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Scope of Works for Sinkhole
Assessment and Remediation**

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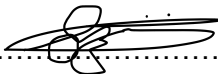
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0.1	Document outlining scope of works for geotechnical assessment of sinkholes and remediation	December 2021
1.0	Document outlining scope of works for geotechnical assessment of sinkholes and remediation	December 2021

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1. INTRODUCTION

Extensive sinkholes have been observed along the Eskom Carmel – Pluto 1 and 2 275kV powerlines. The Carmel – Pluto 1 and 2 275kV powerlines affected towers are located in close proximity to Holfontein, West Rand, approximately 16km from Pluto Substation.

From observations conducted on 20/12/2021, the sinkholes appear to have formed around Carmel-Pluto 1 Tower 63 (the tower being subsequently relocated to Tower 63A and 63B on either side), Carmel – Pluto 2 Tower 64 and a Distribution DX Tower. A total of two (2) towers are currently affected by the sinkholes, surface cracking was observed approximately 10m from Carmel – Pluto 2 Tower 64, and as close as 2m away from the affected DX tower. Sinkhole sizes range from approximately 1m to 4m in diameter (measured as spans between pinnacles), depths could not be ascertained. A total area of 22100m² (2.2 Ha) is affected (see locality image below, Figure 1).

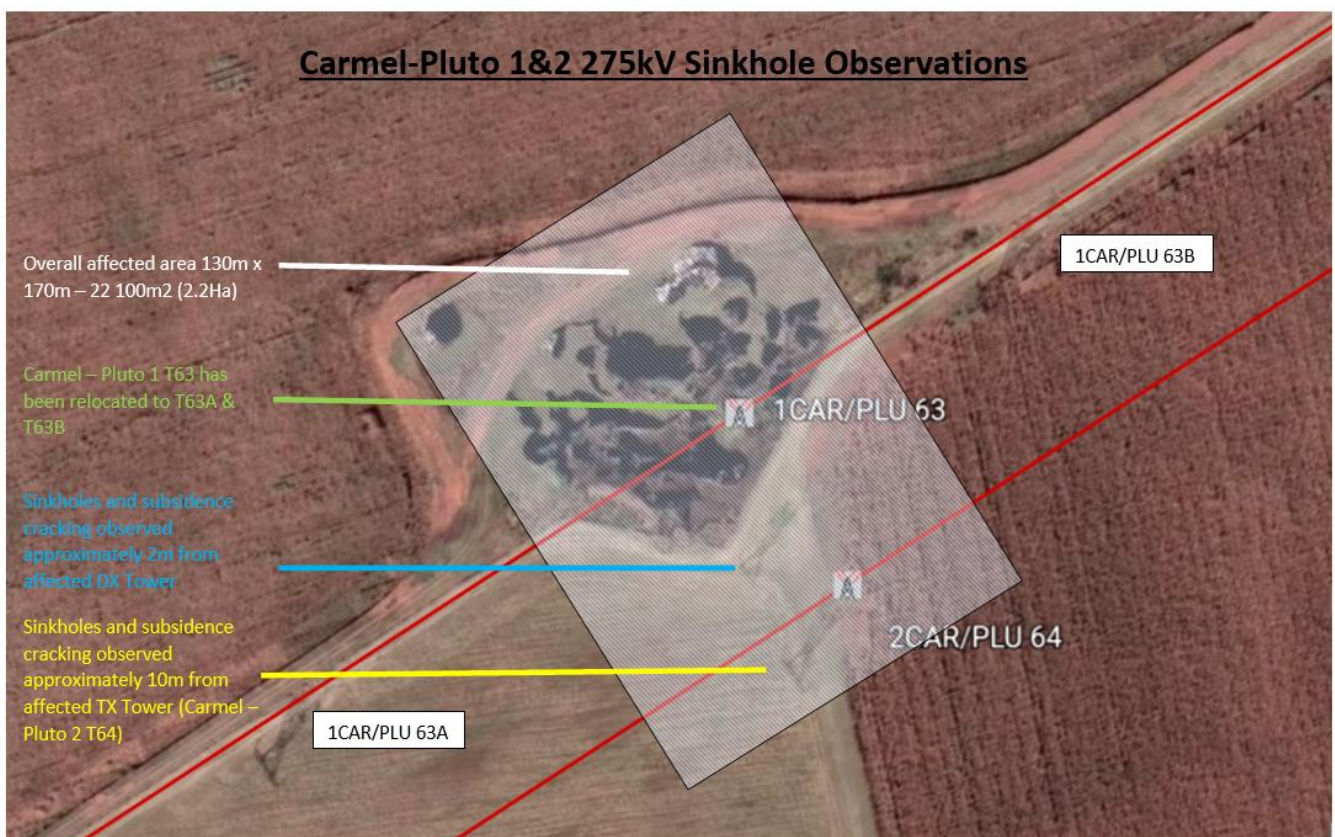


Figure 1. Carmel – Pluto 1 & 2 275kV Sinkhole Locality Image

This document outlines the scope of works required for the assessment of the root cause of the sinkholes and the outline of the remediation work. *It must be noted that initial recollection of sinkholes observed extends as far back as 2008.*

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2. SUPPORTING CLAUSES

2.1 SCOPE

The *Works* comprises of a desk study and site walkover, geotechnical assessment of the area by means of gravity/aerial survey, drilling of percussion boreholes and rehabilitation/remediation works.

All works must be conducted by a competent person (as outlined in SANS 1936:2012), and must adhere to governing guidelines, legislature and nation standards.

All rehabilitation must be conducted as per SANS 2001: BE 3 (2012).

The Successful tenderer (*Contractor*) provides all equipment and resources required to execute the *Works*.

2.1.1 Purpose

The *Contractor*:

- a) Performs a desk study of all regional and local geological, geo-hydrological and survey information (where available).
- b) Perform an assessment of the area affected by sinkholes by means of gravity survey/aerial survey (site condition dependent), drilling of percussion boreholes.
- c) Compiles and executes a constructible remediation plan for the overall area.
- d) Obtains necessary approvals and Council of Geoscience Letter of Comments (as needed).
- e) All works is governed by the necessary South African National Standards, governing Legislation and Government Norms & Acts.
- f) Obtains all required licenses and approvals.
- g) All parties working within Eskom servitudes must conduct works under supervision of an allocated, qualified authorized persons (as per HV Regulations ORHVS).
- h) All equipment used for geotechnical investigations purposes must adhere to the necessary equipment height and width clearances and equipment earthing requirements as advised by the *Employer*.

2.1.2 Applicability

This document applies throughout Eskom Holdings Transmission Division.

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] Site Investigation Code of Practice, 1st Edition, South African Institution of Civil Engineering - Geotechnical Division, January, 2010
- [2] All Soil profiling is conducted in accordance with guidelines outlined in: Jennings, J.E, Brink, A.B.A, & Williams, A.A.B, (1973) "Revised Guide to Soil Profiling for Civil Engineering purposes in Southern Africa" Trans. S.A.I.C.E, Vol. 15, No. 1, pp 3 – 12.

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- [3] SANS 1936:2021, Parts 1-4: Development on Dolomitic Land
- [4] SANS 633: Soil profiling and rotary percussion borehole logging in dolomitic land in Southern Africa for engineering purposes
- [5] SANS 634: Geotechnical Development for Township Investigations
- [6] SANS 2001: BE 3: Repair of Sinkholes and Subsidence in Dolomitic Land
- [7] All *works* are conducted in accordance with the requirements of the Occupational Health and Safety Act (Act 85 of 1993) as amended
- [8] The successful tenderer conforms to all relevant legislation, whether natural, social, cultural or technical, and shall liaise with the appropriate authorities if required.

2.2.2 Informative

- [9] 240-80605256: Access to Private Property Standard
- [10] 240-47172520: "The Standard for the Construction of Overhead Powerlines (TRMSCAAC 6.0)

2.3 DEFINITIONS

2.3.1 Classification

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

2.3.2 Definitions

Definitions	Description
Competent Person - Dolomitic Stability Investigation	"person who is qualified by virtue of his experience, qualifications, training and in-depth contextual knowledge of development of dolomitic land to a) plan and conduct geotechnical site investigations for the development of dolomitic land, evaluate factual data, develop a geological model, derive interpretive data and formulate an opinion relating to the outcomes of such investigations; b) develop and inspect for compliance the necessary precautionary measures required on dolomite land to enable safe and sustainable developments to take place; c) develop dolomite risk management strategies; d) investigate the cause of an event and participate in the development of the remedial measures required."
Sinkhole	"feature that occurs suddenly and manifests itself as a hole in the ground."
Subsidence	"shallow, enclosed depression"

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2.4 ABBREVIATIONS

Abbreviation	Description
AASHTO	American Association of State Highway and Transport Officials
CBR	California Bearing Ratio
DRMP	Dolomitic Risk Management Plan
DSI	Dolomitic Stability Investigation
DX	Distribution Division
ECSA	Engineering Council of South Africa
LES	Lines Engineering Services
OSH	Occupational Health and Safety
ORHVS	Operating Regulations for High Voltage Systems
ITP	Inspection and Test Plan
PPE	Personal Protective Equipment
QCP	Quality Control Plan
QIP	Quality Inspection Plan
SACNASP	South African Council for Natural Scientific Professions
SAICE	South African Institute of Civil Engineers
SANAS	South African National Accreditation System
SANS	South African National Standards
SHEQ	Safety Health Environment and Quality
TX	Transmission Division

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2.5 ROLES AND RESPONSIBILITIES

The *Contractor*:

- a) provides adequate resources including provision of equipment for required *Works*;
- b) manages cost and a scheduled time frame of work;
- c) ensures the scope is carried out in full;
- d) provides regular feedback on the status of the works;
- e) ensures that all site work is conducted by a competent person (as defined above and within SANS 1936: 2012);
- f) 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);
- g) applies his discretion in conducting tests in as close an area to the desired location as possible, should access to testing areas be restricted and/or obstructed;
- h) ensures that, should the ground conditions exhibit notable changes, the *Employer* is informed promptly;
- i) notifies the *Employer*, if any impedance occurs as soon as the Contractor becomes aware of them.
- j) must ensure that all work conducted in close proximity to live lines within Eskom servitude is conducted under the supervision of an authorised person.
- k) must ensure that all equipment has maintained required height and width clearances as advised by the *Employer*.
- l) must ensure that all equipment has been earthed to the satisfaction of the *Employer* (see TRMSCAAC 6.0).
- m) ensures the production of constructible foundation designs and long-term monitoring implementations (where applicable).

2.6 PROCESS FOR MONITORING

The *Contractor* provides weekly progress updates, and in addition allows for the following quality control measures:

- a) The *Contractor* exercises strict and adequate quality control during all aspects of the works.
- b) The *Contractor* prepares suitable quality control plans (QCP/QIP), Inspection and Test Plans (ITP) for all work carried out and submits to the Employer for acceptance as required.
- c) The QIP is to be structured as per the agreed scope i.e. a) technical activities as per scope must undergo quality control and should be indicated in the QIP; b) Quality Standards and Procedures as stipulated in the contract must be indicated in the QIP along with linked activities.

2.7 TOWER DETAILS

- a) Affected towers coordinates:

Tower Number	Lat. Co-ordinate	Long. Co-ordinate
Carmel- Pluto 2 Tower 64	-26.257046 S	27.371564 E
Affected DX Tower (google earth estimate)	26° 15'24.71" S	27° 22'16.94" E

- b) Minimum safe working clearance for TX Line: 3m
- c) Overall affected area approximately 2.2Ha,
- d) Sinkhole Sizes (in some instances as spans between pinnacles) range from 1.0m to 4.0m

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3. SAFETY, HEALTH, ENVIRONMENT AND QUALITY (SHEQ)

The *Contractor*:

- a) Submits a Safety File for acceptance by *Employer* before commencement of the Works.
- b) Ensures that all personnel are familiar with the Employers Health and Safety induction, and Personal Protective Equipment (PPE) requirements before commencement of the Works.
- c) Identifies and submits strategic measures to execute fieldworks without contravening environmental compliances and/or guidelines put forth within South African National Standards and/or Legislation.
- d) Ensures that all SHEQ activities are incorporated into the schedule.
- e) Ensures that the SHEQ file must contain as a minimum:
 - Qualification/training requirements
 - PPE as identified by site Health, Safety and Environment personnel
 - Prevention/mitigation measures
 - Emergency procedures
 - Access
 - Coronavirus (Covid-19) Compliance Measures
 - Equipment safety and earthing measures

4. RECIEVABLES

Upon contract award, the Contractor will receive:

- a) Observational Presentation and field images – as made on 20/12/2021
- b) Tower drawings and loading

5. ACCESS

Access to the servitude/ tower positions is done in accordance to the Access to Private Property Standard (240-80605256). The *Employers Project Manager* gives guidance to the *Contractor* regarding access to the powerline servitude route and proposed towers positions. Conditions for access will be elaborated upon at contract award.

6. DESK STUDY

The *Contractor* conducts a desk study review for the entire affected area of along the Carmel – Pluto 1 and 2 275kV powerline servitude. The *Contractor* reviews of all known literature, existing local and regional Dolomitic Stability Investigation (DSI) geotechnical information available for the proposed area. The *Contractor* reviews pertinent soil maps and hydrological/climatological data where needed.

The Contractor; where possible; is to make use of existing dolomitic stability investigations in and around the proposed areas to ensure adequate fieldworks planning and investigations.

The Contractor purchases all relevant information required.

7. SITE WALKOVER

- a) The Contractor conducts a site walkover for the affected area.
- b) The *Contractor* identifies areas of notable adjacent and bisecting infrastructure.
- c) Identifiable landform features and contributing environmental factors are noted.

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8. SCOPE OF WORKS

8.1.1 Survey

- a) A Gravity/Aerial survey is conducted of the affected area.
- b) The type of survey employed will be dependent on the overall condition of the ground at the time of the survey works, as sinkholes have already propagated.
- c) The professionally registered “competent person” will decide what type of survey will be conducted.
- d) The overall survey area is approximately 22100m² (2.2Ha)

8.1.2 Percussion Drilling

- a) Percussion drilling is conducted at the affected area.
- b) The intention of the percussion drilling is to determine the extent of the sinkholes and to determine if the dolomitic branches extend below the transmission infrastructure footing.
- c) Assessment of open excavations and percussion drilling must aim to determine (where possible) the root cause of the sinkholes.
- d) A minimum of three (3) holes are excavated.

8.1.3 Laboratory Testing

- a) The competent person will determine if soil/water laboratory testing is required.
- b) Time and monetary provision must be allowed for the following tests on overburden materials (as per SANS 1936:2012):
 - 3 x Foundation Indicator: Sieve and Hydrometer Analysis plus Atterberg Limits
 - 3 x Direct Shear Tests
 - 3 x Double Oedometer tests
 - 3 x Permeability & Dispersiveness Tests
- c) Provision is made for the following tests on backfill materials during remediation works (as per SANS 2001: BE 3):
 - 6 x Complete CBR test including Moisture Density Relationship (AASHTO effort): for intended backfill materials (during sinkhole remediation)

8.1.4 Sample Management

- a) Sampling is conducted on representative samples.
- b) Samples are collected, stored and labelled as per the relevant SAICE standards.
- c) The Contractor ensures that all samples are transported carefully to the SANAS accredited laboratory, such that the samples retain their sample integrity.
- d) No samples are to be misplaced, damaged or lost during transportation and testing.

8.1.5 Remediation

- a) From the field assessment and geotechnical testing conducted, the competent person must recommend and supervise the implementation of the necessary remediation works.

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- b) Sinkhole remediation must be conducted as per SANS 2001: BE 3 (2012). For mass infill recommendations – the Contractor along with the competent person recommends the material quantities and material sources.
- c) Laydown areas for materials handling and plant are identified.
- d) NB. The *Contractor* must (a) take reasonable and sufficient steps in order to prevent, as far as is reasonably practicable, any person from being buried or trapped by a fall or dislodgement of material in an excavation; (b) may not require or permit any person to work in an excavation which has not been adequately shored or braced as stipulated in Section 13 of Reference [6].

8.1.6 Monitoring & Disaster Management

- a) Adequate monitoring measures are implemented based on geological findings.
- b) Monitoring measure must be put in place and adhered to during excavation and construction works.
- c) Post construction monitoring measure are to be defined by the competent person based on the geological findings.
- d) The *Contractor* provides technical assurance during construction to ensure that monitoring measures are adhered to as outlined within the monitoring plan.
- e) Stakeholder preparedness measures must be identified, this may include the compilation and implementation of a Dolomitic Risk Management Plan (DRMP) as deemed necessary by the competent person.

8.1.7 Deliverables

- a) After completion of the field assessments, the *competent person* (ECSA/SACNASP) prepares and submits the report detailing the root cause of the sinkholes and remediation methods to be employed.
- b) Peripheral observations are noted, this includes smaller “distant” sinkholes which may propagate further failure in future.
- c) Should root cause be identified as damage to water-borne services the local authority must be informed in writing timeously.
- d) The *Contractors* competent person applies for all necessary authorizations and approvals (as required).
- e) The area classification and description as defined in SANS 1936: 2012, Part 1-4 is provided
- f) Where required, a Dolomitic Risk Management Plan (DRMP) is provided. This may include measures for water monitoring and management as deemed necessary by the competent person.
- g) Ensure all sinkhole remediation aligns with SANS 2001:2012, BE 3.
- h) Fieldworks are conducted in the presence of an *Employer Site Representative* (where applicable).
- i) The *Contractor* must ensure that the geotechnical parameters acquired through the geotechnical investigation works are a true reflection of the ground conditions and remains liable and accountable for the investigation findings.
- j) The *Contractor* supervises the remediation works.

NB. Written consent must be received from the Employer for any and all deviations from the testing suite as outlined herein.

9. AUTHORISATION

This document has been seen and accepted by:

Name	Designation
A Simbudayal	Senior Engineering Geologist PrSciNat

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10. REVISIONS

Date	Rev.	Compiler	Remarks
2021-12	0.1	A Simbudayal	Internal draft for review
2022-01	1.0	A Simbudayal	Final document for signature

11. DEVELOPMENT TEAM

The following people were involved in the development of this document:

- Alicia Simbudayal – Senior Engineering Geologist, LES

12. ACKNOWLEDGEMENTS

- Gino Pillay

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