C   16.6

Analysis on a 5% TCLP extract of the sample as received: Reference EPA 1311

DETERMINANTS	KUSILE ASH (S2)	KUSILE GYPSUM (S1)	COMPOSITE(S3)
pH Value on a 10% extract @ 25°C	10.8	7.2	10.4
pH Value @ 25°C (of leach Solution)	4.2	5.1	5.2
Chloride, Cl	3.1	5.2	11.3
Fluoride, F	0.8	7.5	0.6
Mercury, Hg	<0.001	<0.001	<0.001
Sulfate, SO$_4$	60	2387	2038
Sulfide Sulfur, S	<0.2	<0.2	<0.2
Sulfate and Sulfide Sulfur as S	20	797	680
Hexavalent Chromium Cr^{6+}	<0.01	<0.01	<0.01

The results are expressed in mg/ℓ where applicable
A list of Test Methods is appended.

NOTE 1: Sample marked Kusile Ash was extracted using TCLP solution 2
NOTE 2: Samples marked Kusile Gypsum and S3 were extracted using TCLP solution no. 1
NOTE 3: S3 was prepared on a 1:6 composite of S1:S2.

Results reported relate only to items tested
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Mahmood Patel

Authorised Signature
OPERATIONAL MANAGER

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Date : 2008.11.12

Page : 2 of 13

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SUBJECT	:	**ANALYSIS OF 3 SAMPLES OF GYPSUM AND ASH**
MARKED	:	**KUSILE,and as below**
INSTRUCTED BY	:	**D.A. Baldwin**
PROJECT NO.	:	**P962/2008**
RECEIVED ON	:	**2008.09.23**
LAB NO(S)	:	**E50788,E50789,E51657**
DATE ANALYSED	:	**2008/10/19**

Analysis on a 5% Acid Rain extraction of the samples as received:

SAMPLE MARKS	KUSILE ASH(S2)	KUSILE GYPSUM(S1)	COMPOSITE(S3)
pH Value @ 22°C	8.8	7.3	11.6
Chloride,Cl	5.1	4.4	2 .0
Fluoride,F	0.6	6.2	2.1
Mercury, Hg	<0.001	<0.001	<0.001
Sulfate,SO_4	41	1703	1622
Sulfide Sulfur, S	<0.2	<0.2	<0.2
Sulfate and Sulfide Sulfur as S	13.7	568	541
Hexavalent chromium, Cr^{6+}	<0.01	<0.01	<0.01

The results are expressed in mg/ℓ where applicable
A list of Test Methods is appended.

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Page   :   3 of 13

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PROJECT NO.	:	P962/2008
RECEIVED ON	:	2008.09.23
LAB NO(S)	:	E50788,E50789,E51657
DATE ANALYSED	:	2008/10/19

<u>Analysis on a 5 % TCLP extract of the samples as received:</u>

Sample marks	S2	S1	S3
Arsenic, As	0.06	<0.02	0.13
Selenium, Se	0.06	0.12	<0.03
Titanium, Ti	<0.001	<0.001	0.02
Aluminium, Al	1.9	2.5	0.39
Nickel, Ni	0.11	0.007	0.03
Manganese, Mn	0.79	0.04	0.57
Iron, Fe	0.05	0.15	<0.001
Vanadium, V	0.08	0.002	0.50
Zinc, Zn	<0.005	0.06	0.10
Antimony, Sb	<0.01	<0.01	<0.01
Lead, Pb	0.73	<0.01	2.3
Cobalt, Co	0.04	0.25	0.18
Copper, Cu	0.02	0.02	0.06
Total Chromium, Cr	0.05	<0.003	0.08
Silicon, Si	78	4.3	55
Tin, Sn	<0.02	<0.02	<0.02
Zirconium, Zr	<0.001	0.001	0.002
Bismuth, Bi	<0.005	<0.005	<0.005
Thallium, Tl	<0.009	<0.009	<0.009
Beryllium, Be	<0.002	<0.002	<0.002
Cadmium, Cd	0.002	<0.001	<0.001
Strontium, Sr	4.5	0.47	2.7
Boron, B	1.7	0.09	1.9
Phosphorus, P	6.0	1.1	12.7
Uranium, U	<0.004	<0.004	<0.004
Molybdenum, Mo	0.03	0.007	0.05
Barium, Ba	0.83	0.07	0.24
Sodium, Na	2.0	6.5	<0.02
Potassium, K	0.96	0.61	1.6
Magnesium, Mg	76	33	62
Calcium, Ca	457	928	1010
Silver, Ag	<0.004	0.01	<0.004
Thorium, Th	0.005	0.01	0.03

- The results are expressed in mg/l
- Method: Quantitative ICP scan (A.P.H.A 3120 B)

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Date   :   2008.11.12

Page   :   4 of 13

COMPANY NAME	:	EN-CHEM CONSULTANTS CC
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MARKED	:	KUSILE,and as below
INSTRUCTED BY	:	D.A. Baldwin
PROJECT NO.	:	P962/2008
RECEIVED ON	:	2008.09.23
LAB NO(S)	:	E50788,E50789,E51657
DATE ANALYSED	:	2008/10/19

Analysis on a 5% Acid Rain Extraction of the samples as received

Sample marks	S2	S1	S3
Arsenic, As	<0.02	<0.02	<0.02
Selenium, Se	<0.03	0.06	<0.03
Titanium, Ti	<0.001	<0.001	<0.001
Aluminium, Al	0.28	0.45	0.25
Nickel, Ni	0.02	<0.003	0.05
Manganese, Mn	0.01	0.009	0.03
Iron, Fe	0.03	0.05	0.68
Vanadium, V	0.13	0.003	0.06
Zinc, Zn	<0.005	<0.005	<0.005
Antimony, Sb	<0.01	<0.01	<0.01
Lead, Pb	0.08	<0.01	<0.01
Cobalt, Co	0.05	0.08	0.18
Copper, Cu	<0.002	<0.002	<0.002
Total Chromium, Cr	0.08	0.003	0.05
Silicon, Si	12.7	0.32	10.3
Tin, Sn	<0.02	<0.02	<0.02
Zirconium, Zr	<0.001	0.001	0.001
Bismuth, Bi	<0.005	<0.005	<0.005
Thallium, Tl	<0.009	<0.009	<0.009
Beryllium, Be	<0.002	<0.002	<0.002
Cadmium, Cd	0.003	<0.001	0.002
Strontium, Sr	1.2	0.47	1.7
Boron, B	0.74	0.11	0.35
Phosphorus, P	0.92	0.23	0.70
Uranium, U	<0.004	<0.004	<0.004
Molybdenum, Mo	0.02	0.004	0.03
Barium, Ba	0.11	0.08	0.30
Sodium, Na	2.5	0.77	1.1
Potassium, K	1.5	0.20	0.71
Magnesium, Mg	19.0	1.6	0.14
Calcium, Ca	128	631	517
Silver, Ag	<0.004	<0.004	0.003
Thorium, Th	0.002	0.004	<0.002

- The results are expressed in mg/l
- Method: Quantitative ICP scan (A.P.H.A 3120 B)

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SUBJECT	:	ANALYSIS OF 1 SAMPLE OF WASTE
MARKED	:	KUSILE,and as below
INSTRUCTED BY	:	D.A. Baldwin
PROJECT NO.	:	P962/2008
RECEIVED ON	:	2008.09.23
LAB NO(S)	:	E50789
DATE ANALYSED	:	2008/11/07

Analysis on dry basis (Total Digestion):

Determinants Sample marks	Results Kusile Gypsum (S1
Arsenic, As	<2
Selenium, Se	22
Nickel, Ni	6.8
Vanadium, V	5.0
Zinc, Zn	<0.5
Antimony, Sb	<1
Lead, Pb	93
Cobalt, Co	8.2
Copper, Cu	2.8
Total Chromium, Cr	7.8
Tin, Sn	<2
Zirconium, Zr	3.3
Bismuth, Bi	9.2
Thallium, Tl	<0.9
Beryllium, Be	36
Cadmium, Cd	<0.1
Strontium, Sr	128
Uranium, U	<0.4
Molybdenum, Mo	0.79
Barium, Ba	17
Potassium, K	899
Silver, Ag	1.2
Thorium, Th	1.1

- The results are expressed in mg/kg unless otherwise stated.
- Method: Quantitative ICP scan (A.P.H.A 3120 B)

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PROJECT NO.	:	P962/2008
RECEIVED ON	:	2008.09.23
LAB NO(S)	:	E50789
DATE ANALYSED	:	2008/10/28

Analysis on dry basis (Total Digestion):

SAMPLE MARKS	KUSILE GYPSUM(S1)
Chloride,Cl	210
Fluoride,F	355
Mercury, Hg	<1
Sulfate,SO4	60.5%
Hexavalent chromium, Cr^{6+}	<1

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at
Date   :   2008.11.12
Page   :   7 of 13

COMPANY NAME	:	EN-CHEM CONSULTANTS CC
ADDRESS	:	PO BOX 2856, CRESTA, 2118
SUBJECT	:	ANALYSIS OF 1 SAMPLE OF WASTE
MARKED	:	KUSILEGypsum S1 and as below
INSTRUCTED BY	:	D.A. Baldwin
PROJECT NO.	:	P962/2008
RECEIVED ON	:	2008.09.23
LAB NO(S)	:	E50789
DATE ANALYSED	:	2008/10/28

Analysis on as received basis:

Determinants	Results %
Loss on ignition (1000°C)	14.1
Silicon as SiO_2	1.0
Aluminium as Al_2O_3	0.2
Total Iron as Fe_2O_3	0.19
Titanium as TiO_2	<0.05
Phosphorus as P_2O_5	<0.05
Calcium as CaO	36.3
Magnesium as MgO	0.35
Sodium as Na_2O	<0.05
Potassium as K_2O	0.07
Manganese as MnO	<0.05

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Mahmood Patel

Authorised Signature
OPERATIONAL MANAGER

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Page   : 8 of 13

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MARKED	:	KUSILE,and as below
INSTRUCTED BY	:	D.A. Baldwin
PROJECT NO.	:	P962/2008
RECEIVED ON	:	2008.09.23
LAB NO(S)	:	E50789
DATE ANALYSED	:	2008/10/24

Analysis on as received basis:
Test: VOC
Test Ref.: EPA 8260B & EPA 5035

DETERMINANTS	KUSILE GYPSUM (S1)
Benzene	BDL
Bromobenzene	BDL
Bromodichloromethane	BDL
Bromoform	BDL
n-Butylbenzene	BDL
sec-Butylbenzene	BDL
tert-Butylbenzene	BDL
Carbon Tetrachloride	48
Chlorobenzene	BDL
Chloroform	BDL
Dibromochloromethane	BDL
Dibromomethane	BDL
Ethylbenzene	BDL
Hexachlorobutadiene	BDL
Isopropylbenzene	BDL
Naphthalene	BDL
n-Propylbenzene	BDL
Styrene	BDL
Tetrachloroethene	BDL
Toluene	49

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Page   : 9 of 13

DETERMINANTS	KUSILE GYPSUM (S1)
Trichloroethene	BDL
Xylenes	10
1,1-Dichloroethane	BDL
1,1-Dichloroethene	BDL
1,1-Dichloropropene	BDL
1,1,1-Trichloroethane	BDL
1,1,1,2-Tetrachloroethane	BDL
1,1,2-Trichloroethane	BDL
1,1,2,2-Tetrachloroethane	BDL
1,2-Dibromoethane	BDL
1,2-Dichlorobenzene	BDL
1,2-Dichloroethane	BDL
Cis-1,2-Dichloroethene	BDL
Trans-1,2-Dichloroethene	BDL
1,2,3-Trichlorobenzene	BDL
1,2,3-Trichloropropane	BDL
1,2,4-Trichlorobenzene	BDL
1,2,4-Trimethylbenzene	6
1,3-Dichlorobenzene	BDL
1,3-Dichloropropane	BDL
Cis-1,3-Dichloropropene	BDL
Trans-1,3-Dichloropropene	BDL
1,3,5-Trimethylbenzene	BDL
1,4-Dichlorobenzene	BDL
2-Chlorotoluene	BDL
2,2-Dichloropropane	BDL
4-Chlorotoluene	BDL
4-Isopropyltoluene	BDL

VOC-GC/MS Following Purge & Trap Technique
1.   All results reported in (µg/kg).
2.   BDL – Below Detection Limit (5µg/kg).
3.   No Field Blank supplied by Client.

COMPANY NAME	:	EN-CHEM CONSULTANTS CC
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LAB NO(S)	:	E50789
DATE ANALYSED	:	2008/10/23

Analysis on as received basis:

Test: SVOC

Test Ref.: EPA 8270C & EPA 3550B

DETERMINANTS	KUSILE GYPSUM (S1)
Acenaphthene	BDL
Acenaphthylene	BDL
Anthracene	BDL
Azobenzene	BDL
Benzo(a)anthracene	BDL
Benzo(a)pyrene	BDL
Benzo(b)fluoranthene	BDL
Benzo(k)fluoranthene	BDL
Bis-(2-chloroethoxy) methane	BDL
Bis-(2-chloroethyl) ether	BDL
Bis-(2-chloroisopropyl) ether	BDL
Butyl benzyl phthalate	BDL
Carbazole	BDL
Chrysene	BDL
Di-n-butyl phthalate	BDL
Dibenzofuran	BDL
Diethyl phthalate	BDL
Dimethyl phthalate	BDL
Fluoranthene	BDL
Fluorene	BDL
Hexachlorobenzene	BDL
Hexachlorobutadiene	BDL

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DETERMINANTS:	KUSILE GYPSUM
	(S1)
Hexachlorocyclopentadiene	BDL
Hexachloroethane	BDL
Isophorone	BDL
N-nitrosodi-n-propylamine	BDL
N-nitrosodimethylamine	BDL
Naphthalene	BDL
Nitrobenzene	BDL
Phenanthrene	BDL
Phenol	BDL
Pyrene	BDL
1,2-Dichlorobenzene	BDL
1,2,4-Trichlorobenzene	BDL
1,3-Dichlorobenzene	BDL
1,4-Dichlorobenzene	BDL
2-Chloronaphthalene	BDL
2-Chlorophenol	BDL
2-Methylnaphthalene	BDL
2-Methylphenol	BDL
2-Nitroaniline	BDL
2-Nitrophenol	BDL
2,4-Dichlorophenol	BDL
2,4-Dimethylphenol	BDL
2,4-Dinitrotoluene	BDL
2,4,5-Trichlorophenol	BDL
2,4,6-Trichlorophenol	BDL
2,6-Dinitrotoluene	BDL
3-Nitroaniline	BDL
4-Bromophenylphenyl ether	BDL
4-Chloro-3-methylphenol	BDL
4-Chloroaniline	BDL
4-Chlorophenylphenyl ether	BDL
4-Methylphenol	BDL
4-Nitroaniline	BDL

SVOC – GC/MS Following Solvent Extraction Technique.

- All Results Reported in (µg/kg).
- BDL – Below Detection Limit (50µg/kg).
- No field blank supplied by client.

DETERMINANT	METHOD	METHOD REFERENCES
pH Value	Electrometric	W044-08-W (A.P.H.A. 4500-H$^+$ B)
Conductivity	Potentiometric	W044-04-0 (A.P.H.A. 2510 B)
Total Dissolved Solids	Gravimetric	W044-03-W (A.P.H.A. 2540 C)
Total Solids and Loss On Ignition	Gravimetric	A.P.H.A. 2540 BE
Total Alkalinity	Titrimetric	Auto Analyser or A.P.H.A. 2320 B
Calcium	Atomic Absorption Spectrophotometry	W044-15-W (A.P.H.A. 3111 B)
Magnesium	Atomic Absorption Spectrophotometry	W044-01-W (A.P.H.A. 3111 B)
Potassium	Atomic Absorption Spectrophotometry	W044-01-W (A.P.H.A. 3111 B)
Sodium	Atomic Absorption Spectrophotometry	A.P.H.A. 3111 B
Colour Hazen Units	Lovibond Comparator	B.D.H. Nessleriser Method
Turbidity N.T.U.	Comparator	A.P.H.A. 2130 B
Odour	Physical Testing	A.P.H.A. 2150 B
Carbonate Hardness	By Calculation	A.P.H.A. 2340 A
Chloride	Titrimetric or Mercuric Nitrate Titration	Auto Analyser or A.P.H.A. 4500-Cl C
Sulfate	Gravimetric	A.P.H.A. 4500-SO$_4$ C
Sulfate	Turbimetric	A.P.H.A. 4500-SO$_4$ E
Sulfite,	Titrimetric	A.P.H.A. 4500-SO$_3$ B
Settle-able Solids	Volumetric Measurement	A.P.H.A. 2540-F
Nitrate	Colorimetric	EPA 352.1
Nitrate	Nitrate Electrode	Auto Analyser (A.P.H.A. 4500-NO$_3$ D)
Nitrite	Colorimetric	A.P.H.A. 4500-NO$_2$ B
Fluoride	Ion Selective Electrode	A.P.H.A. 4500-F C
Mercury	Cold Vapour Generation A.A.S.	A.P.H.A. 3112 B
Hexavalent Chromium	Colorimetric – Diphenyl Carbazide	A.P.H.A. 3500-Cr D
Total Cyanide	Titrimetric following distillation	A.P.H.A. 4500-CN CD
Phenolic Compounds as Phenol	Colorimetric following distillation	A.P.H.A. 5530 BC
Biochemical Oxygen Demand	Titrimetric	A.P.H.A. 5210 B
Chemical Oxygen Demand	Titrimetric	A.P.H.A. 5220 C
Total Suspended Solids	Gravimetric	A.P.H.A. 2540 D
Soap, Oil & Grease	Gravimetric	S.A.B.S. 1051
Sulfide Sulfur	Lead Acetate Method	S.A.B.S. 1056
Sulfide Sulfur	Titrimetric	A.P.H.A. 4500-S^2 F
Free & Saline Ammonia	Titrimetric following distillation	A.P.H.A. 4500-NH$_3$ BC
Kjeldahl Nitrogen	Titrimetric following distillation	A.P.H.A. 4500-Norg B
Acidity/ P Alkalinity	Titrimetric	Auto Analyser or A.P.H.A. 2310/2320 B
Dissolved Oxygen	Titrimetric	A.P.H.A. 4500-O C
Oxygen Absorbed (Permanganate Value)	Titrimetric	S.A.B.S. 220
Residual/Free Chlorine	Colorimetric	A.P.H.A. 4500-Cl G
Bromide	Ion Chromatograph	A.P.H.A. 4110 C
Calcium Carbonate Saturated pH	Potentiometric	P.C.I. 9.28
Free Carbon Dioxide	Nomographic	A.P.H.A. 4500-CO$_2$ B
Free Carbon Dioxide	Titrimetric	A.P.H.A. 4500-CO$_2$ C
Arsenic, Selenium, Titanium, Aluminium, Nickel, Manganese, Iron, Vanadium, Zinc, Antimony, Lead, Cobalt, Copper, Total Chromium, Silicon, Tin, Zirconium, Bismuth, Thallium, Beryllium, Cadmium, Boron, Phosphorus, Phosphorus as Phosphate, Uranium, Molybdenum, Barium, Silver, Thorium, Lithium, (also Ca, Mg, Na, K)	ICP Quantitative Scan	A.P.H.A. 3120 B

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Page   : 13 of 13

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The following test schedule outlines only the test methods and/or techniques accredited.
Uncertainties of Measurement for these accredited test methods are available upon request:

Materials/Products Tested	Types of Tests/Properties Measured, Range of Measurement	Standard Specifications, Equipment/ Techniques Used
CHEMICAL:		
Water	Total dissolved solids	W044-03-W
	pH	W044-05-W
	Electrical conductivity	W044-04-O
	Calcium by AAS	W044-15-W
	Magnesium by AAS	W044-01-W
	Potassium by AAS	W044-02-W
Pharmaceutical and Veterinary Products	TECHNIQUE – HPLC Determination of Perindopril and degradation products.	PF.T.CTR.A02.R44.09490.01
	Determination of Abamectin, Amitraz and Cypermethrim in Veterinary products.	HP040-54-W and HP040-55-W
MICROBIOLOGY:		
Water	Escherichia coli per 100 ml	SANS 5221:2006, Edition 4.2/ ISO 7218: 1996 (E)
	Faecal coliform bacteria per 100 ml	SANS 5221:2006, Edition 4.2/ ISO 7218: 1996 (E)
	Total coliform bacteria per 100 ml	SANS 5221:2006, Edition 4.2/ ISO 7218: 1996 (E)
	Standard (Heterotrophic) Plate Count cfu/ml	SANS 5221:2006, Edition 4.2/ ISO 7218: 1996 (E)
Pre-prepared foods	Escherichia coli per gram	SABS 758:1975
Pharmaceuticals	Total coliform bacteria per gram	SABS ISO 4832:1991 (E)
Soils	Standard (Heterotrophic) Plate Count cfu/gram	SABS ISO 4833:1991 (E)
ENVIRONMENTAL:		
Water	GC for BTEX	EPA 502.2
Solids	GC for BTEX	EPA 8015B
Water	GC for DRO	EPA 8015B
Solids	GC for DRO	EPA 8015B
Solids	GC for GRO	EPA 8015B
OCCUPATIONAL HYGIENE		
Water	GC/MS for VOC	EPA 8260B
Solids		EPA 8260B

Please also refer to web site www.sanas.co.za for the full Certificate and Schedule of Accreditation.

Table 2: Analytical results for the FGD Gypsum

Species	S1: FGD Gypsum Total, mg/kg or %	S1 TCLP¹, mg/l	S1 ARLP, mg/l	S2: Ash TCLP², mg/l	S2 ARLP, mg/l	S3: Ash FGD Gypsum 6:1 Mixture TCLP¹, mg/l	S3 ARLP, mg/l	HG	ARL, mg/l	Comment
Moisture	16.6%	-	-	-	-	-	-			
Ag	1.2	0.01	<0.004	<0.004	<0.004	0.03	0.003	3	2	See text
Al	2544	2.5	0.45	1.9	0.28	0.39	0.25	3/4	10	
As	<2	<0.02	<0.02	0.06	<0.02	0.13	<0.02	2	0.43	
B	na	0.09	0.11	1.7	0.74	1.9	0.35	3	10	
Ba	17	0.07	0.08	0.83	0.11	0.24	0.30	3	7.8	
Be	36	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	3	1.2	
Bi	9.2	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-	-	
Ca	25.93%³	928	631	457	128	1010	517	NT	-	
Cd	<0.1	<0.001	<0.001	0.002	0.003	<0.001	0.002	1	0.031	
Cl	210	5.2	4.4	3.1	5.1	11.3	2.0	NT	-	
Co	8.2	0.25	· 0.08	0.04	0.05	0.18	0.18	2	6.9	
Cr_{Total}	7.8	<0.003	0.003	0.05	0.08	0.08	0.05	3	4.7	All present as Cr(III)
Cr(VI)	<1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	1	0.02	
Cu	2.8	0.02	<0.002	0.02	<0.002	0.06	<0.002	2	0.1	
F	355	7.5	6.2	0.8	0.6	0.6	2.1	3	1	
Fe	963	0.15	0.05	0.05	0.03	<0.001	0.68	3	9	
Hg	<1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	1	0.022	
K	899	0.61	0.20	0.96	1.5	1.6	0.71	4	43.5	
Mg	2197	33	1.6	76	19	62	0.14	NT	-	
Mn	7.1	0.04	0.009	0.79	0.01	0.57	0.03	2	0.3	
Mo	0.79	0.007	0.004	0.03	0.02	0.05	0.03	4	3.7	
Na	91	6.5	0.77	2.0	2.5	<0.02	1.1	NT	-	
Ni	6.8	0.007	<0.003	0.11	0.02	0.03	0.05	3	1.12	
P	4276	1.1	0.23	6.0	0.92	12.7	0.70	4	10	
Pb	93	<0.01	<0.01	0.73	0.08	2.3	<0.01	2	0.10	
Sulphate	65.5%	2387	1703	60	41	2038	1622	NT	-	Present as sulphate
Sb	<1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	2	0.7	
Se	22	0.06	0.06	0.12	<0.03	<0.03	<0.03	2	0.26	
Si	0.47%³	4.3	0.32	78	12.7	55	10.3	NT	-	As silicate
Sn	<2	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	3	2.99	
Sr	128	0.47	0.47	4.5	1.2	2.7	1.7	NT	180	
Th	1.1	0.01	0.004	0.005	0.002	0.03	<0.002			

Species	S1: FGD Gypsum			S2: Ash		S3: Ash FGD Gypsum 6:1 Mixture		HG	ARL, mg/l	Comment
	Total, mg/kg or %	TCLP[1], mg/l	ARLP, mg/l	TCLP[2], mg/l	ARLP, mg/l	TCLP[1], mg/l	ARLP, mg/l			
Tl	<0.9	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	2	0.1	
Ti	97	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	2	0.73	
U	<0.4	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	2	0.55	
V	5	0.002	0.003	0.08	0.13	0.50	0.06	3	1.3	
Zn	<0.5	0.06	<0.005	<0.005	<0.005	0.10	<0.005	2	0.70	
Zr	3.3	<0.001	0.001	0.001	<0.001	0.002	0.001	3	2	
pH leach	-	5.1	7.3	4.2	8.8	4.2	11.6			
pH waste	7.2	-	-	10.8	-	10.4	-			

NT = non-toxic; na = not analysed; [1]TCLP solution number 1 used; [2]TCLP solution Number 2 used; [3]Results obtained using XRF

1

APPENDIX 6

KUSILE CLIMATIC WATER BALANCE ASSESSMENT

PANEL B CONSULTANTS JOINT VENTURE

Kusile Project Climatic Water Balance

Annual precipitation data for the Kusile site is based on records from Station 0514618W on the Wilge River. This station has a long history of data and was decided to be the most representative of the site. The best available evaporation data is for evaporation station B2E001. Although monthly data could not be obtained, half of the mean annual evaporation was considered to be a conservative estimate of the wet season evaporation.

The climatic water balance is defined by:

$B = R - E,$

where B is the water balance (indicated by B+ when rainfall exceeds evaporation and B- alternatively), R is the precipitation (in mm) and E is the evaporation (in mm). The assessment of positive and negative water balance is based on the wet season of the five years on record with the highest rainfall. If four of the worst five years yield B+, a water surplus is indicated with certainty and leaching can be expected. If four of the worst five years yield B-, a water deficit can be expected and leaching will only occur under extreme circumstances.

The climatic water balance assessment for the Kusile site is presented in the table below:

YEAR	WET SEASON TOTALS (NOVEMBER TO APRIL)		
	PRECIPITATION (mm)	EVAPORATION (mm)	WATER BALANCE (mm)
1995	13787	875	+12912
1933	9972	875	+9097
1924	8452	875	+7577
1989	10184	875	+9309
1908	9728	875	+8853

The above results clearly indicate that a B+ water balance is the case for the Kusile site. Leaching can be expected and waste disposal facilities should be designed accordingly.

Rainfall Station - 0514618W

Record 1905 -2003

Year	Months												Total	Average
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep		
1905	323	850	1236	1232	862	930	140	0	0	0	0	117	5690	474.167
1906	1089	701	1728	2080	1400	234	660	0	0	0	0	210	8102	675.167
1907	828	1746	1015	1408	236	520	51	0	0	216	175	91	6286	523.833
1908	901	697	1247	3237	1609	2037	50	114	0	0	594	56	10542	878.500
1909	276	1129	2012	1267	608	590	0	0	231	0	0	142	6255	521.250
1910	1048	615	1158	1467	480	430	802	654	0	13	20	8	6695	557.917
1911	591	863	600	968	1169	641	912	25	0	0	0	0	5769	480.750
1912	247	602	1255	1398	726	791	592	0	0	0	234	5	5850	487.500
1913	883	470	543	838	1039	1062	332	211	0	0	185	58	5621	468.417
1915	614	1028	781	359	185	704	180	26	0	0	0	0	3877	323.083
1916	354	638	1110	677	1590	373	356	373	244	8	506	183	6412	534.333
1917	575	2186	1546	1917	1118	1758	0	0	0	74	920	51	10145	845.417
1918	482	1024	1287	1088	842	986	143	18	0	30	0	51	5951	495.917
1919	454	1558	1283	839	822	735	220	119	0	71	0	203	6304	525.333
1920	1872	711	1064	1019	1587	2445	223	146	0	0	0	259	9326	777.167
1921	744	1500	1089	652	1347	1318	0	412	360	0	834	208	8464	705.333
1922	675	1395	1442	2190	857	528	335	5	41	23	0	71	7562	630.167
1923	320	1261	984	792	816	1131	273	386	0	0	23	209	6195	516.250
1924	714	1569	1550	1029	1408	2222	674	909	203	3	10	808	11099	924.917
1925	318	1209	859	619	667	574	221	472	28	257	0	96	5320	443.333
1926	231	1416	604	1378	738	844	65	0	0	861	168	180	6485	540.417
1927	1580	463	682	1422	765	384	154	10	0	0	320	97	5877	489.750
1928	423	1686	885	869	826	1268	150	176	119	0	0	5	7239	603.250
1929	2060	1039	1763	1192	1492	840	288	56	0	287	165	8	9190	765.833
1930	161	328	597	858	507	714	538	0	10	717	0	0	4430	369.167
1931	463	988	739	2236	608	333	94	170	3	0	0	386	6020	501.667
1932	458	1340	795	803	787	569	242	5	53	0	0	198	5250	437.500
1933	50	2354	1653	2176	2331	757	701	279	64	379	156	813	11713	976.083
1934	455	1366	1529	763	927	1179	82	31	0	0	53	31	6416	534.667
1935	160	831	927	1405	1165	1478	460	1261	0	5	0	317	8009	667.417
1936	707	1919	905	1803	1700	260	245	51	0	5	0	173	7768	647.333
1937	807	270	1962	1794	575	295	1095	71	112	163	71	85	7300	608.333
1938	676	804	1744	1187	2300	1087	186	577	0	605	50	196	9412	784.333
1939	677	2130	1712	904	687	680	309	313	689	0	11	758	8870	739.167
1940	295	1645	1359	1088	883	1047	972	0	0	3	10	394	7696	641.333
1941	561	303	952	1470	625	935	361	417	163	0	175	229	6191	515.917
1942	1010	1364	1587	1013	811	600	1175	449	0	572	548	288	9417	784.750
1943	815	1158	1007	1539	2421	805	58	64	524	0	0	363	8754	729.500
1944	933	1428	653	1153	889	632	658	132	0	0	0	0	6478	539.833
1945	318	612	744	2201	2547	979	97	137	0	0	0	0	7635	636.250
1946	278	538	1351	790	848	1184	229	3	97	23	0	80	5421	451.750
1947	366	1482	1700	1714	188	891	249	180	0	0	0	203	6973	581.083
1948	985	1285	501	1815	51	165	447	195	30	0	0	183	5657	471.417
1949	652	1503	1253	844	596	337	955	84	33	18	0	90	6365	530.417
1950	200	703	1177	860	986	458	767	665	15	20	259	28	6138	511.500
1951	1093	66	1494	615	1267	290	109	64	36	178	5	0	5217	434.750
1952	235	1253	859	780	1065	1010	376	72	0	0	6	21	5677	473.083
1953	259	1989	911	1217	1111	779	376	90	0	0	8	94	6834	569.500
1954	302	1192	453	1844	1710	867	645	125	135	0	10	0	7283	606.917
1955	672	843	1921	925	1473	983	3	1052	124	65	0	731	8792	732.667
1956	1355	892	1460	722	1053	1141	330	249	419	635	229	691	9176	764.667
1957	679	440	243	1566	630	535	1126	115	0	0	0	685	6019	501.583
1958	1076	1024	1510	1293	631	375	419	135	5	90	0	40	6598	549.833
1959	140	1588	1344	690	406	874	750	167	55	25	260	87	6386	532.167
1960	528	1247	1177	595	619	893	890	293	96	80	0	160	6578	548.167
1961	642	710	465	600	1590	558	515	0	25	0	45	100	5250	437.500
1962	541	1719	795	1372	153	445	797	158	915	177	0	0	7072	589.333
1963	380	950	840	1875	365	332	360	110	51	0	60	80	5403	450.250
1964	2145	260	1880	904	290	36	368	240	0	50	10	0	6183	515.250
1965	80	861	513	575	635	116	117	100	230	0	9	40	3276	273.000
1966	950	1032	929	2167	1720	752	1947	195	0	5	265	12	9974	831.167
1967	868	1277	1204	1051	579	947	634	279	1	100	97	3	7040	586.667
1968	450	1069	994	813	1051	1743	421	650	0	7	25	117	7340	611.667
1969	1381	1210	1738	400	912	523	350	112	10	10	160	98	6904	575.333
1970	1400	1498	1046	1900	331	498	913	170	13	0	0	356	8125	677.083
1971	386	1490	1421	1737	526	1404	280	75	7	0	67	203	7596	633.000
1972	583	837	854	1318	469	1025	640	0	0	0	31	460	6217	518.083
1973	731	598	1845	1516	247	18	604	60	31	135	5	140	5930	494.167
1974	155	820	893	3311	1630	411	1022	140	95	1	0	5	8483	706.917
1975	346	2054	1162	1467	1253	1153	365	280	0	0	0	78	8158	679.833
1976	1095	970	895	1265	60	820	392	55	0	0	22	305	5879	489.917
1977	481	620	732	3526	976	1103	333	18	0	4	152	217	8162	680.167
1978	676	310	371	660	262	380	387	67	0	107	143	78	3441	286.750
1979	1105	1483	543	1780	1987	781	113	20	0	0	0	430	8242	686.833
1980	193	2053	738	1473	873	994	365	0	135	0	125	230	7179	598.250
1981	475	672	642	1375	456	900	45	0	6	345	0	85	5001	416.750
1982	846	312	972	1037	462	691	182	170	180	115	380	80	5427	452.250
1983	852	2046	1125	665	585	910	68	6	197	150	90	0	6694	557.833
1984	1073	722	693	886	1376	1038	5	168	0	5	150	353	6469	539.083
1985	805	286	1213	1068	581	644	275	0	115	0	15	5	5007	417.250
1986	927	1049	1602	978	166	2500	80	0	0	0	250	997	8549	712.417
1987	406	1826	1587	995	683	914	195	0	140	34	88	401	7269	605.750
1988	1082	403	1243	599	2002	582	546	15	808	0	119	20	7419	618.250
1989	495	2487	1944	760	1776	1529	1688	109	0	55	20	90	10953	912.750
1990	511	728	1612	1273	1750	2346	35	90	209	0	0	73	8627	718.917
1991	688	473	1710	1232	911	172	226	0	22	0	175	0	5609	467.417
1992	1257	1290	1618	759	1648	1261	330	66	0	0	31	601	8861	738.417
1993	2222	1359	1362	1274	1848	608	91	0	0	0	0	243	9007	750.583
1994	710	1508	1335	1045	148	2113	955	194	0	0	90	245	8343	695.250
1995	924	2038	2573	3150	4058	1017	951	132	0	10	55	0	14908	1242.333
1996	1006	397	496	1005	73	2418	355	885	0	56	36	213	6940	578.333
1997	727	1280	547	1099	442	640	3	0	0	0	0	374	5112	426.000
1998	586	2200	1366	472	270	553	387	318	85	0	0	48	6285	523.750
1999	582	1017	1365	1926	1815	1326	789	328	70	16	0	211	9445	787.083
2000	1219	648	1108	335	534	136	132	429	102	0	0	126	4769	397.417
2001	1311	1631	920	304	663	240	496	316	177	0	269	197	6524	543.667
2002	918	282	1530	1146	727	835	175	0	50	0	30	0	5693	474.417
2003	517	261	1405	1122	2215	2780	375	70	82	255	0	0	9082	756.833

APPENDIX 7

WATER MASS BALANCE

RAINFALL
0

EVAPORATION
399

RAW WATER RESERVOIR

MINE POTABLE WATER USES
822

FILTERED POTABLE WATER TANKS (FWT 3&4) 2 X 300 CU M

POTABLE WATER HEAD TANK

POWER PLANT POTABLE WATER USES
375

SANITARY SEWAGE TREATMENT PLANT
375

SANITARY SEWER EFFLUENT
375

TO CONDENSATE POLISHERS
308

TO OTHER USES (SEE NOTE 4)

TOP FURNACE WALL SOOT BLOWING
276

NON-RECOVERABLE LOSSES

OTHER LOSSES
3681

11486
11486
2922
1197

NORM 0

FIRE WATER USES

REGEN WATER
421

NORM 0

223903

ULTRAFILTRATION PRETREATMENT SYSTEM

15711
4225

RAW WATER TANKS (RWT) 2 X 2000 CU M

17116

68
FLOOR WASHING

68

7181

383

38
7016

CYCLE MAKEUP

STEAM CONDENSATE CYCLE

223903

CONDENSATE POLISHERS

REGEN WATER FROM DEMIN WATER STORAGE TANK
308

Reject 1405

FILTERED PROCESS WATER TANKS (FWT 1&2) 2 X 300 CU M

FIRE WATER TANKS

PRIMARY DEMIN-ERALISATION PLANT (PACKED BED)

7029

POLISHED DEMINERAL-IZER FEED TANKS (PDFT) 3 X 375 CU M

POLISHING DEMIN-ERALISATION PLANT

DEMINERAL-ISED WATER STORAGE TANKS (DWST) 3 X 5000 CU M

6287

CYCLE LIQUID LOSSES
2330

308

REGENERATION WASTE
154

17116

FROM RECOVERED WATER FILTER SYSTEM
2956

7181

1725

MISC SERVICE WATER USES

EVAPORATION & DRIFT
6350

MAKEUP 8496

AUXILIARY COOLING TOWERS

535

51

TO FILTERED WATER TANKS (PROCESS)

2956

RECOVERED WATER FILTER SYSTEM

PROCESS DRAINS RECOVERY TANKS

154
HIGH QUALITY DRAINS

RECOVERED WATER FROM FGD PURGE TMT
472

16524

1635

BOTTOM FURNACE WALL SOOT BLOWING FLOWS (NON RECOVERABLE)
90

MISC. PLANT & EQUIPMENT USES (SEE NOTE 2)

CT BLOWDOWN 2146

REGENERATION WASTE

586

NEUTRALISATION SUMPS

740

2536
GYPSUM WASH & VAC PUMP SEAL WATER

1635

1635

3040

375 SANITARY SEWER EFFLUENT

1405

18267

37520
RAW WATER PIPELINE FROM KENDAL PWR STA

MAKEUP TO HOLDING/ RECYCLE DAM

EVAPORATION

FLUE GAS DESULFURIZATION SCRUBBERS

17683

CHLORIDE BLEED
562

ZLED WASTEWATER TREATMENT SYSTEM (CHLORIDE PURGE TREATMENT)

DISTILLATE TO PROCESS DRAINS RECOVERY TANKS
472

ENTRAINED MOISTURE IN SOLIDS
90

PROCESS WASTEWATER

RAINFALL 0
FLOOR WASHING 68

RAINFALL 0

WATER IN GYPSUM BYPRODUCT 815

STORMWATER RUNOFF FROM DIRTY-CLEAN AREAS 0

0

STATION DIRTY-DIRTY AREAS (BOILER BLOCK AND FABRIC FILTER AREAS)

STATION DIRTY-DIRTY AREAS (LIMESTONE BUILDING, COAL STORAGE YARD, EMERGENCY ASH DUMP)

FLY ASH PROCESSING
3798

EVAP 981

SDD SETTLING TANKS/ OIL WATER SEPARATORS

EVAPORATION 292

3798

RAINFALL RUNOFF 0

1920

BOTTOM ASH PROCESSING (SSCC INCL CONVEYOR WASH)

2901

EVAP 87

3040

STATION DIRTY DAM (2 X 82,500 CU M)

0

UNITISED YARD GRIT SUMPS

68

RAINFALL 0

EVAP 68

WATER ENTRAINED IN SOLIDS
7387

ACTIVE ASH DUMP

RAINFALL 0

2748

0
Note 5

RAINFALL 0

EVAP 112

CSY/LB SETTLING TANKS/ OIL WATER SEPARATORS

ASH DUMP DIRTY DAM (2 X 104,200 CU

RAINFALL 0

FOR WET SEASON AS REQUIRED

HOLDING/ RECYCLE DAM (2 X 39,200 CU M)

966

IRRIGATION & DUST CNTRL 854

MAKEUP FROM KENDAL PIPELINE 18267

0

AS NEEDED DURING DRY SEASON 966

0

0

0
OVERFLOW

AREAS
STATION DIRTY-DIRTY AREAS   73.4 Ha
CSY SETTLING BASIN   2.0 Ha
ASH DUMP ACTIVE AREA   160.4 Ha
ASH DUMP DIRTY DAM   3.2 Ha
HOLDING/RECYCLE POND   2.5 Ha
STATION DIRTY-CLEAN AREAS   29.7 Ha
STATION DIRTY DAM & STILLING BASIN 8.4 Ha
GRIT SUMPS CATCHMENT AREA   4.8 Ha

NOTES
1 Values given are in m3/day
2 Misc. service water uses include ACC washing, hose bibs, seal water, etc.
3 Misc. demin water uses such as closed cycle system makeup (normally 0 flow)
4 Cycle makeup based on 2 percent of steaming rate (plus demin regen water)
5 Flow from the ADDD to the SDD after a large rainfall event will only occur after the SDD level is drawn down
   and will not exceed the transfer rate from the SDD to the HRD.

REV	DATE	DESCRIPTION	BY	CHK'D	APP'D	REV	DATE	DESCRIPTION	BY	CHK'D	APP'D
7	8-30-10	UPDATE PER CURRENT DESIGN	DRM	KRW	KRW	0	2-14-08	INITIAL ISSUE	DRM	KRW	KRW
						1	5-30-08	UPDATE	DRM	KRW	KRW
						2	6-24-08	UPDATE	DRM	KRW	KRW
						3	8-5-08	UPDATE	DRM	KRW	KRW
						4	10-21-08	UPDATE	DRM	KRW	KRW
						5	11-10-08	UPDATE	DRM	KRW	KRW
						6	6-26-09	UPDATE	DRM	KRW	KRW

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CLIENT: ESKOM
PROJECT NO.: 146838
DRAWING: WMB-1B
REV: 7

ENGINEERED BY: DRM   DATE: 2/14/2008
DRAWN BY: DRM   DATE: 2/14/2008
CHECKED BY: KRW   DATE: 2/19/2008

PROJECT: KUSILE POWER STATION

TITLE: WATER MASS BALANCE NO RAINFALL CASE

USER: WED04450
FILE: M:\Projects\146838 Project Bravo\Water Mass Balances\[BRAVO WMB 10.20.2008.xls]PFD W FGD PURGE TMT
DATE: 8/31/10 14:20:27

RAINFALL 215
EVAPORATION 399

RAW WATER RESERVOIR

FILTERED POTABLE WATER TANKS (FWT 3&4) 2 X 300 CU M

POTABLE WATER HEAD TANK

822
MINE POTABLE WATER USES

POWER PLANT POTABLE WATER USES

375

SANITARY SEWAGE TREATMENT PLANT

375 SANITARY SEWER EFFLUENT

TO CONDENSATE POLISHERS 308

TO OTHER USES (SEE NOTE 4)

TOP FURNACE WALL SOOT BLOWING 276 NON-RECOVERABLE LOSSES

OTHER LOSSES 3681

ULTRAFILTRATION PRETREATMENT SYSTEM

RAW WATER TANKS (RWT) 2 X 2000 CU M

17116

15711

11486   11486

2922

1197

NORM 0

FIRE WATER USES

383

421 REGEN WATER

NORM 0

38

7016

DEMINERALISED WATER STORAGE TANKS (DWST) 3 X 5000 CU M

CYCLE MAKEUP

223903

STEAM CONDENSATE CYCLE

223903

CONDENSATE POLISHERS

REGEN WATER FROM DEMIN WATER STORAGE TANK 308

Reject 1405

FROM RECOVERED WATER FILTER SYSTEM

2956

FILTERED PROCESS WATER TANKS (FWT 1&2) 2 X 300 CU M

68   7181

68 FLOOR WASHING

7181

PRIMARY DEMIN-ERALISATION PLANT (PACKED BED)

7029

POLISHED DEMINERAL-IZER FEED TANKS (PDFT) 3 X 375 CU M

POLISHING DEMIN-ERALISATION PLANT

6287

2330 CYCLE LIQUID LOSSES

308

REGENERATION WASTE 154

17116

FIRE WATER TANKS

7181   7181

1725

EVAPORATION & DRIFT

6350

535

51

PROCESS DRAINS RECOVERY TANKS

154 HIGH QUALITY DRAINS

RECOVERED WATER FROM FGD PURGE TMT 472

MISC SERVICE WATER USES

90

MAKEUP 8496

AUXILIARY COOLING TOWERS

TO FILTERED WATER TANKS (PROCESS)

586

2956

RECOVERED WATER FILTER SYSTEM

1635

BOTTOM FURNACE WALL SOOT BLOWING FLOWS (NON RECOVERABLE)

CT BLOWDOWN 2146

REGENERATION WASTE

740

NEUTRALISATION SUMPS

16524

MISC. PLANT & EQUIPMENT USES (SEE NOTE 2)

1635

1635

3040

375 SANITARY SEWER EFFLUENT

2536 GYPSUM WASH & VAC PUMP SEAL WATER

1405

14610

MAKEUP TO HOLDING/ RECYCLE DAM

EVAPORATION

FLUE GAS DESULFURIZATION SCRUBBERS

562 CHLORIDE BLEED

ZLED WASTEWATER TREATMENT SYSTEM (CHLORIDE PURGE TREATMENT)

472 DISTILLATE TO PROCESS DRAINS RECOVERY TANKS

90 ENTRAINED MOISTURE IN SOLIDS

PROCESS WASTEWATER

33648 RAW WATER PIPELINE FROM KENDAL PWR STA

17683

STORMWATER RUNOFF FROM DIRTY-CLEAN AREAS 456

456

WATER IN GYPSUM BYPRODUCT 815

RAINFALL 89

FLOOR WASHING 68

RAINFALL 1127

STATION DIRTY-DIRTY AREAS (BOILER BLOCK AND FABRIC FILTER AREAS)

STATION DIRTY-DIRTY AREAS (LIMESTONE BUILDING, COAL STORAGE YARD, EMERGENCY ASH DUMP)

FLY ASH PROCESSING

3798

EVAP 981

SDD SETTLING TANKS/ OIL WATER SEPARATORS

EVAPORATION 292

3798

RAINFALL RUNOFF 1512

1920

BOTTOM ASH PROCESSING (SSCC INCL CONVEYOR WASH)

2901

EVAP 87

3496

1127

UNITISED YARD GRIT SUMPS

157

RAINFALL 38

EVAP 71

WATER ENTRAINED IN SOLIDS 7213

ACTIVE ASH DUMP

1512

RAINFALL 47

5392

780 Note 5

RAINFALL 157

STATION DIRTY DAM (2 X 82,500 CU M)

EVAP 112

RAINFALL 60

ASH DUMP DIRTY DAM (2 X 104,200 CU)

FOR WET SEASON AS REQUIRED

HOLDING/ RECYCLE DAM (2 X 39,200 CU M)

CSY/LB SETTLING TANKS/ OIL WATER SEPARATORS

0

IRRIGATION & DUST CNTRL 680 AS NEEDED DURING DRY SEASON

0

14610 MAKEUP FROM KENDAL PIPELINE

1251

OVERFLOW

1251

1251

AREAS
STATION DIRTY-DIRTY AREAS	73.4 Ha
CSY SETTLING BASIN	2.0 Ha
ASH DUMP ACTIVE AREA	160.4 Ha
ASH DUMP DIRTY DAM	3.2 Ha
HOLDING/RECYCLE POND	2.5 Ha
STATION DIRTY-CLEAN AREAS	29.7 Ha
STATION DIRTY DAM & STILLING BASIN	8.4 Ha
GRIT SUMPS CATCHMENT AREA	4.8 Ha

NOTES
1 Values given are in m3/day
2 Misc. service water uses include ACC washing, hose bibs, seal water, etc.
3 Misc. demin water uses such as closed cycle system makeup (normally 0 flow)
4 Cycle makeup based on 2 percent of steaming rate (plus demin regen water)
5 Flow from the ADDD to the SDD after a large rainfall event will only occur after the SDD level is drawn down
   and will not exceed the transfer rate from the SDD to the HRD.

USER: WEI04450
FILE: M:\Projects\146838 Project Bravo\Water Mass Balances\[BRAVO WMB 10.20.2008.xls]PFD W FGD PURGE TMT
DATE: 8/31/10 14:20:27

REV	DATE	DESCRIPTION	BY	CHK'D	APP'D	REV	DATE	DESCRIPTION	BY	CHK'D	APP'D
7	8-30-10	UPDATE PER CURRENT DESIGN	DRM	KRW	KRW	0	2-14-08	INITIAL ISSUE	DRM	KRW	KRW
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						2	6-24-08	UPDATE	DRM	KRW	KRW
						3	8-5-08	UPDATE	DRM	KRW	KRW
						4	10-21-08	UPDATE	DRM	KRW	KRW
						5	11-10-08	UPDATE	DRM	KRW	KRW
						6	6-26-09	UPDATE	DRM	KRW	KRW

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CLIENT: ESKOM

PROJECT NO.: 146838   DRAWING: WMB-2B   REV: 7

ENGINEERED BY: DRM   DATE: 2/14/2008
DRAWN BY: DRM   DATE: 2/14/2008
CHECKED BY: KRW   DATE: 2/19/2008

PROJECT: KUSILE POWER STATION

TITLE: WATER MASS BALANCE ANNUAL AVG RAINFALL CASE

WATER MASS BALANCE DIAGRAM — KUSILE POWER STATION

Key flow labels and values (m3/day):

RAINFALL 14458 — EVAPORATION 399
RAW WATER RESERVOIR

RAW WATER TANKS (RWT) 2 X 2000 CU M
17116 → ULTRAFILTRATION PRETREATMENT SYSTEM
Reject 1405
FROM RECOVERED WATER FILTER SYSTEM 2956
17116

FILTERED PROCESS WATER TANKS (FWT 1&2) 2 X 300 CU M
15711 → 4225
7181

FILTERED POTABLE WATER TANKS (FWT 3&4) 2 X 300 CU M
11486 / 11486

POTABLE WATER HEAD TANK
2922 / 1197

822 → MINE POTABLE WATER USES

375 → POWER PLANT POTABLE WATER USES → 375 → SANITARY SEWAGE TREATMENT PLANT → 375 SANITARY SEWER EFFLUENT

NORM 0 → FIRE WATER USES
68 FLOOR WASHING
FIRE WATER TANKS 68

7181 → PRIMARY DEMINERALISATION PLANT (PACKED BED) → 7029 → POLISHED DEMINERALIZER FEED TANKS (PDFT) 3 X 375 CU M → 535 → POLISHING DEMINERALISATION PLANT → 38 / 7016

421 REGEN WATER
383
308 TO CONDENSATE POLISHERS
NORM 0 TO OTHER USES (SEE NOTE 4)
TOP FURNACE WALL SOOT BLOWING 276 NON-RECOVERABLE LOSSES
OTHER LOSSES 3681

DEMINERALISED WATER STORAGE TANKS (DWST) 3 X 5000 CU M
CYCLE MAKEUP 6287 → STEAM CONDENSATE CYCLE ← 223903 → CONDENSATE POLISHERS ← 308 REGEN WATER FROM DEMIN WATER STORAGE TANK
223903
CYCLE LIQUID LOSSES 2330
308 REGENERATION WASTE 154

PROCESS DRAINS RECOVERY TANKS ← 154 HIGH QUALITY DRAINS
RECOVERED WATER FILTER SYSTEM 2956
RECOVERED WATER FROM FGD PURGE TMT 472

MISC SERVICE WATER USES 1725
90 → BOTTOM FURNACE WALL SOOT BLOWING FLOWS (NON RECOVERABLE)
MAKEUP 8496 → AUXILIARY COOLING TOWERS
EVAPORATION & DRIFT 6350
CT BLOWDOWN 2146
TO FILTERED WATER TANKS (PROCESS)
51
586
REGENERATION WASTE → NEUTRALISATION SUMPS
740

MISC. PLANT & EQUIPMENT USES (SEE NOTE 2)
1635 / 1635 / 1405 / 1635 / 3040
375 SANITARY SEWER EFFLUENT

16524
GYPSUM WASH & VAC PUMP SEAL WATER 2536
RAW WATER PIPELINE FROM KENDAL PWR STA 4795
MAKEUP TO HOLDING/RECYCLE DAM 0

EVAPORATION → FLUE GAS DESULFURIZATION SCRUBBERS
17683
562 CHLORIDE BLEED → ZLED WASTEWATER TREATMENT SYSTEM (CHLORIDE PURGE TREATMENT)
472 DISTILLATE TO PROCESS DRAINS RECOVERY TANKS
90 ENTRAINED MOISTURE IN SOLIDS
WATER IN GYPSUM BYPRODUCT 815

PROCESS WASTEWATER
STORMWATER RUNOFF FROM DIRTY-CLEAN AREAS 30706 / 30706

RAINFALL 5991 — FLOOR WASHING 68
STATION DIRTY-DIRTY AREAS (BOILER BLOCK AND FABRIC FILTER AREAS)
UNITISED YARD GRIT SUMPS → 6059

RAINFALL 75860
STATION DIRTY-DIRTY AREAS (LIMESTONE BUILDING, COAL STORAGE YARD, EMERGENCY ASH DUMP)
75860
RAINFALL 2560 — EVAP 71
CSY/LB SETTLING TANKS/ OIL WATER SEPARATORS
84408 OVERFLOW

FLY ASH PROCESSING 3798 / 3798
RAINFALL RUNOFF 101844
EVAP 981
BOTTOM ASH PROCESSING (SSCC INCL CONVEYOR WASH)
1920 / 2901
WATER ENTRAINED IN SOLIDS 6533
ACTIVE ASH DUMP 101844
EVAP 87
RAINFALL 3159
EVAP 112
SURGE: 88882
RAINFALL 4040
ASH DUMP DIRTY DAM (2 X 104,200 CU)
IRRIGATION & DUST CNTRL 0
FOR WET SEASON AS REQUIRED
AS NEEDED DURING DRY SEASON 0

SDD SETTLING TANKS/ OIL WATER SEPARATORS
33746
EVAPORATION 292
SURGE: 128433
STATION DIRTY DAM (2 X 82,500 CU M)
16890 / 16890 Note 5
RAINFALL 10571
HOLDING/RECYCLE DAM (2 X 39,200 CU M)
MAKEUP FROM KENDAL PIPELINE 0
84408 / 84408

AREAS
STATION DIRTY-DIRTY AREAS 73.4 Ha
CSY SETTLING BASIN 2.0 Ha
ASH DUMP ACTIVE AREA 160.4 Ha
ASH DUMP DIRTY DAM 3.2 Ha
HOLDING/RECYCLE POND 2.5 Ha
STATION DIRTY-CLEAN AREAS 29.7 Ha
STATION DIRTY DAM & STILLING BASIN 8.4 Ha
GRIT SUMPS CATCHMENT AREA 4.8 Ha

NOTES
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						5	11-10-08	UPDATE	DRM	KRW	KRW
						6	6-26-09	UPDATE	DRM	KRW	KRW

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CLIENT: ESKOM
PROJECT NO.: 146838
DRAWING: WMB-6B
REV: 7

ENGINEERED BY: DRM DATE: 2/14/2008
DRAWN BY: DRM DATE: 2/14/2008
CHECKED BY: KRW DATE: 2/19/2008

PROJECT: KUSILE POWER STATION

TITLE: WATER MASS BALANCE 1-DAY, 50-YEAR EVENT