- *Site Investigations*
- *Slope Stability*
- *Rock Mechanics*
- *Soil Mechanics*
- *Foundations*
- *Borrow Pits and Materials*
- *Roads*
- *Groundwater*
- *NHBRC*
- *Geotechnical Instrumentation*

Geological Comparison Report for the Proposed Necsa MPR Phase 2 Siting Process: Preliminary Report

Client: Manyabe Consultancy / Necsa

GCS Reference: ***23-0071R01***
Client Reference: ***Annexure B2: MPR-EXT-DES-0002***
Dated: ***11 April 2023***

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Geological Comparison Report for the Proposed Necsa MPR Phase 2 Siting Process: Preliminary Report

Reference: 23-0071R01 **Date: 11 April 2023**

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Geological Comparison Report for the Proposed Necsa MPR Phase 2 Siting Process: Preliminary Report

Reference: 23-0071R01 **Date: 11 April 2023**

EXECUTIVE SUMMARY

This report contains the preliminary findings for a geological comparison of two candidate sites for the development of a new Multipurpose Reactor (MPR) at the Necsa Pelindaba facility.

Both sites appear to be underlain by transported hillwash soils and further underlain by reworked/residual shale of the Timeball Hill, Pretoria Group (Transvaal Supergroup). ***However, Site 15 also exhibits the presence of a diabase intrusion that maybe an indication of a possible fault that has been delineated on existing geological maps. Both sites are considered non-dolomitic since the dolomite is expected to occur at a depth in excess of 300 m below both sites.***

Provisional test pitting and trenching was initiated prior to the more formalised trenching that is normally required with the directive assistance of geophysical surveys (the latter forming part of Annexure B1: MPR-EXT-DES-0001: Geotechnical & Geophysical Survey).

For the purposes of earthworks and for the installation of services, both sites indicate ***SOFT*** *excavation material, according to* ***SANS 1200D, DA and DB,*** *to depths varying between 0.6 m and 1.7 m below existing ground surface. Beneath these depths, it is envisaged that* ***INTERMEDIATE*** *to* ***HARD*** *rock excavation material will be encountered. Intermediate to hard rock excavation material may be removed using medium to heavy earth-moving equipment assisted by percussion methods.* ***Due to the slightly steeper ground slope, Site 15 will require more intermediate to hard rock excavation.***

It is considered that Site 1 and Site 15 are suitable for the development from a preliminary high-level perspective. ***However, due to the possible presence of a diabase dyke and slightly steeper ground slope at Site 15, it is further recommended that, from a geological perspective, Site 1 appears to be the more suitable site. This is summarised using the simplified geological suitability rating system of 1) most suitable, 2) moderately suitable and 3) least suitable as follows:***

Site	*Dolomite*	*Seismicity*	*Excavatability*	*Complexity*	*TOTAL*
1	*1*	*2*	*1*	*1*	*5*
15	*1*	*2*	*2*	*2*	*7*

Finally, it must be understood that the ground conditions described in this preliminary report refer to those interpreted from the literature survey and encountered on the site during the provisional trenching and test pitting exercise. It is therefore possible that conditions at variance with those discussed above may be encountered.

In this regard it is important that GCS Geotechnical carry out the more formalised trenching subsequent to the CSW geophysical survey that may more accurately guide the cross trenching to facilitate the exposure and mapping of any indications of faulting on both sites.

Geological Comparison Report for the Proposed Necsa MPR Phase 2 Siting Process: Preliminary Report

Reference: 23-0071R01 **Date: 11 April 2023**

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Geological Comparison Report for the Proposed Necsa MPR Phase 2 Siting Process: Preliminary Report

Reference: 23-0071R01 **Date: 11 April 2023**

Definitions and Abbreviations

Commercial:

GCS Geotechnical	GCS Geotechnical (Pty.) Ltd.

Technical:

CH	Chainage (metres)
mbgl	metres below ground level
masl	metres above sea level
NGL	Natural Ground Level
FL	Foundation Level
BH	Borehole
SPT	Standard Penetration Test
N	SPT N value (blows per 300 mm)
TLB	Tractor-mounted Loader Backhoe
TP	Test Pit
DCP	Dynamic Cone Penetrometer
EABC	Estimated Allowable Bearing Capacity
G1-G10	Standard classification of natural road building materials (TRH 14)
CBR	California Bearing Ratio
MDD	Maximum Dry Density (kg/m3)
MADD	Modified AASHTO Dry Density
OMC	Optimum moisture Content (%)
PI	Plasticity Index
LL	Liquid Limit
LS	Linear Shrinkage
RMR	Rock Mass Rating
GSI	Geological Strength Index
mi	Hoek-Brown Constant (origin & texture dependent)
RQD	Rock Quality Designation (%)
FF	Fracture frequency
UCS	Unconfined Compressive Strength (MPa)
C (c')	Cohesion (kPa) – total stress and (effective stress)
Φ (Φ')	Friction Angle (degrees) – total stress and (effective stress)
Kv	Modulus of Subgrade Reaction (MN/mm or kPa/mm)
CFA	Continuous Flight Auger (pile type)
DCI	Driven Cast In situ (pile type)
Cv	Coefficient of Consolidation (m2/yr)
Mv	Modulus of Compressibility (m2/MN)
MC1	Moisture Content Before Test (%)
MC2	Moisture Content After Test (%)
ρ	Dry Density (kg/m3)
VSR	Very soft rock
SR	Soft rock
MHR	Medium hard rock
HR	Hard rock
VHR	Very hard rock

Geological Comparison Report for the Proposed Necsa MPR Phase 2 Siting Process: Preliminary Report

Reference: 23-0071R01 **Date: 11 April 2023**

1. PURPOSE

At the request of Manyabe Consultancy (Pty) Ltd (MC), acting on behalf of Necsa, GCS Geotechnical (Pty) Ltd (hereafter referred to as GCS) was asked to provide a proposal and cost estimate for a two-part study of the geotechnical, geophysical and seismic conditions (Annexure B1: MPR-EXT-DES-00001) as well as a separate geological comparison study (Annexure B2: MPR-EXT-DES-00002) of two candidate sites for the proposed Multi-Purpose nuclear research Reactor (MPR) at the established Pelindaba facility. This report details the findings of the latter geological comparison study. Preliminary fieldwork was undertaken on 14 March 2023 and completed on 15 March 2023 across the two candidate sites, Site Location 15 and Site Location 1 and comprised general test pitting to identify the typical strata and soil profile. **The more formalized trench mapping can only be completed once the geophysical traverses (CSW) are completed as part of the directives in the Geotechnical and Geophysical Survey (MPR-EXT-DES-00001) as part of the larger investigation. This portion of the investigation was not completed in advance due to time constraints.**

2. JUSTIFICATION

The completion of this investigation and report is reliant upon the results of the geophysical survey (CSW) that has been allocated in Annexure B1 (MPR-EXT-DES-00001). The report status is therefore considered preliminary.

3. PROJECT DESCRIPTION

This study has been carried out in terms of the Development Facilitation Act (DFA), Section 30 of the Government Gazette No. 20775, dated 04 January 2000 as well as the Terms of Reference (ToR) (Annexure B2: MPR-EXT-DES-0002) provided by the Client. This section requires that a geological comparison of the two sites be carried out based on desk top level information as well as fieldwork and indicating the suitability of the sites by reference to a number of factors. These areas of concern and the outcome of the study are outlined below:

- Detailed literature study of the Pelindaba site, detailed description of the topography and the presence of eluvial, ie erosional processes.
- Identify any structural disturbances (such as faults if any) in the trenches.
- Clearly delineate the geolayers/stratigraphy at the candidate sites.
- Any previously known faults running close to the centres of these sites.
- Finally give a comparison between the candidate sites and their suitability for siting the MPR based on the geology.

4. INFORMATION USED

The following information was drawn upon for the purposes of this investigation:

- The 1:50 000 Geological Map Series titled *"2527DD – Broederstroom"* as compiled by the South African Geological Survey, 1981.
- The 1:500 000 Hydrogeological Map titled "*2526 Johannesburg*" as compiled by DWAF, 1999.
- Brink (1985): Engineering Geology of Southern Africa - Vol. 4.
- Jones & Wagener (2007): Geotechnical Investigation: PBMR Pilot Fuel Plant, Pelindaba.
- SRK (2012): Geotechnical and Geophysical Investigations for the Dedicated Isotope Production Reactor (DIPR) at Pelindaba.
- SRK (2014): Environmental Impact Assessment for a Proposed Nuclear Power Station (Nuclear-1) and Associated Infrastructure: Geotechnical Characterization Assessment Study.
- AEC (1997): The Geohydrology of Pelindaba.
- Banzi (2023): Geotechnical and Geophysical Survey of the MPR Site Selection.

A summary of the physiographical information for the greater region is presented below.

Table 4: Summary of Available Physiographical Information

Parameter	Value	Reference
Development	Multipurpose Reactor	Necsa
Site coordinates	Site 1: 25°47'50.97"S / 27°54'34.33"E Site 15: 25°47'33.45"S / 27°54'50.64"E	Necsa
Weinerts N-value	3-4	Weinert (1974)
Climatic Region	Moderate	TRH 2 (1978)
Rainfall	600-800 mm	After DWAF (1986)
Temperature	7-36°C	After DWAF (1986)
Evaporation	1400-1600 mm	After DWAF (1986)
Water Balance	Deficit	Schulze (1985)
Weathering Type	Moderate Decomposition to Moderate Decomposition with Frost Action	Fookes et al (1971) & Embleton et al (1979)
General geology	Slate, shale and hornfels of the Timeball Hill Formation, Pretoria Group (Transvaal Supergroup)	1:250 000 Geological Map Series titled *"2526 Rustenburg"* (1981)
Drainage region	Quaternary Catchment for Site 1 and 15: A21H	DWAF (1999)
Hydrogeology	Fractured 0.1 to 0.5 l/s	Hydrogeological Map – "*2526 Johannesburg"* (1999)
Groundwater	Unknown	GCS (2018).
Erodibility Index	9-15 (medium)	WRC (1992)
Seismic Intensity	V (MMS)	Fernandez et al (1972)
Liquefaction	50-100 cm/s^2	Welland (2002)

5. GENERAL SITE CONDITIONS

5.1 Location & General Site Description

Site 1 is located to the south of Necsa Gate 1 and to the southwest of Site 15. The site covers a total area of approximately 25 hectares, although the footprint of the proposed development (namely a Multipurpose reactor (MPR)) will be approximately 4 hectares in size. The site topography dips gradually to the north with a gradient of approximately 6 to 7%. The site is covered by short to long veld grass and scattered trees. An existing parking lot is present at the south-eastern corner of the site. Several gravel roads traverse the site. A homestead exists in the southern central region of the site.

Site 15 is located in between Necsa Gate 1 and Gate 2 and to the northeast of Site 1. The site covers a total area of approximately 10 hectares, although the footprint of the proposed development (namely a Multipurpose reactor (MPR)) will be approximately 4 hectares in size. The site dips gradually to the north with a gradient of approximately 8% and is covered by short to long veld grass and scattered trees with abundant trees outside the western boundary. The entire site is bound by a gravel road and existing staff accommodation is located to the south of the site.

5.2 Geology

The 1:250 000 scale geological map series, titled "*2526: Rustenburg (1981)"* and the 1:50 000 geological map indicate that the site is underlain by shale with interlayered quartzite of the Timeball Hill Formation, Pretoria Group (Transvaal Supergroup). Fieldwork indicated the presence of a transported hillwash horizon underlain by reworked residual shale and further underlain by residual shale grading to very soft rock shale at shallow depth. **A fault has been marked on Site 1 on the 1:50 000 scale geological map (and confirmed in the literature search) and also an additional fault on Site 15 (Banzi, 2023). Both faults trend northeast-southwest and located in the western half of Site 1 and in the centre of Site 15 (Banzi, 2023).**

5.3 Hydrogeology

A detailed hydrogeological study is not part of the scope of this Part 1 assessment. However, a desk top study, based on historical information (Vivier, et al, 1997; SRK, 2012) has deduced the following:

- The aquifer system consists of two aquifers, namely the saturated, weathered zone which forms the upper aquifer and the lower aquifer which consists of fractured bedrock.
- The bedrock aquifer is composed of a low permeability matrix with occurrences of high permeability fractures.
- Data from pumping, slug and packer tests was used to identify aquifer parameters.
- Limited data on the hydraulic properties of the aquifer is available and more aquifer tests are recommended.
- Groundwater levels at depth beneath the site vary from 16 m to 43 m below existing ground surface.

5.4 Seismicity

A detailed seismological study does not form part of this report but is included in the associated report (MPR-EXT-DES-00001). **However, a seismic study using CSW or MASW is planned across the site to identify any major fracture zones or faults and also facilitate the more detailed and accurate placing of cross trenches for fault mapping purposes.**

In broad terms and from previous work done on the site (Jones & Wagener, 2007) as well as SABS 0161-1989, the site is considered to have a peak horizonal acceleration of 50-100 cm/s^2 and a seismic intensity (Modified Mercalli Scale) of V.

5.5 Liquefaction Potential

A detailed liquefaction study does not from part of the scope of this report. However, the following can be said with regards to liquefaction potential (SRK, 2014):

Soil liquefaction describes the behaviour of loose, saturated, unconsolidated soils, i.e. loose sands, which go from a solid state to having the consistency of a heavy liquid (or reach a liquefied state as a consequence of increasing pore water pressures), and thus decreasing effective stress, induced by their tendency to decrease in volume when subjected to cyclic undrained loading (e.g. earthquake loading).

The following criteria are considered pertinent when undertaking a liquefaction potential study:

- Percentage finer than 0.005mm ≤ 15%
- Liquid limit (LL) ≤ 35%
- Natural water content ≥ 0.9LL
- Liquidity index ≤ 0.75
- Sandy and silty soils of low plasticity and density
- Soils subjected to saturated conditions.
- Having measured SPT-N values of < 15

Other influences on liquefaction potential are:

- Plant geometry and final earthworks/design levels
- Seismic response to earthquakes and shaking.

6. SITE 1 GEOLOGICAL CHARACTERISTICS

6.1 Preliminary Geological Characterization of Site 1

The published 1:50 000 scale geological map shows a possible fault traversing this site trending northeast-southwest in the western half of the site. Nine test pits and three trenches were excavated across the site using a tractor-loader-backhoe (backacter) in view of the proposed development and site comparison survey and **in order to assess the in-situ soil/rock conditions beneath the site in advance of the geophysical survey and the associated formalised trenches for mapping.** The trenches were profiled in-situ by an engineering geologist according to standard practice. Soil samples were collected and are

being tested in a SANAS accredited soil testing laboratory in order to validate our tactile and visual interpretations.

The results of the preliminary investigation indicate that the trenches and test pits refused due to hard digging at depths varying between 0.6 m below existing ground surface and a maximum depth of 1.7 m below existing ground surface (average depth of 1.2 m). No structural disturbances were noticed in any of the test pits and trenches. The trench soil profiles are presented in **Appendix A**, while summaries of the trench profiles are presented in **Tables 6.1a** and **6.1b** below.

Table 6.1a: Summary of the soil layers in the trenches at Site 1.

TP/Trench No.	Transported Hillwash) (m-m)	Reworked Residual Shale (m-m)	Residual to Very Soft Rock Shale (m-m)
TP1	0-0.6	0.6-1.4 (Ref)	-
TP2	0-0.4	0.4-1.0	1.0-1.6 (Ref)
TP3	0-0.2	0.2-0.4	0.4-1.2 (Ref)
TP4	0-0.2	0.2-1.1	1.1-1.7 (Ref)
TP5	0-0.1	0.1-0.7	0.7-0.8 (Ref)
TP6	0-0.3	0.3-0.6 (Ref)	-
TP7	0-0.4	0.4-1.2	1.2-1.4 (Ref)
TP8	0-0.2	0.2-1.1 (Ref)	-
TP9	0-0.3	0.3-0.8	0-8-1.2 (Ref)
Trench1/TP10	0-0.3	0.3-1.3 (Ref)	-
Trench2/TP11	0-0.4	0.4-0.9	0.9-1.0 (Ref)
Trench3/TP12	0-0.4	0.4-0.9	0.9-1.0 (Ref)
Average Depth (m)	**0.35**	**0.95**	**1.25**

Ref – Refusal of the backacter

Table 6.1b: Average soil profile across Site 1

Depth		Description	EABC (kPa)	Kv (kPa/mm)	E (MPa)	C (kPa)
From (m)	To (m)					
Transported Hillwash						
0	0.35	Dry orange to red-brown MEDIUM DENSE open-voided silty sandy **GRAVEL** with scattered to abundant cobbles and roots within the upper 150mm.	<50	20-25	10-15	-
Reworked Residual Shale						
0.35	0.95	Slightly moist grey to beige-brown FIRM to STIFF jointed friable gravelly **SILT** with residual shale lenses.	150-200	55-70	-	36-72
Residual to Very Soft Rock Shale						
0.95	1.25	Dry to slightly moist yellow to grey-brown STIFF to VERY STIFF jointed friable gravelly **SILT.**	200-300	70-100	-	72-144

EABC = estimated allowable bearing capacity: Kv = modulus of subgrade reaction: E = elastic modulus: C = cohesion (kPa)

6.2 Dolomite Site Characterization of Site 1

In terms of dolomite stability, the current site is located within shale and interlayered quartzite of the Timeball Hill Formation of the Pretoria Group (Transvaal Supergroup). Surface dolomite of the Lyttelton and Monte Christo Formations of the Malmani Subgroup of the Chuniespoort Group is located approximately 3.5 km to the south of the southern extent of Site 1. Based on a combination of the dip angles of the dolomite bedding to the

north of approximately 20 to 30 degrees, and the topography, it has been determined that dolomite bedrock will be present at depths in excess of 300 m below Site 1. Considering the above, the site is therefore deemed to be ***non-dolomitic***.

6.3 Evaluation of Site Sensitivity of Site 1

In light of all of the above preliminary results, Site 1 is considered to be stable with no potential issues pertaining to seismic activity (at a desktop level only) or dolomite instability. Site 1 may therefore be considered as a potential candidate site for the proposed MPR.

7. SITE 15 GEOLOGICAL CHARACTERISTICS

7.1 Preliminary Geological Site Characterization of Site 15

The literature survey (Banzi, 2023) and published 1:50 000 scale geological map has revealed the possible presence of a fault trending northeast-southwest in the centre of the site. **The approximate position, orientation and trend of this fault was plotted on the Google Earth imagery of the site to assist in the plotting of potential cross-cutting geophysical surveys (CSW) that will assist in the more accurate and formalised trenching for mapping purposes in order to positively identify this fault.**

Six trenches and four test pits were excavated across the site using a tractor-loader-backhoe (backacter) in view of the proposed development and comparison survey in order to assess the in-situ soil/rock conditions beneath the site. The trenches were profiled in-situ by an engineering geologist according to standard practice. Soil samples were collected and are being tested in a soil testing laboratory in order to validate the tactile and visual interpretations.

The results of the investigation indicate that the trenches refused or were terminated due to hard digging at depths varying between 0.6 m below existing ground surface and a maximum depth of 1.5 m below existing ground surface (average depth of 1.1 m). The trenches soil profiles are presented in **Appendix A**, while summaries of the trench profiles are presented in **Tables 7.1a** to **7.1c** below.

Table 7.1a: Summary of the soil layers in the trenches at Site 15.

TP No.	Transported Hillwash (m-m)	Reworked Residual Shale (m-m)	Residual to Very Soft Rock Shale (m-m)	Residual Diabase (m-m)
TP1	0-0.3	0.3-0.9	0.9-1.5 (Ref)	-
TP2	0-0.1	-	0.1-1.5 (Ref)	-
Trench1/TP3	0-0.6	-	-	0.6-1.0 (Ref)
Trench2/TP4	0-0.3	0.3-1.3 (Ref)	-	-
Trench3/TP5	0-0.4	-	0.4-1.0 (Ref)	-
Trench4/TP6	0-0.3	0.3-1.0 (Ref)	-	-
Trench5/TP7	0-0.1	0.1-0.6	0.6-0.65 (Ref)	-
Trench6/TP8	0-0.2	0.2-1.0	1.0-1.05 (Ref)	-
TP9	-	0-0.5	0.5-0.6 (Ref)	-
TP10	0-0.3	0.3-1.0 (Ref)	-	-
Average Depth (m)	**0.3**	**0.9**	**1.1**	**1.0**

Ref – Refusal of the backacter

The occurrence of diabase on the northern border in Trench 1 may suggest one of two geological possibilities:

a) A diabase sill intrusion striking east west as shown on the available geological maps (Banzi, 2023).
b) A diabase dyke possibly occupying the inferred fault trending northeast-southwest as shown on the geological maps included in the literature search (Banzi, 2023).

Definitive confirmation of b) above can only be realized after the completion of the geophysical CSW survey and detailed trenching to be completed under MPR-EXT-DES-00001.

Table 7.1b: Average soil profile across Site 15 – Shale Zone.

Depth		Description	EABC (kPa)	Kv (kPa/mm)	E (MPa)	C (kPa)
From (m)	To (m)					
Transported Hillwash						
0	0.3	Dry orange to red-brown MEDIUM DENSE open-voided silty sandy **GRAVEL** with scattered to abundant cobbles and roots within the upper 150mm.	<50	20-25	10-15	-
Reworked Residual Shale						
0.3	0.9	Slightly moist grey to beige-brown FIRM to STIFF jointed friable gravelly **SILT** with residual shale lenses.	150-200	55-70	-	36-72
Residual to Very Soft Rock Shale						
0.9	1.1	Dry to slightly moist yellow to grey-brown STIFF to VERY STIFF jointed friable gravelly **SILT.**	200-300	70-100	-	72-144

EABC = estimated allowable bearing capacity Kv = modulus of subgrade reaction
E = elastic modulus
C = cohesion (kPa)

Table 7.1c: Average soil profile across Site 15 – Diabase Zone.

Depth		Description	EABC (kPa)	Kv (kPa/mm)	E (MPa)	C (kPa)
From (m)	To (m)					
Transported Hillwash						
0	0.6	Dry orange to red-brown MEDIUM DENSE open-voided silty sandy **GRAVEL** with scattered to abundant cobbles and roots within the upper 150mm.	<50	20-25	10-15	-
Residual to Very Soft Rock Shale						
0.6	1.0	Slightly moist dark red-brown blotched cream-white DENSE to VERY DENSE jointed and blocky gravelly silty **SAND** with abundant weathered diabase boulders and brecciated quartz veins.	200-300	70-100	25-35	-

EABC = estimated allowable bearing capacity (ignoring collapse potential): Kv = modulus of subgrade reaction: E = elastic modulus
C = cohesion (kPa)

7.2 Dolomite Site Characterization

In terms of dolomite stability, the current site is located within the shale and interlayered quartzite of the Timeball Hill Formation of the Pretoria Group (Transvaal Supergroup). Surface dolomite of the Lyttelton and Monte Christo Formations of the Malmani Subgroup

of the Chuniespoort Group is located approximately 3.5 km to the south of the southern extent of Site 1. Based on a combination of the dip angles of the dolomite bedrock to the north of approximately 20 to 30 degrees, and the topography, it has been determined dolomite bedrock will be present at depths in excess of 300 m below Site 15. Considering the above, the site is therefore deemed to be ***non-dolomitic***.

7.3 Evaluation of Site Sensitivity

In light of all of the above parameters, Site 15 is considered to be potentially stable with no potential issues pertaining to seismic activity (based on desktop information only) or dolomite instability. Site 15 may therefore be considered as a potential candidate site for the proposed MPR. However, the occurrence of diabase may be indicative of a fault and could cause some geological and geotechnical complications during construction (eg uneven foundation conditions and subsequent differential movements).

8. LIMITATIONS AND ASSUMPTIONS

The following is a summary of the limitations and assumptions applicable to this preliminary investigation and report:

- **The preliminary test pitting and trenching included in this report have been organised for the comparative purpose of "clearly delineating the geolayers/stratigraphy at the candidate sites" (see Chapter 3 of this report and the ToR of MPR-EXT-DES-0002). The test pits were organised as a matter of urgency due to time constraints and are not intended to replace the more formalised trench mapping to identify fault features with the assistance of the geophysical surveys (CSW).**

- The extensive literature search has revealed the possible occurrence of inferred faults traversing both sites and these have been marked on the test pit plans as accurately as possible.

- A preliminary status has been temporarily applied to this report and will be finalised once the geophysical (CSW or MASW) surveys have been completed to allow the more precise trench mapping to be finalised.

- The candidate sites under investigation are located within a Critical Biodiversity Area and the extent of preliminary test pitting and trenching has been restricted due to the environmental laws regarding the clearance of indigenous vegetation.

- The required extent of geophysical surveys and effective trench mapping to confirm and expose any structural disturbances or faults that may affect the selection of one site over the other can only be realised with the appropriate environmental authorisations if considered necessary.

9. CONCLUSIONS & RECOMMENDATIONS

- This report contains the preliminary findings of a geological comparison analysis of two candidate sites for the development of a new Multipurpose Reactor at the Necsa Pelindaba facility.

- **The required literature search revealed similar geological conditions at both sites and also the presence of possible inferred faults at both sites.**

- It is considered that, at a preliminary high level, Site 1 and Site 15 are suitable for the development. However, Site 1 could be deemed the better option due to a slightly shallower gradient from south to north (approximately 6 to 7% compared to 8% for Site 15) and also possible complications due to the presence of an inferred fault and more complex geological conditions due to a diabase intrusion at Site 15.

- Both sites appear to be underlain by shallow transported hillwash soils and further underlain by reworked/residual shale of the Timeball Hill, Pretoria Group (Transvaal Supergroup). **However, Site 15 also exhibits the possible presence of a diabase intrusion which may be occupying the fault zone.**

- For the purposes of earthworks and for the installation of services and foundations, both sites indicate **SOFT** excavation material, according to **SANS 1200D, DA and DB,** to depths varying between 0.6 m and 1.7 m below existing ground surface. Beneath these depths, it is envisaged that **INTERMEDIATE to HARD** rock excavation material will be encountered. Intermediate to hard rock excavation material may be removed using medium to heavy earth-moving equipment with percussion assistance.

- Therefore, due to the possible presence of a fault zone (Banzi, 2023) that may or may not be infilled by a diabase intrusion (encountered during this preliminary investigation) and slightly steeper ground slope at Site 15, it is further recommended that, from a geological perspective, Site 1 appears to be the more suitable site. This is summarised using the simplified geological suitability rating system of 1) most suitable, 2) moderately suitable and 3) least suitable as follows:

Site	Dolomite	Seismicity	Excavatability	Complexity	TOTAL
1	1	2	1	1	5
15	1	2	2	2	7

- **Finally, it must be understood that the ground conditions described in this preliminary report refer to those encountered on the site during limited test pitting and trenching and a literature search.** It is therefore possible that conditions at variance with those discussed above may be encountered when the more detailed geophysical surveys (CSW) and formalised trench mapping have been completed.

- In this regard it is important that ***GCS Geotechnical*** carry out the geophysical traverses (CSW) to confirm the presence of these inferred faults and this will be reported in the associated report (MPR-EXT-DES-00001). **Detailed and formalised trench mapping can then be accurately aligned to intersect any anomalies encountered during the geophysical surveys and included to finalise this report.**





N Welland: Pr.Eng. / Pr.Sci.Nat

Warren Kretzinger: Pr.Sci.Nat

11 April 2023

For GCS Geotechnical

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www.gcs-sa.biz

APPENDIX A

Test Pit Soil Profiles

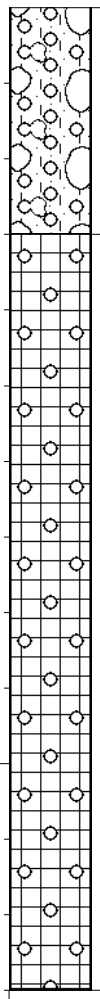
Site 1 & Site 15

NECSA
NECS MPR Siting - Site 1

HOLE No: TP10 (Trench 1)
Sheet 1 of 1

JOB NUMBER: 23-0071

Scale 1:10



0.00 Dry orange to red-brown MEDIUM DENSE open-voided silty sandy GRAVEL with scattered to abundant cobbles. Transported Hillwash.

0.30 Slightly moist grey to beige-brown FIRM to STIFF jointed friable gravelly SILT with residual shale lenses. Reworked Residual Shale.

1.30

NOTES

1) No Groundwater Seepage.
2) Stable Sidewalls.
3) Refusal at 1.3m (Refusal on very stiff to very soft rock residual shale).
4) Disturbed sample taken at 0.3m--1.3m (1S).

CONTRACTOR : N/A
MACHINE : JCB 3CX
DRILLED BY : -
PROFILED BY : Warren Kretzinger

INCLINATION : -
DIAM : N/A
DATE : -
DATE : 14/03/2023

ELEVATION : N/A
X-COORD : 27˚54'30.08"E
Y-COORD : 25˚47'53.44"S

HOLE No: TP10 (Trench 1)

TYPE SET BY : Warren Kretzinger
SETUP FILE : STANDARD.SET

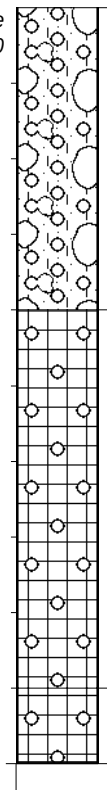
DATE : 29/03/2023 11:00
TEXT : ..1NECSAMPRSite1TPLogs.TXT

NECSA
NECS MPR Siting - Site 1

HOLE No: TP11 (Trench 2)
Sheet 1 of 1

JOB NUMBER: 23-0071

Scale 1:10



0.00 Dry orange to red-brown MEDIUM DENSE open-voided silty sandy GRAVEL with scattered to abundant cobbles. Transported Hillwash.

0.40 Slightly moist grey to beige-brown FIRM to STIFF jointed friable gravelly SILT with residual shale lenses. Reworked Residual Shale.

0.90 Dry to slightly moist yellow to grey-brown STIFF to VERY STIFF jointed friable gravelly SILT. Residual Shale.

1.00

NOTES

1) No Groundwater Seepage.
2) Stable Sidewalls.
3) Refusal at 1.0m (Refusal on very stiff to very soft rock residual shale).
4) No samples taken.

CONTRACTOR : N/A
MACHINE : JCB 3CX
DRILLED BY : -
PROFILED BY : Warren Kretzinger

INCLINATION : -
DIAM : N/A
DATE : -
DATE : 14/03/2023

ELEVATION : N/A
X-COORD : 27˚54’29.86"E
Y-COORD : 25˚47’50.37"S

HOLE No: TP11 (Trench 2)

TYPE SET BY : Warren Kretzinger
SETUP FILE : STANDARD.SET

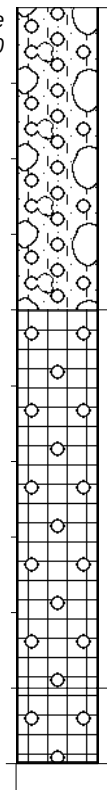
DATE : 29/03/2023 11:00
TEXT : ..1NECSAMPRSite1TPLogs.TXT

NECSA
NECS MPR Siting - Site 1

HOLE No: TP12 (Trench 3)
Sheet 1 of 1

JOB NUMBER: 23-0071

Scale 1:10



0.00 Dry orange to red-brown MEDIUM DENSE open-voided silty sandy GRAVEL with scattered to abundant cobbles. Transported Hillwash.

0.40 Slightly moist grey to beige-brown FIRM to STIFF jointed friable gravelly SILT with residual shale lenses. Reworked Residual Shale.

0.90 Dry to slightly moist yellow to grey-brown STIFF to VERY STIFF jointed friable gravelly SILT. Residual Shale.

1.00

NOTES

1) No Groundwater Seepage.
2) Stable Sidewalls.
3) Refusal at 1.0m (Refusal on very stiff to very soft rock residual shale).
4) No samples taken.

CONTRACTOR : N/A
MACHINE : JCB 3CX
DRILLED BY : -
PROFILED BY : Warren Kretzinger

INCLINATION : -
DIAM : N/A
DATE : -
DATE : 14/03/2023

ELEVATION : N/A
X-COORD : 27˚54’29.45"E
Y-COORD : 25˚47’45.79"S

HOLE No: TP12 (Trench 3)

TYPE SET BY : Warren Kretzinger
SETUP FILE : STANDARD.SET

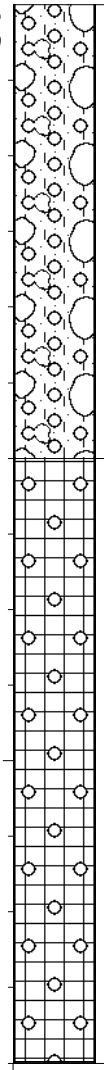
DATE : 29/03/2023 11:00
TEXT : ..1NECSAMPRSite1TPLogs.TXT

NECSA
NECS MPR Siting - Site 1

HOLE No: TP01
Sheet 1 of 1

JOB NUMBER: 23-0071

Scale 1:10



0.00

Dry orange to red-brown MEDIUM DENSE open-voided silty sandy GRAVEL with scattered to abundant cobbles. Transported Hillwash.

0.60

Slightly moist grey to beige-brown FIRM to STIFF becoming VERY STIFF jointed friable gravelly SILT. Reworked Residual Shale.

1.40

NOTES

1) No Groundwater Seepage.
2) Stable Sidewalls.
3) Refusal at 1.4m (Slow digging).
4) No samples taken.

CONTRACTOR : N/A
MACHINE : JCB 3CX
DRILLED BY : -
PROFILED BY : Warren Kretzinger

INCLINATION : -
DIAM : N/A
DATE : -
DATE : 14/03/2023

ELEVATION : N/A
X-COORD : 27˚54'40.46"E
Y-COORD : 25˚47'51.16"S

HOLE No: TP01

TYPE SET BY : Warren Kretzinger
SETUP FILE : STANDARD.SET

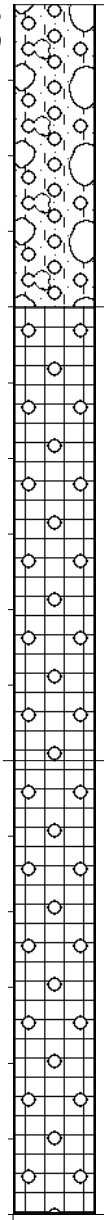
DATE : 29/03/2023 11:00
TEXT : ..1NECSAMPRSite1TPLogs.TXT

NECSA
NECS MPR Siting - Site 1

HOLE No: TP02
Sheet 1 of 1

JOB NUMBER: 23-0071

Scale 1:10



0.00 Dry orange to red-brown MEDIUM DENSE open-voided silty sandy GRAVEL with scattered to abundant cobbles. Transported Hillwash.

0.40 Slightly moist grey to beige-brown FIRM to STIFF jointed friable gravelly SILT. Reworked Residual Shale.

1.00 Dry to slightly moist yellow to grey-brown STIFF to VERY STIFF jointed friable gravelly SILT. Residual Shale.

1.60

NOTES

1) No Groundwater Seepage.
2) Stable Sidewalls.
3) Refusal at 1.6m (Slow digging).
4) No samples taken.

CONTRACTOR : N/A
MACHINE : JCB 3CX
DRILLED BY : -
PROFILED BY : Warren Kretzinger

INCLINATION : -
DIAM : N/A
DATE : -
DATE : 14/03/2023

ELEVATION : N/A
X-COORD : 27˚54'38.15"E
Y-COORD : 25˚47'48.06"S

HOLE No: TP02

TYPE SET BY : Warren Kretzinger
SETUP FILE : STANDARD.SET

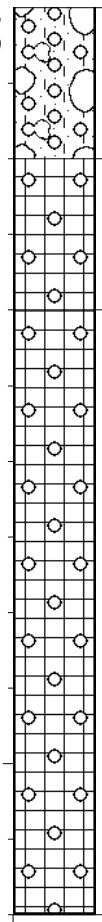
DATE : 29/03/2023 11:00
TEXT : ..1NECSAMPRSite1TPLogs.TXT

NECSA
NECS MPR Siting - Site 1

HOLE No: TP03
Sheet 1 of 1

JOB NUMBER: 23-0071

Scale 1:10



0.00 Dry orange to red-brown MEDIUM DENSE open-voided silty sandy GRAVEL with scattered to abundant cobbles. Transported Hillwash.

0.20 Slightly moist grey to beige-brown FIRM to STIFF jointed friable gravelly SILT. Reworked Residual Shale.

0.40 Dry to slightly moist yellow to grey-brown STIFF to VERY STIFF jointed friable gravelly SILT. Residual Shale.

1.20

NOTES

1) No Groundwater Seepage.
2) Stable Sidewalls.
3) Refusal at 1.2m (Refusal on very stiff to very soft rock residual shale).
4) No samples taken.

CONTRACTOR : N/A
MACHINE : JCB 3CX
DRILLED BY : -
PROFILED BY : Warren Kretzinger

INCLINATION : -
DIAM : N/A
DATE : -
DATE : 14/03/2023

ELEVATION : N/A
X-COORD : 27˚54’36.16"E
Y-COORD : 25˚47’45.14"S

HOLE No: TP03

TYPE SET BY : Warren Kretzinger
SETUP FILE : STANDARD.SET

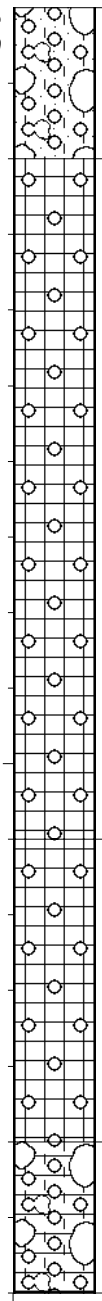
DATE : 29/03/2023 11:00
TEXT : ..1NECSAMPRSite1TPLogs.TXT

NECSA
NECS MPR Siting - Site 1

HOLE No: TP04
Sheet 1 of 1

JOB NUMBER: 23-0071

Scale 1:10



0.00 Dry orange to red-brown MEDIUM DENSE open-voided silty sandy GRAVEL with scattered to abundant cobbles. Transported Hillwash.

0.20 Slightly moist grey to beige-brown FIRM to STIFF jointed friable gravelly SILT. Reworked Residual Shale.

1.10 Dry to slightly moist yellow to grey-brown STIFF to VERY STIFF jointed friable gravelly SILT. Residual Shale.

1.50 Blue-grey VERY DENSE to VERY SOFT ROCK jointed silty GRAVEL and COBBLES. VERY SOFT ROCK SHALE.

1.70

NOTES

1) No Groundwater Seepage.
2) Stable Sidewalls.
3) Refusal at 1.7m (Refusal on very soft rock shale).
4) No samples taken.

CONTRACTOR : N/A
MACHINE : JCB 3CX
DRILLED BY : -
PROFILED BY : Warren Kretzinger

INCLINATION : -
DIAM : N/A
DATE : -
DATE : 14/03/2023

ELEVATION : N/A
X-COORD : 27˚54'33.68"E
Y-COORD : 25˚47'42.32"S

HOLE No: TP04

TYPE SET BY : Warren Kretzinger
SETUP FILE : STANDARD.SET

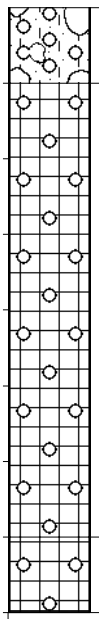
DATE : 29/03/2023 11:00
TEXT : ..1NECSAMPRSite1TPLogs.TXT

NECSA
NECS MPR Siting - Site 1

HOLE No: TP05
Sheet 1 of 1

JOB NUMBER: 23-0071

Scale 1:10



0.00 Dry orange to red-brown MEDIUM DENSE open-voided silty sandy GRAVEL with scattered to abundant cobbles. Transported Hillwash.

0.10 Slightly moist grey to beige-brown FIRM to STIFF jointed friable gravelly SILT. Reworked Residual Shale.

0.70 Dry to slightly moist yellow to grey-brown STIFF to VERY STIFF jointed friable gravelly SILT. Residual Shale.

0.80

NOTES

1) No Groundwater Seepage.
2) Stable Sidewalls.
3) Refusal at 0.8m (Refusal on very stiff to very soft rock residual shale).
4) No samples taken.

CONTRACTOR : N/A
MACHINE : JCB 3CX
DRILLED BY : -
PROFILED BY : Warren Kretzinger

INCLINATION : -
DIAM : N/A
DATE : -
DATE : 14/03/2023

ELEVATION : N/A
X-COORD : 27˚54'31.72"E
Y-COORD : 25˚47'44.29"S

HOLE No: TP05

TYPE SET BY : Warren Kretzinger
SETUP FILE : STANDARD.SET

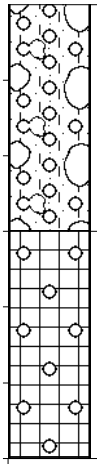
DATE : 29/03/2023 11:00
TEXT : ..1NECSAMPRSite1TPLogs.TXT

NECSA
NECS MPR Siting - Site 1

HOLE No: TP06
Sheet 1 of 1

JOB NUMBER: 23-0071

Scale 1:10



0.00 Dry orange to red-brown MEDIUM DENSE open-voided silty sandy GRAVEL with scattered to abundant cobbles. Transported Hillwash.

0.30 Slightly moist grey to beige-brown FIRM to STIFF jointed friable gravelly SILT. Reworked Residual Shale.

0.60

NOTES

1) No Groundwater Seepage.
2) Stable Sidewalls.
3) Refusal at 0.6m (Refusal on very stiff to very soft rock residual shale).
4) No samples taken.

CONTRACTOR : N/A
MACHINE : JCB 3CX
DRILLED BY : -
PROFILED BY : Warren Kretzinger

INCLINATION : -
DIAM : N/A
DATE : -
DATE : 14/03/2023

ELEVATION : N/A
X-COORD : 27˚54'33.20"E
Y-COORD : 25˚47'48.73"S

HOLE No: TP06

TYPE SET BY : Warren Kretzinger
SETUP FILE : STANDARD.SET

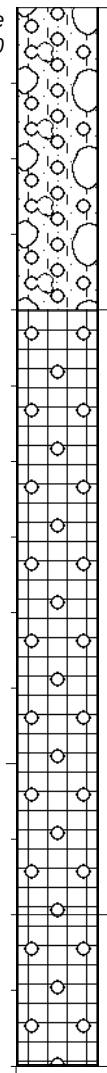
DATE : 29/03/2023 11:00
TEXT : ..1NECSAMPRSite1TPLogs.TXT

NECSA
NECS MPR Siting - Site 1

HOLE No: TP07
Sheet 1 of 1

JOB NUMBER: 23-0071

Scale 1:10



0.00 Dry orange to red-brown MEDIUM DENSE open-voided silty sandy GRAVEL with scattered to abundant cobbles. Transported Hillwash.

0.40 Slightly moist grey to beige-brown FIRM to STIFF jointed friable gravelly SILT. Reworked Residual Shale.

1.20 Dry to slightly moist yellow to grey-brown STIFF to VERY STIFF jointed friable gravelly SILT. Residual Shale.

1.40

NOTES

1) No Groundwater Seepage.
2) Stable Sidewalls.
3) Refusal at 1.4m (Refusal on very stiff to very soft rock residual shale).
4) No samples taken.

CONTRACTOR : N/A
MACHINE : JCB 3CX
DRILLED BY : -
PROFILED BY : Warren Kretzinger

INCLINATION : -
DIAM : N/A
DATE : -
DATE : 14/03/2023

ELEVATION : N/A
X-COORD : 27˚54'35.19"E
Y-COORD : 25˚47'53.52"S

HOLE No: TP07

TYPE SET BY : Warren Kretzinger
SETUP FILE : STANDARD.SET

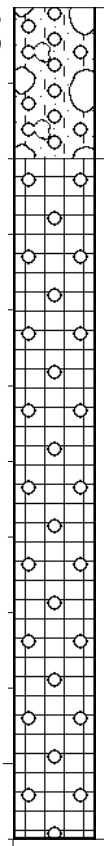
DATE : 29/03/2023 11:00
TEXT : ..1NECSAMPRSite1TPLogs.TXT

NECSA
NECS MPR Siting - Site 1

HOLE No: TP08
Sheet 1 of 1

JOB NUMBER: 23-0071

Scale 1:10



0.00 Dry orange to red-brown MEDIUM DENSE open-voided silty sandy GRAVEL with scattered to abundant cobbles. Transported Hillwash.

0.20 Dry to slightly moist yellow to grey-brown STIFF to VERY STIFF jointed friable gravelly SILT. Residual Shale.

1.10

NOTES

1) No Groundwater Seepage.
2) Stable Sidewalls.
3) Refusal at 1.1m (Refusal on very stiff to very soft rock residual shale).
4) No samples taken.

CONTRACTOR : N/A
MACHINE : JCB 3CX
DRILLED BY : -
PROFILED BY : Warren Kretzinger

INCLINATION : -
DIAM : N/A
DATE : -
DATE : 14/03/2023

ELEVATION : N/A
X-COORD : 27˚54'36.39"E
Y-COORD : 25˚47'56.43"S

HOLE No: TP08

TYPE SET BY : Warren Kretzinger
SETUP FILE : STANDARD.SET

DATE : 29/03/2023 11:00
TEXT : ..1NECSAMPRSite1TPLogs.TXT

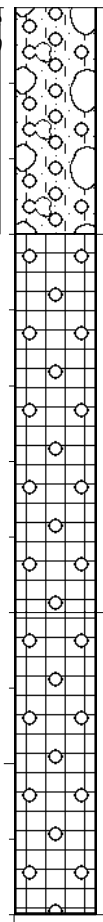
NECSA
NECS MPR Siting - Site 1

HOLE No: TP09
Sheet 1 of 1

JOB NUMBER: 23-0071

Scale 1:10

0.0m--0.3m



0.00 Dry orange to red-brown MEDIUM DENSE open-voided silty sandy GRAVEL with scattered to abundant cobbles. Transported Hillwash.

0.30 Slightly moist grey to beige-brown FIRM to STIFF jointed friable gravelly SILT with residual shale lenses. Reworked Residual Shale.

0.80 Dry to slightly moist yellow to grey-brown STIFF to VERY STIFF jointed friable gravelly SILT. Residual Shale.

1.20

NOTES

1) No Groundwater Seepage.
2) Stable Sidewalls.
3) Refusal at 1.2m (Refusal on very stiff to very soft rock residual shale).
4) Disturbed sample taken at 0.0m--0.3m (1S).

CONTRACTOR : N/A
MACHINE : JCB 3CX
DRILLED BY : -
PROFILED BY : Warren Kretzinger

INCLINATION : -
DIAM : N/A
DATE : -
DATE : 14/03/2023

ELEVATION : N/A
X-COORD : 27˚54'29.02"E
Y-COORD : 25˚47'55.81"S

HOLE No: TP09

TYPE SET BY : Warren Kretzinger
SETUP FILE : STANDARD.SET

DATE : 29/03/2023 11:00
TEXT : ..1NECSAMPRSite1TPLogs.TXT

NECSA
NECS MPR Siting - Site 1

LEGEND
Sheet 1 of 1

JOB NUMBER: 23-0071

	GRAVEL	{SA02}
	GRAVELLY	{SA03}
	SANDY	{SA05}
	SILT	{SA06}
	SILTY	{SA07}
	SHALE	{SA12}
Name ●	DISTURBED SAMPLE	{SA38}
	COBBLES	{SA58}

CONTRACTOR :
MACHINE :
DRILLED BY :
PROFILED BY :

INCLINATION :
DIAM :
DATE :
DATE :

ELEVATION :
X-COORD :
Y-COORD :

TYPE SET BY : Warren Kretzinger
SETUP FILE : STANDARD.SET

DATE : 29/03/2023 11:00
TEXT : ..1NECSAMPRSite1TPLogs.TXT

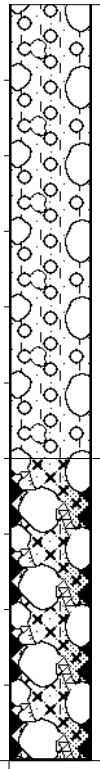
LEGEND
SUMMARY OF SYMBOLS

NECS MPR Siting - Site 15

HOLE No: TP03 (Trench 1)
Sheet 1 of 1

JOB NUMBER: 23-0071

Scale 1:10



0.00

Dry orange to red-brown MEDIUM DENSE open-voided silty sandy GRAVEL with scattered to abundant cobbles. Transported Hillwash.

0.60

Slightly moist dark red-brown blotched cream-white DENSE to VERY DENSE jointed and blocky gravelly silty SAND with abundant weathered diabase boulders and brecciated quartz veins. Reworked Residual Diabase

0.6m--1.0m

1.00

NOTES

1) No Groundwater Seepage.
2) Stable Sidewalls.
3) Refusal at 1.0m (Refusal on diabase boulders).
4) Disturbed sample taken at 0.6m--1.0m (1S).

CONTRACTOR : N/A
MACHINE : JCB 3CX
DRILLED BY : -
PROFILED BY : Warren Kretzinger

INCLINATION : -
DIAM : N/A
DATE : -
DATE : 15/03/2023

ELEVATION : N/A
X-COORD : 27´°54'50.04"E
Y-COORD : 25´°47'29.77"S

HOLE No: TP03 (Trench 1)

TYPE SET BY : Warren Kretzinger
SETUP FILE : STANDARD.SET

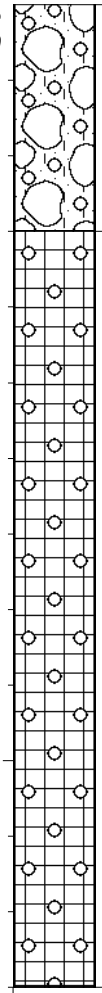
DATE : 29/03/2023 11:01
TEXT : ..NECSAMPRSite15TPLogs.TXT

NECS MPR Siting - Site 15

HOLE No: TP04 (Trench 2)
Sheet 1 of 1

JOB NUMBER: 23-0071

Scale 1:10



0.00 Dry orange to red-brown MEDIUM DENSE open-voided silty sandy GRAVEL with scattered to abundant cobbles and boulders. Transported Hillwash.

0.30 Slightly moist grey to beige-brown FIRM to STIFF jointed friable gravelly SILT. Reworked Residual Shale.

1.30

NOTES

1) No Groundwater Seepage.
2) Stable Sidewalls.
3) Refusal at 1.3m (Refusal on very soft rock shale).
4) No samples taken.

CONTRACTOR : N/A
MACHINE : JCB 3CX
DRILLED BY : -
PROFILED BY : Warren Kretzinger

INCLINATION : -
DIAM : N/A
DATE : -
DATE : 15/03/2023

ELEVATION : N/A
X-COORD : 27˚54'50.02"E
Y-COORD : 25˚47'33.86"S

HOLE No: TP04 (Trench 2)

TYPE SET BY : Warren Kretzinger
SETUP FILE : STANDARD.SET

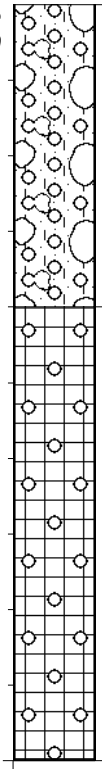
DATE : 29/03/2023 11:01
TEXT : ..NECSAMPRSite15TPLogs.TXT

NECS MPR Siting - Site 15

HOLE No: TP05 (Trench 3)
Sheet 1 of 1

JOB NUMBER: 23-0071

Scale 1:10



0.00

Dry orange to red-brown MEDIUM DENSE open-voided silty sandy GRAVEL with scattered to abundant cobbles. Transported Hillwash.

0.40

Dry to slightly moist yellow to grey-brown STIFF to VERY STIFF jointed friable gravelly SILT. Residual Shale.

1.00

NOTES

1) No Groundwater Seepage.
2) Stable Sidewalls.
3) Refusal at 1.0m (Refusal on very stiff to very soft rock residual shale).
4) No samples taken.

CONTRACTOR : N/A
MACHINE : JCB 3CX
DRILLED BY : -
PROFILED BY : Warren Kretzinger

INCLINATION : -
DIAM : N/A
DATE : -
DATE : 15/03/2023

ELEVATION : N/A
X-COORD : 27˚54'50.05"E
Y-COORD : 25˚47'32.41"S

HOLE No: TP05 (Trench 3)

TYPE SET BY : Warren Kretzinger
SETUP FILE : STANDARD.SET

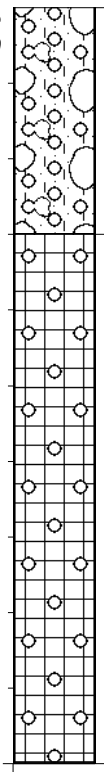
DATE : 29/03/2023 11:01
TEXT : ..NECSAMPRSite15TPLogs.TXT

NECS MPR Siting - Site 15

HOLE No: TP06 (Trench 4)
Sheet 1 of 1

JOB NUMBER: 23-0071

Scale 1:10



0.00 Dry orange to red-brown MEDIUM DENSE open-voided silty sandy GRAVEL with scattered to abundant cobbles. Transported Hillwash.

0.30 Slightly moist grey to beige-brown FIRM to STIFF jointed friable gravelly SILT. Reworked Residual Shale.

1.00

NOTES

1) No Groundwater Seepage.
2) Stable Sidewalls.
3) Refusal at 1.0m (Refusal on very stiff to very soft rock residual shale).
4) No samples taken.

CONTRACTOR : N/A
MACHINE : JCB 3CX
DRILLED BY : -
PROFILED BY : Warren Kretzinger

INCLINATION : -
DIAM : N/A
DATE : -
DATE : 15/03/2023

ELEVATION : N/A
X-COORD : 27˚54'50.05"E
Y-COORD : 25˚47'30.80"S

HOLE No: TP06 (Trench 4)

TYPE SET BY : Warren Kretzinger
SETUP FILE : STANDARD.SET

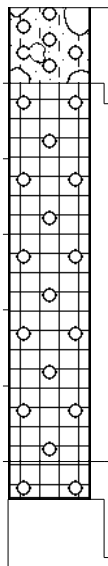
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NECS MPR Siting - Site 15

HOLE No: TP07 (Trench 5)
Sheet 1 of 1

JOB NUMBER: 23-0071

Scale 1:10



0.00 Dry orange to red-brown MEDIUM DENSE open-voided silty sandy GRAVEL with scattered to abundant cobbles. Transported Hillwash.

0.10 Slightly moist grey to beige-brown FIRM to STIFF jointed friable gravelly SILT. Reworked Residual Shale.

0.60 Dry to slightly moist yellow to grey-brown STIFF to VERY STIFF jointed friable gravelly SILT. Residual Shale.

0.65

NOTES

1) No Groundwater Seepage.
2) Stable Sidewalls.
3) Refusal at 0.65m (Refusal on very stiff to very soft rock residual shale).
4) No samples taken.

CONTRACTOR : N/A
MACHINE : JCB 3CX
DRILLED BY : -
PROFILED BY : Warren Kretzinger

INCLINATION : -
DIAM : N/A
DATE : -
DATE : 15/03/2023

ELEVATION : N/A
X-COORD : 27˚54'50.03"E
Y-COORD : 25˚47'34.83"S

HOLE No: TP07 (Trench 5)

TYPE SET BY : Warren Kretzinger
SETUP FILE : STANDARD.SET

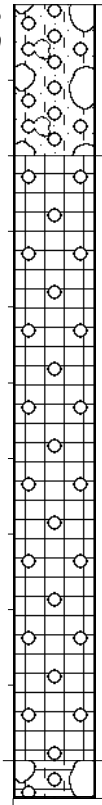
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TEXT : ..NECSAMPRSite15TPLogs.TXT

NECS MPR Siting - Site 15

HOLE No: TP08 (Trench 6)
Sheet 1 of 1

JOB NUMBER: 23-0071

Scale 1:10



0.00 Dry orange to red-brown MEDIUM DENSE open-voided silty sandy GRAVEL with scattered to abundant cobbles. Transported Hillwash.

0.20 Dry to slightly moist yellow to grey-brown STIFF to VERY STIFF jointed friable gravelly SILT. Residual Shale.

1.00 Blue-grey VERY DENSE to VERY SOFT ROCK jointed silty GRAVEL and COBBLES. VERY SOFT ROCK SHALE.

1.05

NOTES

1) No Groundwater Seepage.
2) Stable Sidewalls.
3) Refusal at 1.05m (Refusal on very stiff to very soft rock residual shale).
4) No samples taken.

CONTRACTOR : N/A
MACHINE : JCB 3CX
DRILLED BY : -
PROFILED BY : Warren Kretzinger

INCLINATION : -
DIAM : N/A
DATE : -
DATE : 15/03/2023

ELEVATION : N/A
X-COORD : 27˚54'50.01"E
Y-COORD : 25˚47'36.05"S

HOLE No: TP08 (Trench 6)

TYPE SET BY : Warren Kretzinger
SETUP FILE : STANDARD.SET

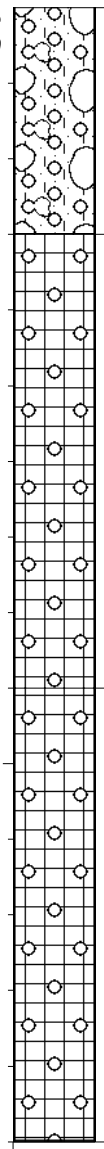
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TEXT : ..NECSAMPRSite15TPLogs.TXT

NECS MPR Siting - Site 15

HOLE No: TP01
Sheet 1 of 1

JOB NUMBER: 23-0071

Scale 1:10



0.00 Dry orange to red-brown MEDIUM DENSE open-voided silty sandy GRAVEL with scattered to abundant cobbles. Transported Hillwash.

0.30 Slightly moist grey to beige-brown FIRM to STIFF becoming VERY STIFF jointed friable gravelly SILT. Reworked Residual Shale.

0.90 Dry to slightly moist yellow to grey-brown STIFF to VERY STIFF jointed friable gravelly SILT. Residual Shale.

1.50

NOTES

1) No Groundwater Seepage.
2) Stable Sidewalls.
3) Refusal at 1.5m (Refusal on very stiff to very soft rock shale).
4) No samples taken.

CONTRACTOR : N/A
MACHINE : JCB 3CX
DRILLED BY : -
PROFILED BY : Warren Kretzinger

INCLINATION : -
DIAM : N/A
DATE : -
DATE : 15/03/2023

ELEVATION : N/A
X-COORD : 27˚54'46.29"E
Y-COORD : 25˚47'34.65"S

HOLE No: TP01

TYPE SET BY : Warren Kretzinger
SETUP FILE : STANDARD.SET

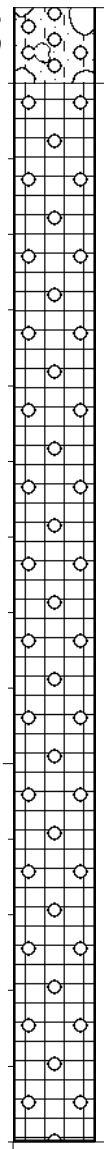
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TEXT : ..NECSAMPRSite15TPLogs.TXT

NECS MPR Siting - Site 15

HOLE No: TP02
Sheet 1 of 1

JOB NUMBER: 23-0071

Scale 1:10



0.00 Dry orange to red-brown MEDIUM DENSE open-voided silty sandy GRAVEL with scattered to abundant cobbles. Transported Hillwash.

0.10 Dry to slightly moist yellow to grey-brown STIFF to VERY STIFF jointed friable gravelly SILT. Residual Shale.

1.50

NOTES

1) No Groundwater Seepage.
2) Stable Sidewalls.
3) Refusal at 1.5m (Refusal on very stiff to very soft rock shale).
4) No samples taken.

CONTRACTOR : N/A
MACHINE : JCB 3CX
DRILLED BY : -
PROFILED BY : Warren Kretzinger

INCLINATION : -
DIAM : N/A
DATE : -
DATE : 15/03/2023

ELEVATION : N/A
X-COORD : 27˚54'46.34"E
Y-COORD : 25˚47'31.49"S

HOLE No: TP02

TYPE SET BY : Warren Kretzinger
SETUP FILE : STANDARD.SET

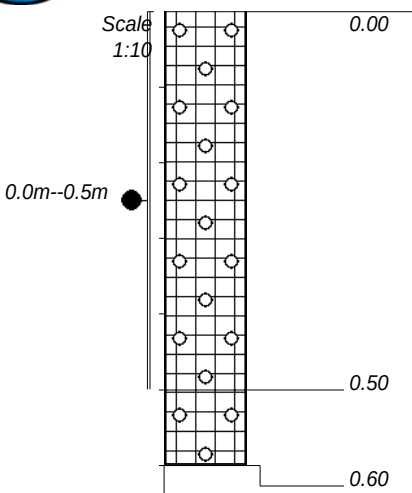
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NECS MPR Siting - Site 15

HOLE No: TP09
Sheet 1 of 1

JOB NUMBER: 23-0071

Scale 1:10



Slightly moist grey to beige-brown FIRM to STIFF jointed friable gravelly SILT with residual shale lenses. Reworked Residual Shale.

Dry to slightly moist yellow to grey-brown STIFF to VERY STIFF jointed friable gravelly SILT. Residual Shale.

NOTES

1) No Groundwater Seepage.
2) Stable Sidewalls.
3) Refusal at 0.6m (Refusal on very stiff to very soft rock residual shale).
4) Disturbed sample taken at 0.0m--0.5m (1S).

CONTRACTOR : N/A
MACHINE : JCB 3CX
DRILLED BY : -
PROFILED BY : Warren Kretzinger

INCLINATION : -
DIAM : N/A
DATE : -
DATE : 15/03/2023

ELEVATION : N/A
X-COORD : 27˚54'53.86"E
Y-COORD : 25˚47'35.15"S

HOLE No: TP09

TYPE SET BY : Warren Kretzinger
SETUP FILE : STANDARD.SET

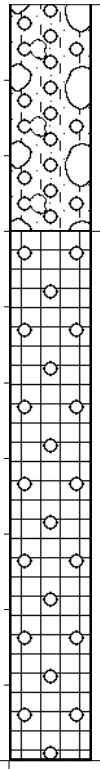
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TEXT : ..NECSAMPRSite15TPLogs.TXT

NECS MPR Siting - Site 15

HOLE No: TP10
Sheet 1 of 1

JOB NUMBER: 23-0071

Scale 1:10



0.3m--1.0m

0.00 Dry orange to red-brown MEDIUM DENSE open-voided silty sandy GRAVEL with scattered to abundant cobbles. Transported Hillwash.

0.30 Slightly moist grey to beige-brown FIRM to STIFF jointed friable gravelly SILT with residual shale lenses. Reworked Residual Shale.

1.00

NOTES

1) No Groundwater Seepage.
2) Stable Sidewalls.
3) Refusal at 1.3m (Refusal on very stiff to very soft rock residual shale).
4) Disturbed sample taken at 0.3m--1.0m (1S).

CONTRACTOR : N/A
MACHINE : JCB 3CX
DRILLED BY : -
PROFILED BY : Warren Kretzinger

INCLINATION : -
DIAM : N/A
DATE : -
DATE : 15/03/2023

ELEVATION : N/A
X-COORD : 27˚54'54.30"E
Y-COORD : 25˚47'32.26"S

HOLE No: TP10

TYPE SET BY : Warren Kretzinger
SETUP FILE : STANDARD.SET

DATE : 29/03/2023 11:01
TEXT : ..NECSAMPRSite15TPLogs.TXT

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NECS MPR Siting - Site 15

LEGEND
Sheet 1 of 1

JOB NUMBER: 23-0071

	BOULDERS	{SA01}
	GRAVEL	{SA02}
	GRAVELLY	{SA03}
	SAND	{SA04}
	SANDY	{SA05}
	SILT	{SA06}
	SILTY	{SA07}
	SHALE	{SA12}
	DIABASE	{SA18}{SA41}
	QUARTZ VEINS	{SA20}
	BRECCIATED	{SA46}
Name ●	DISTURBED SAMPLE	{SA38}
	COBBLES	{SA58}

CONTRACTOR :
MACHINE :
DRILLED BY :
PROFILED BY :

INCLINATION :
DIAM :
DATE :
DATE :

ELEVATION :
X-COORD :
Y-COORD :

TYPE SET BY : Warren Kretzinger
SETUP FILE : STANDARD.SET

DATE : 29/03/2023 11:01
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LEGEND
SUMMARY OF SYMBOLS

APPENDIX B

Laboratory Test Results (Outstanding)

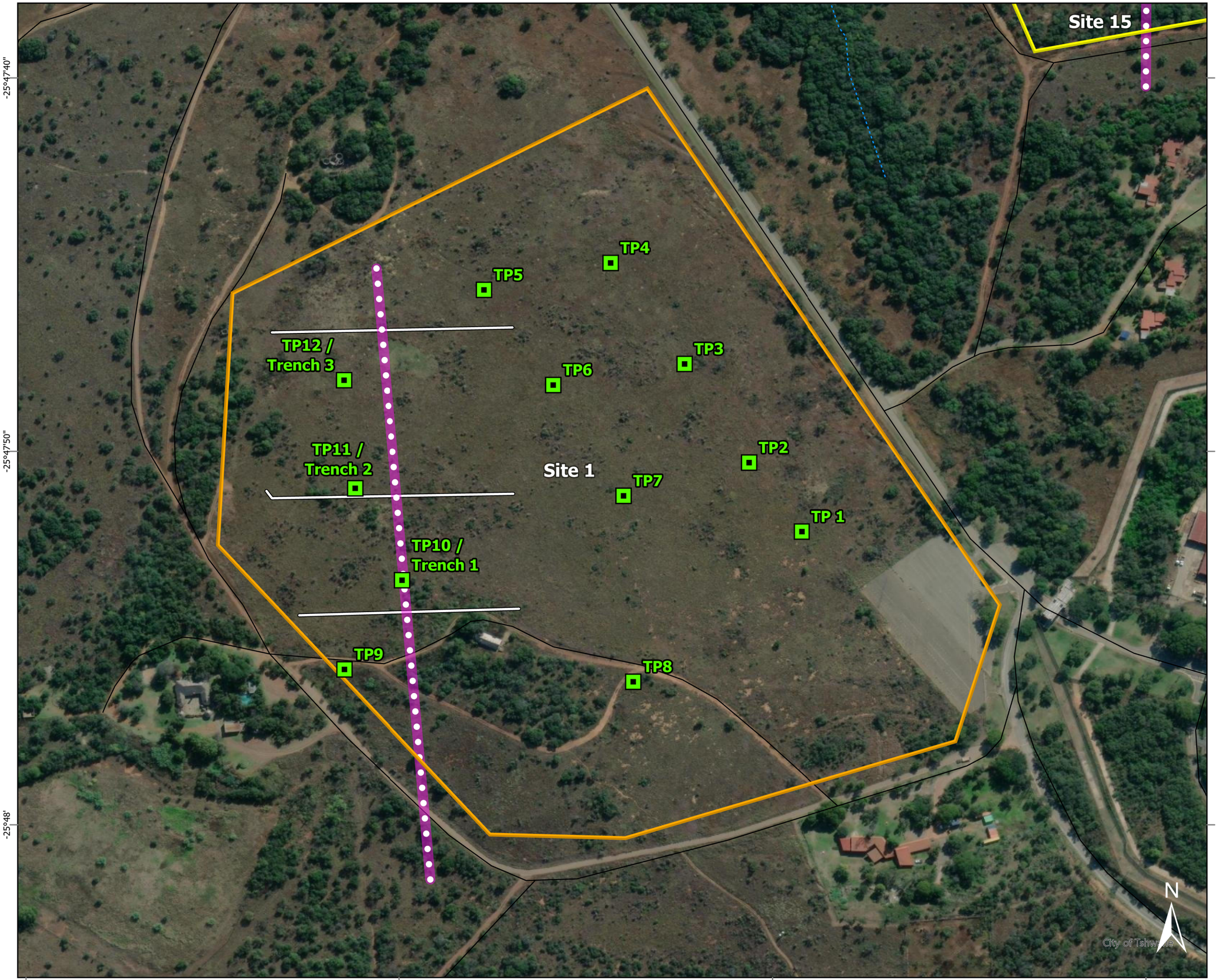
APPENDIX C

Selected Historical References

FIGURES 1 & 2

Site Plans & Geological Maps for Site 1 & Site 15

NECSA - SITE1 PLAN



Legend

- Test Pit
- Inferred fault
- Proposed Seismic Line

Site Locations

- Site 1
- Site 15

Road Network

- Street

Rivers and Streams

- Non-Perennial



Data Sources:
Esri World Imagery Basemap
Test Pit GPS co-ordinates provided by Necsa

0 50 100 Meters

SCALE: 1:3 000

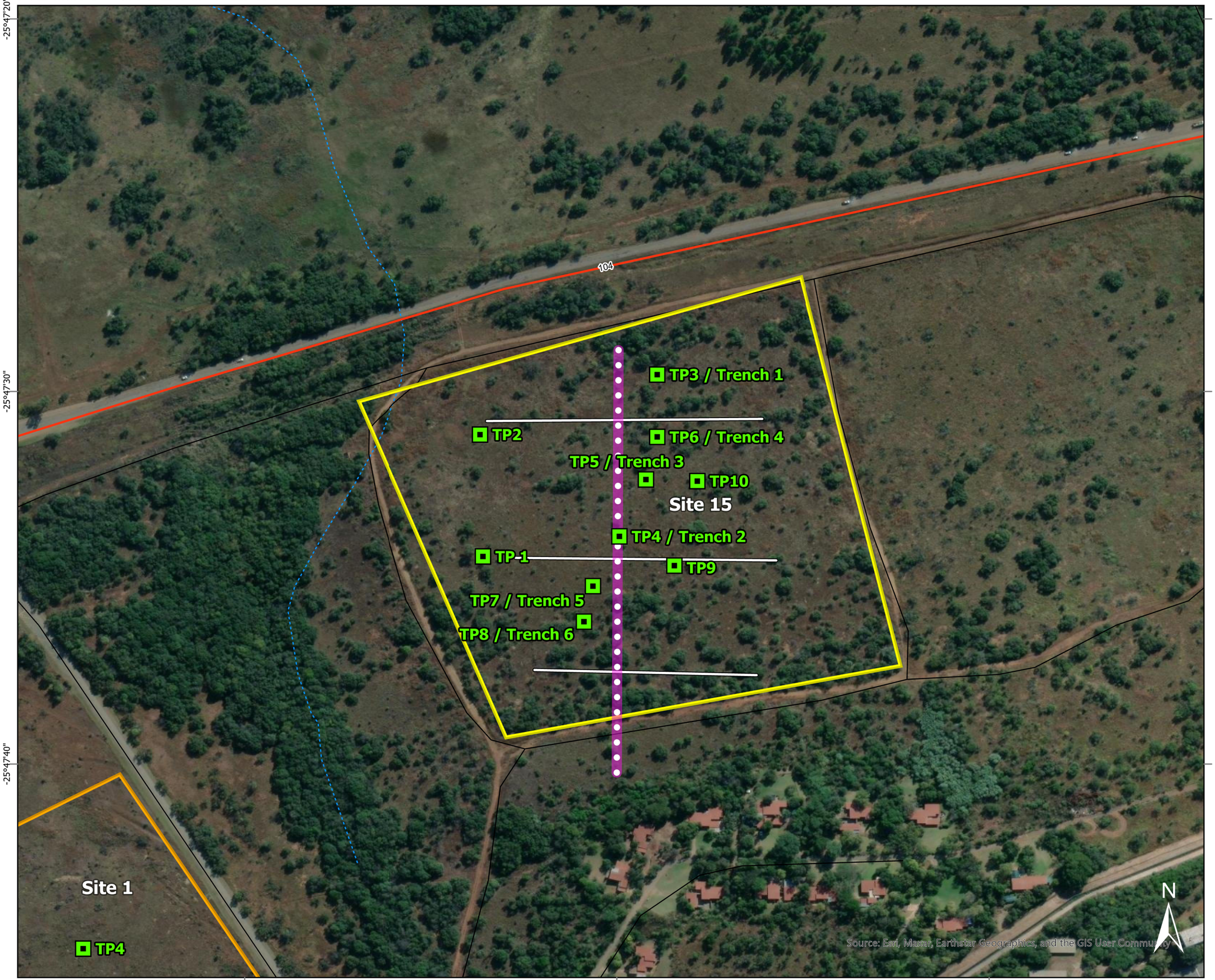
FIGURE NO.: -	MAP NUMBER: 23-0071-02-V2
DRAWN BY: N MBOKAZI GIS CONSULTANT	REVIEWED BY: N WELLAND PROJECT MANAGER
DATUM: WGS84 PROJECTION: GEOGRAPHIC	DATE: 14 APRIL 2023
PROJECT: GEOTECHNICAL INVESTIGATION FOR MPR SITING	
CLIENT: MANYABE CONSULTANCY (PTY) LTD.	

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63 Wessel Road Woodmead
PO Box 2597 Rivonia 2128
South Africa

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Fax: +27 (0) 11 803 5745
E-mail: jhb@gcs-sa.biz
www.gcs-sa.biz

NECSA - SITE15 PLAN



Legend

- Test Pit
- Inferred fault/diabase intrusion
- Proposed Seismic Line

Site Locations

- Site 1
- Site 15

Road Network

- Main Road
- Street

Rivers and Streams

- Non-Perennial



Data Sources:
Esri World Imagery Basemap
GPS co-ordinates provided by Necsa

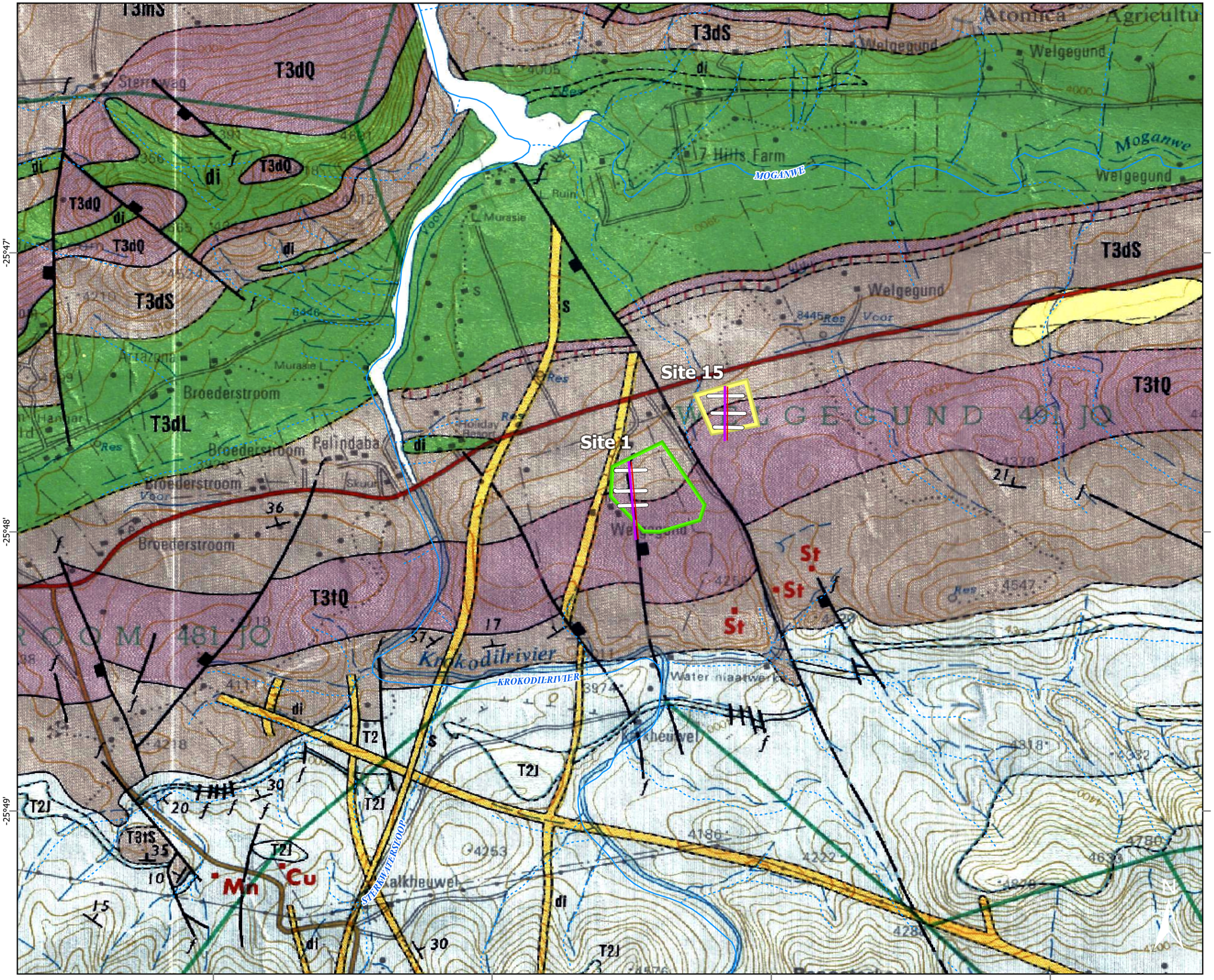
0 50 100 Meters

SCALE: 1:3 000

FIGURE NO.: -	MAP NUMBER: 23-0071-03-V2
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DATUM: WGS84 PROJECTION: GEOGRAPHIC	DATE: 14 APRIL 2023
PROJECT: GEOTECHNICAL INVESTIGATION FOR MPR SITING	
CLIENT: MANYABE CONSULTANCY (PTY) LTD.	

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NECSA - SITE 1 AND SITE 15 GEOLOGY MAP



Legend

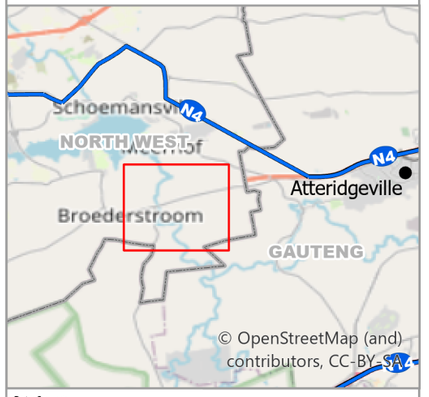
- Inferred fault on site 1 & fault/ diabase intrusion on site 15
- Proposed Seismic Line

Site Locations

- Site 1
- Site 15

Rivers and Streams

- Non-Perennial
- Perennial



Data Sources:
Council for Geoscience, 1:50 000 Geological Series 2527DD

0 0.5 1 Kilometers

SCALE: 1:24 000

FIGURE NO.: -	MAP NUMBER: 23-0071-04-V2
DRAWN BY: N MBOKAZI GIS CONSULTANT	REVIEWED BY: N WELLAND PROJECT MANAGER
DATUM: WGS84 PROJECTION: GEOGRAPHIC	DATE: 17 APRIL 2023
PROJECT: GEOTECHNICAL INVESTIGATION FOR MPR SITING	
CLIENT: MANYABE CONSULTANCY (PTY) LTD.	

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