Department of Environment and Science

Cooloola Great Walk Ecotourism Project
Poona Lake Groundwater Investigation

March 2021

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Table of contents

1. Introduction 1
   - 1.1 Purpose of this report 1
   - 1.2 Background 1
   - 1.3 Scope of work 1
   - 1.4 Project objectives 1
   - 1.5 Assumptions 2
2. Survey methodology 3
   - 2.1 Electrical Resistivity Imaging 3
   - 2.2 Survey configuration 3
3. Data acquisition 5
   - 3.1 Survey statistics 5
   - 3.2 Survey layout 5
4. Data processing 7
   - 4.1 Electrical Resistivity Imaging data processing 7
   - 4.2 Digital surface models 8
5. Results and interpretation 10
   - 5.1 Apparent resistivity survey lines 10
   - 5.2 Hydrogeological interpretation 11
   - 5.3 Limitations of the interpretation 13

Table index

Table 2-1 Poona Lake ERI survey parameters 4

Table 3-1 ERI lines coordinates and survey statistics 5

Figure index

Figure 2-1 Generalised ABEM Terrameter ERI imaging system array roll along schematic 3

Figure 3-1 Typical survey setup of Terrameter LS, electrode pins and cables 6

Figure 4-1 Schwartz-Christoffel transformation topographically distorted finite-element mesh used in resistivity and IP inversion 8

Appendices

Appendix A – Electrical Resistivity Imaging Cross Sections

Appendix B – Hydrogeological Interpretation Figures

1. Introduction

1.1 Purpose of this report

GHD has been engaged by DES to undertake an electrical resistivity imaging (ERI) survey at Poona Lake. The purpose of the services is to investigate the low permeability layer supporting Poona Lake and investigate groundwater flows in the area of the proposed eco-accommodation facilities to inform DES of potential environmental risks to Poona Lake.

1.2 Background

Poona Lake in the Great Sandy National Park is an ephemeral, perched freshwater lake of high ecological and indigenous cultural heritage value. The lake and associated perched aquifer lie within a depression of dune sands, perched on a low permeability layer within the sands. This low permeability base to the perched aquifer is vital to the presence of the lake and must not be disturbed by the proposed development.

Refinement of the current understanding of the hydrogeological conditions within the relevant part of the Poona Lake groundwater catchment, including depth to the low permeability layer and groundwater flow directions beneath and within the area of the proposed development is needed. The refined hydrogeological understanding will inform mitigation of potential risks to Poona Lake from the proposed development.

1.3 Scope of work

The scope of work carried included the following:

- Completion of an ERI survey comprising six survey lines, within the area of interest
- Development and interpretation of 2-dimensional (2D) sections of apparent resistivity along the surveyed lines
- Interpretation of the surface of the low permeability layer, groundwater table and groundwater flow directions, based on interpolation of the apparent resistivity sections
- Identification of potential risk to the Poona Lake groundwater catchment and low permeability layer with regard to the proposed development

1.4 Project objectives

The project objectives are to:

- Understand depth to the low permeability layer beneath the proposed accommodation structures and communal area
- Characterise the depth to the groundwater table of the perched aquifer and characterise groundwater flow directions beneath and in vicinity of proposed development, including understanding the groundwater flow direction through the southeast ‘saddle’ and on either side of the ridgeline separating the Poona Lake catchment from the adjacent catchment to the south
- Inform assessment of potential risks of the proposed development on groundwater and Poona Lake

1.5 Assumptions

The following information supplied by DES has been used in this assessment. It has been assumed that the provided information is accurate and representative:

- Poona Lake 1 m contours
- Proposed site layout, access tracks and appurtenant geospatial data
- Queensland Government Department of Natural Resources, Mines and Energy Fraser Coast 2009 Project LiDAR point cloud data - Vertical Accuracy:+/- 0.15 m (1 sigma) Horizontal Accuracy: +/- 0.45 m (1 sigma)

2. Survey methodology

2.1 Electrical Resistivity Imaging

The ERI method measures the electrical resistivity of the subsurface; both laterally and vertically, to infer rock/soil types, water saturation and stratigraphy. The resistivity of soil and rock depends, in part, on the constituent materials; however grain-size, porosity, soil-type, temperature, water saturation and total dissolved solids (TDS) concentration are the primary factors controlling resistivity.

2.2 Survey configuration

An ERI survey involves injecting an electrical current into the ground at a series of points along a line whilst simultaneously recording the voltage at numerous other points. The difference between the current introduced into the ground and the measured voltage is a direct measure of the electrical resistivity of the material in which the current is passing through. Furthermore, the time taken for the measured voltage to decay to its background value provides a measure of the apparent chargeability of the subsurface – a technique known as induced polarisation.

The depth at which ERI techniques can obtain information depends on the spacing of electrodes, which ultimately determines the array length, as well as the array method used to collect data. For the Poona Lake investigation, GHD acquired data using a modified gradient array protocol, illustrated in (Figure 2-1 and Table 2-1). This array measures all instrument channels simultaneously and provides a signal-to-noise ratio better than that of conventional array configurations to provide a balance of high resolution and depth of investigation.

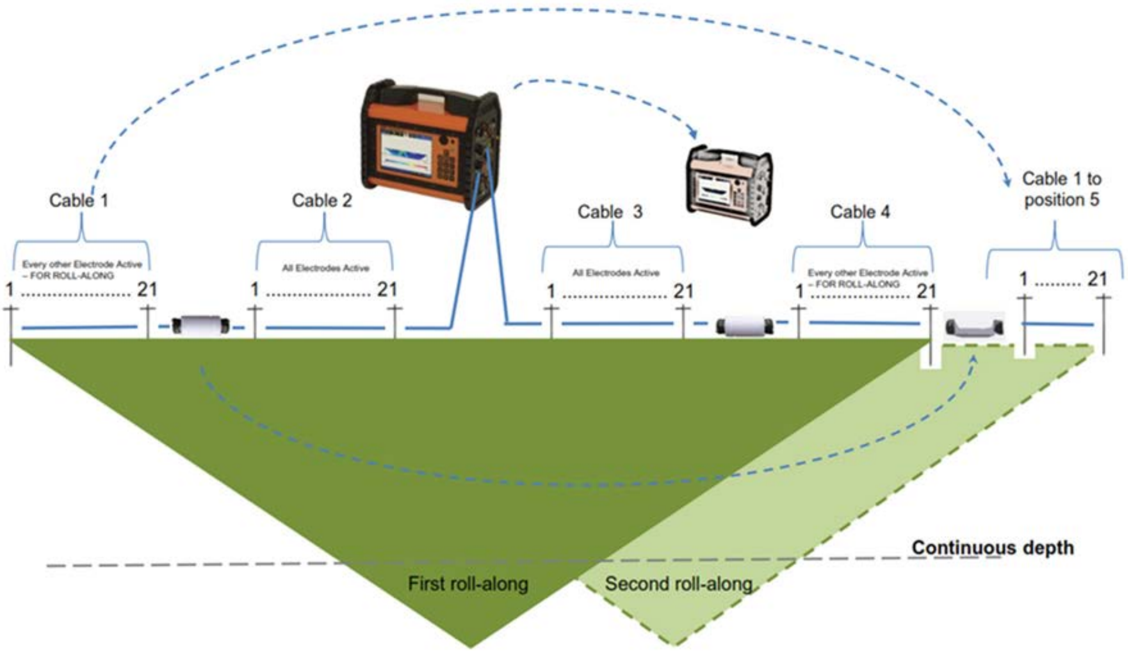


Figure 2-1 Generalised ABEM Terrameter ERI imaging system array roll along schematic

Table 2-1 Poona Lake ERI survey parameters

Parameter	Value
System	ABEM Terrameter LS
Acquisition Method	Resistivity and IP
Receiver	
Data sampling rate	30 kHz
ENOB	24
Input voltage range	+/- 600 V
Input impedance	200 MΩ, 30 MΩ, 20 GΩ
Precision	0.1 %
Accuracy	0.2 %
Resolution	3 nV at 1 second integration
Linearity	0.005 %
Frequency Response	Better than 1 % up to 300 Hz
Transmitter	
Output power	250 W
Maximum output current	2500 mA
Maximum output voltage	1200 V peak to peak
Accuracy	0.4 %
Precision	0.1 %
Survey	
Cycle time	1 s
Stacking	1
Acquisition array type	Modified Gradient Array
No. of cables and length	4 x 100 m
Electrode spacing	3 and 5 m (line dependent)
No. of electrodes	81 (60 active)
Full waveform record	Yes

3. Data acquisition

Fieldwork was undertaken from 15 to 18 February 2021, including mobilisation and demobilisation either side of two full field days and two half-days utilising DES personnel as field hands.

The geophysical work was undertaken with all relevant Health Safety and Environment (HSE) documentation (e.g. GHD JSEA), as well as daily safety pre-start meetings with the fieldwork team.

3.1 Survey statistics

The ERI survey consisted of six (6) resistivity lines with a total coverage of 1,659 m across the area of investigation, as shown in Appendix A.

Table 3-1 provides the location details of each of the lines.

Table 3-1 ERI lines coordinates and survey statistics

Line Name	Start Easting	Start Northing	End Easting	End Northing	Line Length (m)
ERI L1	510800	7128240	511084	7128019	365.49
ERI L2	510856	7128286	511162	7128092	382.5
ERI L3	510802	7128103	510972	7128249	228.9
ERI L4	511102	7127892	511094	7128101	231.74
ERI L5	510922	7128009	511066	7128172	224.64
ERI L6	510733	7128166	510916	7128288	225.57
				Total	1658.8
Table note: Coordinate system: GDA 94, MGA Zone 56					

3.2 Survey layout

The ERI line spread geometry was selected based on the survey objectives for depth penetration of 50 m or greater and maximum vertical near-surface resolution. The ERI survey configuration consisted of 80 electrodes per single spread with 3 m electrode spacing on 240 m lines and 5 m spacing on 400 m lines.

Before data acquisition commenced for each survey line, 100 m long survey tapes were laid along the line heading and the proposed location for each line checked using a geo-reference PDF on a smart phone (accuracy within 3 m). ERI cables and electrodes were then set out by placing the survey cable as straight as practically possible whilst taking into consideration areas of cultural heritage value and dense vegetation.

Due to the survey site primarily consisting of sandy soils, electrode pins were placed in the ground by hand with little difficulty to an approximate depth of 200 mm. Figure 3-1 shows the typical field setup of survey lines with orange cables connected to a number of take-outs and electrode pins as well as the Terrameter LS system.

Section 2.1 and Section 2.2 present instrument configuration details.

Figure 3-1 Typical survey setup of Terrameter LS, electrode pins and cables

4. Data processing

This section describes the processing procedures implemented by GHD to produce the geophysical survey outputs and interpreted surfaces.

4.1 Electrical Resistivity Imaging data processing

ERI data was processed with the Res2Dinv software package and gridded with the Surfer software packages. The data processing procedure is summarised below.

4.1.1 Bad data point removal

Prior to inversion, pseudo-section plots and profile plots were reviewed visually for bad data. Bad data points with systematic noise showed up as spots with unusually low or high values. In profile form, they stood out as elevated readings to their surrounding measurements. The following automated data rejection procedure was followed:

1. Undertake a preliminary inversion of the profile with all the data points
2. Review root mean square (RMS) error statistics between the logarithms of the measured and calculated apparent resistivity values
3. Select all readings in the profile with an RMS error above a 100 % threshold
4. Delete reading from observation file prior to running main inversion
5. Delete any negative resistivity values arising from field acquisition typically in areas of very high conductivity gradients e.g. traversing of buried pipework

4.1.2 Model discretisation

By default, RES2DINV uses a heuristic algorithm to generate the size and position of the model mesh. The depth to the deepest layer in the model is set to be approximately equal to the maximum pseudodepth in the data set. The first layer thickness was set to the minimum pseudodepth of the data points (0.225 m) with the thickness of subsequent layers increased by 20 % with each deeper layer. The thickness of each deeper layer is increased to reflect the decreasing resolution of the resistivity method with increasing depth. The width of all mesh nodes was set to half of the electrode separation with the exception of boundary nodes whose width is determined by the heuristic algorithm as a function of depth and electrode spacing.

The finite-element mesh defined above is distorted into a trapezoidal mesh using the Schwartz-Christoffel transformation (Figure 4-1) to take into consideration topographic variation along the profile using a damped distortion approach such that the surface nodes of the mesh match the actual topography. This gives more accurate results than using the correction factors for a homogeneous earth model calculated with the finite-element method, which can cause distortions in cases where large resistivity variations occur near the surface. The subsurface nodes are progressively shifted to a lesser extent compared with the surface nodes, i.e. the effect of the topography is “damped” with depth. This discretisation represents the optimal solution in the case where the curvature of the topography is less than the depth of the deepest model layer.

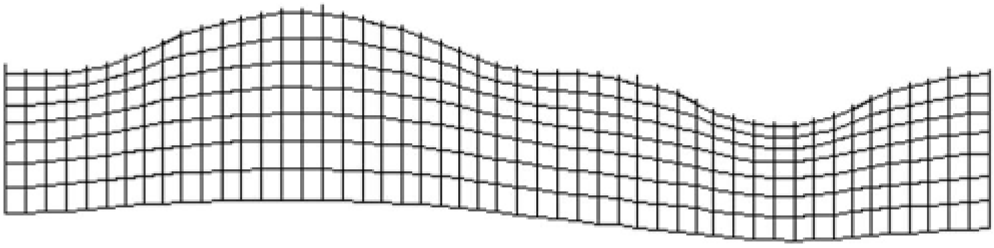


Figure 4-1 Schwartz-Christoffel transformation topographically distorted finite-element mesh used in resistivity and IP inversion

4.1.3 Numerical optimisation

RES2DINV uses a finite-element modelling subroutine to calculate the apparent resistivity values, and a non-linear blocky least-squares optimization technique is used to calculate the resistivity of the model blocks.

To reduce the effect of outlier data points the L1 norm robust data constraint inversion method, where the absolute difference (or the first power) between the measured and calculated apparent resistivity values is minimised, was used.

In many typical environments, resistivity inversions use smoothness-constrained least-squares method which attempts to minimise the square of the changes (L2 norm) in the model resistivity values. This will produce a model with a smooth variation in the resistivity values. Such a model is more suitable where subsurface resistivity also changes in a smooth manner.

A robust model constraint inversion method was used which attempts to minimise the absolute changes in the resistivity values. This constraint tends to produce models with sharper interfaces between different regions with different resistivity values, but within each region the resistivity value is almost constant.

The inversions were stopped once the difference of the RMS error between the current and previous iterations is <0.2 %.

4.1.4 Gridding

Processed data points were gridded in Surfer software package using a minimum curvature algorithm to interpolate between data points and lines. 2D cross sections of apparent resistivity and induced polarisation were gridded for each survey line.

4.2 Digital surface models

The 2D resistivity cross sections (refer Section 4.1) were interpreted for the following features:

- Thickness and extent of aeolian dune sand cover
- Depth to top of low permeability layer (cemented sand unit)
- Depth to top of saturated zone

4.2.1 Gridding

Eastings, northings and elevations of the interpretative features were gridded in Surfer software package using a kriging algorithm to interpolate between data points and lines to produce thickness grids.

4.2.2 Digital Elevation Model

The reference digital elevation model (DEM) was generated from the original Queensland Government Department of Natural Resources, Mines and Energy Fraser Coast 2009 Project LiDAR point cloud data - Vertical Accuracy:+/- 0.15 m (1 sigma) Horizontal Accuracy: +/- 0.45 m (1 sigma). Ground strike classified points were gridded on a 0.5 m grid using GlobalMapper.

The DEM is based on Geodetic Datum of Australia 1994 (GDA94) horizontal datum with Map Grid of Australia (MGA) Zone 56 projection. All heights are with respect to Australian Height Datum (AHD) on the basis of AusGeoid09.

4.2.3 Interpreted hydrogeological features

The thickness and depth grids (Section 4.2.1) were subtracted from the reference DEM to derive AHD referenced surfaces for evaluation of hydrogeological flow parameters.

5. Results and interpretation

5.1 Apparent resistivity survey lines

Graphical results of the geophysical investigation are provided in Appendix A and interpretation is described in the following sections.

5.1.1 ERI Line 1

ERI Line 1 traverses the proposed location of the accommodation facility in a northwest-southeast orientation (Appendix A, 12545456-FIG01). The section displays a variable thickness (2 to 10 m) high resistivity (> 4000 ohm.m) layer in the near surface, separated between chainages 30 and 120 m by an intermediate electrical resistivity (500-1500 ohm.m) unit.

This low electrical resistivity material coincides with a topographic high in the area. Beyond chainage 200 m this low electrical resistivity layer decreases in electrical resistivity to below 700 ohm.m, indicating that this unit is likely saturated in this area.

The high electrical resistivity surface layer likely reflects the presence of a variable thickness cover of clean well sorted dry aeolian sand overlying a low permeability cemented sand or coffee rock unit. This unit appears to be saturated with groundwater in the valley draining from the southeast corner of Poona Lake.

5.1.2 ERI Line 2

ERI Line 2 traverses parallel with the long axis of Poona Lake approximately 40 m from its shoreline (Appendix A, 12545456-FIG02). The section displays a distinct 5 to 10 m thick high electrical resistivity (>4000 ohm.m) surface layer along the entirety of the section. This layer likely reflects the presence of dry aeolian sands which overly a deeper intermediate resistivity unit.

The resistivity of the underlying intermediate resistivity unit is consistent with that anticipated of a cemented sand or coffee rock. Areas of this unit with resistivities of 700 ohm.m or less are interpreted to be saturated with groundwater.

5.1.3 ERI Line 3

ERI Line 3 intersects the proposed accommodation site perpendicular to ERI Lines 1 and 2 and approaches Poona Lake towards the east (Appendix A, 12545456-FIG03). As with ERI Line 1, this section displays a high electrical resistivity (>4000 ohm.m) layer in the near surface which is separated by lower electrical resistivity material at the peak of the topographic high at chainage 80 to 100 m. This high electrical resistivity layer likely reflects the distribution of dry aeolian sands at surface overlying a low permeability intermediate resistivity cemented sand or coffee rock unit. There is no evidence of groundwater saturation in the deeper cemented sand unit except at its eastern-most extent, with the line terminating on the shoreline of Poona Lake.

5.1.4 ERI Line 4

ERI Line 4 traverses in a north-south orientation at the south-eastern limit of Poona Lake and is aligned along a saddle in local topography that falls towards the south (Appendix A, 12545456-FIG04). The section is characterised by a high electrical resistivity (4000 ohm.m) surface layer which between chainage 60 and 240 m. This is consistent with the presence of a 0 to 5 m thick layer of aeolian sand overlying an intermediate resistivity cemented sand or coffee rock unit. This sand is likely saturated between chainages 0 and 40 m. Beneath the aeolian sand cover, the underlying low permeability cemented sand or coffee rock unit appears to be saturated from its upper surface to a depth of 10 to 15 m.

5.1.5 ERI Line 5

ERI Line 5 traverses perpendicular to ERI Lines 1 and 2 on the slope of a local topographic high to the west and extends towards Poona Lake at the end of the survey line (Appendix A, 12545456-FIG05).

The section displays an approximately 10 m thick surface layer of high electrical resistivity (>4000 ohm.m) material with isolated patches of lower electrical resistivity scattered at surface along the section. This layer is likely reflecting the presence of the same aeolian sands observed on other ERI lines. Isolated patches of low electrical resistivity at the ground surface are attributed to an influx of water into the aeolian sand associated with rainfall, immediately prior to carrying out the ERI survey of this line.

An intermediate resistivity unit consistent with the presence of a variably saturated cemented sand or coffee rock unit underlies the aeolian sand. Areas of this unit with a resistivity of 750 ohm.m from chainage 160 m and beyond are interpreted as being saturated with groundwater.

5.1.6 ERI Line 6

ERI Line 6 traverses perpendicular to ERI lines 1 and 2 on the west of the local topographic high of the proposed accommodation facility and extends towards Poona Lake to the east (Appendix A, 12545456-FIG06).

The section displays three veneers of high electrical resistivity (>4000 m/s) zones at the surface separated by relatively lower electrical resistivity areas. These high electrical resistivity zones likely reflect areas comprising dry aeolian sands likely separated by the underlying low permeability intermediate resistivity cemented sand or coffee rock unit. The underlying intermediate resistivity cemented sand unit does not appear to have any anomalously low resistivity zones that may be attributed to groundwater saturation.

5.2 Hydrogeological interpretation

A hydrogeological interpretation of the ERI cross sections is provided below, supported by Figure 1 to Figure 5 of Appendix B. The surfaces presented in the Figures, with the exception of the ground surface, have been developed by interpolation between the interpreted ERI section lines (refer Section 4.2).

- The subsurface within the surveyed areas at the Poona Lake site appears to be comprised of two dominant lithologies:
  - A variable thickness surficial layer of typically highly resistive (when dry) well sorted aeolian sand (the interpreted thickness of this layer is shown on Figure 5, Appendix B).
  - Underlain by a thick, intermediate resistivity, cemented sand or coffee rock unit. This unit appears to be saturated close to Poona Lake (indicated on Line 2, Line 4, and Line 5, Appendix A, and Figure 1 and Figure 3 of Appendix B). There is no evidence of a deeper, different underlying geological unit in the ERI survey results.
- The top of the intermediate resistivity, cemented sand appears to be a lower permeability layer, and is thought to extend beneath Poona Lake and be responsible for retaining water in Poona Lake. The lateral extent or continuity of a lower permeability layer beneath or within the area around the lake is not known, however its presence beneath the lake is indicated by the difference in elevation between the lake water level (estimated to be around 154 to 155 m AHD [based on LiDAR]) and the top of saturated cemented sands

close to the lake (estimated to be at around 151 m AHD). This difference in levels indicates that the lake water is perched on a low permeability layer. A low ridge line formed by the top of the cemented sand runs parallel to the lake and across the saddle (illustrated on Figure 4, Appendix B), which is anticipated to assist in regulating the water level within Poona Lake.

- Groundwater is indicated to be present within the cemented sand unit to the east and southeast of the proposed site area (P4) (illustrated on Figure 3, Appendix B) but does not appear to be present beneath the proposed footprint of P4. Groundwater may also be present beneath Poona Lake however the survey did not extend into the lake to confirm this.
- The groundwater table is interpreted as being at or close to the top of the cemented sand unit within the surveyed area, with localised groundwater flow towards Poona Lake. On the south side of the cemented sand unit ridge line, groundwater flow is indicated to be towards the southwest, away from Poona Lake.
- Within the proposed waste storage facility area and part of the communal area at the top of the hill, the top of the cemented sand is indicated to be 1 m or less below ground surface, however depth does increase to around 3 m below ground surface across the rest of the communal area (Figure 5, Appendix B). Depth to the cemented sand beneath much of the proposed accommodation area (across the northern part of the footprint) is in the order of 4 to 6 m below ground surface, with only a relatively small portion of the accommodation area indicated to have a depth to cemented sand of less than 2 m below ground surface. Depth to the cemented sand within the footprint of the proposed walking track across the saddle area to connect to the Cooloola walking track is indicated to be around 5 m below ground surface.
- Whilst the ERI results provide an indication of the depth to and extent of groundwater, and depth to the top of the cemented sand layer, intrusive investigations would be required to constrain this further.

Potential environmental risks to Poona Lake are detailed in the following points:

- There is potential for localised disturbance of the cemented sand unit beneath some areas of the proposed development on the hill where the top of the cemented sand is intersected by development footings and proposed new vehicle access track, for example. The disturbance cannot however drain Poona Lake, because the development site is at a much higher elevation than the elevation of the lake.
- Localised disturbance of the cemented sand unit on the hill will likely result in an increase in the permeability of the cemented sand local to the disturbed area, and provide a potentially easier pathway for infiltration of rainfall or leakage from waste storage facilities for example, into the cemented sand unit and potentially to the nearby groundwater. Mitigation measures for consideration include:
  - Minimising disturbance of the cemented sand unit throughout the development
  - Re-instatement of all disturbances, and, or lining the full extent of the disturbed area with a material of the same or lower permeability than the cemented sand unit
  - Mounding of low permeability material (or other measures to create the same effect) around building footings at the point where the cemented sand is penetrated to shed infiltrated water onto undisturbed cemented sand
- The topography of the top of the cemented sand unit has the potential to direct shallow sub-surface flow, such as infiltrated rainwater, leakage from wastewater storages etc. towards Poona Lake from within some areas of the proposed development footprint (illustrated on

Figure 4, Appendix B). To mitigate this risk, appropriately designed waste storage facilities should be sited in an area where the cemented sand unit slopes away from Poona Lake, thereby directing shallow subsurface flows away from the lake.

- Construction of the vehicle access track has the potential to alter the topography of the top of the cemented sand unit in areas where the depth to the cemented sand is shallow, and to create a topographic fall from the waste storage facility area towards the lake where one does not currently exist. This should be considered in the design of the track to mitigate the risk.
- Disturbance of the cemented sand unit close to the lake, throughout the saddle area, and within and close to the areas where groundwater is indicated to be present has the potential to change the hydrogeological conditions maintaining the presence of Poona Lake. Disturbance of the cemented sand in this area must be avoided. A proposed access track across the saddle connecting to the Cooloola walking track should be designed to avoid any risk of disturbance or penetration of the cemented sand unit in this area and ideally along the length of the track.
- The vertical resolution of the survey is anticipated to be 0.5 m however, it is important to note that the top of the cemented sand has been picked by interpretation of the ERI results and has not been confirmed by intrusive investigation. The estimated depth to the top of the cemented sand from ground surface could be greater than +/- 0.5 m and this uncertainty must be considered in the planning and construction of the development to minimise environmental risk.

5.3 Limitations of the interpretation

The following limitations of the hydrogeological interpretation are noted:

- No intrusive investigations were carried out to confirm the lithology of the sub-surface, depth to the intermediate resistivity cemented sand unit, depth to groundwater, or to confirm the direction of the inferred head gradient between Poona Lake and groundwater table.
- The ERI survey did not extend into the lake and therefore hydrogeological conditions and the presence/absence of a low permeability layer beneath the lake or outside of the survey area are only inferred.
- The results of the ERI survey have an anticipated vertical and horizontal resolution of 0.5 m, however interpretation of the survey results is subjective and the information presented in this report has not been ground-truthed. Vertical and horizontal resolution of the interpretation could therefore be greater than +/- 0.5 m.

The resistivity method is an effective geophysical tool that exploits the fact that the resistivity of geological materials varies over several orders of magnitude (more than any other petrophysical properties). However, as with any geophysical technique there are limitations as identified below:

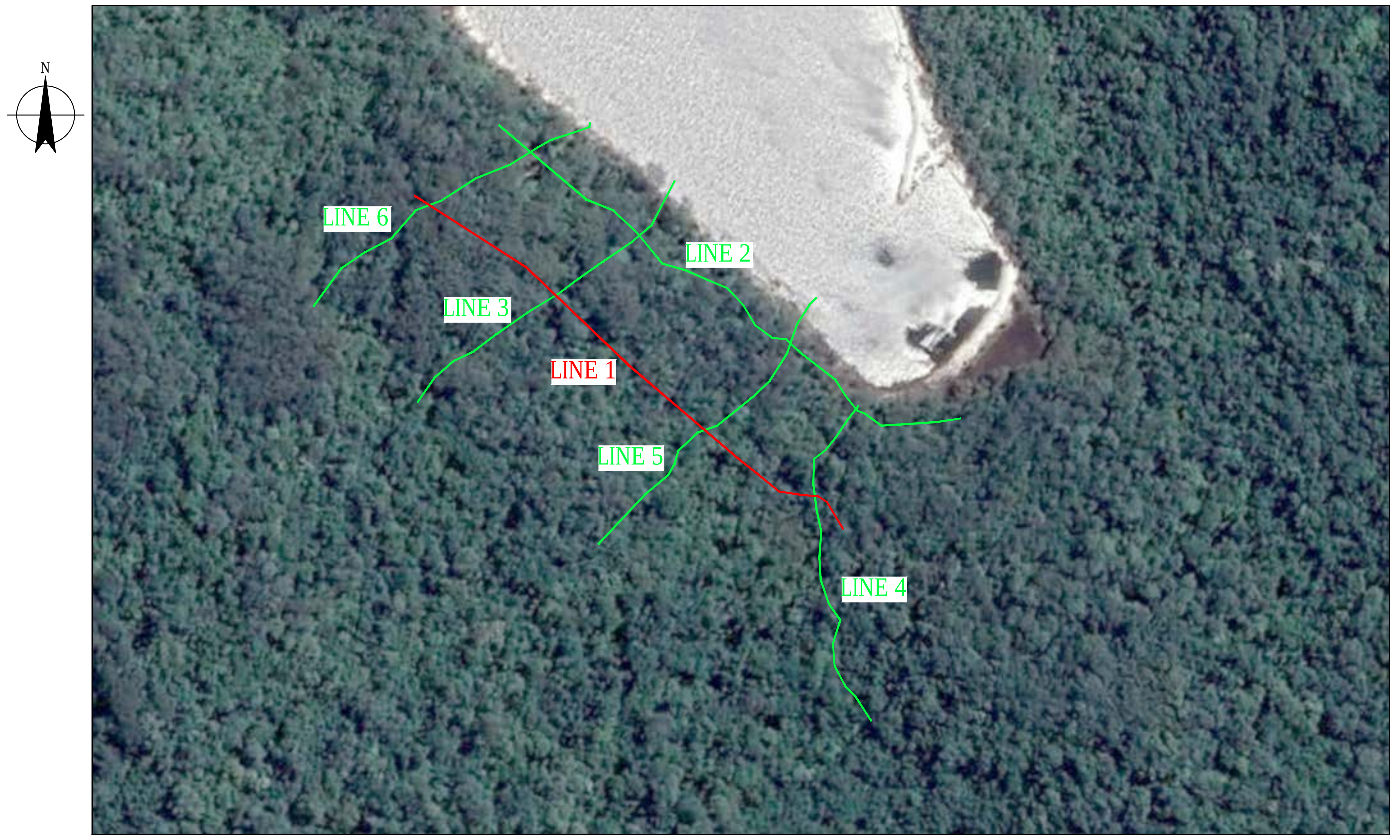
- The static nature of the current source limits current penetration depths. Therefore, resolution of a surface based resistivity survey decreases with depth. Caution should be used in interpretation of resistivity sections at depth.
- The penetration of the ERI method will strongly depend on the conductivity of the shallow ground according to the skin effect. This phenomenon is expressed in the tendency of an alternating electric current (AC) to become distributed within a conductor such that the current density is largest near the surface of the conductor, and decreases with greater

depths in the conductor. Penetration of the method might be limited in higher conductive shallow ground environments.

- Sources of noise in the survey results can be present and include telluric currents, power lines, buried cables, earthing systems and self-potential.
- Poor coupling between the electrodes and ground can occur in sandy, dry or outcropping geology which can lead to unusually high apparent resistivity data.
- The electrode polarisation effect is unavoidable when using stainless steel electrodes over porous pots. This is due to the change in mode of conduction from metallic to ionic and can be significant.
- Capacitive coupling between the current and voltage channels in the multichannel cables increases with increased cable length and this can interfere with resistivity measurements. It is also increased by differing contact resistances of the takeout electrodes.

Appendices

Appendix A – Electrical Resistivity Imaging Cross Sections



SITE PLAN

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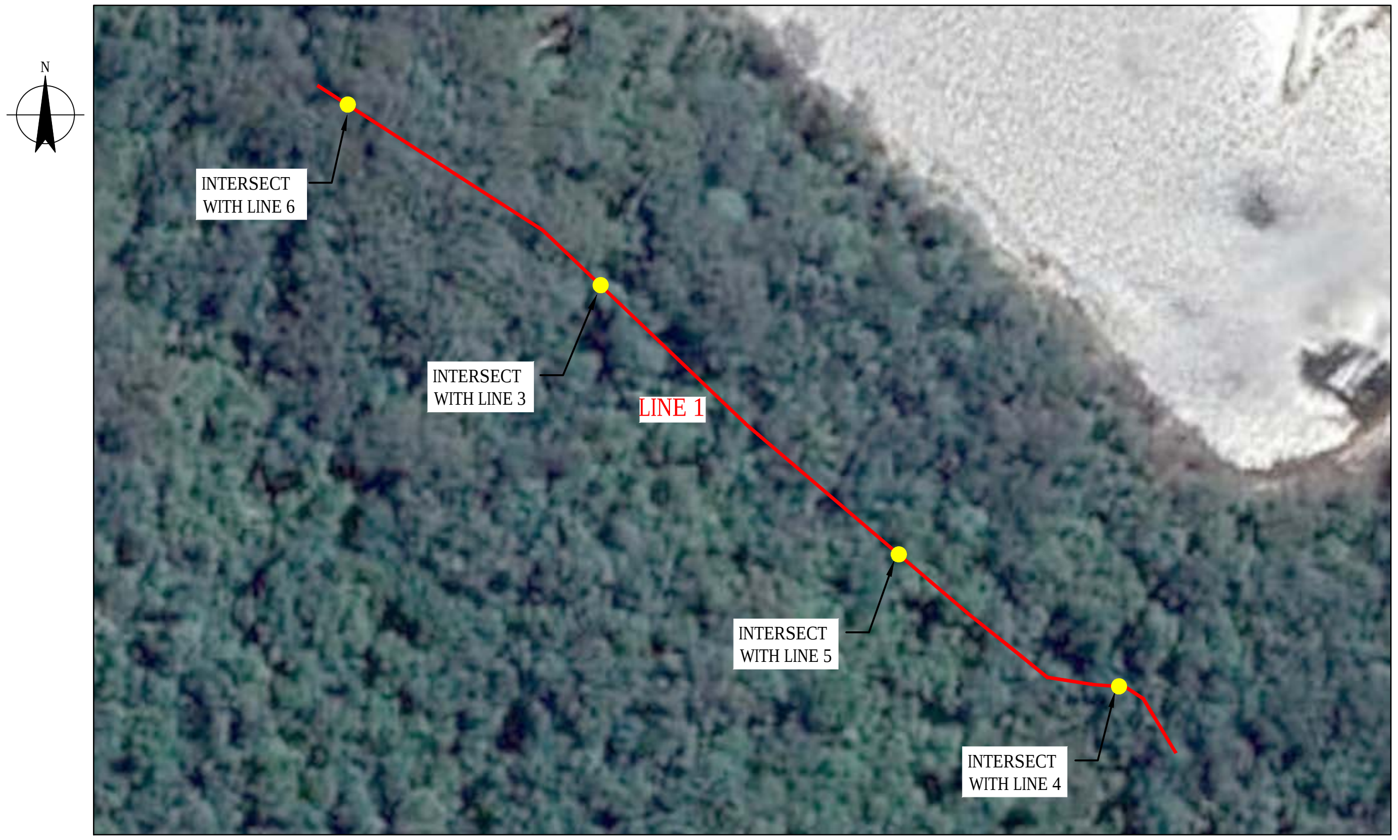

LINE 1 PLAN

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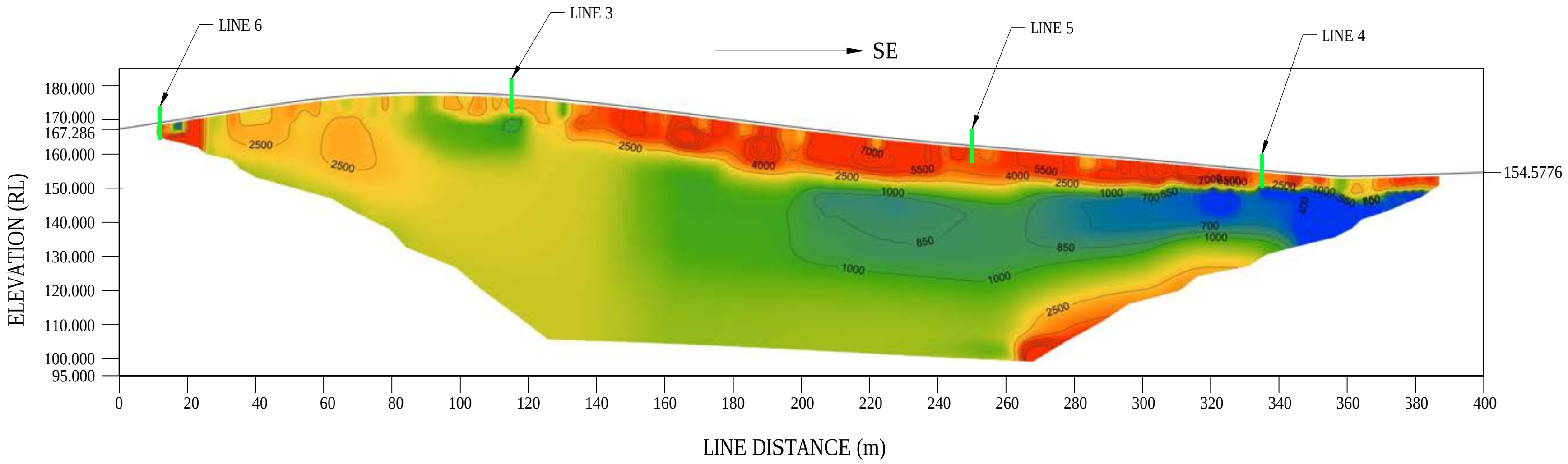

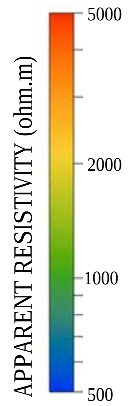

LINE 1 PROFILE

SCALE 1:2000

LEGEND:

ELECTRICAL RESISTIVITY LINE

BASE SURVEY SUPPLIED BY:
DES SUPPLIED, GYMPIE 2009 REGIONAL 1m DEM

PRELIMINARY

No | Revision | Note: * indicates signatures on original issue of drawing or last revision of drawing | Drawn | Job Manager | Project Director | Date

0 50 100 150m
SCALE 1:5000 AT ORIGINAL SIZE

0 25 50 75m
SCALE 1:2500 AT ORIGINAL SIZE

0 20 40 60m
SCALE 1:2000 AT ORIGINAL SIZE

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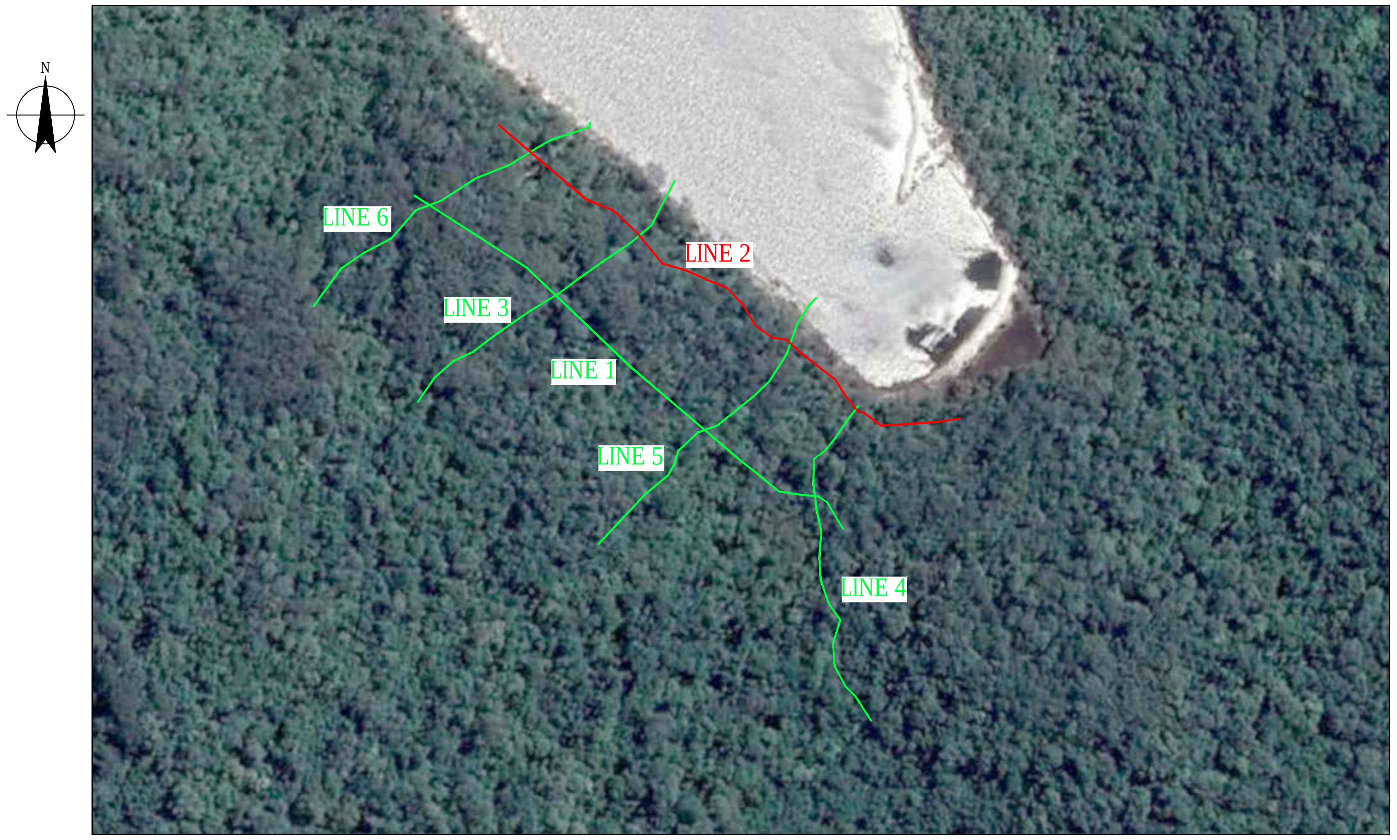
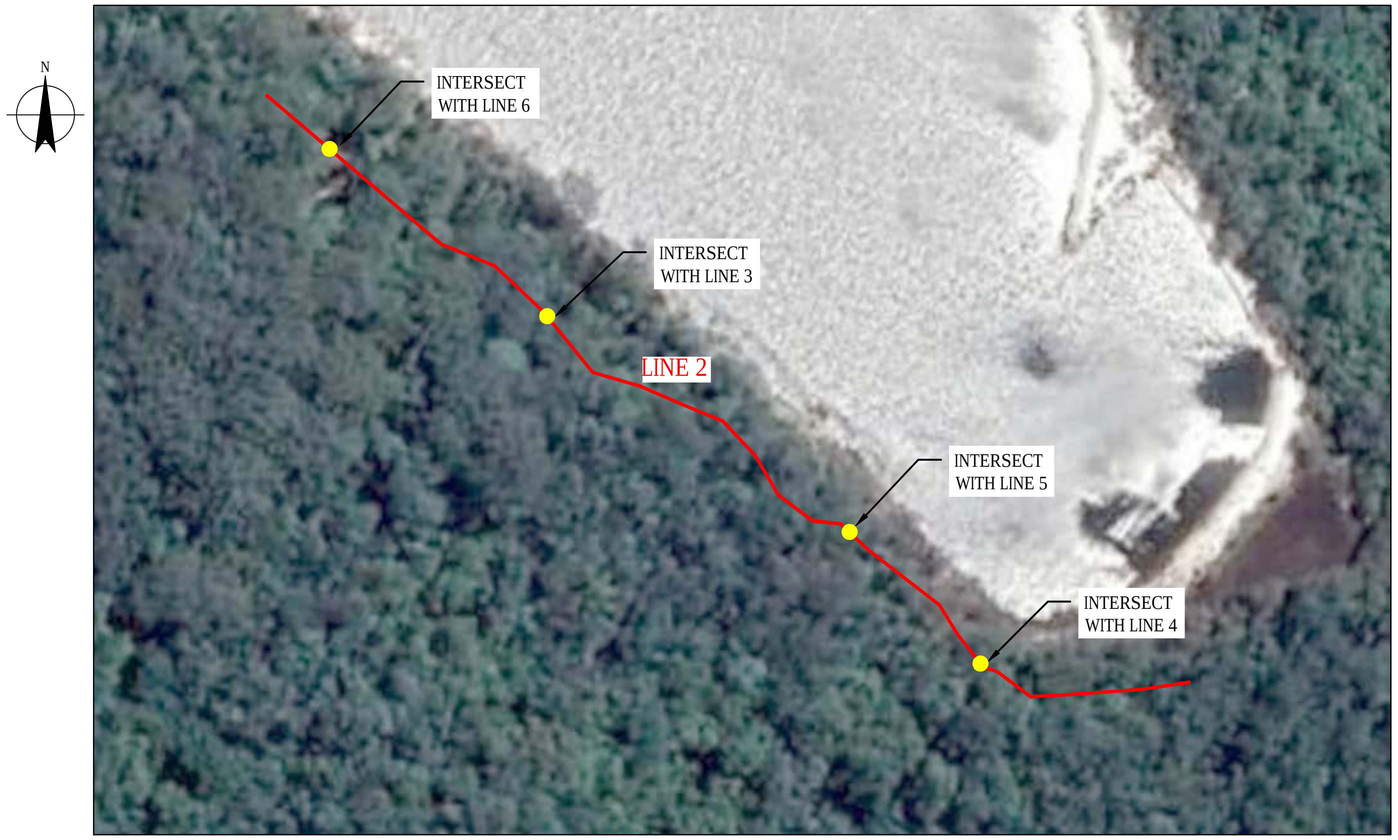
Project **COOLOOLA GREAT WALK ECOTOURISM PROJECT**
Title **POONA LAKE GROUNDWATER INVESTIGATION LINE 1**

Original Size **A3**
Drawing No: **12545456-FIG01**
Rev: **A**

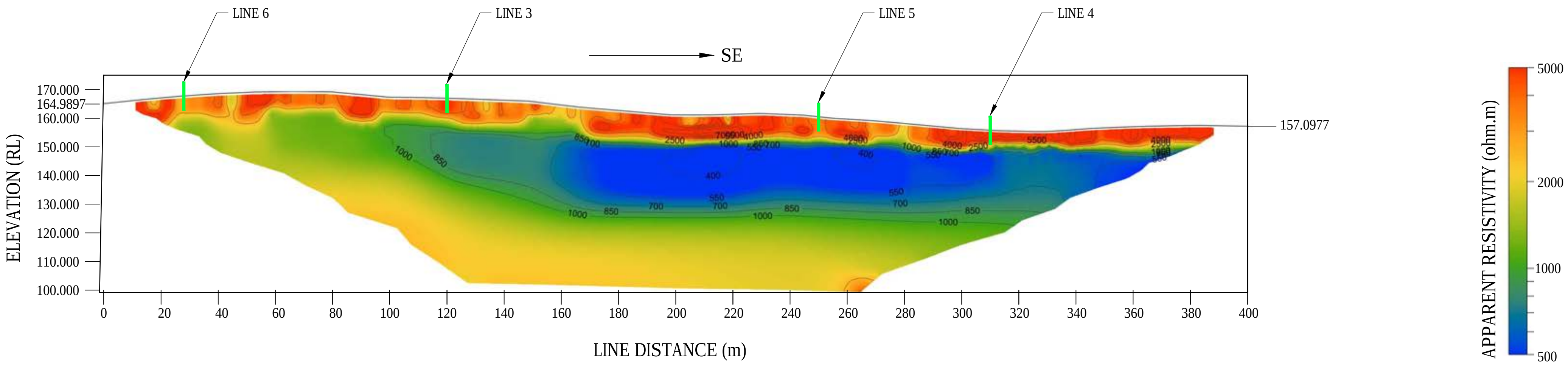
Plot Date: 25 February 2021 - 1:48 PM Plotted By: Victoria Jenkins Cad File No: G:\32\12545456\CADD\Drawings\12545456-FIG01 - FIG06.dwg



SITE PLAN
SCALE 1:5000



LINE 2 PLAN
SCALE 1:2500



LINE 2 PROFILE
SCALE 1:2000

LEGEND:

ELECTRICAL RESISTIVITY LINE

BASE SURVEY SUPPLIED BY:
DES SUPPLIED, GYMPIE 2009 REGIONAL 1m DEM

PRELIMINARY

No	Revision	Note: * indicates signatures on original issue of drawing or last revision of drawing	Drawn	Job Manager	Project Director	Date

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SCALE 1:5000 AT ORIGINAL SIZE

0 25 50 75m
SCALE 1:2500 AT ORIGINAL SIZE

0 20 40 60m
SCALE 1:2000 AT ORIGINAL SIZE

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Drafting Check | Design Check
Approved (Project Director)
Date
Scale AS SHOWN
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Original Size A3

Client **DEPARTMENT OF ENVIRONMENT AND SCIENCE**
Project **COOLOOLA GREAT WALK ECOTOURISM PROJECT**
Title **POONA LAKE GROUNDWATER INVESTIGATION LINE 2**

Drawing No: **12545456-FIG02** Rev: **A**

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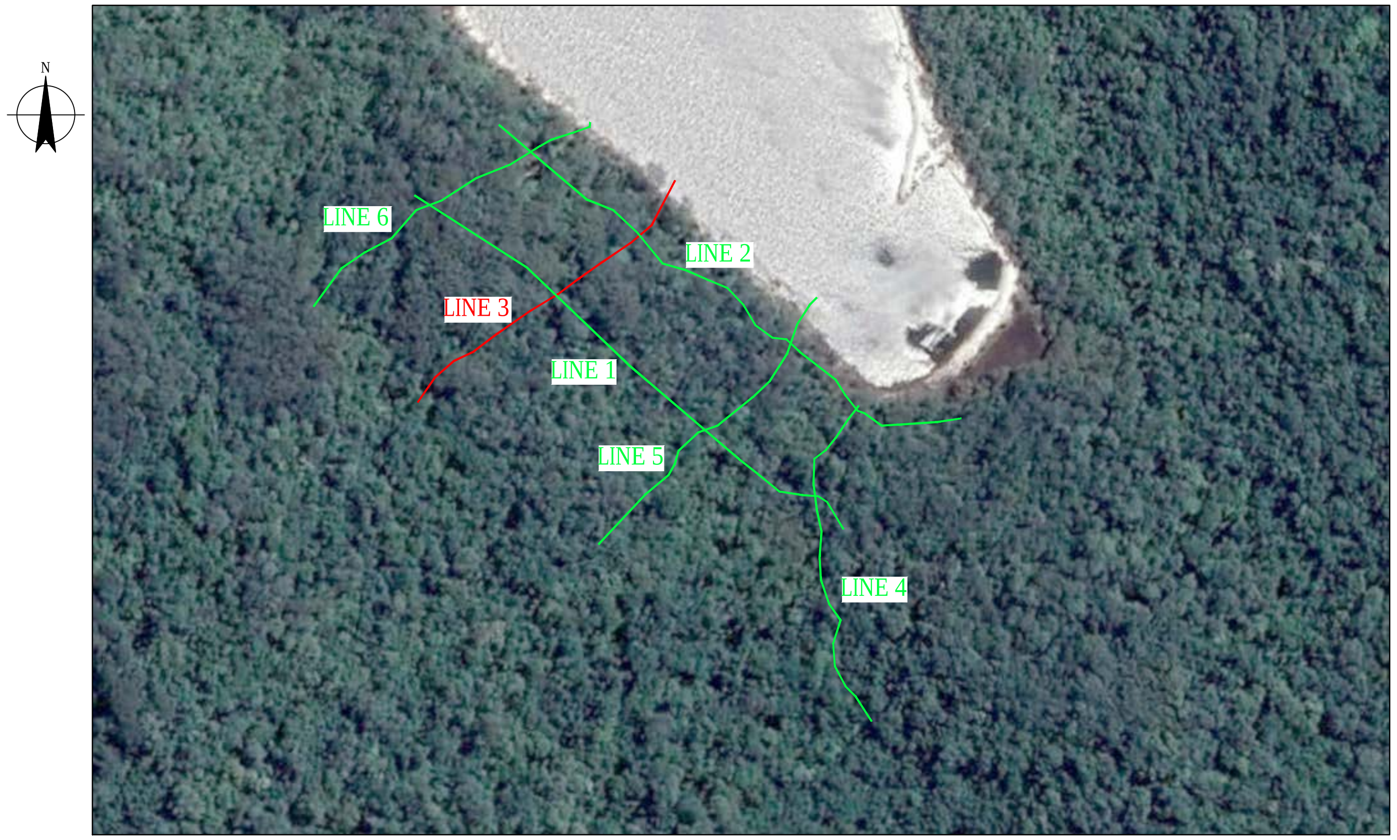
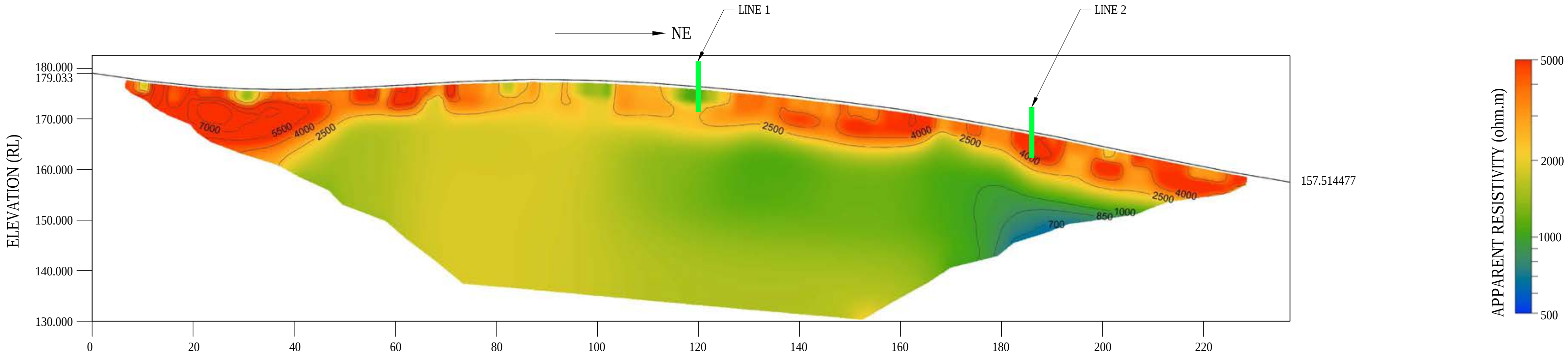


SITE PLAN
SCALE 1:5000

LINE 3 PLAN
SCALE 1:2000



LINE 3 PROFILE
SCALE 1:1000

LEGEND:
ELECTRICAL RESISTIVITY LINE

BASE SURVEY SUPPLIED BY:
DES SUPPLIED, GYMPIE 2009 REGIONAL 1m DEM

PRELIMINARY

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0 50 100 150m
SCALE 1:5000 AT ORIGINAL SIZE

0 20 40 60m
SCALE 1:2000 AT ORIGINAL SIZE

0 10 20 30m
SCALE 1:1000 AT ORIGINAL SIZE

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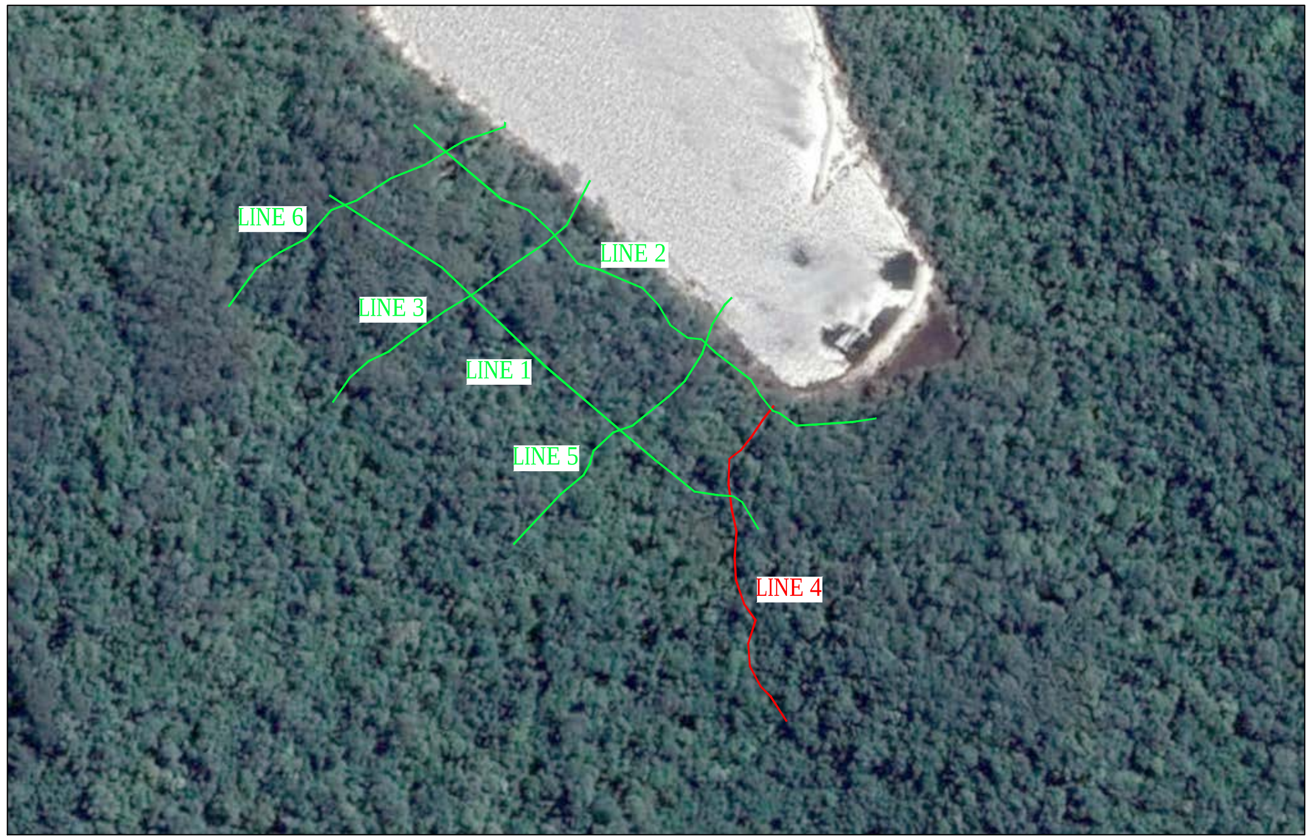
Client **DEPARTMENT OF ENVIRONMENT AND SCIENCE**
Project **COOLOOLA GREAT WALK ECOTOURISM PROJECT**
Title **POONA LAKE GROUNDWATER INVESTIGATION LINE 3**

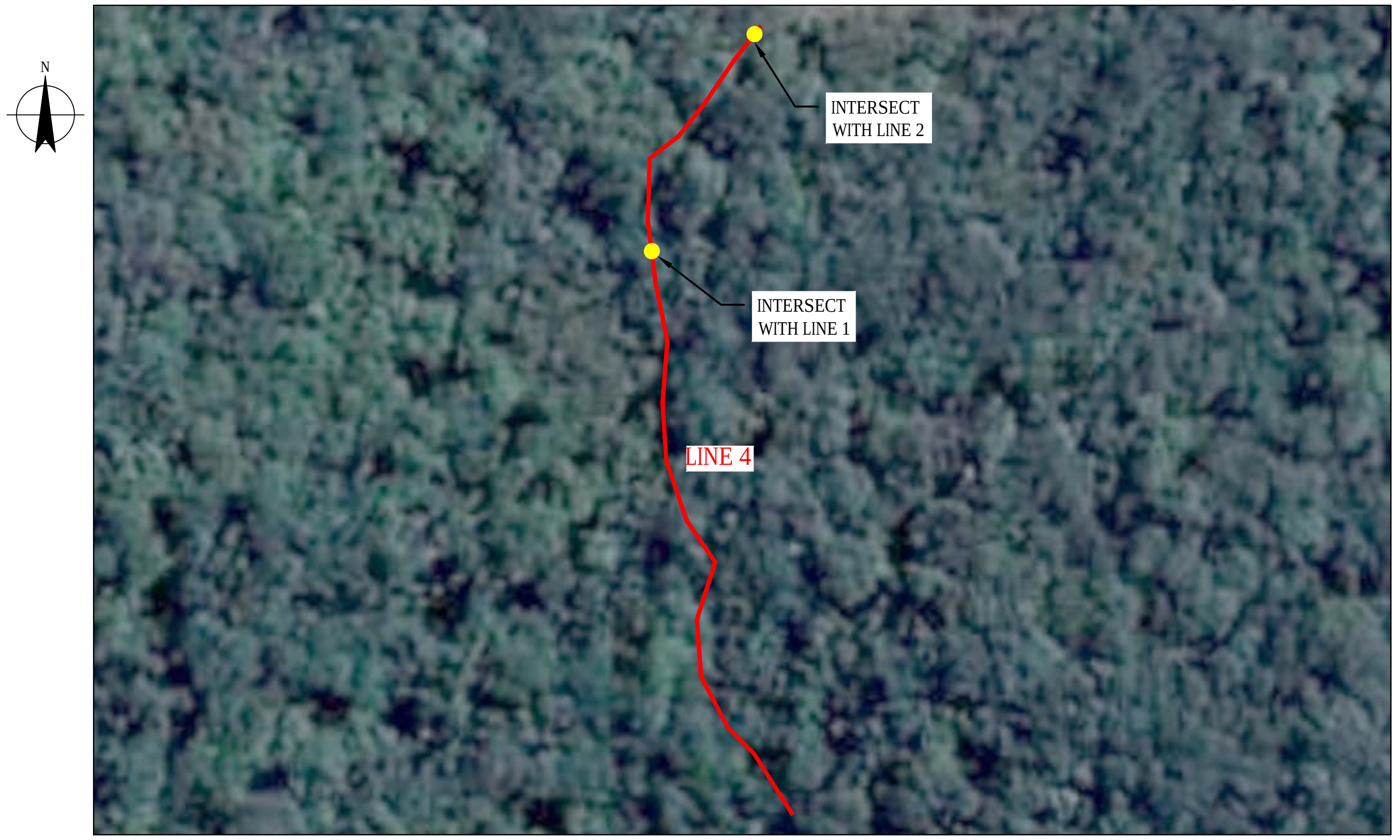
Original Size **A3** Drawing No: **12545456-FIG03** Rev: **A**

Plot Date: 25 February 2021 - 2:21 PM Plotted By: Victoria Jenkins Cad File No: G:\32\12545456\CADD\Drawings\12545456-FIG01 - FIG06.dwg



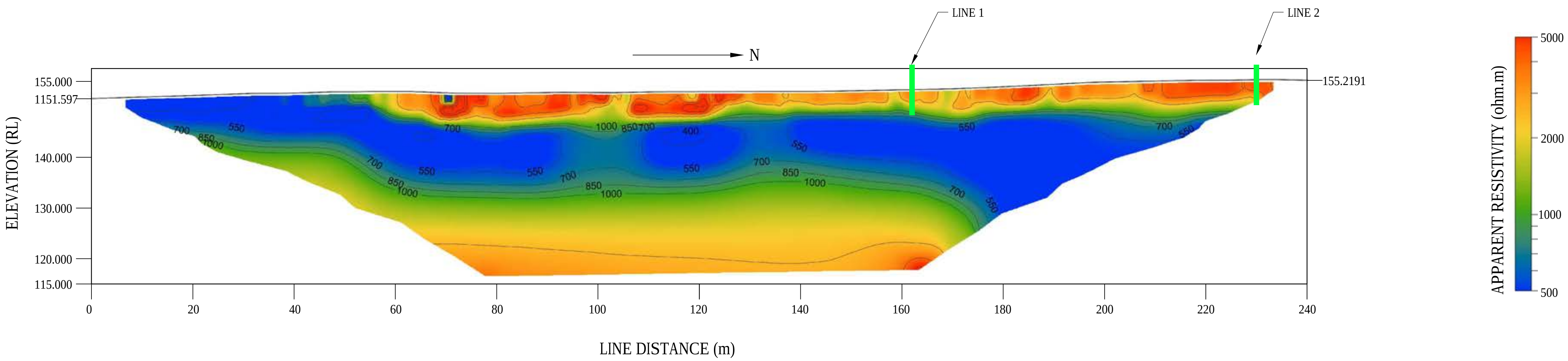
SITE PLAN

SCALE 1:5000



LINE 4 PLAN

SCALE 1:2000



LINE 4 PROFILE

SCALE 1:1000

LEGEND:

ELECTRICAL RESISTIVITY LINE

BASE SURVEY SUPPLIED BY:
DES SUPPLIED, GYMPIE 2009 REGIONAL 1m DEM

PRELIMINARY

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0 20 40 60m
SCALE 1:2000 AT ORIGINAL SIZE

0 10 20 30m
SCALE 1:1000 AT ORIGINAL SIZE

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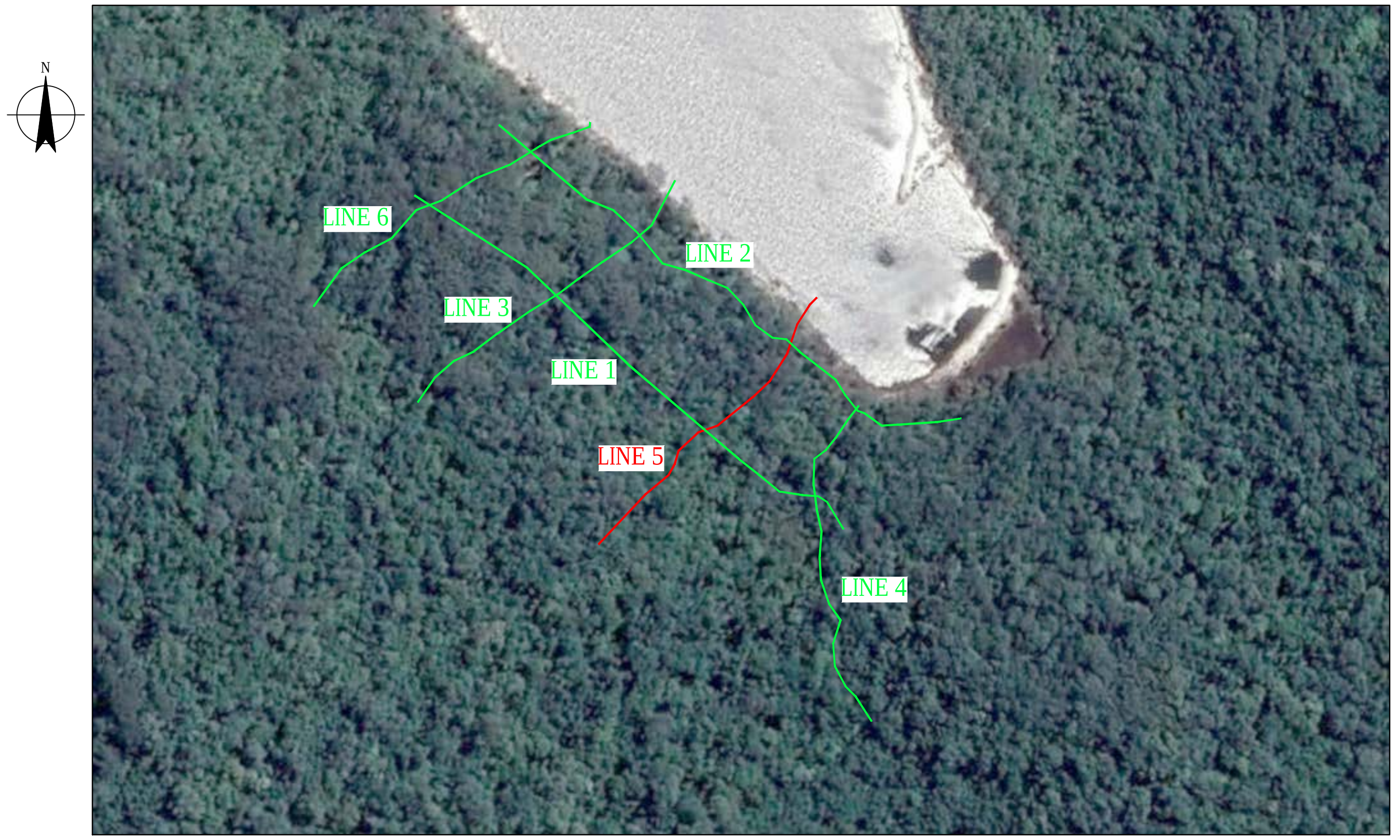
Project **COOLOOLA GREAT WALK ECOTOURISM PROJECT**
Title **POONA LAKE GROUNDWATER INVESTIGATION LINE 4**

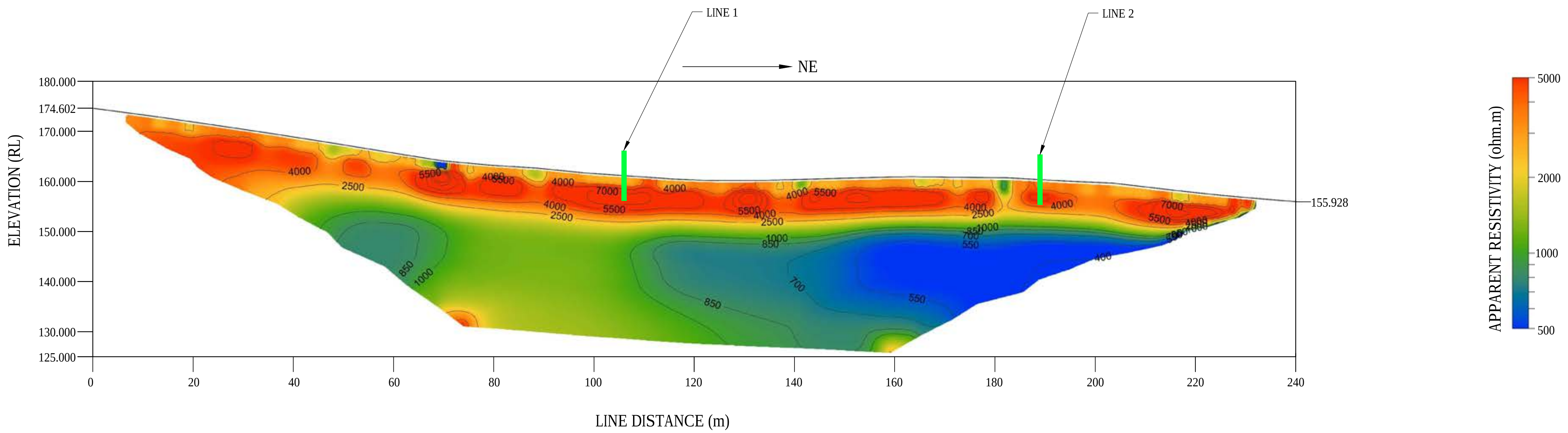
Original Size **A3** Drawing No: **12545456-FIG04** Rev: **A**

Plot Date: 25 February 2021 - 2:21 PM Plotted By: Victoria Jenkins Cad File No: G:\32\12545456\CADD\Drawings\12545456-FIG01 - FIG06.dwg



SITE PLAN
SCALE 1:5000

LINE 5 PLAN
SCALE 1:2000



LINE 5 PROFILE
SCALE 1:1000

LEGEND:
ELECTRICAL RESISTIVITY LINE

BASE SURVEY SUPPLIED BY:
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0 10 20 30m
SCALE 1:1000 AT ORIGINAL SIZE

0 20 40 60m
SCALE 1:2000 AT ORIGINAL SIZE

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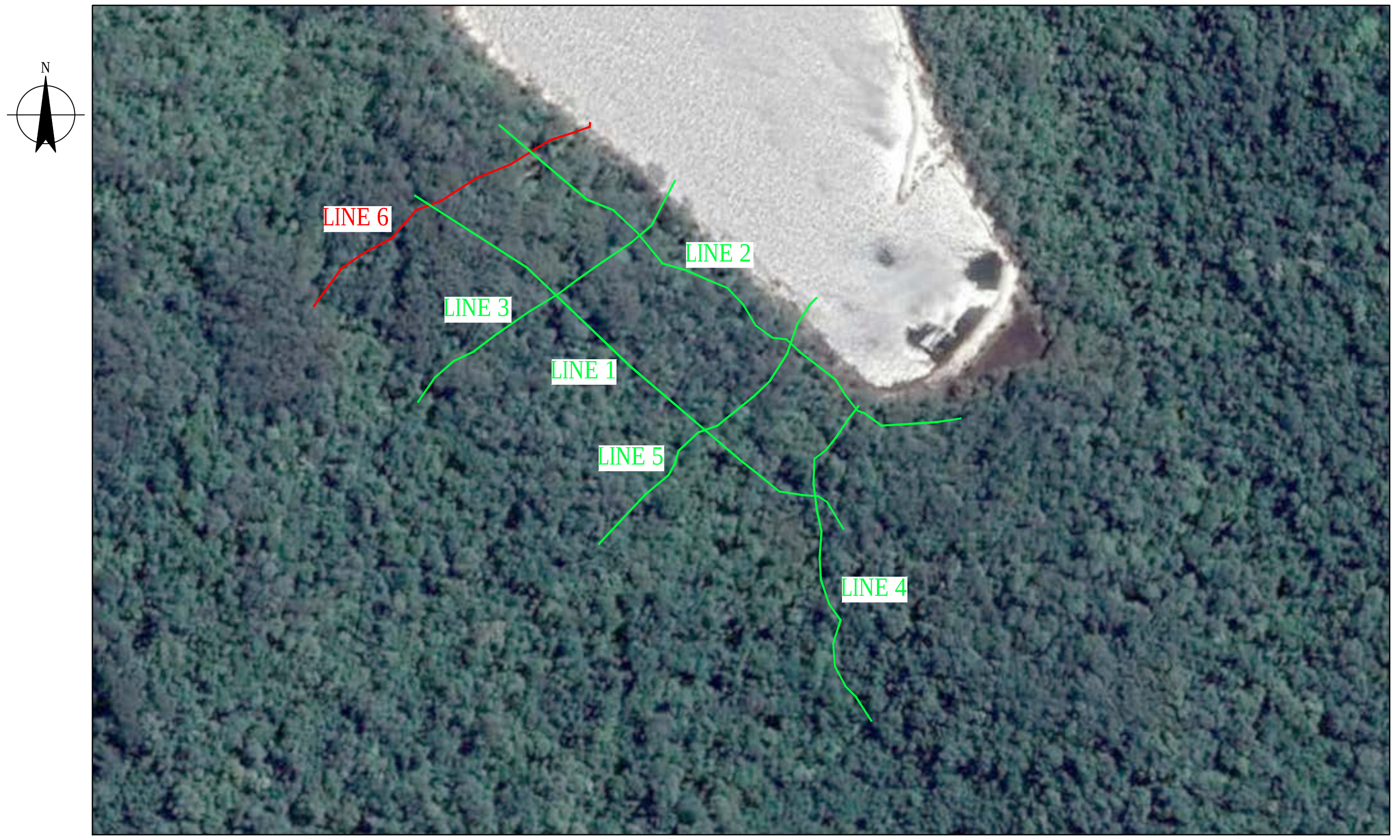
Project **COOLOOLA GREAT WALK ECOTOURISM PROJECT**
Title **POONA LAKE GROUNDWATER INVESTIGATION LINE 5**

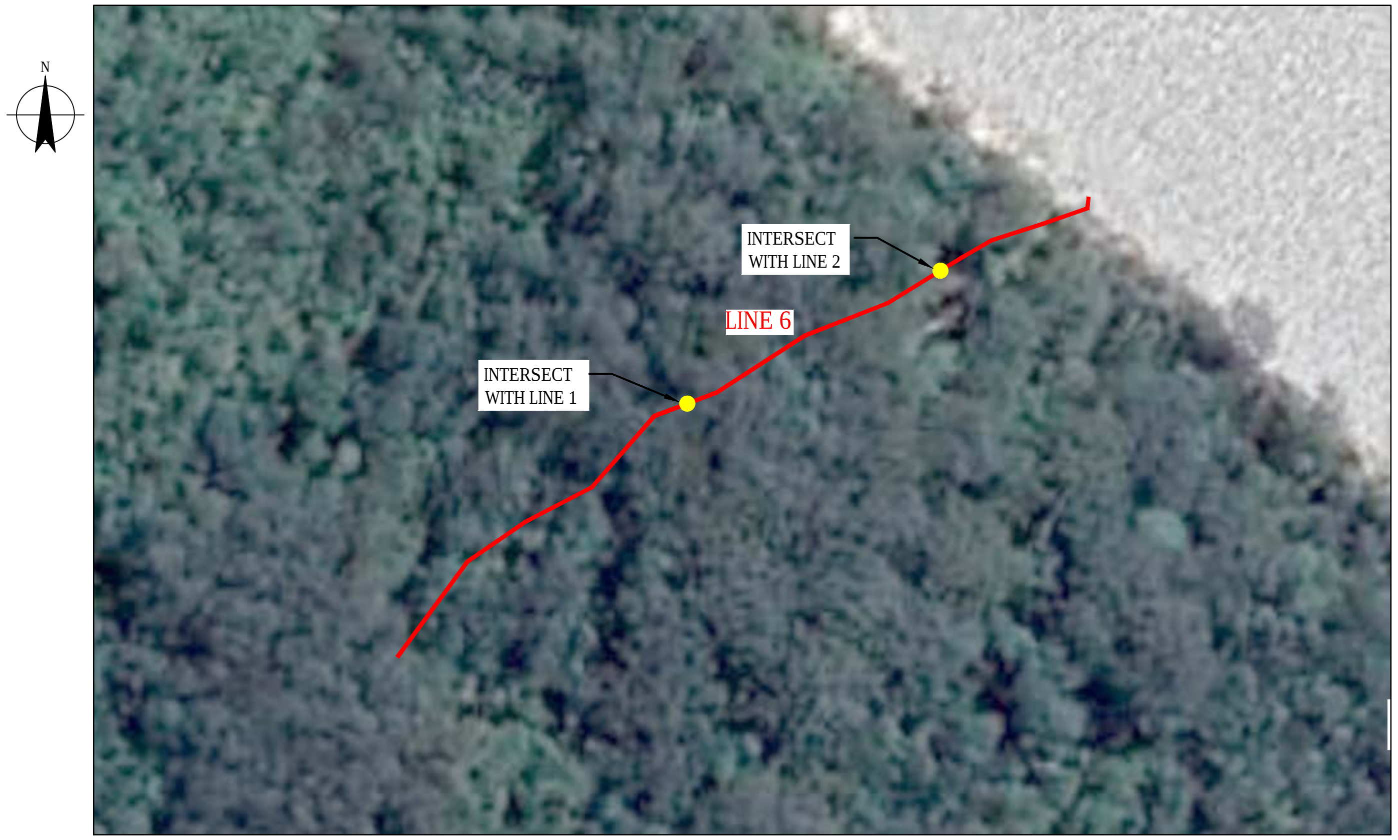
Original Size **A3**
Drawing No: **12545456-FIG05**
Rev: **A**

Plot Date: 25 February 2021 - 2:24 PM Plotted By: Victoria Jenkins Cad File No: G:\32\12545456\CADD\Drawings\12545456-FIG01 - FIG06.dwg



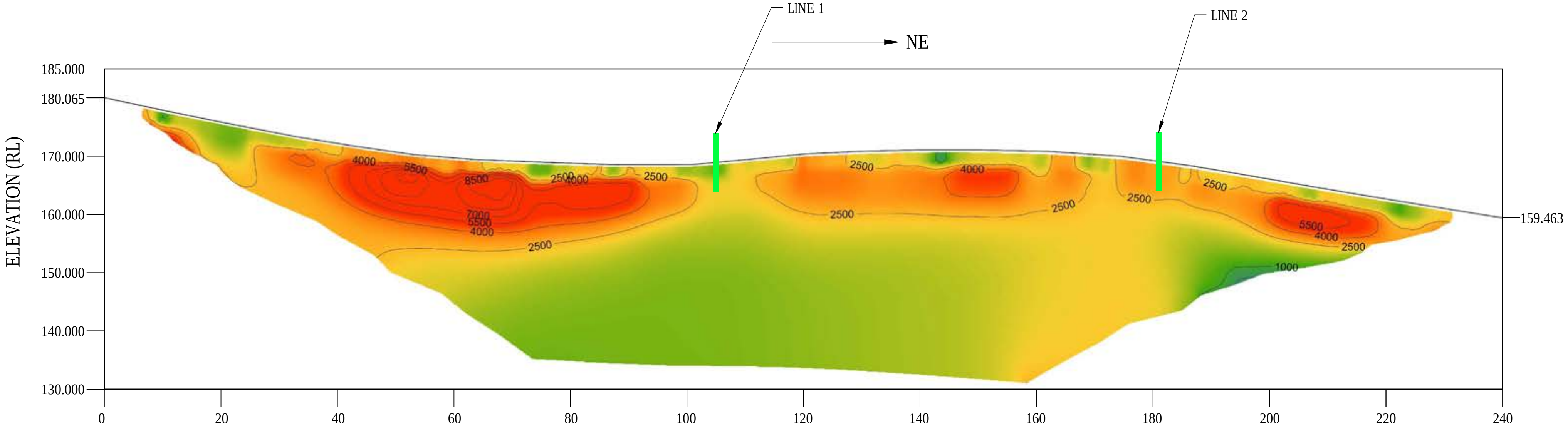
SITE PLAN

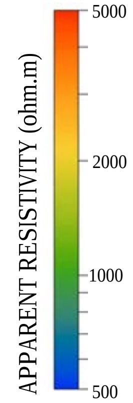
SCALE 1:5000



LINE 6 PLAN

SCALE 1:2000





LINE 6 PROFILE

SCALE 1:1000

LEGEND:

ELECTRICAL RESISTIVITY LINE

BASE SURVEY SUPPLIED BY:
DES SUPPLIED, GYMPIE 2009 REGIONAL 1m DEM

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0 20 40 60m
SCALE 1:2000 AT ORIGINAL SIZE

0 10 20 30m
SCALE 1:1000 AT ORIGINAL SIZE

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Project **COOLOOLA GREAT WALK ECOTOURISM PROJECT**
Title **POONA LAKE GROUNDWATER INVESTIGATION LINE 6**

Original Size **A3** Drawing No: **12545456-FIG06** Rev: **A**

Plot Date: 25 February 2021 - 2:17 PM Plotted By: Victoria Jenkins Cad File No: G:\32\12545456\CADD\Drawings\12545456-FIG01 - FIG06.dwg

Appendix B – Hydrogeological Interpretation Figures

1:1,750 @ A3

0 5 10 20 30 40

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 MGA Zone 56
Height Datum: AHD (AusGeoid09)

N

LEGEND

- Current Proposed Site
- Low Permeability Cemented Sand at Surface
- Cooloola walking access
- Proposed access
- Extent of interpreted surfaces
- Inferred presence of saturated cemented sands
- Interpreted extent of saturated cemented sand unit
- Proposed Site Area (indicated with white lines)

Department of Environment and Science (DES)
Cooloola Great Walk Ecotourism
Poona Lake Groundwater Investigation

Job Number 32-12545456
Revision 0
Date 12 Mar 2021

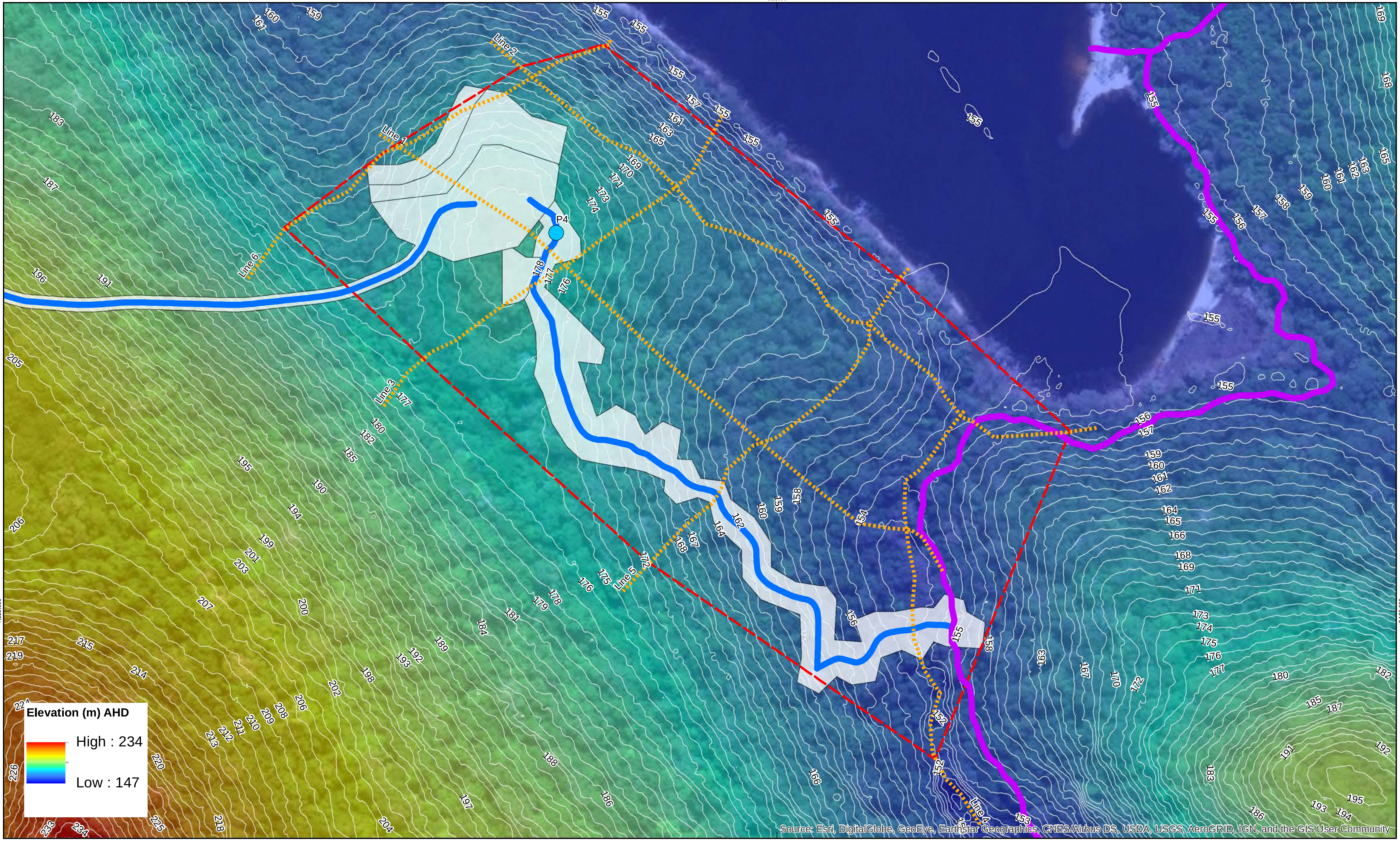
Interpreted groundwater extent

Figure 1

G:\32\12545456\GIS\Maps\Deliverables\10.6\12545456_A3L_Figure_1_ Interpreted_groundwater_extent_Poona_Lake_RevB.mxd

2 Salamanca Square, Hobart Tasmania 7000 Australia **T** 61 3 6210 0600 **E** hbamail@ghd.com **W** www.ghd.com

Data source: DES, Proposed Access Roads, Cooloola Walking Track, Contours, 2021; GHD, Geophisical Lines, 2021; Spatial-IMG QLD, Elevation, 2021; ESRI, Image Basemap, 2021. Created by:npolmear



1:1,750 @ A3

0 5 10 20 30 40

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 MGA Zone 56
Height Datum: AHD (AusGeoid09)

N

LEGEND

- Current Proposed Site
- Cooloola walking access
- Proposed access
- Extent of interpreted surfaces
- Proposed site area
- ERI Lines

Department of Environment and Science (DES)
Cooloola Great Walk Ecotourism Project
Poona Lake Groundwater Investigation

Job Number	32-12545456
Revision	0
Date	15 Mar 2021

Surface Elevation

Figure 2

G:\32\12545456\GIS\Maps\Deliverables\10.6\12545456_A3L_Figure_2_Surface_Elevation_Poona_Lake_RevB.mxd

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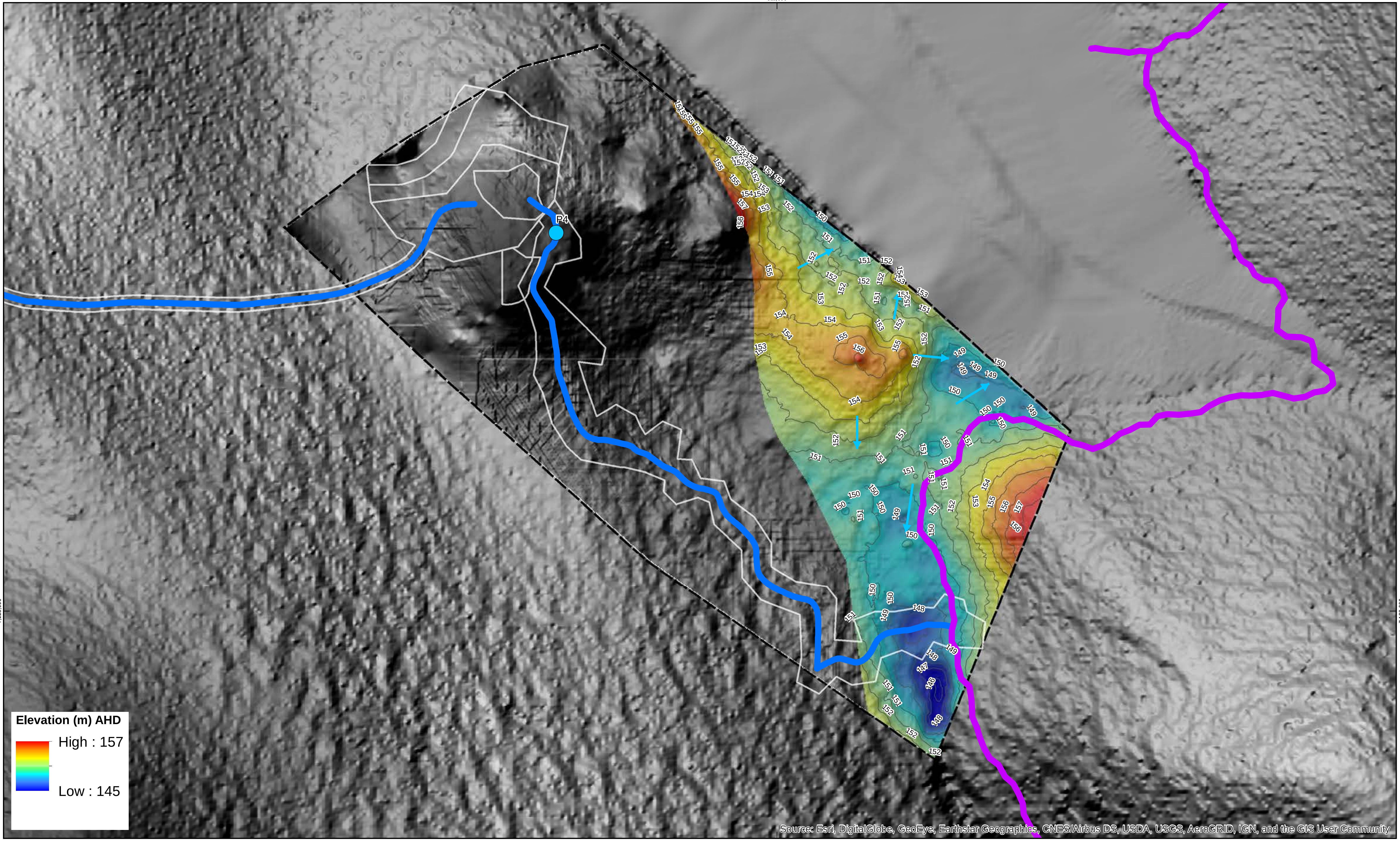
Data source: DES, Proposed Access Roads, Cooloola Walking Track, Contours, 2021; GHD, Geophisical Lines, 2021; Spatial-IMG QLD, Elevation, 2021; ESRI, Image Basemap, 2021. Created by:npolmear



1:1,750 @ A3

0 5 10 20 30 40

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 MGA Zone 56
Height Datum: AHD (AusGeoid09)

N

LEGEND

- Current Proposed Site
- Cooloola walking access
- Proposed access
- Extent of interpreted surfaces
- Proposed Site Area (indicated with white
- Inferred groundwater flow direction

Department of Environment and Science (DES)
Cooloola Great Walk Ecotourism Project
Poona Lake Groundwater Investigation

Job Number	32-12545456
Revision	0
Date	15 Mar 2021

Top of saturated zone

Figure 3

G:\32\12545456\GIS\Maps\Deliverables\10.6\12545456_A3L_Figure_3_Inferred_groundwater_levels_and_flow_directions_Poona_Lake_RevB.mxd

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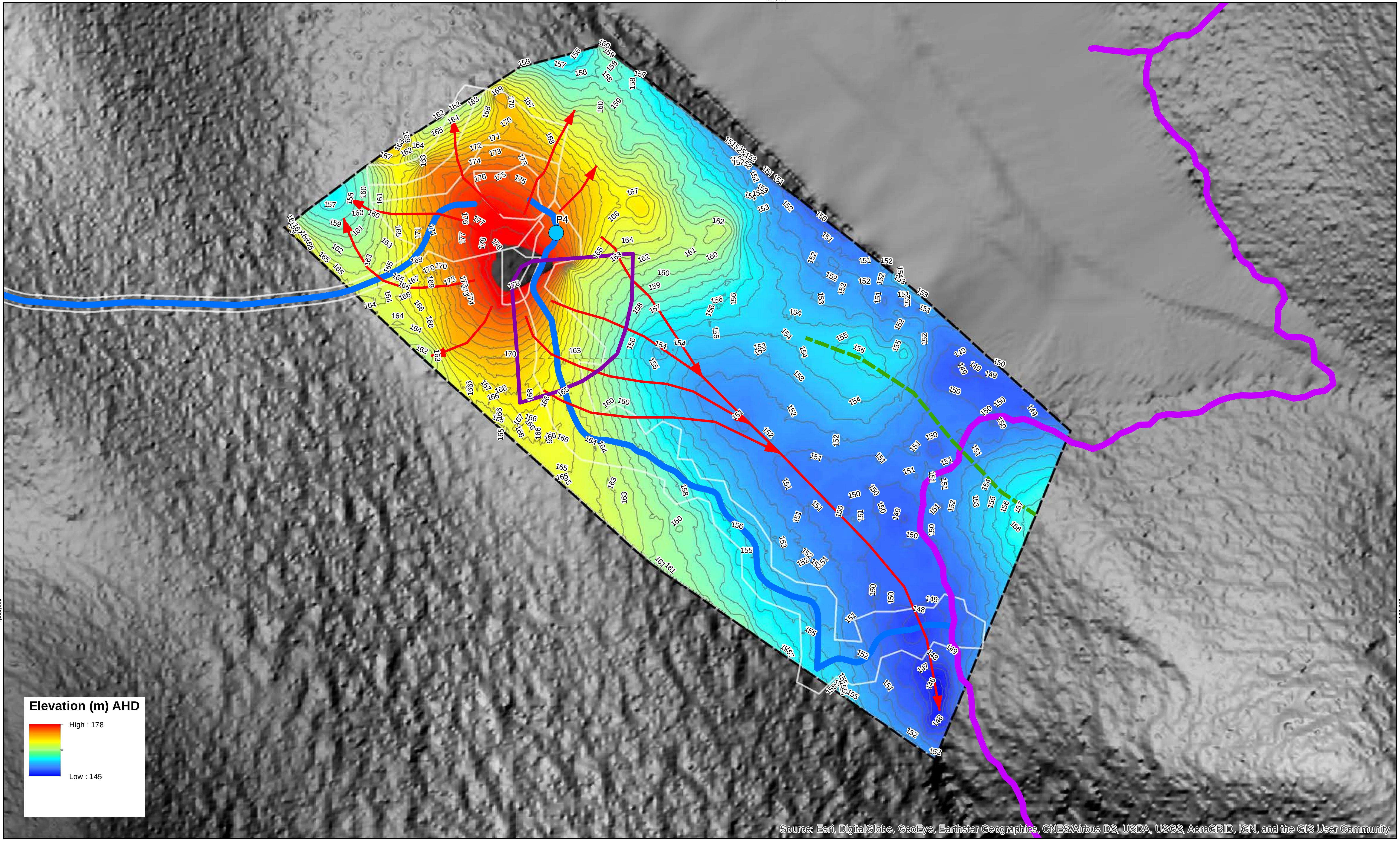
Data source: DES, Proposed Access Roads, Cooloola Walking Track, Contours, 2021; GHD, Geophisical Lines, 2021; Spatial-IMG QLD, Elevation, 2021; ESRI, Image Basemap, 2021. Created by:npolmear



1:1,750 @ A3

0 5 10 20 30 40

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 MGA Zone 56
Height Datum: AHD (AusGeoid09)

N

LEGEND

- Current Proposed Site
- Cooloola walking access
- Proposed access
- Extent of interpreted surfaces
- Proposed Site Area (Indicated with white lines)
- Indicative cemented sand ridgeline
- Indicative low risk area for facilities / storages with potential to leak to the environment
- Indicative direction of migration of waste water, nutrients etc.

Department of Environment and Science (DES)
Cooloola Great Walk Ecotourism Project
Poona Lake Groundwater Investigation

Job Number	32-12545456
Revision	0
Date	15 Mar 2021

Interpreted elevation of top of cemented sand unit

Figure 4

G:\32\12545456\GIS\Maps\Deliverables\10.6\12545456_A3L_Figure_4_Interpreted_elevation_of_top_of_cemented_sand_unit_Poona_Lake_RevB.mxd

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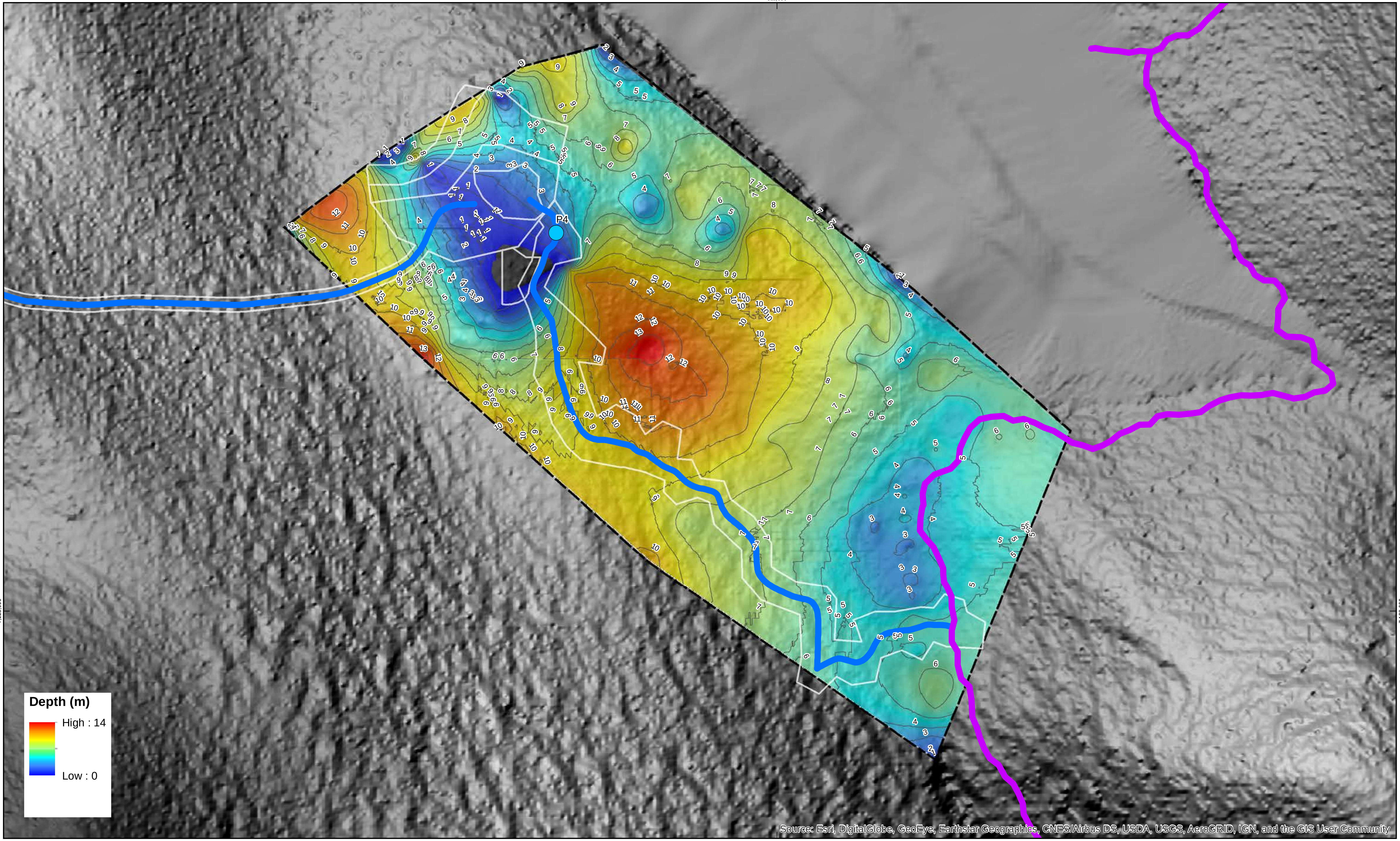
Data source: DES, Proposed Access Roads, Cooloola Walking Track, Contours, 2021; GHD, Geophisical Lines, 2021; Spatial-IMG QLD, Elevation, 2021; ESRI, Image Basemap, 2021. Created by:npolmear



1:1,750 @ A3

0 5 10 20 30 40

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 MGA Zone 56
Height Datum: AHD (AusGeoid09)

N

LEGEND

- Current Proposed Site
- Cooloola walking access
- Proposed access
- Proposed Site Area (indicated with white lines)
- Extent of interpreted surfaces

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Department of Environment and Science (DES)

Cooloola Great Walk Ecotourism Project
Poona Lake Groundwater Investigation

Job Number	32-12545456
Revision	0
Date	15 Mar 2021

Interpreted depth from ground surface to top of cemented unit

Figure 5

G:\32\12545456\GIS\Maps\Deliverables\10.6\12545456_A3L_Figure_5_Interpreted_depth_to_top_of_cemented_sand_unit_Poona_Lake_RevB.mxd

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12545456-40688-4/

https://projectsportal.ghd.com/sites/pp14_02/cooloolagreatwalkeco/ProjectDocs/12545456_REP_Poona Lake Groundwater Investigation.docx

Document Status

Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
Draft Rev A	W. McAdam	H. Tassell R Brown	-	-	-	26/02/21
Rev 0	W. McAdam R Brown	M Prskalo		M Prskalo		08/03/2021
Rev 1	W. McAdam R Brown	M Prskalo		M Prskalo		19/03/2021

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