Eskom	Scope	Generation Engineering

Tile: **Kriel Ash Dam**

Scope of Works for Satellite & Thermal Stability Monitoring

Unique Identifier:	**474-12496**
Alternative Reference Number:	**NA**
Area of Applicability:	**Kriel Power Station**
Documentation Type:	**Scope**
Revision:	**2.0**
Total Pages:	**8**
Next Review Date:	**NA**
Disclosure Classification:	**CONTROLLED DISCLOSURE**

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Date: 24/03/2021	Date: 24/03/2021	Date: 30/03/2021

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1. INTRODUCTION

Kriel's Approved Professional Person (APP) for the ash dump recently carried out a Stability Analysis which determined that Kriel's ash dam has a Factor of Safety against Stability Failure below acceptable levels. The Stability Report author indicated that the APP should issue an instruction to Kriel to cease operations on Ash Dams 2 & 3.

The APP did not issue an instruction to cease operations, but rather stated in a memo dated 26 November 2020 that the Ash Dam could be operated at risk, provided Kriel applied a "Duty of Care" to limit risks.

In a memo from the Civil & Structural CoE dated 2 December 2020, supporting the operating at risk, Kriel were instructed to undertake a number of risk mitigating and monitoring actions, one of which is to undertake a monthly Lidar survey.

Further to this, the use of Satellite Monitoring is proposed, which would give weekly updates of stability early warning signs. A wet ash dam will usually give early warning indications of a pending stability failure by side slope movement (creep), as happened with the east slope of Kriel's Ash Dam 3 a number of years ago, where the perimeter canal was pushed out of alignment by the moving slope. A slope failure did occur and a toe buttress was constructed in order to prevent further movement of the slope.

Surface Movement Monitoring (SMM) by satellite will allow monitoring of the ash dam side slope stability to be increased from monthly to weekly intervals and provide a much more accurate measurement of side slope movement than the monthly Lidar Survey.

The position of the pools on the ash dam compartments can also be monitored weekly by satellite, giving a much more accurate overall view of the pool position from above, as compared to the proposed pool position photographs taken from the side of the ash dam.

A monthly Thermal Survey is proposed which will indicate water seepage areas on the ash dam sideslopes, as wet areas will be a different temperature to dry areas.

A monthly Lidar and Orthoimage survey is to be done by others.

2. SUPPORTING CLAUSES

2.1 SCOPE

The Scope of Work includes a historical Satellite SMM evaluation and a weekly SMM survey, as well as a weekly Satellite Pool Position Survey and a monthly Thermal survey. A geotechnical evaluation is required to determine the SMM trigger movements/velocities against which the weekly SMM will be compared.

2.1.1 Purpose

The purpose of the project is to increase the level of stability monitoring of the ash dam due to the ash dam being built "at risk" in order to keep Kriel operational. The weekly Satellite monitoring will not only increase the surveillance from monthly to weekly, but will provide new ways to monitor the stability and seepage of the ash dam.

2.1.2 Applicability

This document applies to Kriel Power Station.

2.2 NORMATIVE/INFORMATIVE REFERENCES

Parties using this document apply the most recent edition of the documents listed in the following paragraphs.

2.2.1 Normative

[1] N/A

2.2.2 Informative

[2] Kriel Ash Dam Step-In & Go Higher Geotechnical Investigation and Stability Assessment, Report No.: JW129/15/F015 – Rev 1, DECEMBER 2015, by Jones & Wagener.

[3] Kriel Ash Dam Complex Stability Evaluation, Report No.: 1789563-319669-1 REV2, 20 November 2018, by Golder & JG Africa.

[4] Kriel Power Station Ash Dams Slope Stability Assessment Report No: 2007310/R03R, October 2020 by PG Consulting Engineers & LIS Consulting.

2.3 DEFINITIONS

2.3.1 Classification

Controlled disclosure: controlled disclosure to external parties (either enforced by law, or discretionary).

2.3.2 Abbreviations

Abbreviation	Description
ADF	Ash Disposal Facility
DTM	Digital Terrain Model
GSD	Ground Sampling Distance (pixel size)
InSAR	Interferometric Synthetic Aperture Radar
SAGC	South African Geomatics Council
SMM	Surface Movement Monitoring

2.3.3 Roles and Responsibilities

The *Consultants* lead is required to:

I. provides adequate resources including provision of equipment for required *Works*;
II. manages cost and a scheduled time frame of work;
III. ensures the scope is carried out in full;
IV. provides regular feedback on the status of the work;
V. ensures that all work is conducted by a competent person;

VI. ensures that prior to any fieldwork, all parties working on site familiarized themselves with the *Employer's* safety requirements and the Occupational Health and Safety (OSH) Regulations act (85 of 1993)

2.4 PROCESS FOR MONITORING

Results of the Stability Monitoring work should be made available on a weekly/monthly basis as required by the *Consultant* to the *Employer*.

In addition to the submission of weekly progress report(s), the following quality control measures are to be applied:

I. The *Consultant* exercises strict and adequate quality control during all monitoring procedures;

II. The *Consultant* ensures that all technical activities; as per the scope of works; undergo quality control measures to ensure the technical quality of the deliverables;

2.5 RELATED/SUPPORTING DOCUMENTS

As per Section 2.2

3. SCOPE OF WORKS

The *Scope of Works* for the Kriel Power Station Ash Dam Stability Monitoring with Satellites & Thermal survey is as outlined below:

3.1 SPECIFICATIONS

3.1.1 Survey Duration

The Kriel ash dam satellite SMM, Pool Position Change Detection and Thermal surveys are to be carried out over a period of 12 months. SMM and Pool Position monitoring are to be done on a weekly basis and the Thermal survey on a monthly basis to coincide with the monthly Lidar survey by others.

3.1.2 Survey Area

The survey must be done in **WGS84 Lo29**, bounded by the following coordinates (see Figure 1):

P1: N 2,905,599 E -19,961

P2: N 2,905,916 E -20,882

P3: N 2,907,018 E -20,899

P4: N 2,907,964 E -19,447

P5: N 2,907,964 E -18,907

P6: N 2,907,106 E -17,660

P7: N 2,906,293 E -17,560

The survey area is **555 ha** (see Figure 1).

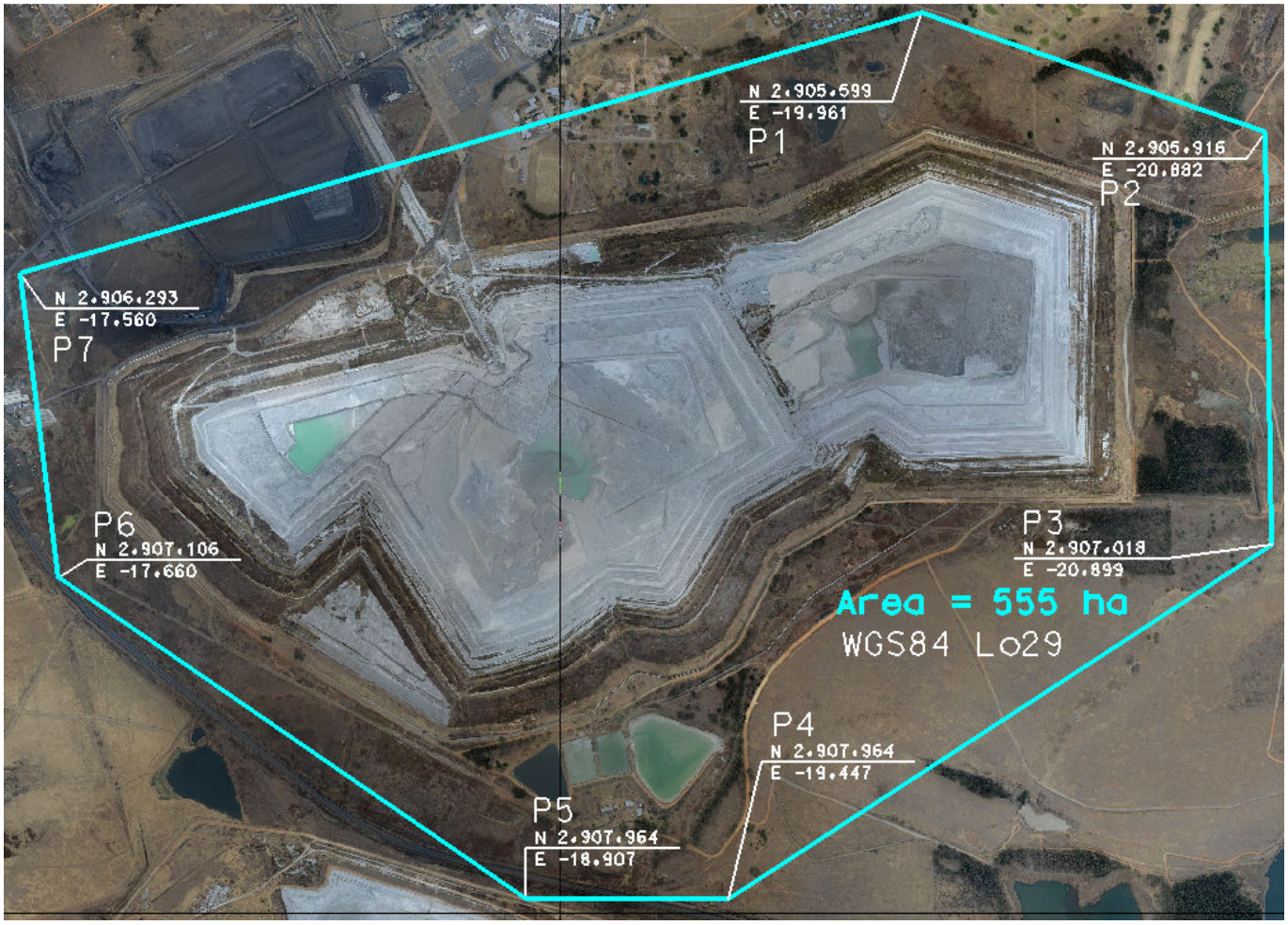

Figure 1 – Kriel Ash Dam Satellite and Thermal Survey Area

3.1.3 Geotechnical Evaluation

a) Review of the Kriel ash dam stability and the historical SMM dataset to determine SMM trigger movements/velocities for the maximum allowable movements/velocities before manual inspection and/or further detailed survey on triggered areas is to be done.

b) Review of the weekly (every 7 days) SMM movements/velocities for input into the weekly SMM report.

3.1.4 Satellite Surface Movement Monitoring

a) Establish a SMM InSAR baseline using 12 previous acquisition datasets prior to the start of the project. This baseline must use archived X-band 8-12 GHz frequency range (2.5-3.75 cm wavelength range) data.

b) Weekly (every 7 days) SMM InSAR acquisitions using X-band 8-12 GHz frequency range (2.5-3.75 cm wavelength range) to ±.1cm accuracy.

3.1.5 Satellite Pool Position Monitoring

a) Weekly (every 7 days) acquisition of 50 cm or better orthorectified satellite imagery data.

b) Processing of satellite imagery and integration into a change detection platform for monitoring of the pool position.

c) Only cloud free imagery (less than 15% cloud cover) to be produced & invoiced.

3.1.6 Aerial Thermal Survey (Seepage Monitoring)

A monthly aerial Thermal Survey of the ash dam is required in order to identify thermal anomalies on and around the ash dam in order to try and identify water seepage areas. The Thermal survey specifications are:

a) Thermal survey to be flown between the hours of 2 am and 5 am.

b) Thermal image pixel resolution 0.75 m or better.

c) Capture of known placed points with a pyrometer using ice boxes and typical ground temperature readings for calibration and verification and for rectification of the thermal survey image into an orthorectified image.

d) Absolute temperature measurements accuracy of 3 degrees Celsius.

e) Relative temperature measurements accuracy of 1 degree Celsius.

3.2 DELIVERABLES

3.2.1 Geotechnical Evaluation

a) Maximum allowable ash dam side slope SMM trigger movements/velocities.

b) Evaluation of the weekly SMM movements/velocities for input into the weekly SMM report.

3.2.2 Satellite Surface Movement Monitoring

a) A Web-Interface to allow interrogation of the SMM data.

b) The Web-Interface is to allow extraction of Change Graphs. The Web Interface should enable Eskom to extract information showing the historical movement of any specific points or lines of interest within the surveyed area.

c) Data Delivery - “Heatmap” Layers:

- SMM (.kmz Google Earth)
- SMM (.shp)
- SMM (.ecw)

d) Web-Interface:

- Interchangeable SMM heatmap layers
- Qualitative layers (comparison layers)
- RGB image layers

e) Report:

- Weekly SMM report

3.2.3 Satellite Change Detection Monitoring (Pool Position)

a) Access to the change detection platform:

- Built-in visualizing and interrogating feature
- Change detection tools

b) Downloadable vectors:

- Change layers will be downloadable in shapefile & Microstation .V8 dgn format.

c) Report:

- Weekly Pool Position and Beach Width Report

3.2.4 Thermal Survey Anomaly Monitoring (Wall Seepage)

a) 0.75 m pixel or better Orthorectified Thermal "Heatmap" with colour scale suitable to identify temperature anomalies in order to try and identify wall seepage areas.

b) Orthoimages to be in ERMapper's ecw format with compression level 3.

c) Non-image tile background areas to be white.

d) Monthly Thermal Survey Report.

4. AUTHORIZATION

This document has been seen and accepted by

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5. REVISIONS

Date	Rev.	Compiler	Remarks
21/01/2021	0.1	A Kreuiter	Draft document
09/02/2021	1.0	A Kreuiter	Final document
23/03/2021	2.0	A Kreuiter	Removed Lidar Survey and added Geotechnical evaluation.

6. DEVELOPMENT TEAM

N/A

7. ACKNOWLEDGEMENTS

N/A