



STATS Australia
Specialist Testing and Technical Services

PROPOSED TELCO PROJECTS (PORT HEDLAND TO MULLEWA) - GROUP 3 - CAPRICORN



Geotechnical Investigation Work

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EXECUTIVE SUMMARY

Specialist Testing and Technical Services (STATS) was engaged by Mr. Nick Oresti on behalf of VERTIV (the Client), to conduct a Geotechnical Investigation Work for fourteen (x14) Proposed Telco Project sites from Port Hedland to Mullewa, Western Australia. This report covers Capricorn site - Group 3.

A total of six (x6) test pits to the depth of 2.5m or refusal and six (x6) DCP tests to the depth of 1.05m were completed. The test locations are presented in Figure 1.

The site investigation work for Capricorn site was carried out on 16th Nov 2023.

Findings

A summary of findings is presented below:

Test Pit Logs

The site soil profiles encountered across all test pits except TP6 are similar, which comprises of a Sand - Silt Mixtures (Silty SAND): fine to medium grained, brown/red, dry, medium dense to very dense, angular to subangular, with fine to coarse grained gravels, trace of oversize up to 400mm in size. At TP6, the soils encountered comprises of a Gravel - Sand - Silt Mixtures (Sandy Silty GRAVEL): fine to medium grained, brown/red, dry, very dense, angular to subangular with trace of boulders up to 400mm in size.

All the test pit locations encountered refusal on a hard rock layer at various depths from 0.3m to 1.7m.

Dynamic Cone Penetrometer

Based on the Soils Testing Handbook of Australian Standard, Table 6.4.6.1 (A), the density of the soils for the granular materials (Silty SAND) over the proposed development area was generally “**very dense**” with an average of 9 blows per 100mm of penetration. In accordance with the Soils Testing Handbook of Australian Standard, Table 6.4.6.1(C) (Correlation of DCP Blow Counts to CBR), an average Field CBR value of 18% was obtained.

Soil Electrical Resistivity Tests

The Field Soil Resistivity Tests have been replaced by the laboratory Soil Resistivity Tests due to the extremely dry soil on site. The laboratory Soil Resistivity Test Results were presented in Section 6 in this report.

Geotech Site Classification

The site is currently assigned a Site Classification of “**S**” in accordance with the definitions provided in the Australian Standard AS2870 -2011, on the assumption that the construction pad shall be prepared and compacted to the specified requirements under Section 10 of the report. For Site Classification “**S**”, it is described as slightly reactive clay sites which may experience slight ground movements from moisture changes and the characteristic surface movement (Y_s Value) for the site was assessed as 0 to 20mm due to seasonal moisture change would occur.



Soils Bearing and Settlement Assessments

Findings revealed pad footings of size 2m by 2m, 3m by 3m, 3m by 4m and 4m by 5m are adequate against an allowable soil bearing capacity of up to 250kPa, based on a minimum embedment depth of 1.0m.

Short and long term settlement estimations are estimated as up to 26.9mm at the centre of flexible footing for a 2m by 2m pad footings, up to 40.4mm at the centre of flexible footing for 3m by 3m pad footings, up to 45.0mm at the centre of flexible footing for 3m by 4m rectangular footings and up to 60.0mm at the centre of flexible footing for 4m by 5m rectangular footings, assuming the soils has been compacted to 95% MDR. A Factor of Safety of 3 is allowed in the assessment.

Any further earthworks for site preparation shall be carried out in accordance with AS 3798-2007.



1.0 INTRODUCTION

- 1.1 Specialist Testing and Technical Services (STATS) was engaged by Mr. Nick Oresti on behalf of VERTIV (the Client), to conduct a Geotechnical Investigation Work for fourteen (x14) Proposed Telco Project sites from Port Hedland to Mullewa, Western Australia. This report covers Group 3 – Capricorn, the site location and tests carried out are presented in Figures 1.
- 1.2 The objective was to obtain information on the subsurface conditions to classify the site in accordance with the definitions provided in Australian Standard AS2870 – 2011, and AS 1726 for the proposed construction work at each site, which shall comprise of substation structures and solar panel arrays.
- 1.4 The scope of work comprises of six (x6) test pits to the depth of 2.5m or refusal and six (x6) DCP tests to the depth of 1.05m.
- 1.6 The site investigation work was conducted on 16th Nov 2023.

2.0 SCOPE OF INVESTIGATION

2.1 The scope of investigation was as follows:

- Undertook Dial Before U Dig information, including review of existing underground services.
- Mobilised and demobilised STATS Engineering Crew (x2) and Equipment.
- Mobilised and demobilised a 8T excavator with a 300mm auger and tooth bucket options and an operator.
- GPS coordinates for four corners of each site were based on a handheld GPS unit.
- Carried out up to six (x6) test pits to a depth of 2.5m to 3.0m or refusal.
- USC of soil profiles, sampling including DCP up to depth of 1m or refusal, to determine soil consistency versus depth as well as estimation of insitu CBR.
- Observed and logged the presence of any ground water.
- Areas of reinstated were carried out using excavated spoils and compacted with a plate compactor.
- Carried out the following laboratory tests on representative soil samples:
 - Particle Size Distribution Tests,
 - Plasticity Index Tests,
 - Modified Maximum Dry Density Tests,
 - 4 days soaked CBR Tests,
 - Multi Stage Direct Shear (Cohesion and Frictional angle) for nominated soils,
 - Laboratory Soil Electrical Resistivity Test.
- The laboratory tests are required as part of AS 1726 requirements to be able to carry out a Unified Soil Classification of the materials encountered, and also to advise the suitability of the insitu materials for use as structural fill, or the need to import filling materials.
- Based on the laboratory and field findings, provided a Geotech report on site preparation, excavation conditions (depths to bedrocks), footing pads, material suitability, earthwork preparation, subsoil drainage requirements and compaction requirements and Geotech Site Classification for the footing at the shed area.
- Provided soils bearing capacity estimations and settlement estimations for the site.



- Provided recommendations on Suitable and Unsuitable soils encountered.

3.0 SITE CHARACTERISTICS

3.1 Geology

- 3.1.1 A review of the 1:250,000 Geological Survey map of Glengarry indicates that the site is situated on colluvium – unconsolidated silt, sand, gravel and rubble; minor alluvium.

3.2 Groundwater

- 3.2.1 No groundwater was encountered during the test pitting program.

4.0 SITE DESCRIPTION

- 4.1 A review of the Landgate information and aerial photography revealed the site is 76.0km to the South of the Newman Airport and located at the western side of the Great Northern Highway.

5.0 FIELD PROGRAMME

5.1 Test Pit Logs

- 5.1.1 The site soil profiles encountered across all test pits except TP6 are similar, which comprises of a Sand - Silt Mixtures (Silty SAND): fine to medium grained, brown/red, dry, medium dense to very dense, angular to subangular, with fine to coarse grained gravels, trace of oversize up to 400mm in size. At TP6, the soils encountered comprises of a Gravel - Sand - Silt Mixtures (Sandy Silty GRAVEL): fine to medium grained, brown/red, dry, very dense, angular to subangular, trace of oversize up to 400mm in size.
- 5.1.2 All the test pit locations encountered refusal on a hard rock layer at various depths from 0.3m to 1.7m.

5.2 Dynamic Cone Penetrometer

- 5.2.1 Based on the Soils Testing Handbook of Australian Standard, Table 6.4.6.1 (A), the density of the soils for the granular materials (Silty SAND) over the proposed development area was generally “very dense” with an average of 9 blows per 100mm of penetration.
- 5.2.2 The DCP results are presented in Appendix 3.
- 5.2.3 In accordance with the Soils Testing Handbook of Australian Standard, Table 6.4.6.1(C) (Correlation of DCP Blow Counts to CBR), an average Field CBR value of 18% was obtained.
- 5.2.4 The Correlation of DCP Blow Counts to CBR Values are presented in Appendix 4 of this report.



6.0 LABORATORY TESTS

6.1 Laboratory Tests

6.1.1 Representative soil samples were taken from the test pit to determine the soil properties. Laboratory tests based on Australian Standards 1289 were conducted on the samples, at STATSWA Laboratory, Canning Vale, Perth.

6.1.2 The laboratory test program consists of the following:

- Particle Size Distribution Tests,
- Plasticity Index Tests,
- Modified Maximum Dry Density Tests,
- 4 days soaked CBR Tests,
- Multi Stage Direct Shear (Cohesion and Frictional angle) for nominated soils,
- Laboratory Soil Electrical Resistivity Test.

6.1.3 The laboratory test results are presented in Appendix 5. A summary of the laboratory test findings is presented in the Tables below.

Table 1: Summary of Laboratory Tests - Classification Tests

Test Pit ID	TP4	TP6
Depth (m)	1.4-1.7m	0.1-0.3m
USC	SM	GM
Passing 2.36mm (%)	65	63
Passing 75µm (%)	15	31
Liquid Limit (%)	19	19
Plastic Limit (%)	15	15
Plasticity Index (%)	4	4
Linear Shrinkage (%)	3.0	2.5
Opt. Moisture Content (%)	6.5	-
Modified Maximum Dry Density (t/m ³)	2.48	-
4 days soaked CBR (%)	45@2.5mm	-

Table 2: Summary of Laboratory Tests – Point Load Tests

Test Pit ID	TP1	TP6
Depth (m)	0.3 – 0.5	0.1 – 0.3
Point Load Strength Index, I_s (50) (MPa)		
No. of Tests	5	5
Minimum	0.17	0.21
Maximum	2.2	3.5
Average	0.766	1.154

Table 3: Summary of Laboratory Tests – Multistage Drained Direct Shear Test

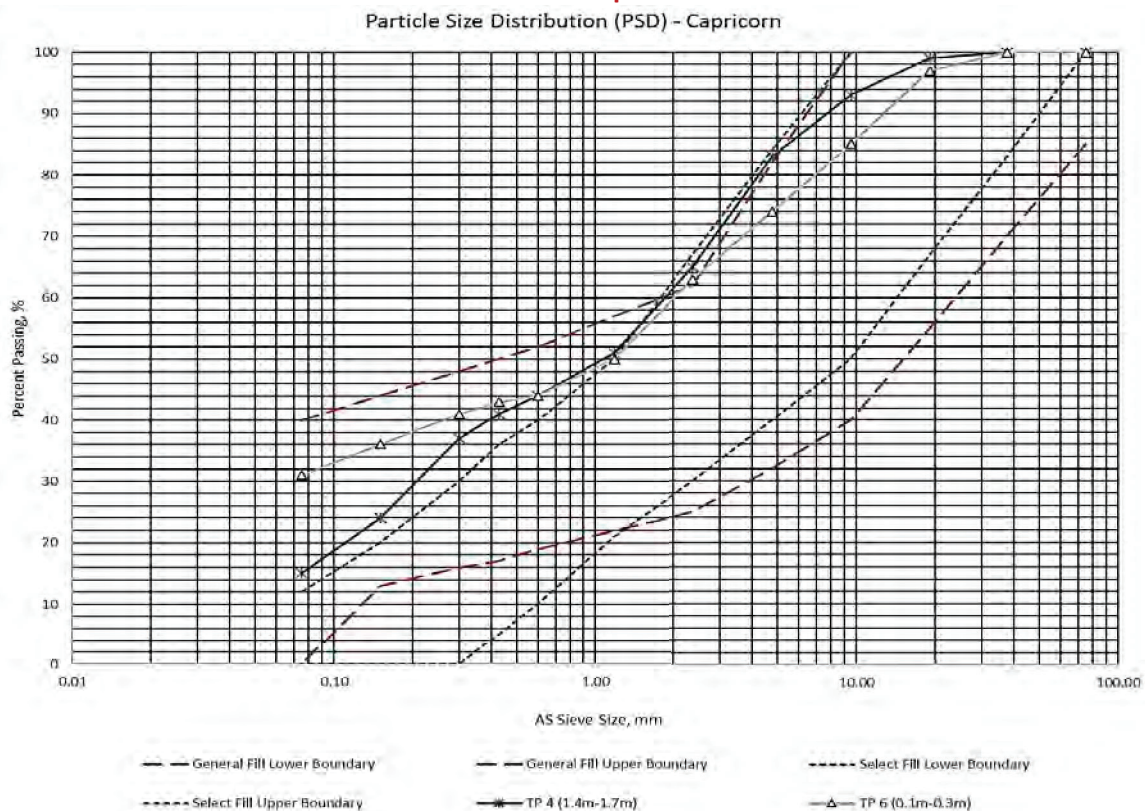
Test Pit ID	TP4	
Depth (m)	1.4 – 1.7m	
	Peak	Ultimate/Residual
Cohesion, C' (kPa)	38.58	22.00
Angle of Shear Resistance, ϕ' (°)	40.03	33.82

Table 4: Summary of Laboratory Tests – Laboratory Soil Resistivity Test

Test Pit ID	TP3
Depth (m)	0.0 – 0.3m
Mean Dry Density (t/m^3):	1.87
Mean Moisture Content (%):	19.9
Mean Resistivity Value in ($\Omega.m$):	230

6.1.4 A summary of the Particle Size Distribution (PSD) for all the materials encountered at Capricorn was plotted against General and Select Fill criteria and presented in Graph 1 below.

Graph 1: Particle Size Distribution (PSD) for materials encountered at Capricorn against General and Select Fill requirements



6.1.5 The findings revealed that the materials encountered on site are **suitable** for use as a General FILL material, but not suitable as a Select Fill.



7.0 GEOTECH SITE CLASSIFICATION

- 7.1 Based on the type of materials encountered, a summary of the Geotechnical Site Classifications is provided in the table below:
- 7.1.1 The site is currently assigned a Site Classification of “S” in accordance with the definitions provided in the Australian Standard AS2870 -2011, on the assumption that the house pad shall be prepared and compacted to the specified requirements under Section 10 of the report. For Site Classification “S”, it is described as slightly reactive clay sites which may experience slight ground movements from moisture changes and the characteristic surface movement (Y_s Value) for the site was assessed as 0 to 20mm due to seasonal moisture change would occur.
- 7.1.2 The explanation of the site classification is outlined in the Table below (source: tables 2.1 & 2.3 AS2870 2011).

Table 5: Classification by Characteristic Surface Movement Y_s

Site Class	Soil Description Based on Reactivity	Characteristic Surface movement Y_s (mm)
A	Most Sand & Rock Sites with little or no ground movement from moisture changes	0
S	Slightly reactive clay sites which may experience slight ground movements from moisture changes	$0 < Y_s \leq 20$
M	Moderately reactive clay or silt sites which may experience moderate ground movements from moisture changes	$20 < Y_s \leq 40$
H1	Highly reactive clay sites which may experience high ground movements from moisture changes	$40 < Y_s \leq 60$
H2	Highly reactive clay sites which may experience very high ground movements from moisture changes	$60 < Y_s \leq 75$
E	Extremely reactive sites which may experience extreme ground movements from moisture changes	$Y_s > 75$
P	Sites with inadequate bearing capacity or is affected by factors other than Reactivity of the soil eg. soft soils, landslip, mine subsidence, uncontrolled fill, coastal erosion and the site cannot be classified based on soil reactivity	-

8.0 SOIL BEARING AND SETTLEMENT ASSESSMENTS

- 8.1 A Soil Bearing Capacity and Settlement estimations for different sizes of pad footings were carried out based on the soil properties at the uppermost depth.
- 8.2 Findings revealed pad footings of size 2m by 2m, 3m by 3m, 3m by 4m and 4m by 5m are adequate against an allowable soil bearing capacity of up to 250kPa, assuming a minimum embedment depth of 1.0m.



- 8.3 Short and long term settlement estimations are estimated as up to 26.9mm at the centre of flexible footing for a 2m by 2m pad footings, up to 40.4mm at the centre of flexible footing for 3m by 3m pad footings, up to 45.0mm at the centre of flexible footing for 3m by 4m rectangular footings and up to 60.0mm at the centre of flexible footing for 4m by 5m rectangular footings, assuming the soils has been compacted to 95% modified maximum dry density. A Factor of Safety of 3 is allowed in the assessment.
- 8.4 A summary of the settlement assessment is presented in the table below. The computed soil bearing capacity and settlement estimations are presented in Appendix 6.

Table 6: Summary of the Settlement Assessments

Size	Loading (kPa)	Max. Long-term Settlement (mm)				Max. Short-term Settlement (mm)			
		Flexible Footing			Rigid Footing	Flexible Footing			Rigid Footing
		Centre	Corner	Average		Centre	Corner	Average	
2m x 2m	250	26.9	13.5	22.7	19.7	21.5	10.8	18.2	15.7
3m x 3m	250	40.4	20.2	34.1	29.5	32.3	16.2	27.2	23.6
3m x 4m	250	45.0	22.7	38.4	34.2	36.0	18.1	30.7	27.4
4m x 5m	250	60.0	30.2	51.2	45.6	48.0	24.2	41.0	36.5

9.0 CONSTRUCTION STAGE SUPERVISION AND CERTIFICATION

- 9.1 The site investigation and subsequent classification has been carried out using a limited amount of test pits, visual inspection, sampling, and testing programme.
- 9.2 To achieve a full coverage of the site to ensure all variations are investigated and coverage is not practical and is seldom done due to cost and time constraints.
- 9.3 Due to the inherent nature of “natural ground” it is very possible that subsurface conditions may vary over short distances within the site. STATS is to be informed if the findings differ from that reported here during the excavation works.
- 9.4 It is essential that during the earthworks, a qualified Engineer/Technician be further engaged to inspect the foundation material and excavation work, including providing certification that the compaction works are completed satisfactory. This enables verification of the information contained in this report, and to advise on any changes to the design that may be needed, based on any variations encountered. Thus, the foundation material can then be certified as complying with the requirements of this report and the proposed design.

10.0 GENERAL EARTHWORKS

- 10.1 Any loose or areas of weakness should be removed and backfilled with approved granular fill. If boulders, rocks, or building rubble (>300mm) is encountered, they should be removed from the works.
- 10.2 Where there is the presence of minor organics and tree roots the material should be raked and removed using a rake with a 50mm grid spacing.



- 10.3 The base of the building pads shall be compacted using a 700kg vibrating plate compactor prior to importing of fill.
- 10.4 For this development, excavate to 0.5m below existing level, stockpile the excavated materials, compact at this base level until satisfactory, then backfill in two layers (max. 250mm lift each) and compact.

10.5 Backfill Materials

- 10.5.1 Any imported structural fill material to support footings should be clean sand with maximum 10% passing 0.075mm sieve.
- 10.5.2 All fill import is to be compacted in maximum layers of 250mm (loose) and compacted to achieve the specified minimum density ratio by an approved method.
- 10.5.3 Compaction required to achieve the density requirements is set out in the following table and shall be conducted in accordance with AS 1289.5.1.1.

Table 7: Compaction Requirements for Fill (AS 3798 – 2007, Table 5.1)

Item	Application	Compaction Criteria – Standard Compactive Effort	
		Min Density Ratio (Cohesive Soils)	Min Density Index (Cohesionless Soils)
1	Commercial: To support minor loadings, including floor loadings up to 20kPa and isolated pad or strip footings to 100kPa	98%	75%
2	Fill to support pavements		
	(a) General fill	95%	70%
	(b) Subgrade (to a depth of 0.3 m)	98%	75%

- 10.5.4 For this project and requirements, we recommend that the fill materials should be compacted to achieve **95% MMDD (modified compaction)** to mitigate any potential differential settlement issues.

10.6 Drainage and Stormwater Disposal

- 10.6.1 If construction works were to take place during the rainy seasons, the perimeter around the site and areas of proposed earthworks should be constructed with a shallow gradient to allow drainage to a sump and to allow water to be discharged from the site. It is important that the conditions under the footings remain relatively dry. Where required, drains should be constructed to divert water from the site and to ensure no erosion or premature saturation occurs around the footings.
- 10.6.2 Storm water should be collected and stored as the surface runoff controlled to prevent scour and loss of soil during periods of high intensity rainfall.
- 10.6.3 Based on the topography on sites, discharge of stormwater on site is not recommended. Stormwater discharge shall be channelled to detention basins or swales.



- 10.6.4 It is recommended that the sitework along the Great Northern Highway shall not to be carried out during wet weather e.g. seasonal cyclone events, whereby the site and road may be impacted by heavy rainfall, localized flash flooding and ponding.

11.0 CONCLUSIONS AND RECOMMENDATIONS

- 11.1 The site is currently assigned a Site Classification of “S” in accordance with the definitions provided in the Australian Standard AS2870 -2011, on the assumption that the house pad shall be prepared and compacted to the specified requirements under Section 10 of the report. For Site Classification “S”, it is described as slightly reactive clay sites which may experience slight ground movements from moisture changes and the characteristic surface movement (Y_s Value) for the site was assessed as 0 to 20mm due to seasonal moisture change would occur.
- 11.2 It is recommended that the site is prepared in accordance with the recommendations given in Australian Standard AS 3798-2011, “Guidelines on Earthworks for Commercial and Residential Developments”.
- 11.3 Storm water should be collected and stored as the surface runoff controlled to prevent scour and loss of soil during periods of high intensity rainfall.
- 11.4 Based on the type of soils encountered, stormwater shall be channelled and discharged offsite into Swale Drains.
- 11.5 It is highly recommended that ongoing geotechnical supervision, sampling and testing be carried out throughout the different stages during the course of construction to verify the level of compaction prior to pouring concrete.
- 11.6 Findings revealed pad footings of size 2m by 2m, 3m by 3m, 3m by 4m and 4m by 5m are adequate against an allowable soil bearing capacity of up to 250kPa, assuming a minimum embedment depth of 1.0m.
- 11.7 Short and long term settlement estimations are estimated as up to 26.9mm at the centre of flexible footing for a 2m by 2m pad footings, up to 40.4mm at the centre of flexible footing for 3m by 3m pad footings, up to 45.0mm at the centre of flexible footing for 3m by 4m rectangular footings and up to 60.0mm at the centre of flexible footing for 4m by 5m rectangular footings, assuming the soils has been compacted to 95% modified compaction. A Factor of Safety of 3 is allowed in the assessment.



12.0 REFERENCES

- AS 1289 -2000, "Methods of Testing Soils for Engineering Purposes".
- AS 1726 - 2017, "Geotechnical Site Investigations".
- AS 2870 - 2011, "Residential Slabs and Footings".
- AS 3798 - 2007, "Guidelines on earthworks for commercial and residential developments".

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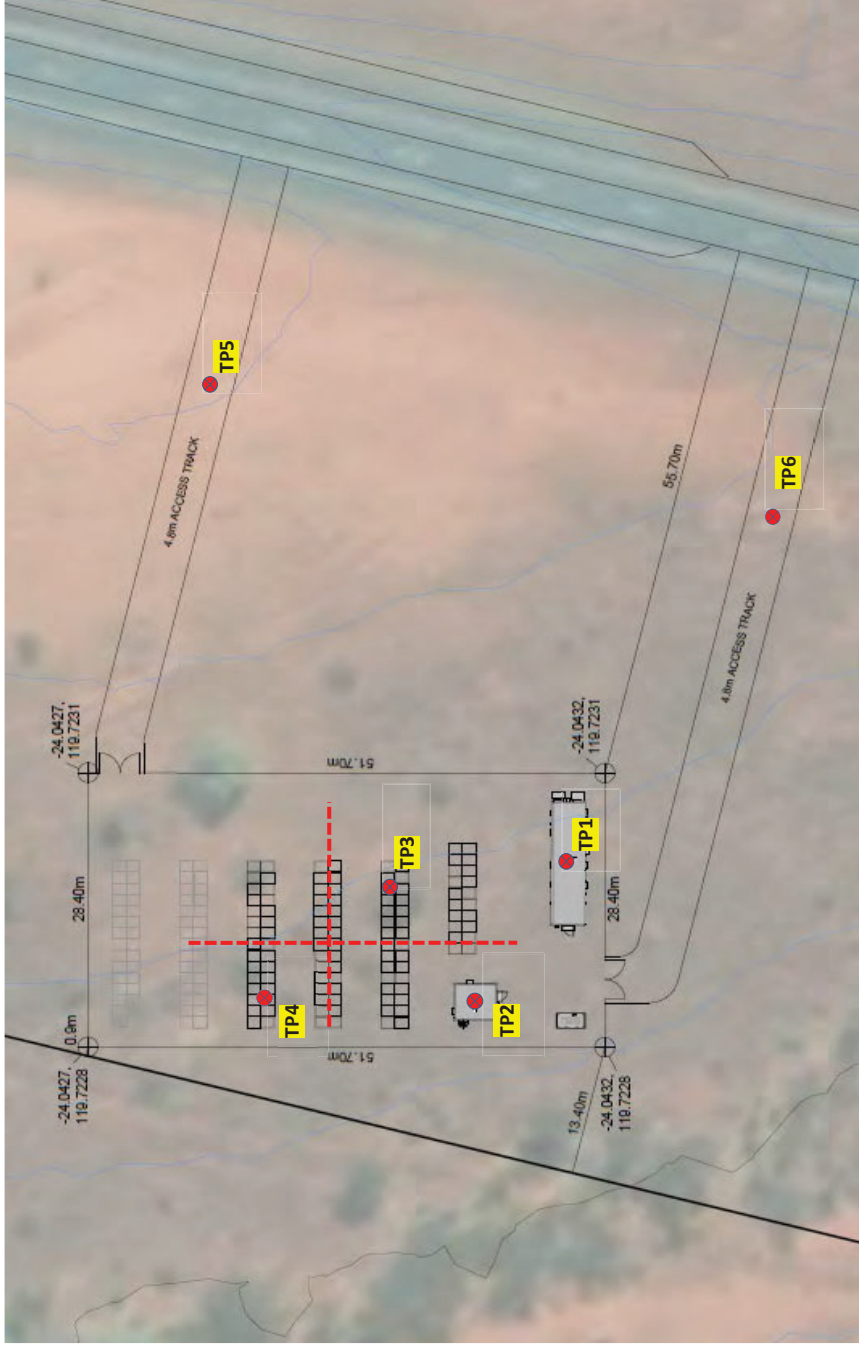
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Figures

Figure 1: Proposed Test Locations

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Legend

- Proposed Test Pit Locations (x6) to depth 2.5m or refusal.
- Field Electrical Resistivity (x2) @0.5m, 1m, 2m, 4m, 8m, 16m and 20m spacing.



Project Title:

Proposed Telco Project at Capricorn, WA
 - Geotechnical Investigation Work

Title: Proposed test locations [-24.0432, 119.7231]

Figure: 1

Scale: NTS

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