APPENDIX 6-1

REPORT ON THE GEOPHYSICAL INVESTIGATION AT BALLYQUIN PIT, CO. CLARE

AGP19178_01

Report
on the
Geophysical Investigation
At
Ballyquin Pit
Co. Clare
For
Roadstone Limited

9th December 2019

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THE FINDINGS OF THIS REPORT ARE THE RESULT OF A GEOPHYSICAL SURVEY USING NON-INVASIVE SURVEY TECHNIQUES CARRIED OUT AT THE GROUND SURFACE. INTERPRETATIONS CONTAINED IN THIS REPORT ARE DERIVED FROM A KNOWLEDGE OF THE GROUND CONDITIONS, THE GEOPHYSICAL RESPONSES OF GROUND MATERIALS AND THE EXPERIENCE OF THE AUTHOR. APEX GEOPHYSICS LTD. HAS PREPARED THIS REPORT IN LINE WITH BEST CURRENT PRACTICE AND WITH ALL REASONABLE SKILL, CARE AND DILIGENCE IN CONSIDERATION OF THE LIMITS IMPOSED BY THE SURVEY TECHNIQUES USED AND THE RESOURCES DEVOTED TO IT BY AGREEMENT WITH THE CLIENT. THE INTERPRETATIVE BASIS OF THE CONCLUSIONS CONTAINED IN THIS REPORT SHOULD BE TAKEN INTO ACCOUNT IN ANY FUTURE USE OF THIS REPORT.

PROJECT NUMBER	AGP19178		
AUTHOR	**CHECKED**	**REPORT STATUS**	**DATE**
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1. EXECUTIVE SUMMARY

APEX Geophysics Limited was requested by Roadstone Limited to carry out a geophysical investigation at the Ballyquin Pit site, Co. Clare. The objective of the investigation was to estimate the extent, thickness and quality of the sand & gravel deposits.

The site is located 1.5 km north-east from Bridgetown, County Clare. The Ballyquin Pit has been divided by the client into 4 survey areas (Areas 1-4) and the total extent of the four is 41.3 ha. Site topography ranges from c.52 m OD to c. 86 m OD. The pit has been worked extensively and is heavily overgrown in places.

The Geological Survey of Ireland (GSI) 1:100k Bedrock Geology map for the area indicates that the site is underlain by red conglomerate, sandstone & mudstone of the Old Red Sandstone formation. The GSI Quaternary sediments map for the area indicates that the site is in an area of gravels derived from Lower Palaeozoic and Devonian sandstones. The site is located within the 'Locally important gravel aquifer - Glenomra Gravels (GSI).'

No direct investigation data was available but the pit has been worked extensively with a number of exposed faces present. A geophysical survey was carried out across the area to the south-east of the present survey in 2013 and outlined a zone of sand/gravel ranging from 7 to 14m in thickness. A resource of 891,000 tonnes was calculated over an area of 5.5 ha.

The investigation consisted of reconnaissance EM ground conductivity mapping with follow-up 2D Electrical Resistivity Tomography (ERT) and Seismic Refraction profiling to target observations from the conductivity survey.

The ERT profiles have outlined a layer of generally thin (3-7m) silty SAND/GRAVEL in Areas 2, 3 and 4, and in a small local pocket in Area 1 (due to the limited access in Area 3 data is sparse). A small area of 'clean' sand/gravel was encountered at the start of ERT profile R6 in Area 2. The outlines of the silty SAND/GRAVEL zones are shown on Drawing AGP19178_03. The material is these zones may have economic potential.

A layer of clayey SAND/GRAVEL occurs underneath the main silty SAND/GRAVEL layer. It is unlikely to have any economic potential due to its high fines content. This clayey SAND/GRAVEL layer comes to or is close to the ground surface where the silty SAND/GRAVEL is thin or absent (see R2, R9, R11, part of R13).

Bedrock varying from mudstone to quartz-rich sandstone has been confirmed by the ERT and seismic data across the site at elevations ranging from 40 mOD to 65 mOD.

A resource calculation has been carried out across Areas 1 to 4 and a resource of **752,160 tonnes of silty SAND/GRAVEL** has been estimated. This is a gross estimate based on interpreted geophysical data and average heights from the topographic data acquired as part of the geophysical investigation.

When the resource of 891,000 tonnes of SAND/GRAVEL estimated from the 2013 survey is added in this gives a **total resource figure of 1.6 million tonnes** of across the existing pit and the new area to the south-east.

Trial pits to confirm the 2019 finding are recommended. The trial pits and boreholes recommended in the 2013 survey report (Appendix D) should also be carried out. The geophysical report should be reviewed after any further direct investigation.

2. INTRODUCTION

APEX Geophysics Limited was requested by Roadstone Limited to carry out a geophysical investigation at the Ballyquin Pit site, Co. Clare.

2.1 Survey Objectives

The objective of the investigation was to estimate the extent, thickness and quality of the sand & gravel deposits.

2.2 Site Background

The site is located 1.5 km north-east from Bridgetown, County Clare (Fig. 2.1) covering a total area of approximately 75 Ha. The Ballyquin Pit has been divided by the client into 4 survey areas (Areas 1-4) as outlined in Fig. 1. The total area of the four sites is 41.3 Ha. Site topography ranges from c.52 m OD to c. 86 m OD across the investigated areas. The pit has been worked extensively and is heavily overgrown in places.

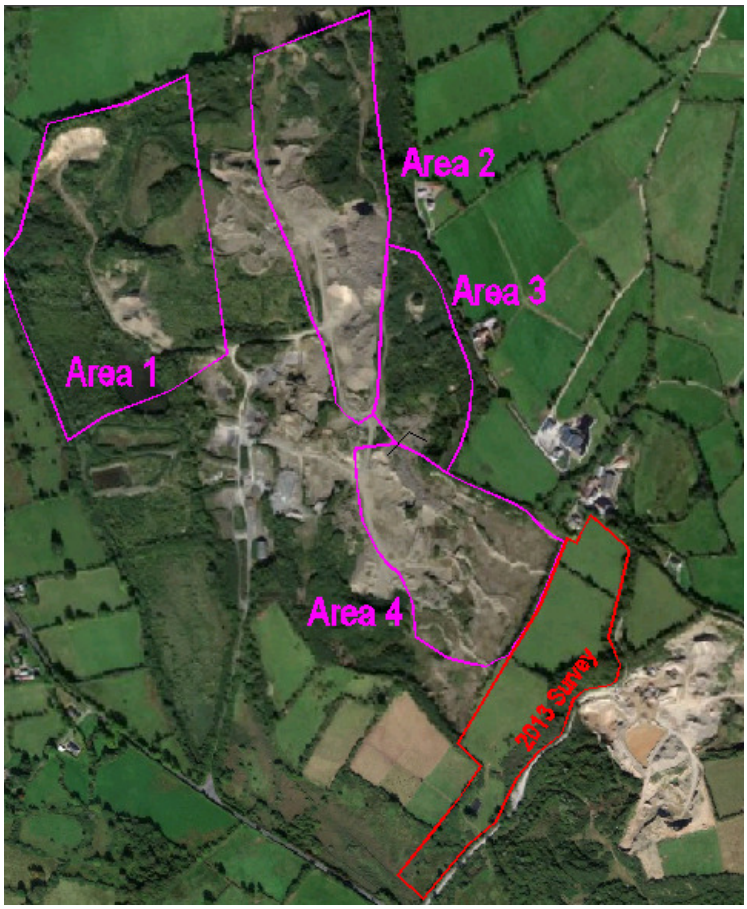

Fig 2.1: Survey areas 1 – 4 and location of previous 2013 survey.

2.2.1 Geology

The Geological Survey of Ireland (GSI) 1:100k Bedrock Geology map for the area (Figure 2.2) indicates that the site is underlain by red conglomerate, sandstone & mudstone of the Old Red Sandstone formation.

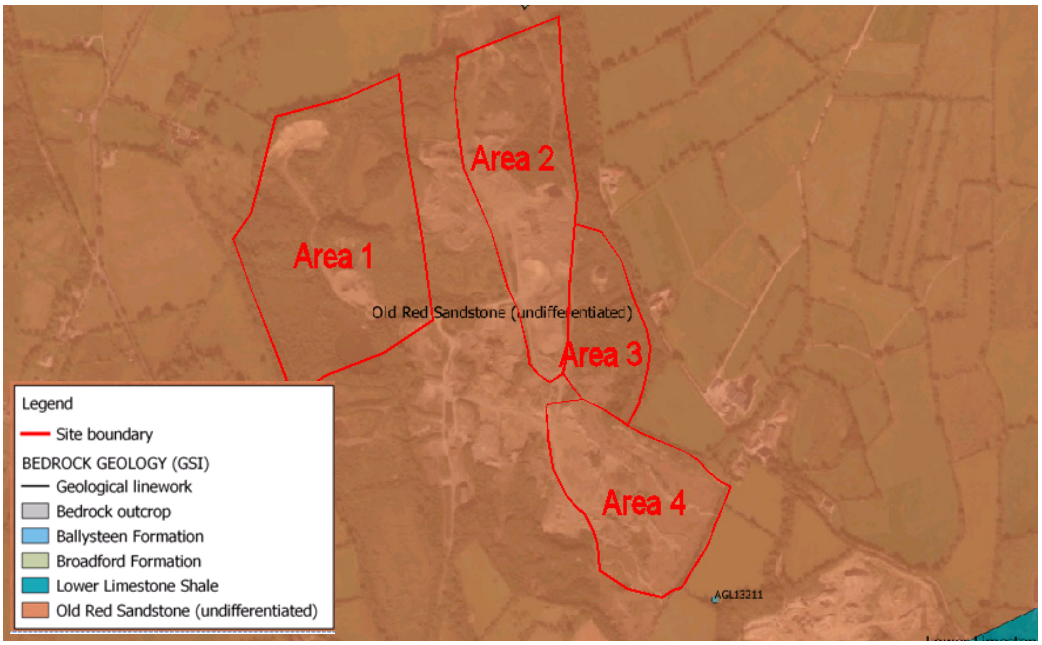

Fig 2.2: Bedrock geology.

2.2.2 Soils

The GSI Quaternary sediments map for the area (Fig. 2.3) indicates that the site is in an area of gravels derived from Lower Palaeozoic and Devonian sandstones with some fen peat in the west of Area 1.

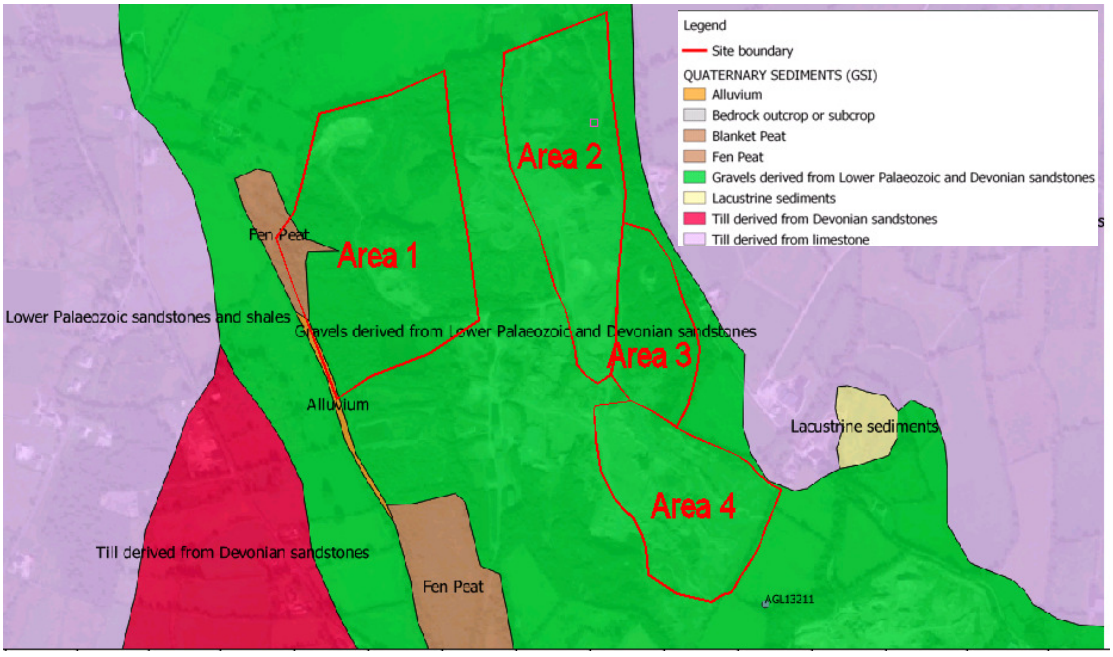

Fig 2.3: Quaternary sediments (soils).

2.2.3 Vulnerability

The groundwater vulnerability rating for the site (Fig. 2.4) is classified as predominantly high, with a moderate vulnerability in the fen peat area in the west of Area 1.

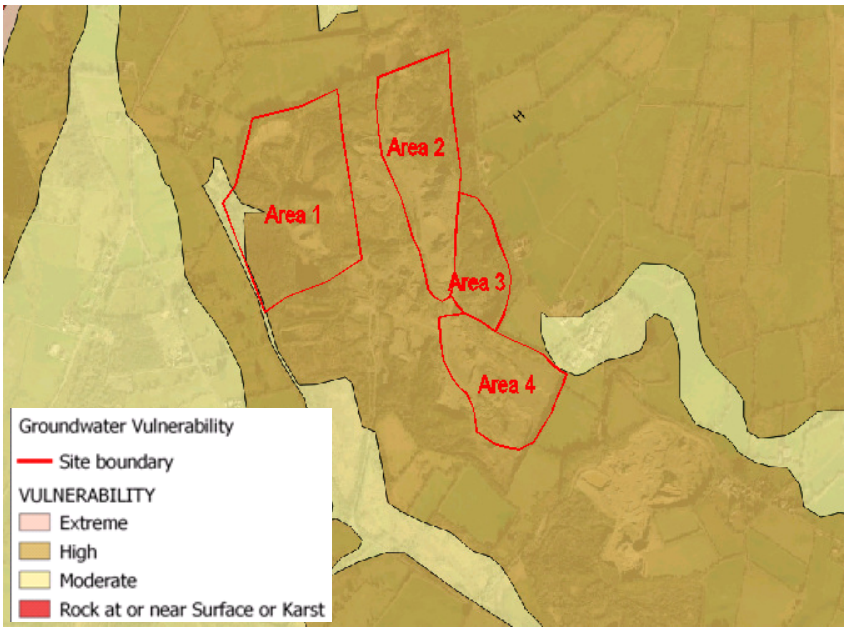

Fig 2.4: Groundwater vulnerability.

2.2.4 Aquifer Classification

The Old Red Sandstone (Fig. 2.5) is classified as a 'Locally Important aquifer – bedrock which is moderately productive only in local zones'. The site is located within the 'Locally important gravel aquifer - Glenomra Gravels (GSI).'

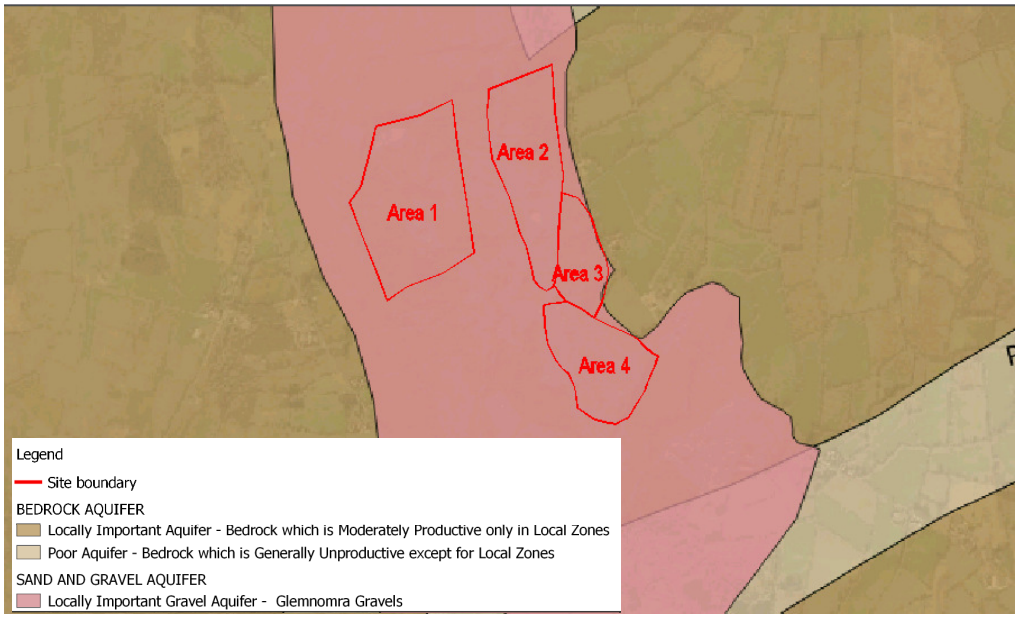

Fig 2.5: Groundwater aquifer.

2.2.5 Historical Data

The historical 6 inch sheet for the area indicates undulating drift (sand and gravel) across the four areas (Figure 2.6) with bog in the south-west of Area 1.

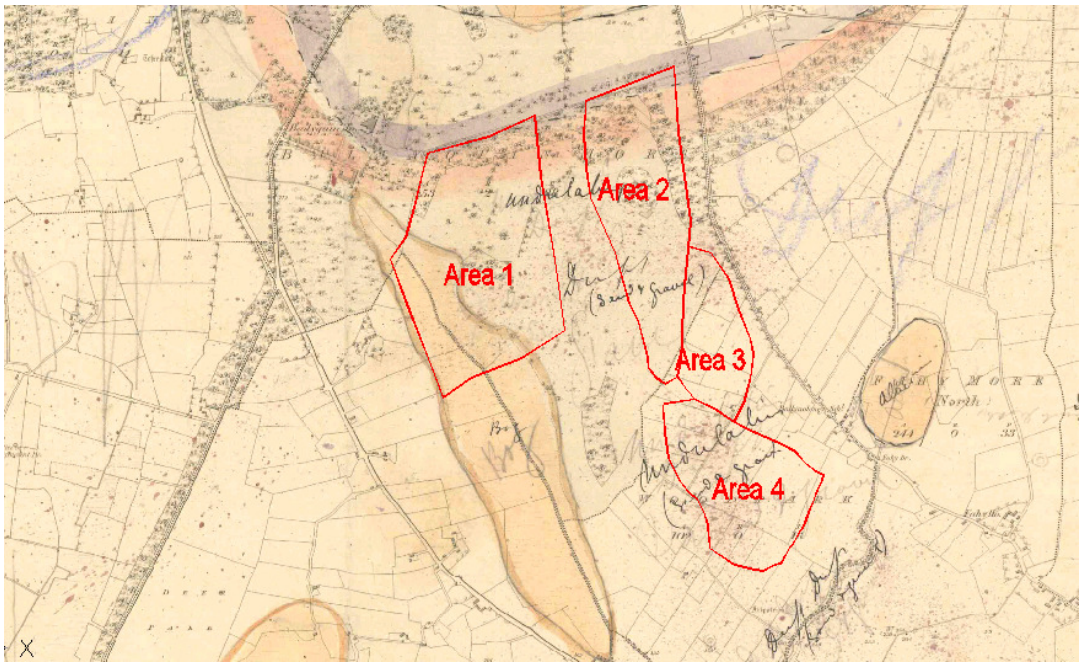

Fig 2.6: The historical 6 inch map. Surveyed areas marked in red.

2.2.6 Direct Investigation Data

No direct investigation data was available but the pit has been worked extensively with a number of exposed faces present. A geophysical survey was carried out across the area to the south-east of the present survey in 2013 and outlined a zone of sand/gravel ranging from 7 to 14m in thickness (Appendix D). A resource of 891,000 tonnes was calculated over an area of 5.5 ha. A 1997 topographic survey was included in the archive file for the 2013 project.

2.3 Survey Rationale

The investigation consisted of reconnaissance EM ground conductivity mapping with follow-up 2D Electrical Resistivity Tomography (ERT) and Seismic Refraction profiling to target observations from the conductivity survey:

EM ground conductivity mapping operates on the principle of inducing currents in conductive substrata and measuring the resultant secondary electro-magnetic field. The strength of this secondary EM field is calibrated to give apparent ground conductivity in milliSiemens/metre (mS/m). This technique will provide information on the shallow (0-6m below ground level) variation of the superficial deposits and outline the shallow bedrock. Clean sand and gravel deposits above the watertable will give low conductivity readings.

ERT images the resistivity of the materials in the subsurface along a profile to produce a cross-section showing the variation in resistivity with depth, depending on the length of the profile. Each cross--section will be interpreted to determine the material type along the profile at increasing depth, based on the typical

resistivities returned for Irish ground materials. Clean, non-saturated sand and gravel deposits will give high resistivity readings.

Seismic Refraction profiling measures the velocity of refracted seismic waves through the overburden and rock material and allows an assessment of the thickness and quality of the materials present to be made. Stiffer and stronger materials usually have higher seismic velocities while soft, loose or fractured materials have lower velocities. Readings are taken using geophones connected via multi-core cable to a seismograph. This method should allow us to profile the depth to the top of the bedrock, along profiles across the site.

As with all geophysical methods the results are based on indirect readings of the subsurface properties. The effectiveness of the proposed approach will be affected by variations in the ground properties. By combining a number of techniques it is possible to provide a higher quality interpretation and reduce any ambiguities which may otherwise exist. Further information on the detailed methodology of each geophysical method employed in this investigation is given in **APPENDIX B: DETAILED GEOPHYSICAL METHODOLOGY**.

3. RESULTS

The survey was carried out on the 23rd and 24th October 2019 involving the collection of 2558 conductivity readings, 14 ERT profiles and 6 seismic refraction profiles. The geophysical survey locations are indicated on Drawing AGP19178_01 (Appendix A).

3.1 EM Ground Conductivity Mapping

The EM ground conductivity results (Drawing AGP19178_02, Appendix A) show the bulk conductivity of the ground materials from 0-6.0m bgl. The recorded conductivity values ranged from 1 to 10 mS/m and have been generally interpreted in conjunction with the ERT and seismic data as follows:

Conductivity (mS/m)	Interpretation
1 -3	SAND/GRAVEL
3-8	Silty SAND/GRAVEL
8-10	Clayey SAND/GRAVEL gravelly CLAY.

3.2 ERT

Fourteen ERT Profiles (R1 to R14) have been acquired across the site. The resistivity values have been interpreted on the following basis.

Resistivity (Ohm-m)	Interpretation
>1000	SAND/GRAVEL
500 - 1000	Silty SAND/GRAVEL
250 - 500	Clayey SAND/GRAVEL
75 - 250	Gravelly CLAY
75 - 2000	BEDROCK (conglomerate/sandstone/shale)

The ERT results have been used for interpretation in conjunction with the EM ground conductivity and seismic refraction datasets.

3.3 Seismic Refraction Profiling

Six seismic refraction spreads were recorded across the site (S1-S6). The seismic refraction data has been interpreted on the following basis:

Layer	P-Wave Seismic Velocity (m/s)	Interpretation	Stiffness/Rock Quality
1	400-800	SAND/GRAVEL, silty SAND/GRAVEL	Loose – medium dense
2	1300-1900	Clayey GRAVEL/SILT/CLAY	Dense/Stiff
3	2600-4200	Mod. Weathered – Fresh MUDST./SST./CONGLOM.	Fair - Good

4. DISCUSSION

Electrical resistivity values for Irish sand and gravel deposits are generally within the following ranges:

Material	*Fines Content %	Resistivity (Ohm-m)	Economic Potential
'Clean' SAND/GRAVEL	< 5	> 1000	Yes
Silty SAND/GRAVEL	5 - 15	500-1000	may have, subject to screening/washing.
Clayey SAND/GRAVEL	> 15%	250-500	unlikely, due to fines content

**(Fines refer to the clay and silt content of the sand/gravel material. The higher the fines content the poorer the material and use is restricted and screening/or washing required. These estimates should be confirmed by subsequent sampling and testing).*

The ERT profiles have outlined a layer of generally thin (3-7m) silty SAND/GRAVEL in Areas 2, 3 and 4, and in a small local pocket in Area 1. The lateral extent of this silty SAND/GRAVEL layer has been outlined from the ERT profiles, the EM31, online historic photographs and the 1997 topographic survey. A small area of 'clean' sand/gravel was encountered at the start of ERT profile R6 in Area 2. The outlines of the silty SAND/GRAVEL zones are shown on Drawing AGP19178_03. The material is these zones may have economic potential.

A layer of clayey SAND/GRAVEL occurs underneath the main silty SAND/GRAVEL layer. This layer ranges in thickness from 3 top 10m. It is unlikely to have any economic potential due to its high fines content. This clayey SAND/GRAVEL layer comes to or is close to the ground surface where the silty SAND/GRAVEL is thin or absent (see R2, R9, R11, part of R13).

Bedrock has been confirmed by the seismic data across the site at depths ranging from 40 mOD to 65 mOD. The electrical resistivity of the rock varies from 75 to 2,000 Ohm-m which indicates a composition varying from mudstone to quartz-rich sandstone. The seismic velocity of the rock ranges from 2,600 ms/ to 4,200 ms in line with this variable composition.

RESOURCE

A resource calculation carried out across Areas 1 to 4 is shown in Table 4.1 below and a resource of 752,160 tonnes of silty SAND/GRAVEL has been estimated. This is a gross estimate based on interpreted geophysical data and average heights from the topographic data acquired as part of the geophysical investigation.

The resource of 891,000 tones outlined by the from the 2013 is also included in Table 4.1.

Note 1: For the resource calculation the SAND/GRAVEL thicknesses shown on the ERT profiles have been multiplied by a calibration factor of 0.7. This is due to the overestimation of the thickness of high resistivity materials, which is an artefact of resistivity data processing software.

Note 2: Stockpiles are present in the southern part of Area 3 and in the western part of Area 2 and it has been necessary to run all (R4) or part (northern end of R6) of the ERT profiles across them. This has the effect of increasing the apparent thickness of sand and gravel present on the profiles and has been taken into account in thickness calculations.

Note 3: Due to the limited access in Area 3 due to the heavy scrub, data coverage is sparse(ERT profiles R4 and R5 only).

	Height (m)	Area (ha)	Volume (cu.m.)	Tonnes @1.6 tonnes/cu.m
Area 1*				
Sub-total	3.0	0.44	13,200	21,120
Area 2**				
Sub-total	7.7	2.90	223,300	357,280
Area 3**				
Sub-total	5.0	2.80	140,000	224,000
Area 4				
Sub-total	3.6	2.60	93,600	149,760
2013 Survey Area***				
Sub-total	9	5.50	495,000	891,000
TOTAL				**1,643,160**
* thin layer on floor, limited data				
**stockpiles present in this area				
*** density of 1.8 tonnes/cu.m. used in 2013 report				

Table 4.1 Resource Calculation.

5. RECOMMENDATIONS

Trial pits at the following locations are recommended to confirm the findings of the geophysical survey. Samples should be taken from the trial pits for Particle Size Distribution (PSD) analysis and for physical, mechanical and laboratory tests.

No.	Easting	Northing
PTP1	563027.8	669023.2
PTP2	562954.7	669126.9
PTP3	562927.1	669319.0
PTP4	562897.0	669460.0
PTP5	562817.0	669562.7
PTP6	562752.3	669665.2

The boreholes recommended in the 2013 report on the area to the south-east should be carried out, if this has not already been done.

The geophysical report should be reviewed after any further direct investigation.

Photo - On ERT profile R13 looking NE.

Photo - On ERT profile R6 looking NW.

Photo - On ERT profile R14 looking NE.

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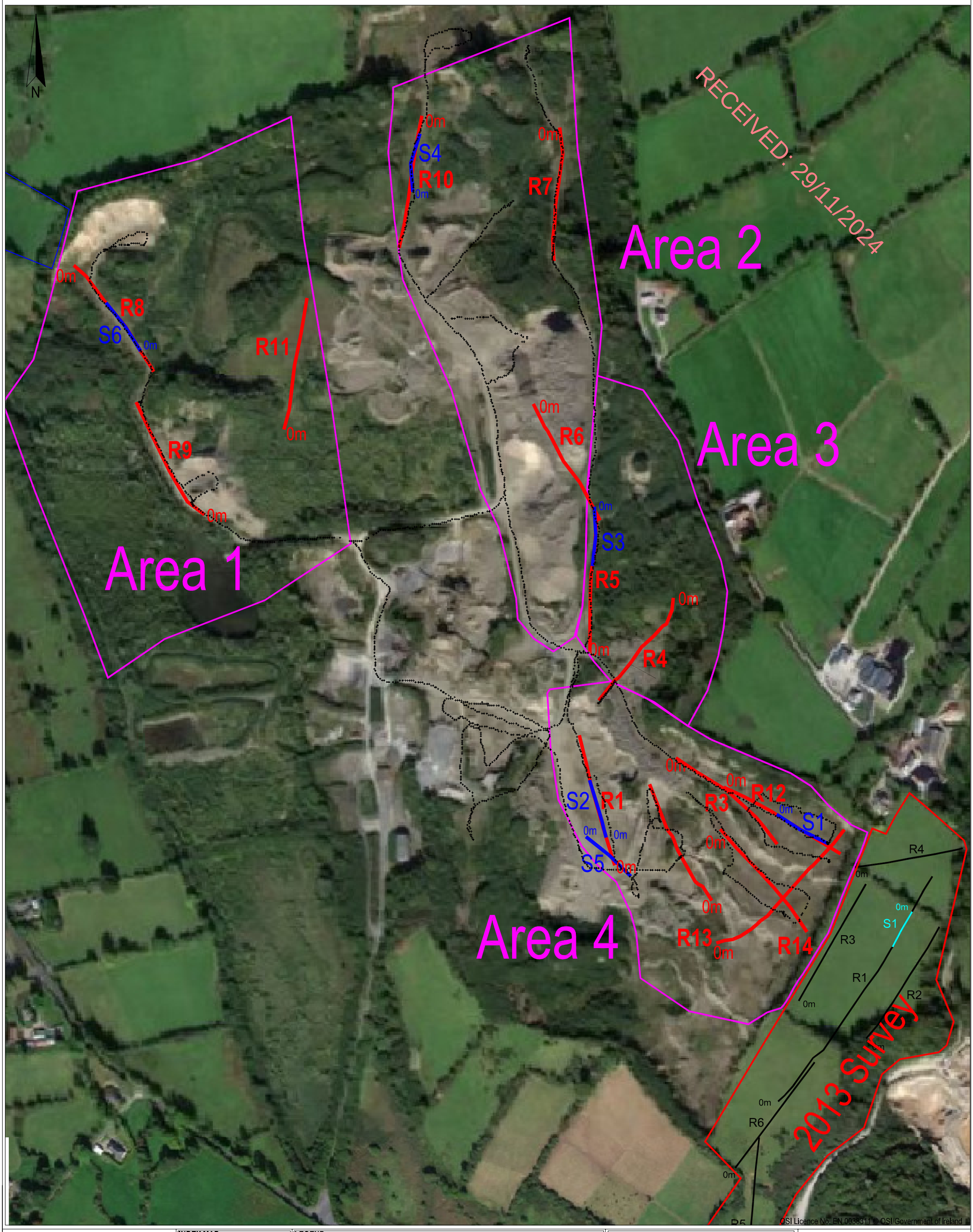
APPENDIX A: DRAWINGS

The information derived from the geophysical investigation as well as correlation with the available direct investigation is presented in the following drawings:

AGP19178_01	Geophysical Locations	1:4000	@ A3
AGP19178_02	EM Conductivity (mS/m)	1:4000	@ A3
AGP19178_04	Summary Map	1:4000	@ A3
AGP19178_R1	Results & Interpretation – ERT R1 & Seismic spreads S2 & S5	1:1000	@ A4
AGP19178_R2	Results & Interpretation – ERT R2	1:1000	@ A4
AGP19178_R3	Results & Interpretation – ERT R3	1:1000	@ A4
AGP19178_R4	Results & Interpretation – ERT R4	1:1000	@ A4
AGP19178_R5	Results & Interpretation – ERT R5 & Seismic spread S3	1:1000	@ A4
AGP19178_R6	Results & Interpretation – ERT R6	1:1000	@ A4
AGP19178_R7	Results & Interpretation – ERT R7	1:1000	@ A4
AGP19178_R8	Results & Interpretation – ERT R8 & Seismic spread S6	1:1000	@ A4
AGP19178_R9	Results & Interpretation – ERT R9	1:1000	@ A4
AGP19178_R10	Results & Interpretation – ERT R10 & Seismic spread S4	1:1000	@ A4
AGP19178_R11	Results & Interpretation – ERT R11	1:1000	@ A4
AGP19178_R12	Results & Interpretation – ERT R12 & Seismic spread S6	1:1000	@ A4
AGP19178_R13	Results & Interpretation – ERT R13	1:1000	@ A4
AGP19178_R14	Results & Interpretation – ERT R14	1:1000	@ A4

FIGURE 1: GEOPHYSICAL LOCATIONS

SCALE 1:4000



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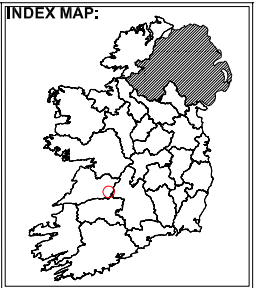
INDEX MAP:



LEGEND:

- Area surveyed in 2019
- Area surveyed in 2013
- \+ EM conductivity reading
- R1 — 2D resistivity profile
- S1 — Seismic refraction profile

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FIGURE 1: EM CONDUCTIVITY (mS/m)

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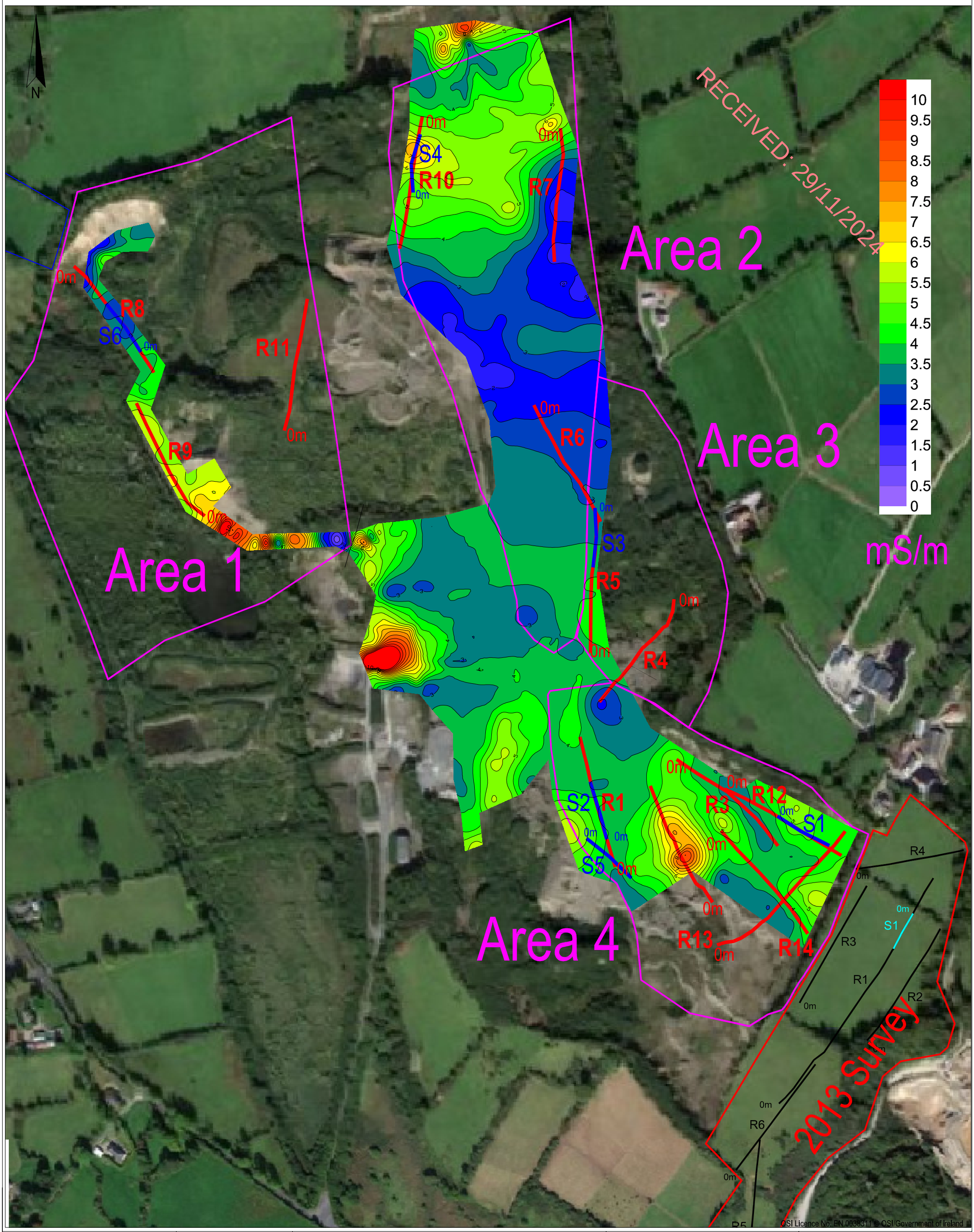

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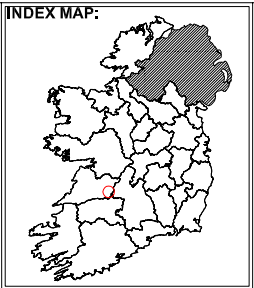

LEGEND:

- Area surveyed in 2019
- Area surveyed in 2013
- \+ EM conductivity reading
- R1 — 2D resistivity profile
- S1 — Seismic refraction profile

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FIGURE 1: SUMMARY MAP

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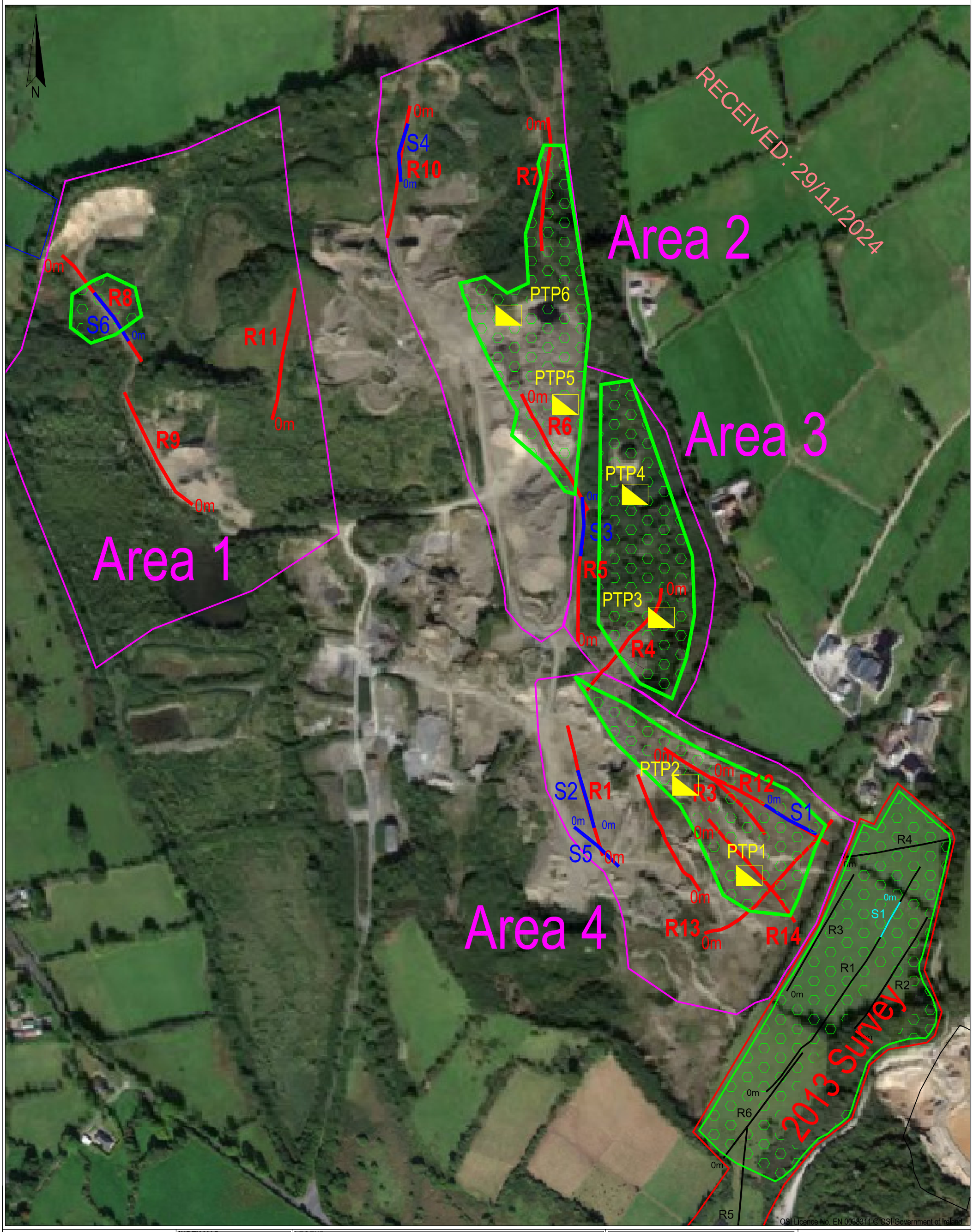

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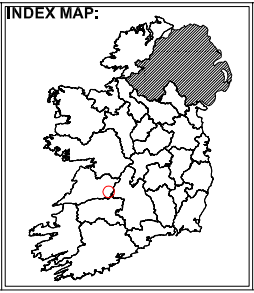

LEGEND:

- Area surveyed in 2019
- Area surveyed in 2013
- Sand/Gravel Body outlined by geophysical surveys
- Proposed Trial Pit
- R1 — 2D resistivity profile
- S1 — Seismic refraction profile

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FIGURE 1: RESULTS & INTERPRETATION - ERT R1 & SEISMIC REFRACTION S2, S5

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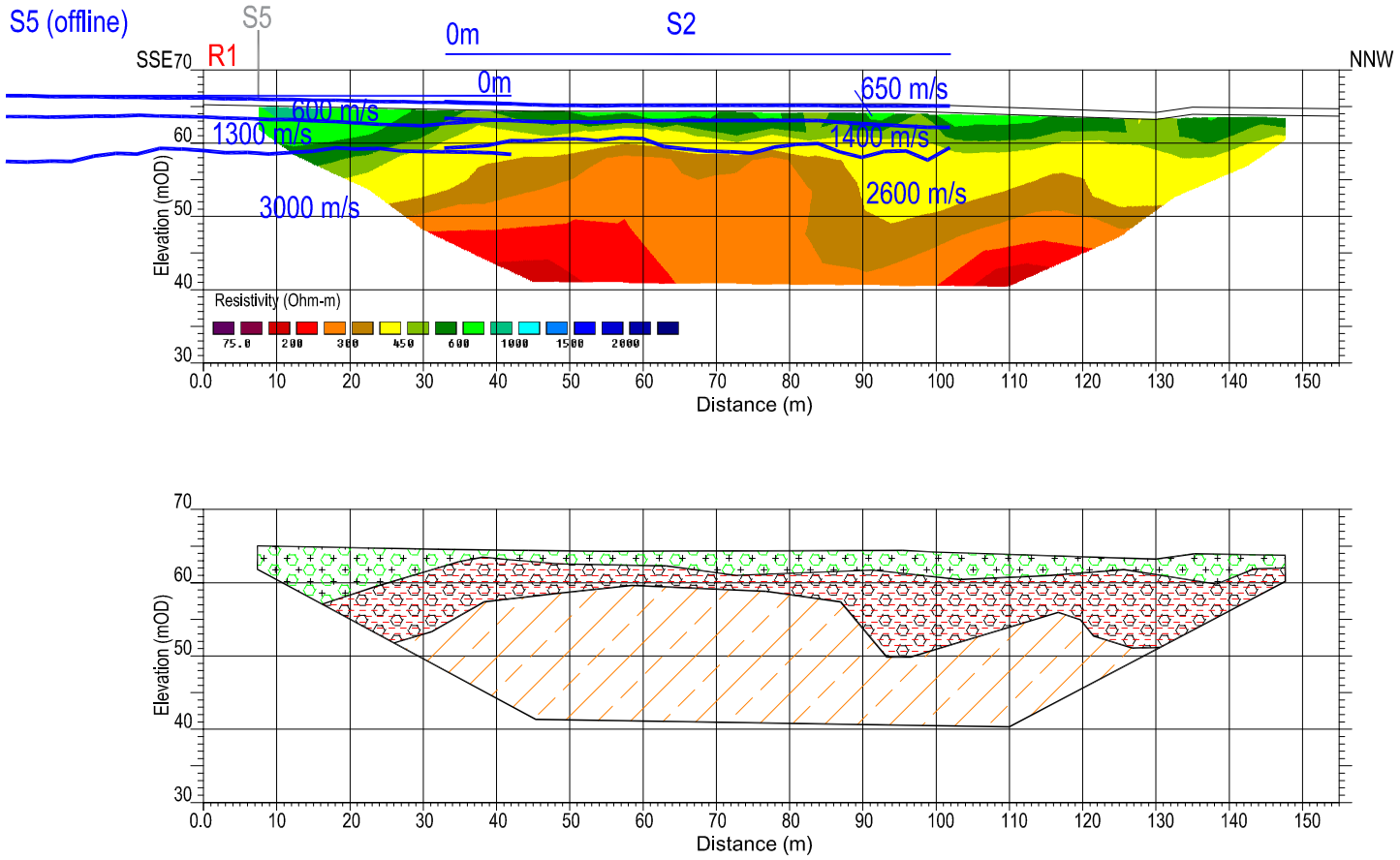

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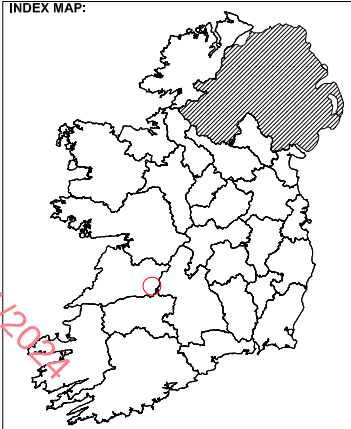

LEGEND:

- SAND/GRAVEL
- Silty SAND/GRAVEL
- Clayey SAND/GRAVEL
- Gravelly CLAY
- ROCK (SANDSTONE/ MUDSTONE/CONGLOM.)

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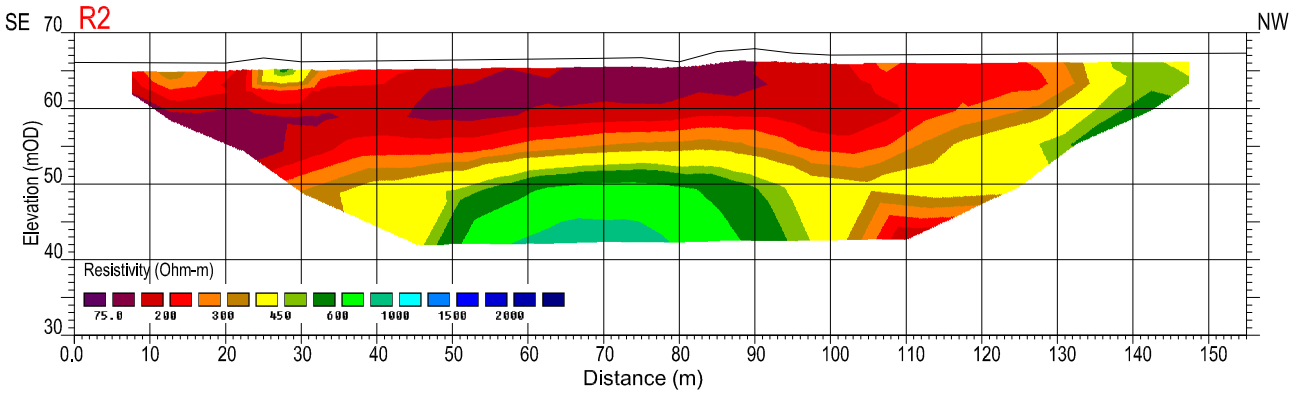
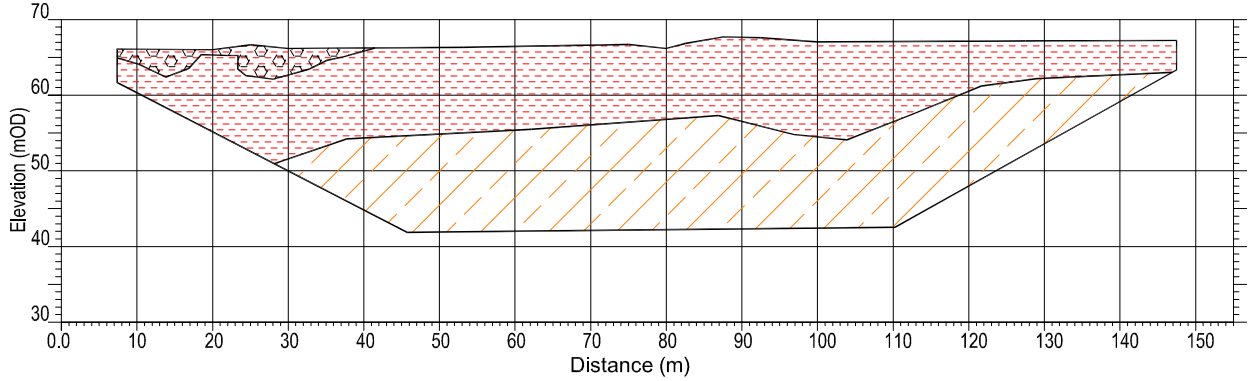
FIGURE 1: RESULTS & INTERPRETATION - ERT R2

SCALE 1:1000





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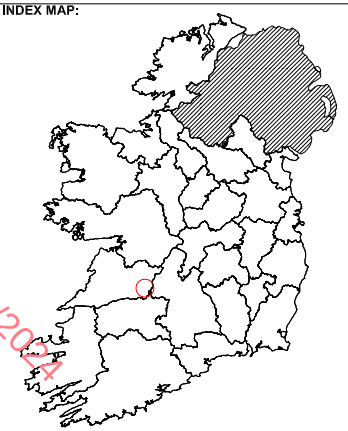

LEGEND:

- SAND/GRAVEL
- Silty SAND/GRAVEL
- Clayey SAND/GRAVEL
- Gravelly CLAY
- ROCK (SANDSTONE/ MUDSTONE/CONGLOM

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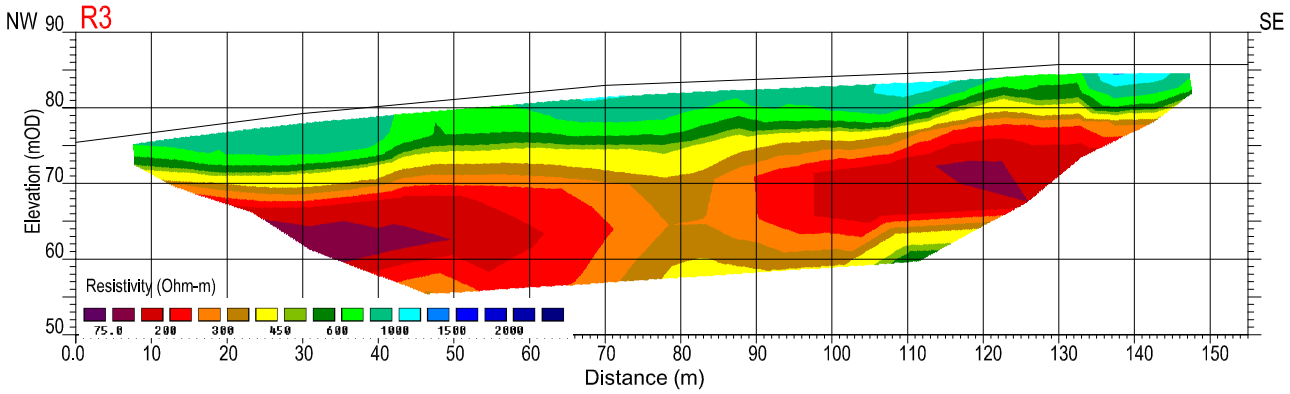
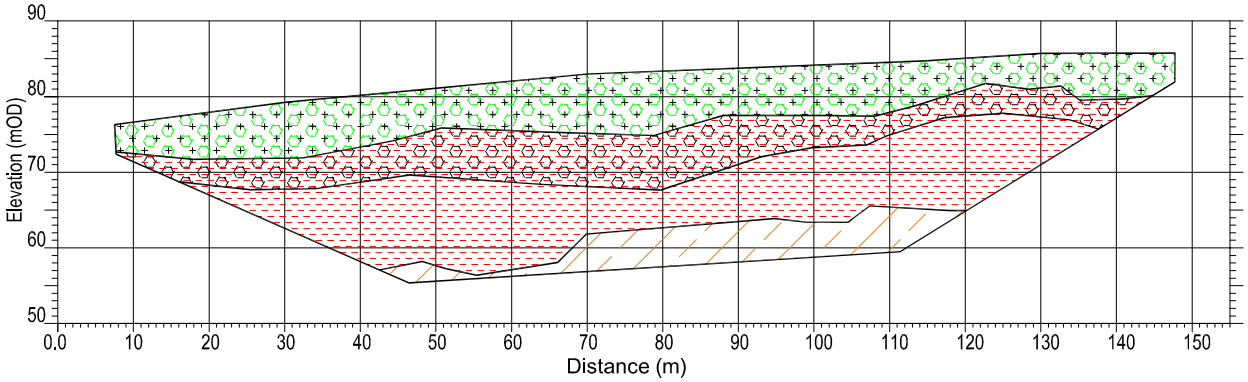
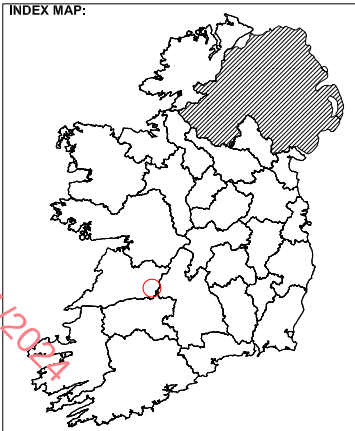
FIGURE 1: RESULTS & INTERPRETATION - ERT R3

SCALE 1:1000





INDEX MAP:



LEGEND:

- SAND/GRAVEL
- Silty SAND/GRAVEL
- Clayey SAND/GRAVEL
- Gravelly CLAY
- ROCK (SANDSTONE/ MUDSTONE/CONGLOM.)

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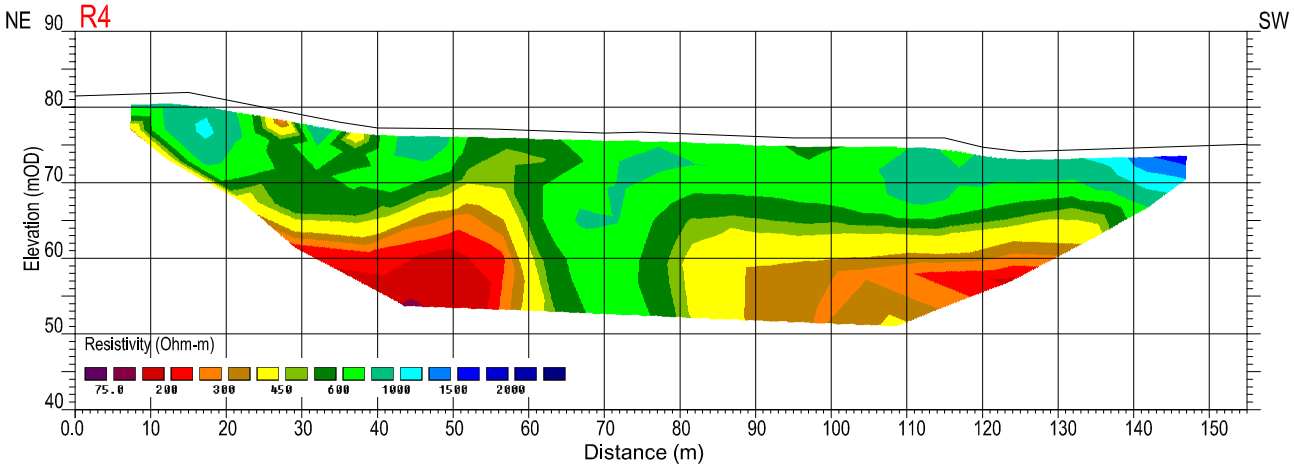
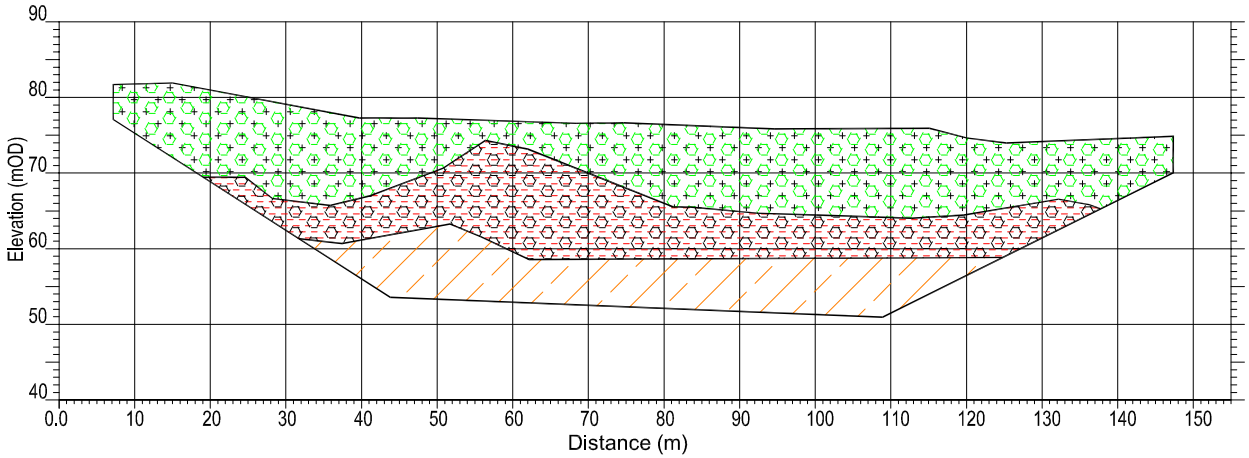
FIGURE 1: RESULTS & INTERPRETATION - ERT R4

SCALE 1:1000

Stockpile





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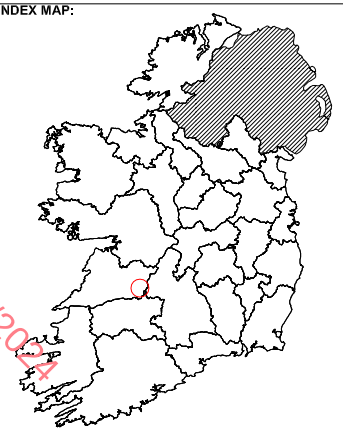

LEGEND:

- SAND/GRAVEL
- Silty SAND/GRAVEL
- Clayey SAND/GRAVEL
- Gravelly CLAY
- ROCK (SANDSTONE/ MUDSTONE/CONGLOM

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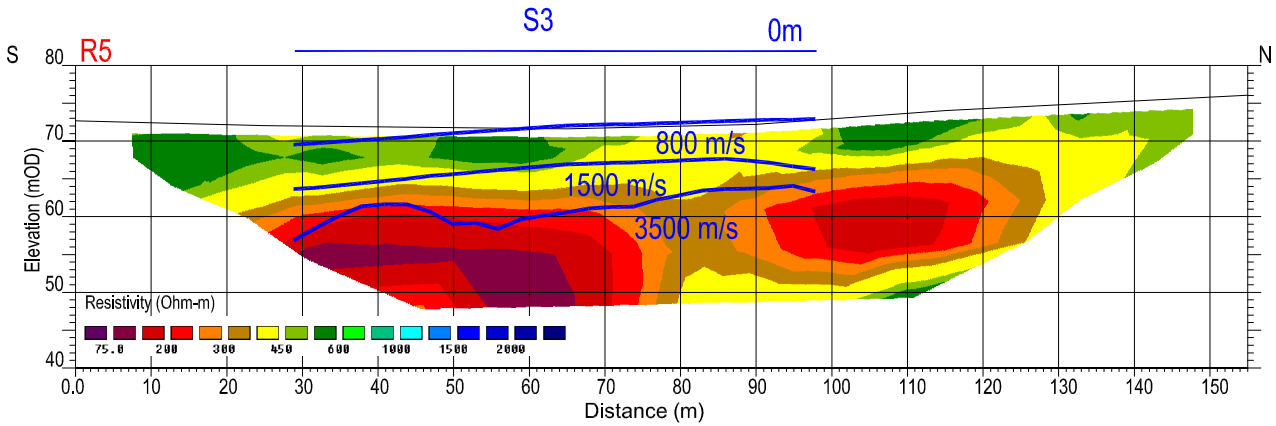
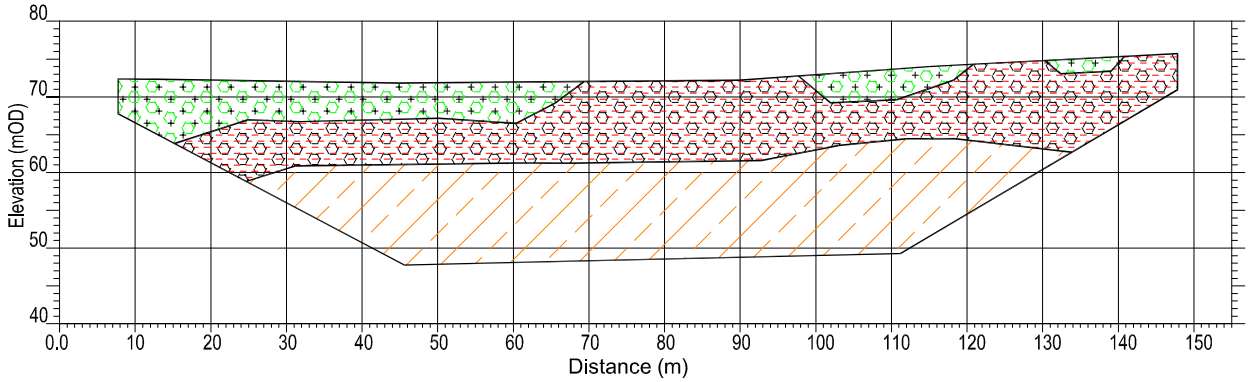
FIGURE 1: RESULTS & INTERPRETATION - ERT R5 & SEISMIC REFRACTION S3

SCALE 1:1000





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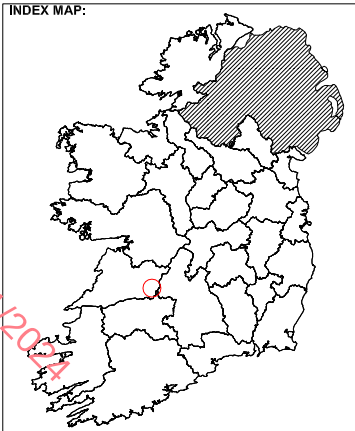

LEGEND:

- SAND/GRAVEL
- Silty SAND/GRAVEL
- Clayey SAND/GRAVEL
- Gravelly CLAY
- ROCK (SANDSTONE/ MUDSTONE/CONGLOM

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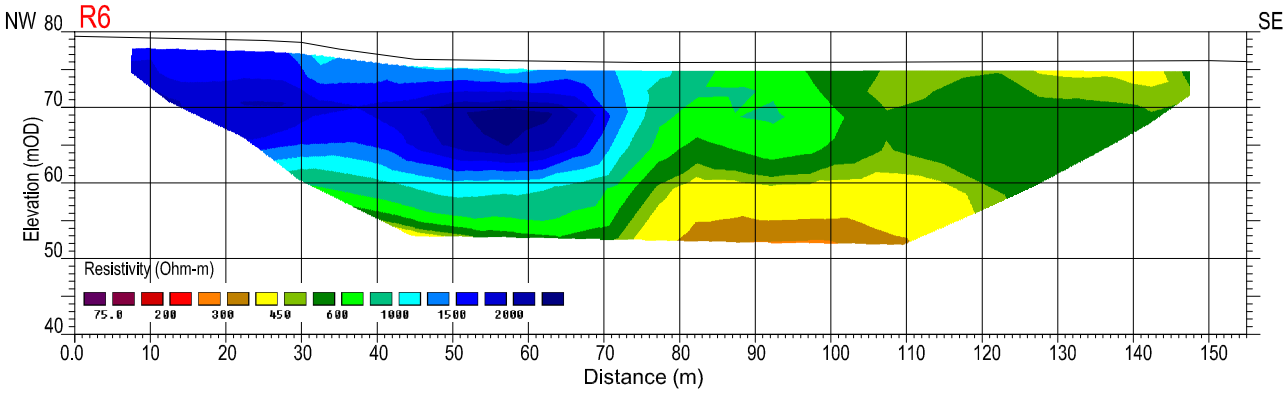
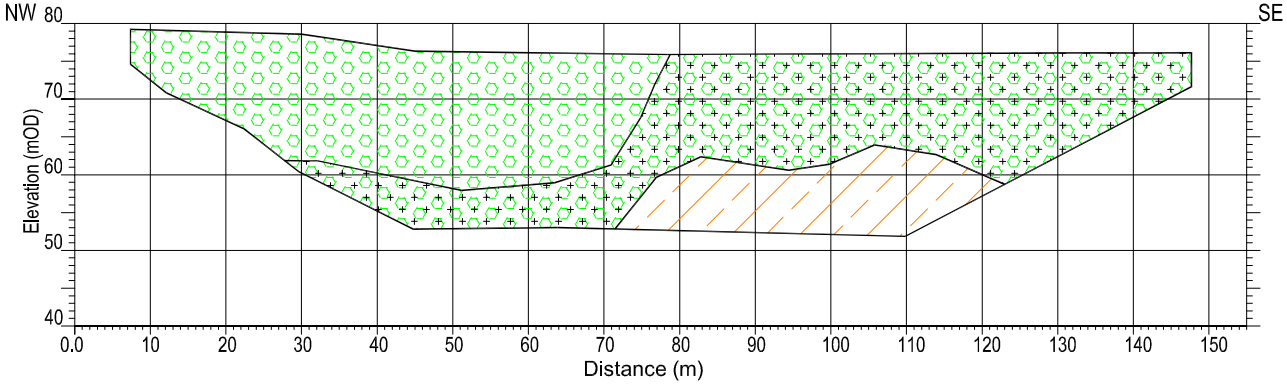
FIGURE 1: RESULTS & INTERPRETATION - ERT R6

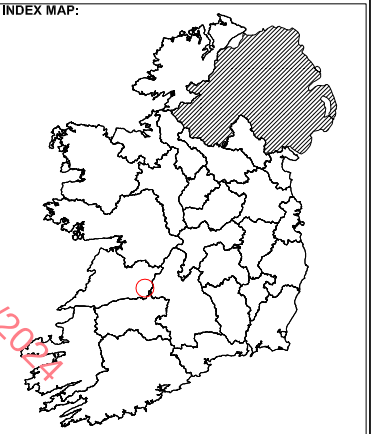
SCALE 1:1000

Stockpile





INDEX MAP:



LEGEND:

- SAND/GRAVEL
- Silty SAND/GRAVEL
- Clayey SAND/GRAVEL
- Gravelly CLAY
- ROCK (SANDSTONE/ MUDSTONE/CONGLOM

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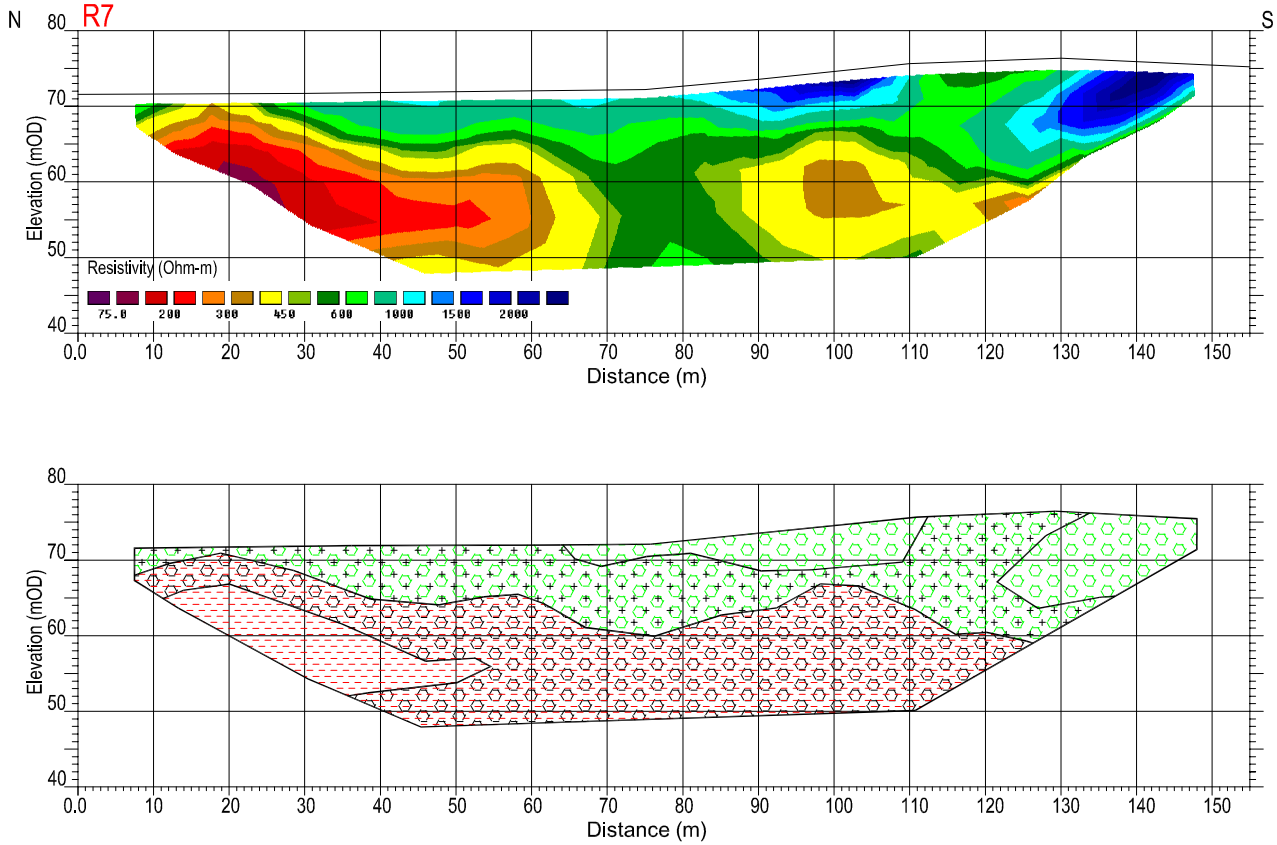
FIGURE 1: RESULTS & INTERPRETATION - ERT R7

SCALE 1:1000



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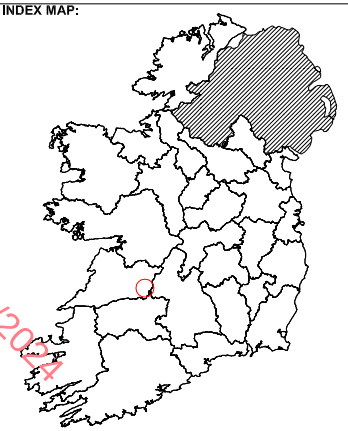

LEGEND:

- SAND/GRAVEL
- Silty SAND/GRAVEL
- Clayey SAND/GRAVEL
- Gravelly CLAY
- ROCK (SANDSTONE/ MUDSTONE/CONGLOM

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DATE:	09-12-2019

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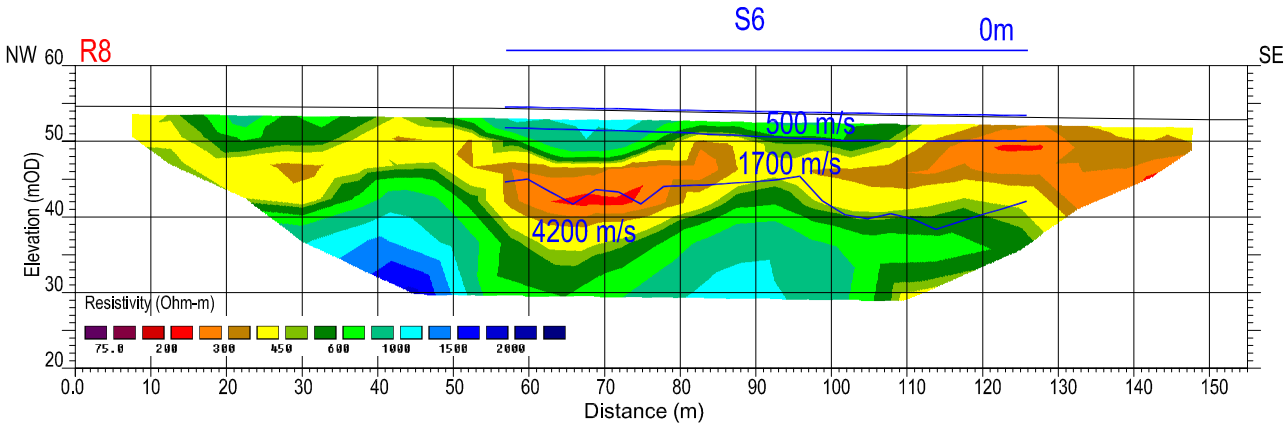
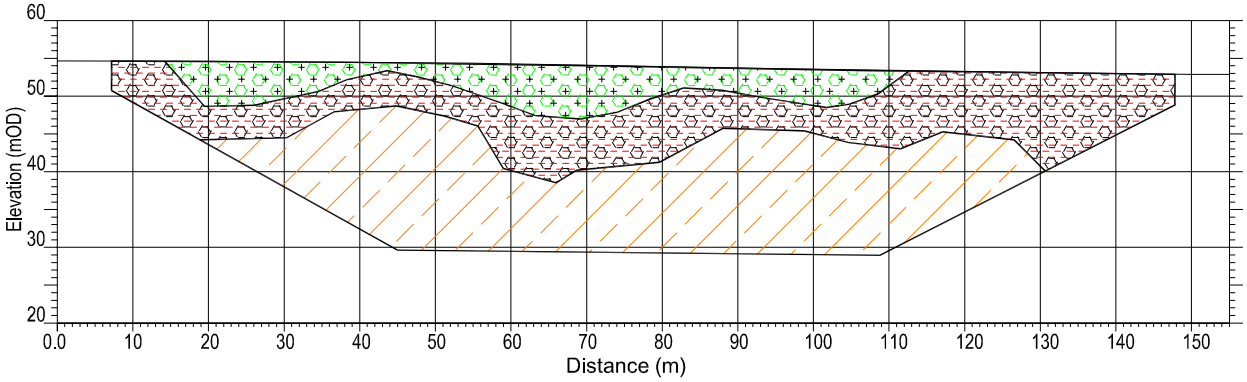
FIGURE 1: RESULTS & INTERPRETATION - ERT R8 & SEISMIC REFRACTION S6

SCALE 1:1000





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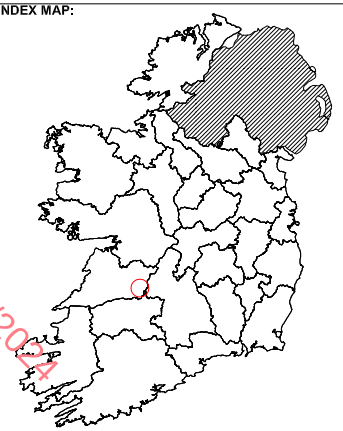

LEGEND:

- SAND/GRAVEL
- Silty SAND/GRAVEL
- Clayey SAND/GRAVEL
- Gravelly CLAY
- ROCK (SANDSTONE/ MUDSTONE/CONGLOM

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DATE:	09-12-2019

Version:	Date:	Drawn By:	Checked:
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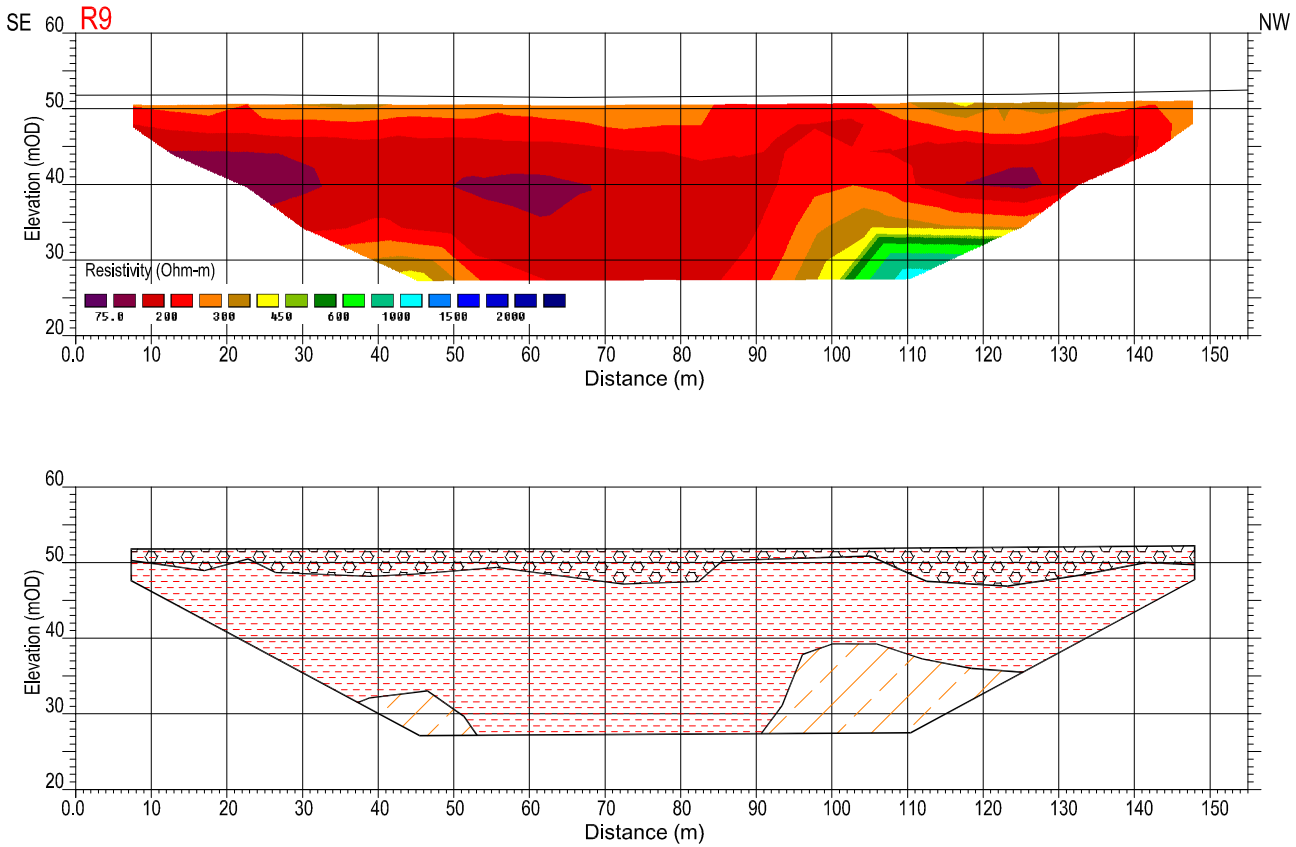
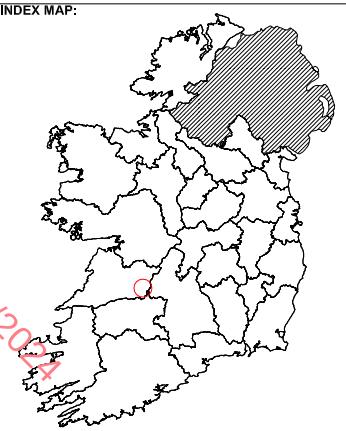
FIGURE 1: RESULTS & INTERPRETATION - ERT R9

SCALE 1:1000



INDEX MAP:



LEGEND:

- SAND/GRAVEL
- Silty SAND/GRAVEL
- Clayey SAND/GRAVEL
- Gravelly CLAY
- ROCK (SANDSTONE/ MUDSTONE/CONGLOM

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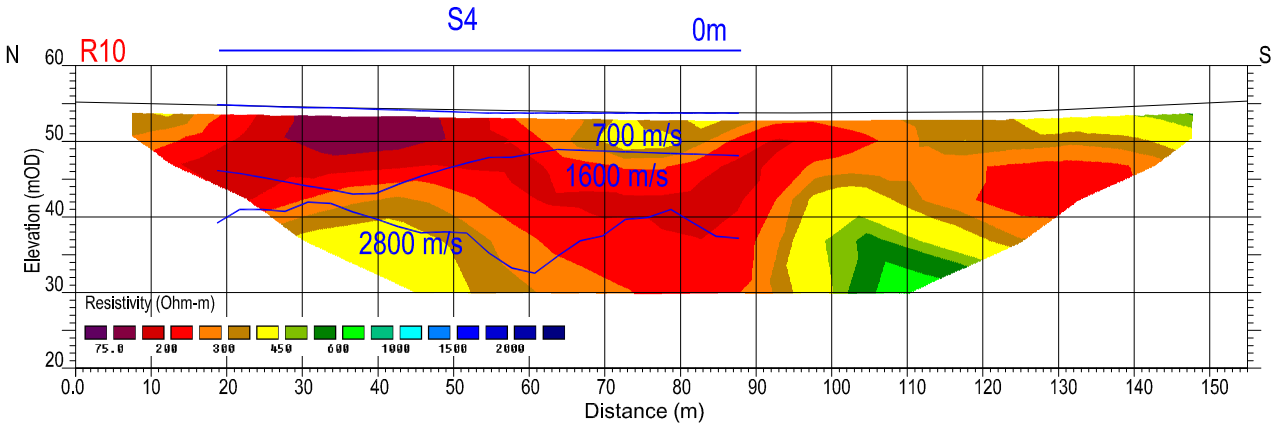
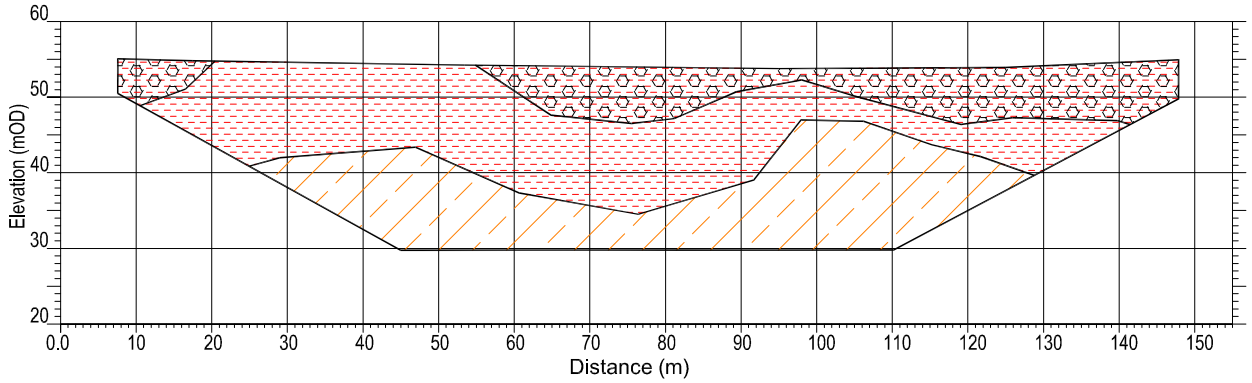
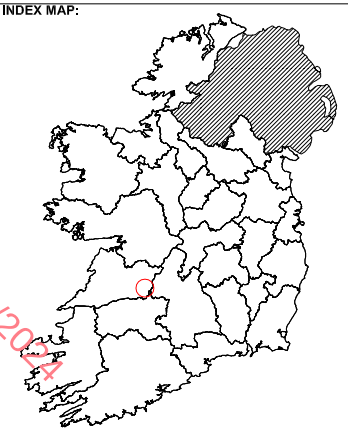
FIGURE 1: RESULTS & INTERPRETATION - ERT R10 & SEISMIC REFRACTION S4

SCALE 1:1000





INDEX MAP:



LEGEND:

- SAND/GRAVEL
- Silty SAND/GRAVEL
- Clayey SAND/GRAVEL
- Gravelly CLAY
- ROCK (SANDSTONE/ MUDSTONE/CONGLOM

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Version:	Date:	Drawn By:	Checked:
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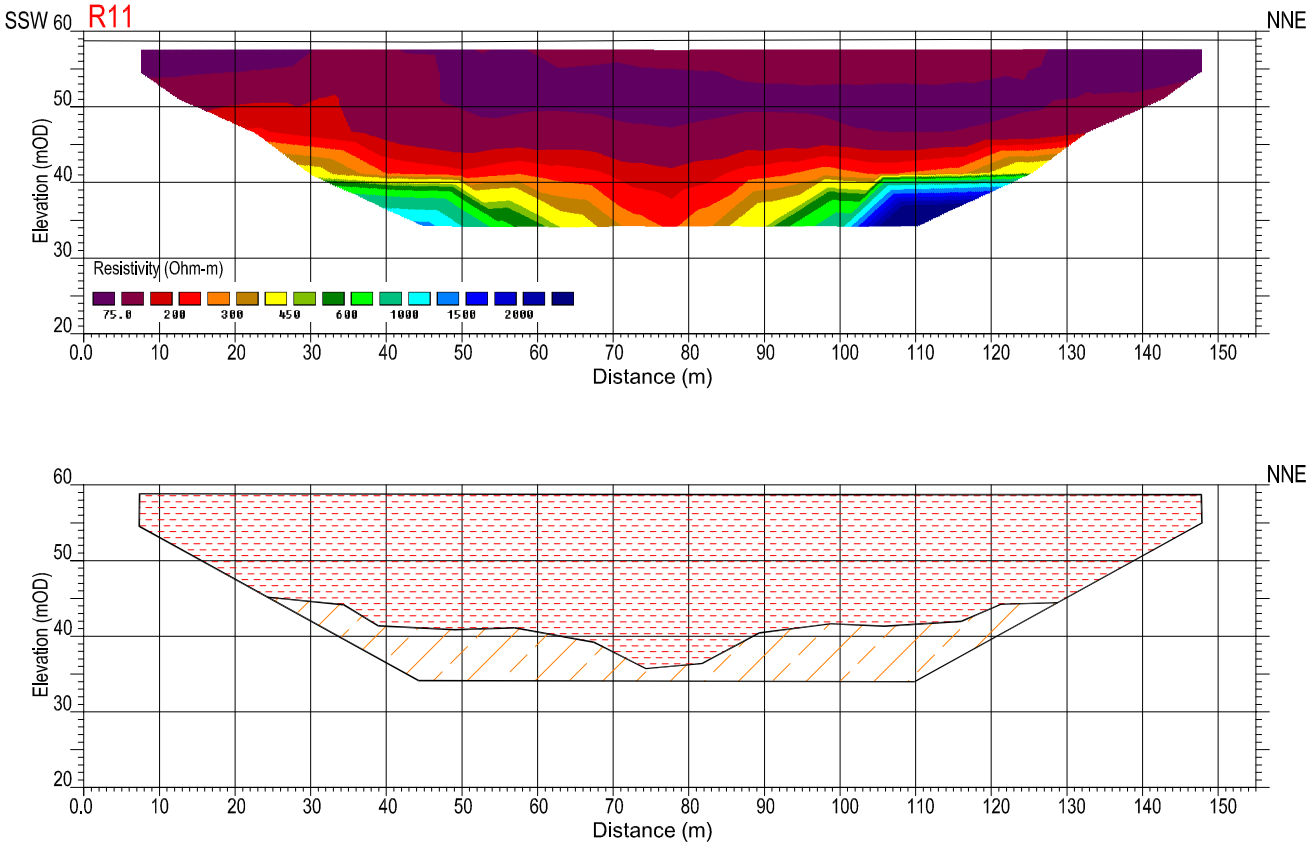
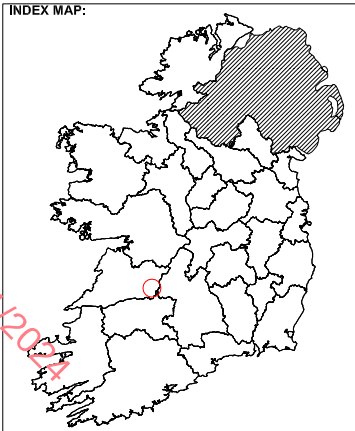
FIGURE 1: RESULTS & INTERPRETATION - ERT R11

SCALE 1:1000



INDEX MAP:



LEGEND:

- SAND/GRAVEL
- Silty SAND/GRAVEL
- Clayey SAND/GRAVEL
- Gravelly CLAY
- ROCK (SANDSTONE/ MUDSTONE/CONGLOM

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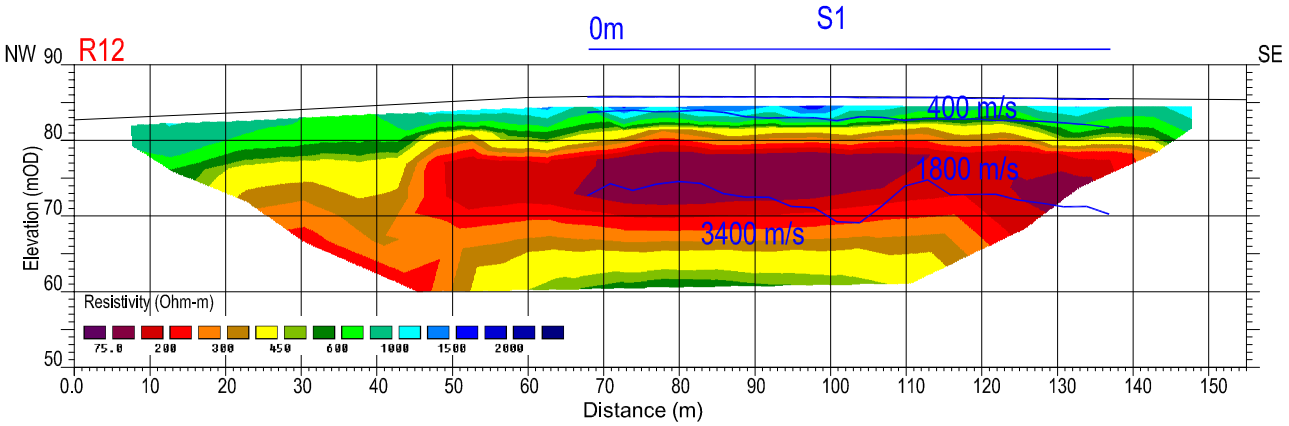
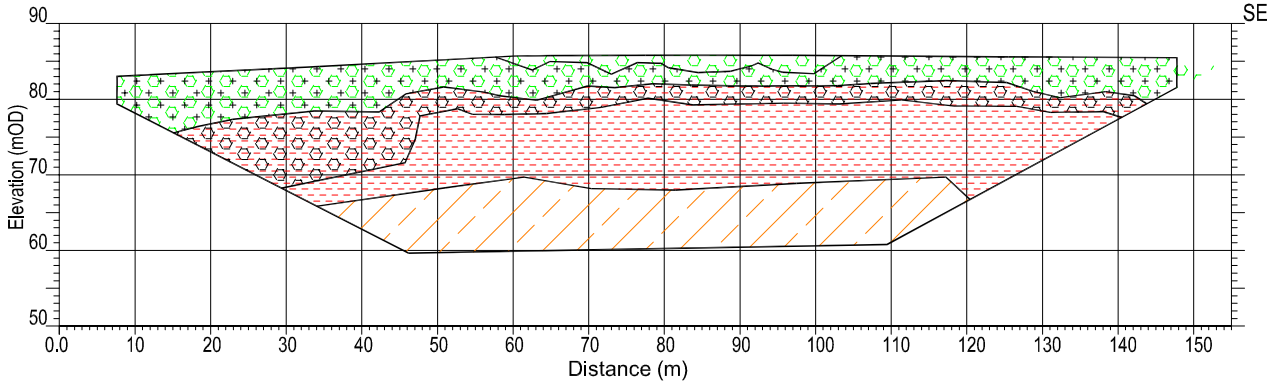
FIGURE 1: RESULTS & INTERPRETATION - ERT R12 & SEISMIC REFRACTION S1

SCALE 1:1000





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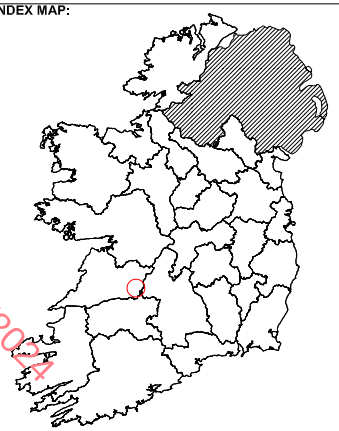

LEGEND:

- SAND/GRAVEL
- Silty SAND/GRAVEL
- Clayey SAND/GRAVEL
- Gravelly CLAY
- ROCK (SANDSTONE/ MUDSTONE/CONGLOM

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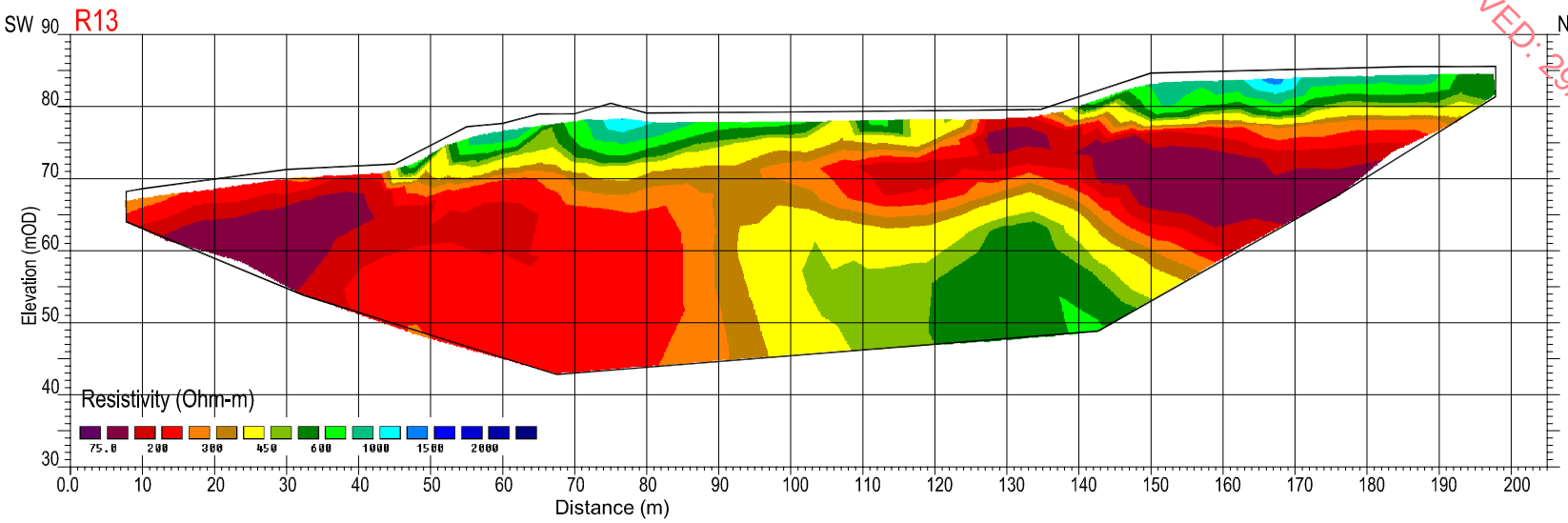
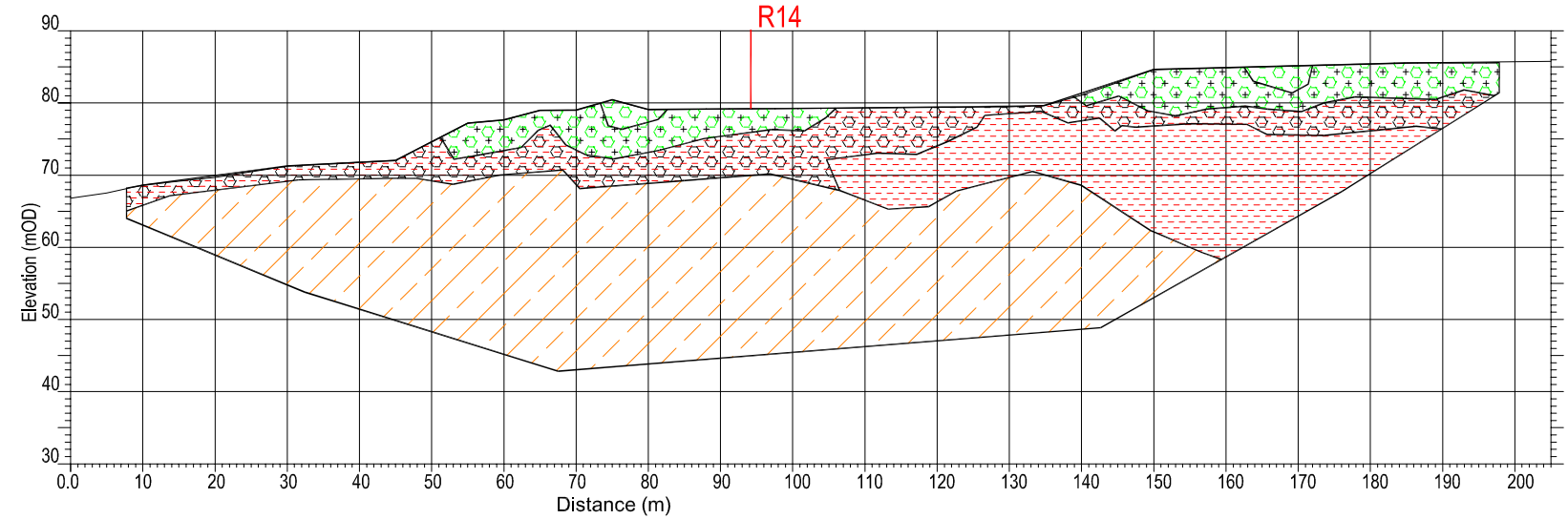
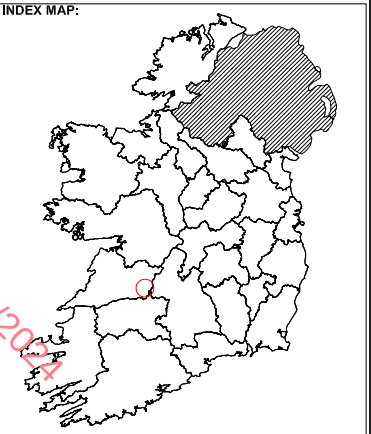
FIGURE 1: RESULTS & INTERPRETATION - ERT R13

SCALE 1:1000





INDEX MAP:



LEGEND:

- SAND/GRAVEL
- Silty SAND/GRAVEL
- Clayey SAND/GRAVEL
- Gravelly CLAY
- ROCK (SANDSTONE/ MUDSTONE/CONGLOM

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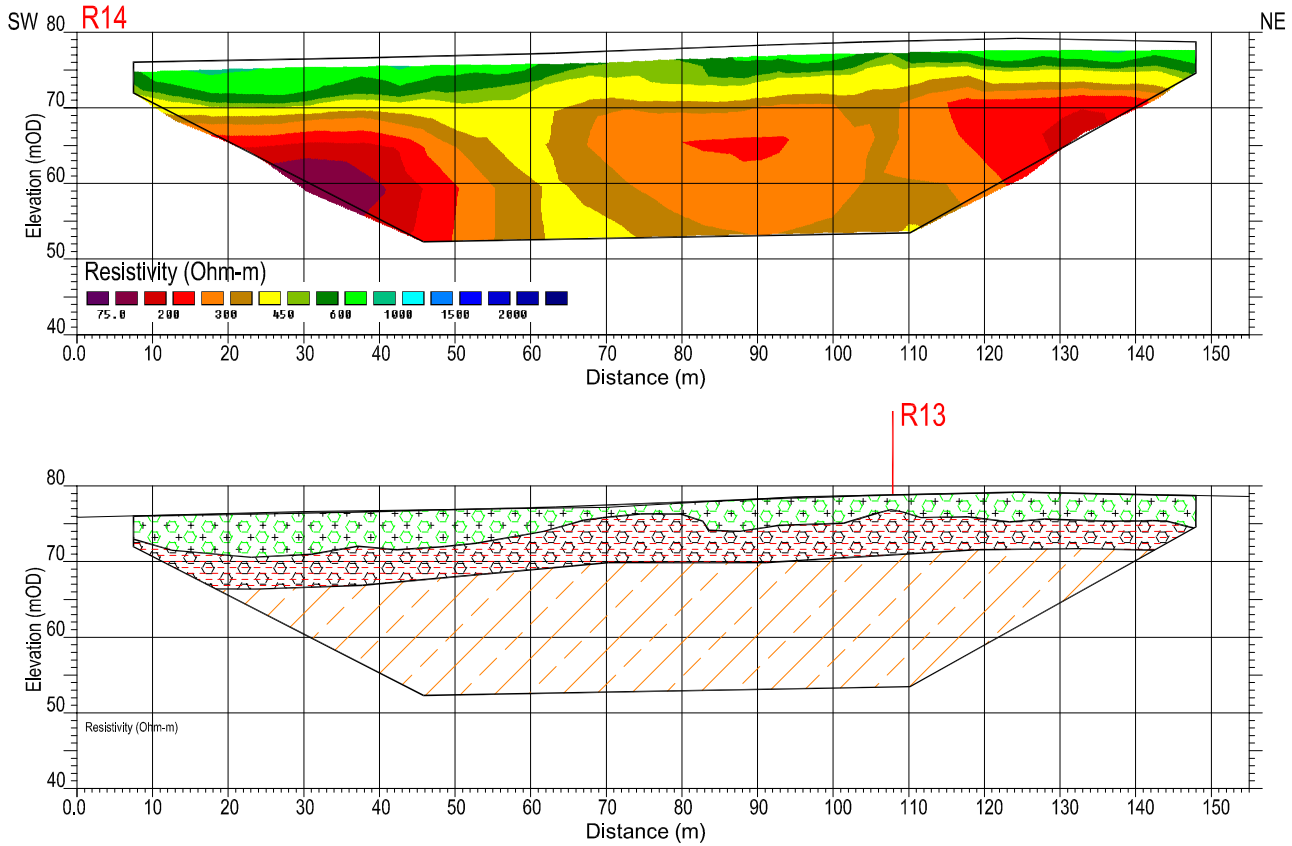
PROJECT:	BALLYQUIN PIT GEOPHYSICAL INVESTIGATION
CLIENT:	ROADSTONE LIMITED
DRAWING NO:	AGP19178_R13
SCALE:	AS INDICATED @ A4
DATE:	09-12-2019

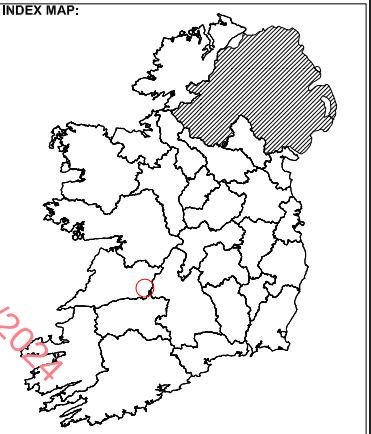
Version:	Date:	Drawn By:	Checked:
01	09-12-2019	MN	POC

FIGURE 1: RESULTS & INTERPRETATION - ERT R14

SCALE 1:1000



INDEX MAP:



LEGEND:

- SAND/GRAVEL
- Silty SAND/GRAVEL
- Clayey SAND/GRAVEL
- Gravelly CLAY
- ROCK (SANDSTONE/ MUDSTONE/CONGLOM

'The information displayed here is to be used in conjunction with Report AGP19178_01 Report on the Geophysical Investigation at BALLYQUIN PIT, County Clare for Roadstone Limited; APEX Geophysics Ltd. 9th December 2019'

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PROJECT:	BALLYQUIN PIT GEOPHYSICAL INVESTIGATION
CLIENT:	ROADSTONE LIMITED
DRAWING NO:	AGP19178_R14
SCALE:	AS INDICATED @ A4
DATE:	09-12-2019

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01	09-12-2019	MN	POC

APPENDIX B: DETAILED GEOPHYSICAL METHODOLOGY

A combination of geophysical techniques was used to provide a high quality interpretation and reduce any ambiguities, which November otherwise exist.

EM Ground Conductivity Mapping

Principles

This is an electromagnetic technique used to investigate lateral variations in overburden material and to assist with the indication of the depth to bedrock. This method operates on the principle of inducing currents in conductive substrata and measuring the resultant secondary electro-magnetic field. The strength of this secondary EM field is calibrated to give apparent ground conductivity in milliSiemens/metre (mS/m). Readings over material such as organic waste and peat give high conductivity values while readings over dry materials with low clay mineral content such as gravels, limestone or quartzite give low readings. The EM31 survey technique determines the apparent conductivity of the different overburden layers from 0-6m bgl depending on the dipole mode used.

Data collection

The EM31 equipment used was a GF CMD-4 conductivity meter equipped with data logger. This instrument features a real time graphic display of the previous 20 measurement points to monitor data quality and results. Conductivity and in-phase values were recorded across the site. Local conditions and variations were recorded.

Data processing

The conductivity and in-phase field readings were downloaded, contoured and plotted using the SURFER 12 program (Golden Software, 2015). Data which was affected by metallic objects was removed. Assignation of material types and possible anomaly sources was carried out, with cross-reference to other data.

Electrical Resistivity Tomography (ERT)

Electrical Resistivity Tomography was carried out to provide information on lateral variations in the overburden material as well as on the underlying overburden and bedrock.

Principles

This surveying technique makes use of the Wenner resistivity array. The 2D-resistivity profiling method records a large number of resistivity readings in order to map lateral and vertical changes in material types. This method involves the use of electrodes connected to a resistivity meter, using computer software to control the process of data collection and storage.

Data Collection

Profiles were recorded using a Tigre resistivity meter, imaging software, two 32 takeout multicore cables and up to 64 stainless steel electrodes. Saline solution was used at the electrode/ground interface in order to gain a good electrical contact required for the technique to work effectively. The recorded data were processed and viewed immediately after surveying.

Data Processing

The field readings were stored in computer files and inverted using the RES2DINV package (Geotomo Software, 2006) with up to 5 iterations of the measured data carried out for each profile to obtain a 2D-depth model of the resistivities.

The inverted 2D resistivity models and corresponding interpreted geology are displayed on the accompanying drawings alongside the processed seismic sections. Profiles have been contoured using the same contour intervals and colour codes. Distance is indicated along the horizontal axis of the profiles.

Seismic Refraction Profiling

Principles

This method measures the velocity of refracted seismic waves through the overburden and rock material and allows an assessment of the thickness and quality of the materials present to be made. Stiffer and stronger materials usually have higher seismic velocities while soft, loose or fractured materials have lower velocities.

Seismic profiling measures the p-wave velocity (Vp) of refracted seismic waves through the overburden and rock material and allows an assessment of the thickness and quality of the materials present to be made. Stiffer and stronger materials usually have higher Vp velocities while soft, loose or fractured materials have lower Vp velocities. Readings are taken using geophones connected via multi-core cable to a seismograph.

Data Collection

A Geode high resolution 24 channel digital seismograph, 24 10HZ vertical geophones and a 10 kg hammer were used to provide first break information, with a 24 take-out cable. Equipment was carried and operated by a two-person crew.

Readings are taken using geophones connected via multi-core cable to a seismograph. The depth of resolution of soil/bedrock boundaries is determined by the length of the seismic spread, typically the depth of resolution is about one third the length of the profile.(eg. 69m profile ~23m depth, 33m profile ~ 11m depth).

Data Processing

First break picking in digital format was carried out using the FIRSTPIX software program to construct p-wave (Vp) traveltime plots for each spread. Velocity phases were selected from these plots using the GREMIX software program and were used to calculate the thickness of individual velocity units. Topographic data were input. Material types were assigned and estimation made of material properties, cross-referenced to borehole and MASW data. The processed seismic data are displayed in Appendix A.

First break picking in digital format was carried out using the FIRSTPIX software program to construct traveltime plots for each spread. The recorded data was processed and interpreted using the ray-tracing and tomographic inversion methods, to acquire depths to boundaries and the P-wave velocities of these layers, using the SeisImager/2D programme from Geometrics. Material types were assigned and estimation made of material properties, cross-referenced to borehole and MASW data. The processed seismic data are displayed in Appendix A.

GREMIX interprets seismic refraction data as a laterally varying layered earth structure. It incorporates the slope-intercept method, parts of the Plus-Minus Method of Hagedoorn (1959), Time-Delay Method, and features the

Generalized Reciprocal Method (GRM) of Palmer (1980). Up to four layers can be mapped; one deduced from direct arrivals and three deduced from refractions. Phantoming of all possible travel time pairs can be carried out by adjusting reciprocal times of off shots.

Approximate errors for Vp velocities are estimated to be +/- 10%. Errors for the calculated layer thicknesses are of the order of +/-20%. Possible errors due to the "hidden layer" and "velocity inversion" effects November also occur (Soske, 1959).

Spatial Relocation

All the geophysical investigation locations were acquired using a Trimble Geo 7X high-accuracy GNSS handheld system using the settings listed below. This system allows collection of GPS data with c.20mm accuracy.

Projection:	Irish Transverse Mercator
Datum:	Ordnance
Coordinate units:	Meters
Altitude units:	Meters
Survey altitude reference:	MSL
Geoid model:	Republic of Ireland

APPENDIX C: SEISMIC PLATES

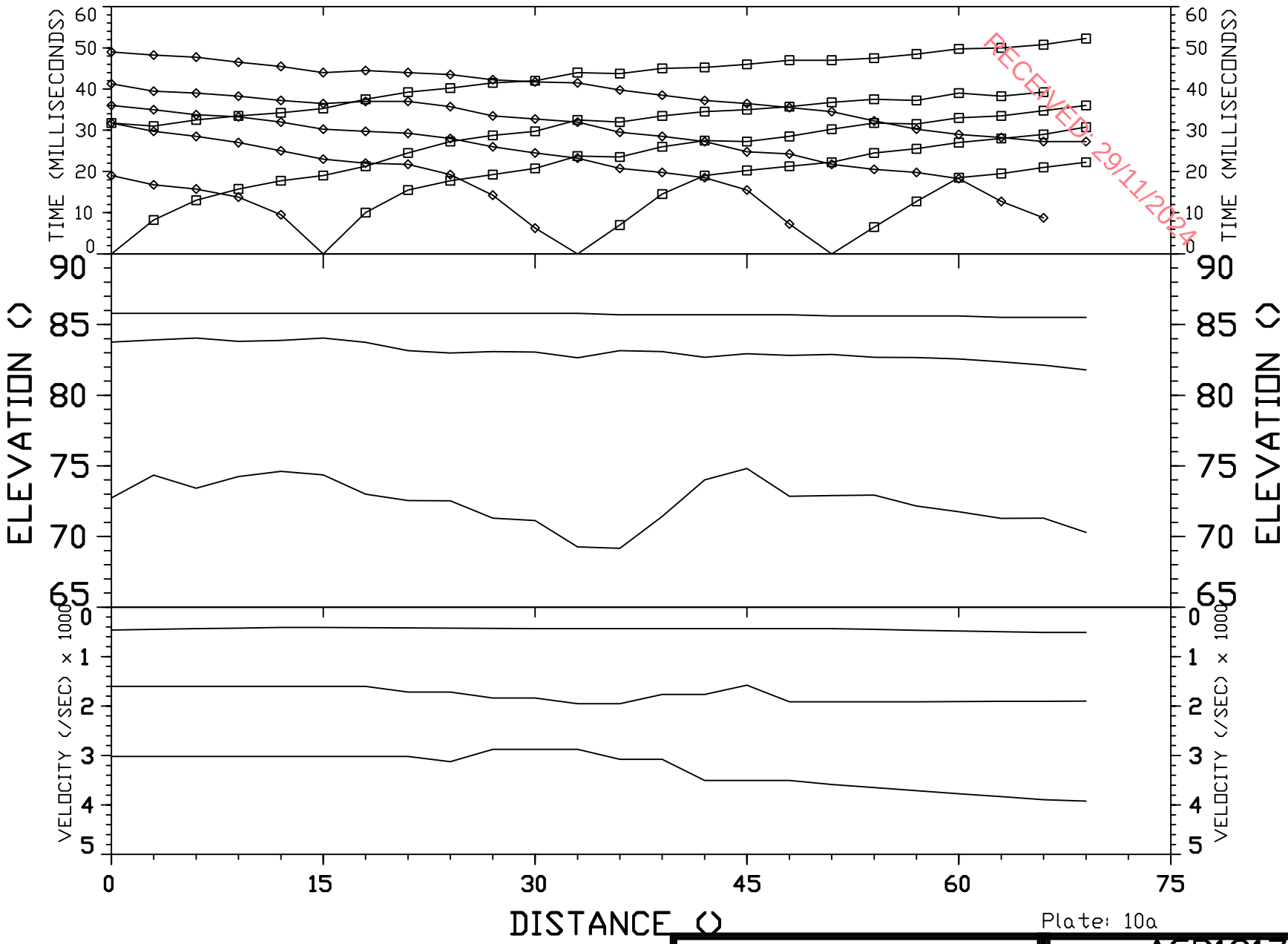

Plate: 10a

for: Roadstone Limited	AGP19178
by: APEX Geophysics Ltd.	Ballyquin Clare
Data SetS1 / Date: 29/10/19	
Equipment: Geode / Spread: S1	Azimuth:

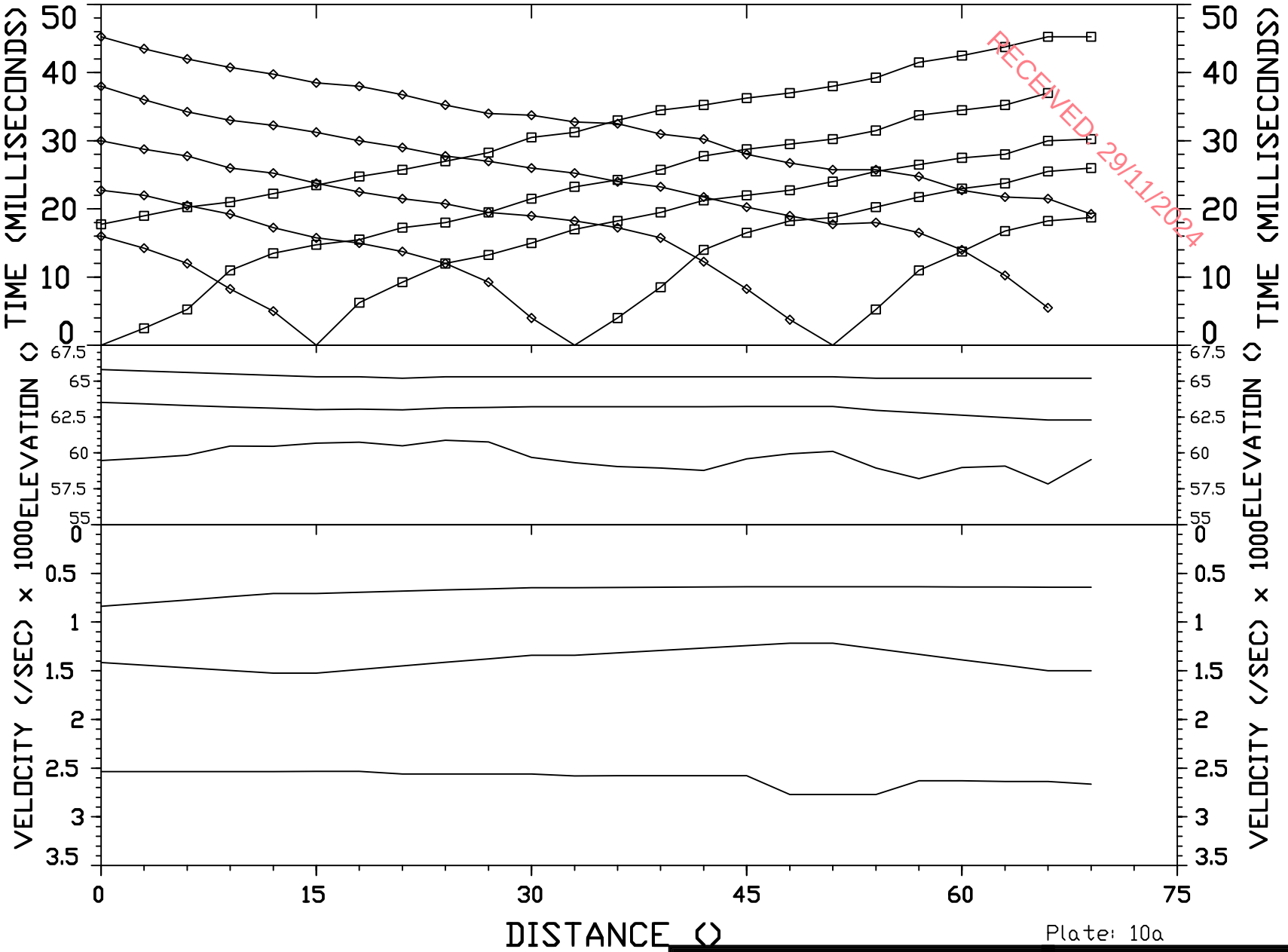

Plate: 10a

for: Roadstone Limited	AGP19178
by: APEX Geophysics Ltd.	Ballyquin Clare
Data SetS2 / Date: 29/10/19	
Equipment: Geode / Spread: S2	Azimuth:

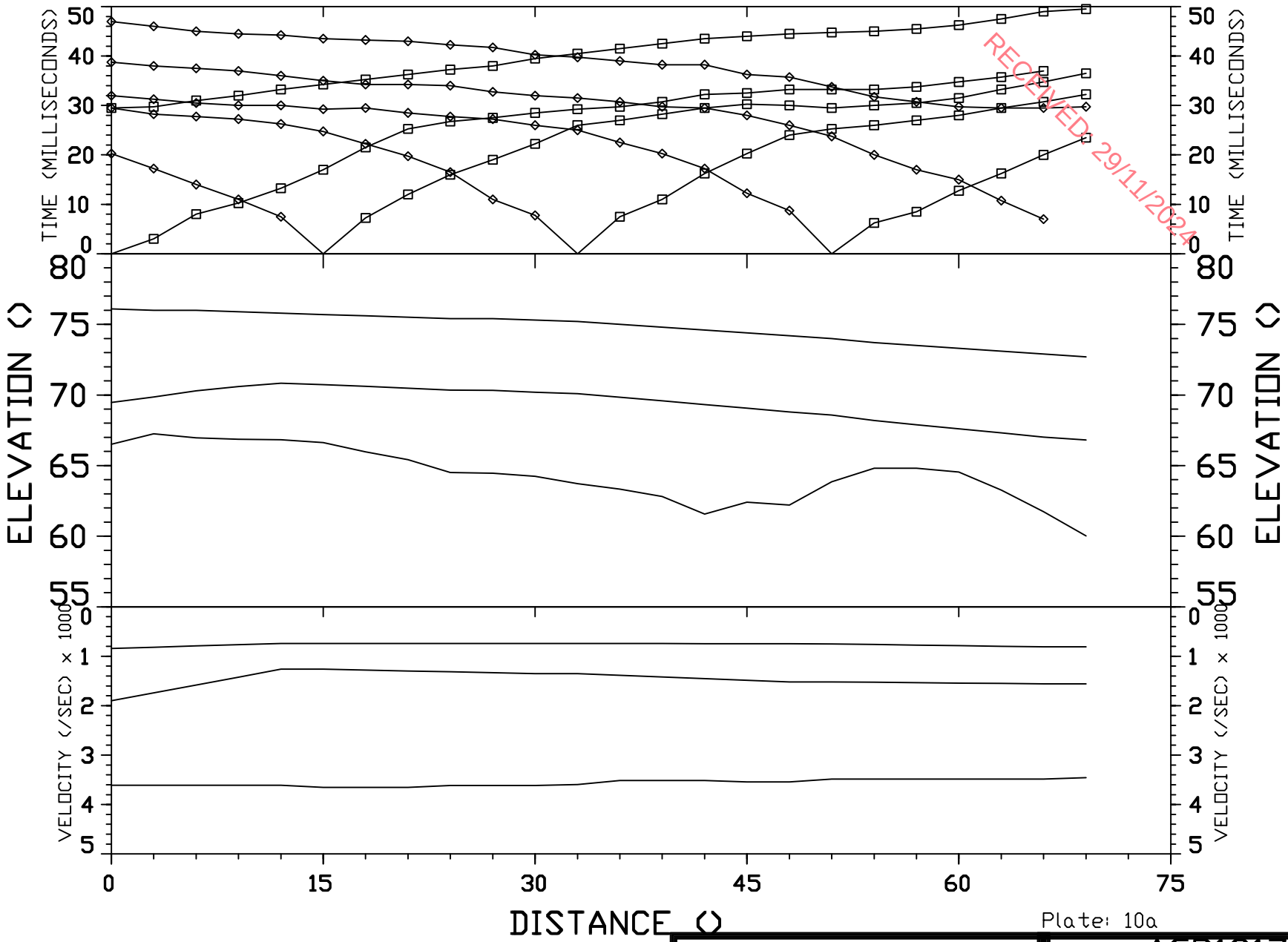

Plate: 10a

for: Roadstone Limited	AGP19178
by: APEX Geophysics Ltd.	Ballyquin Clare
Data SetS3 / Date: 29/10/19	
Equipment: Geode / Spread: S3	Azimuth:

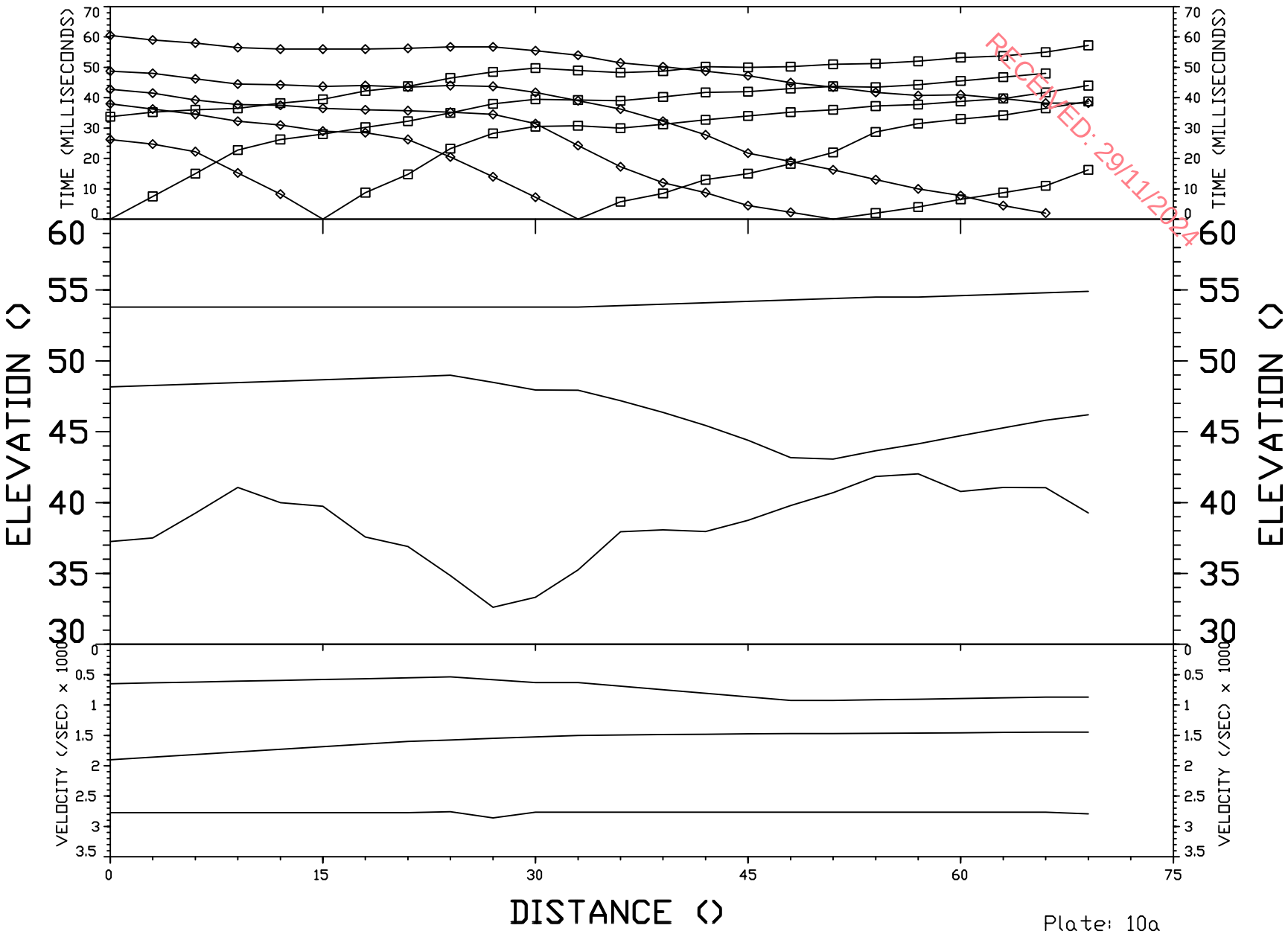

Plate: 10a

for: Roadstone Limited	AGP19178
by: APEX Geophysics Ltd.	Ballyquin Clare
Data SetS4 / Date: 29/10/19	
Equipment: Geode / Spread: S4	Azimuth:

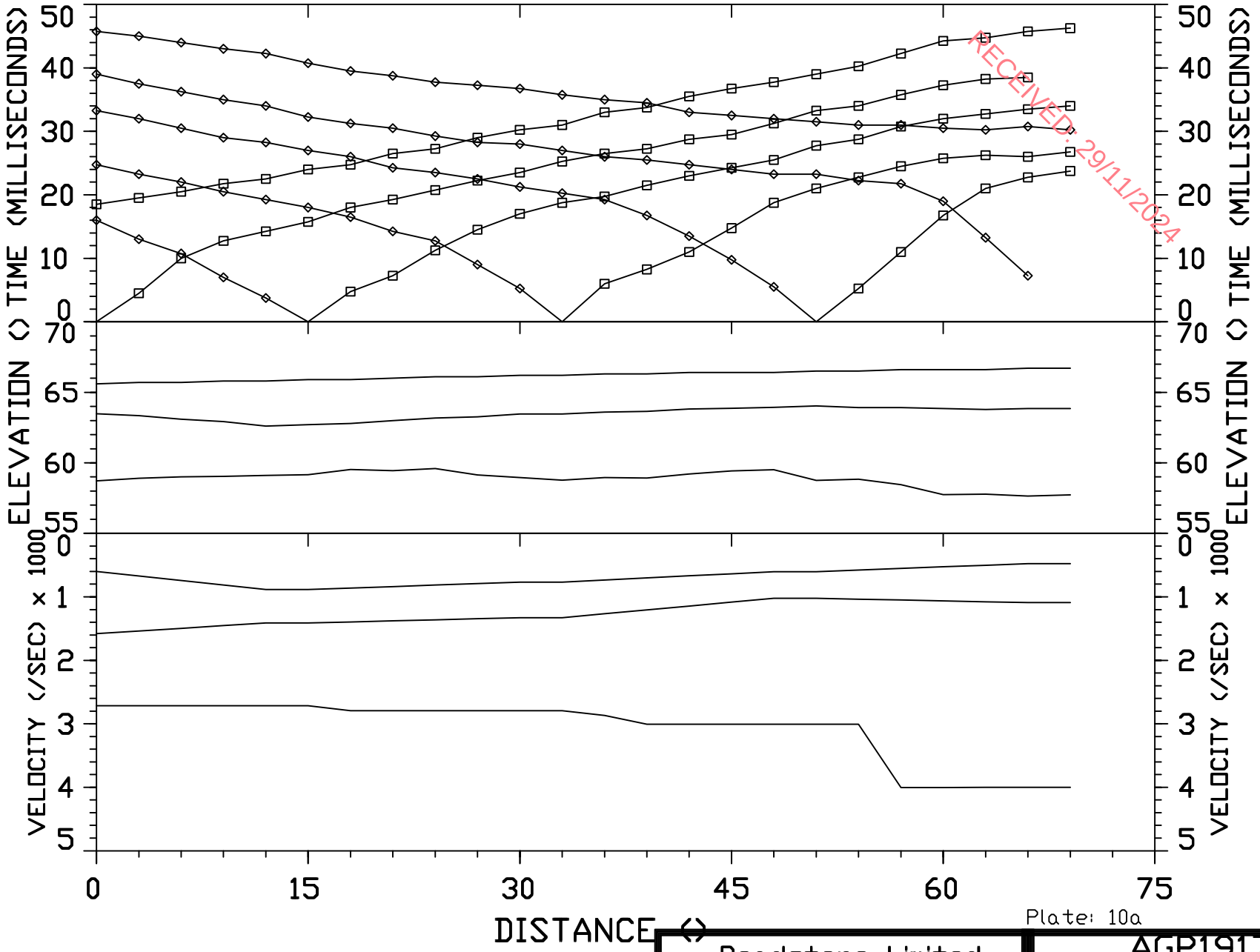

Plate: 10a

for: Roadstone Limited	AGP19178
by: APEX Geophysics Ltd.	Ballyquin Clare
Data SetS5 / Date: 29/10/19	
Equipment: Geode / Spread: S5	Azimuth:

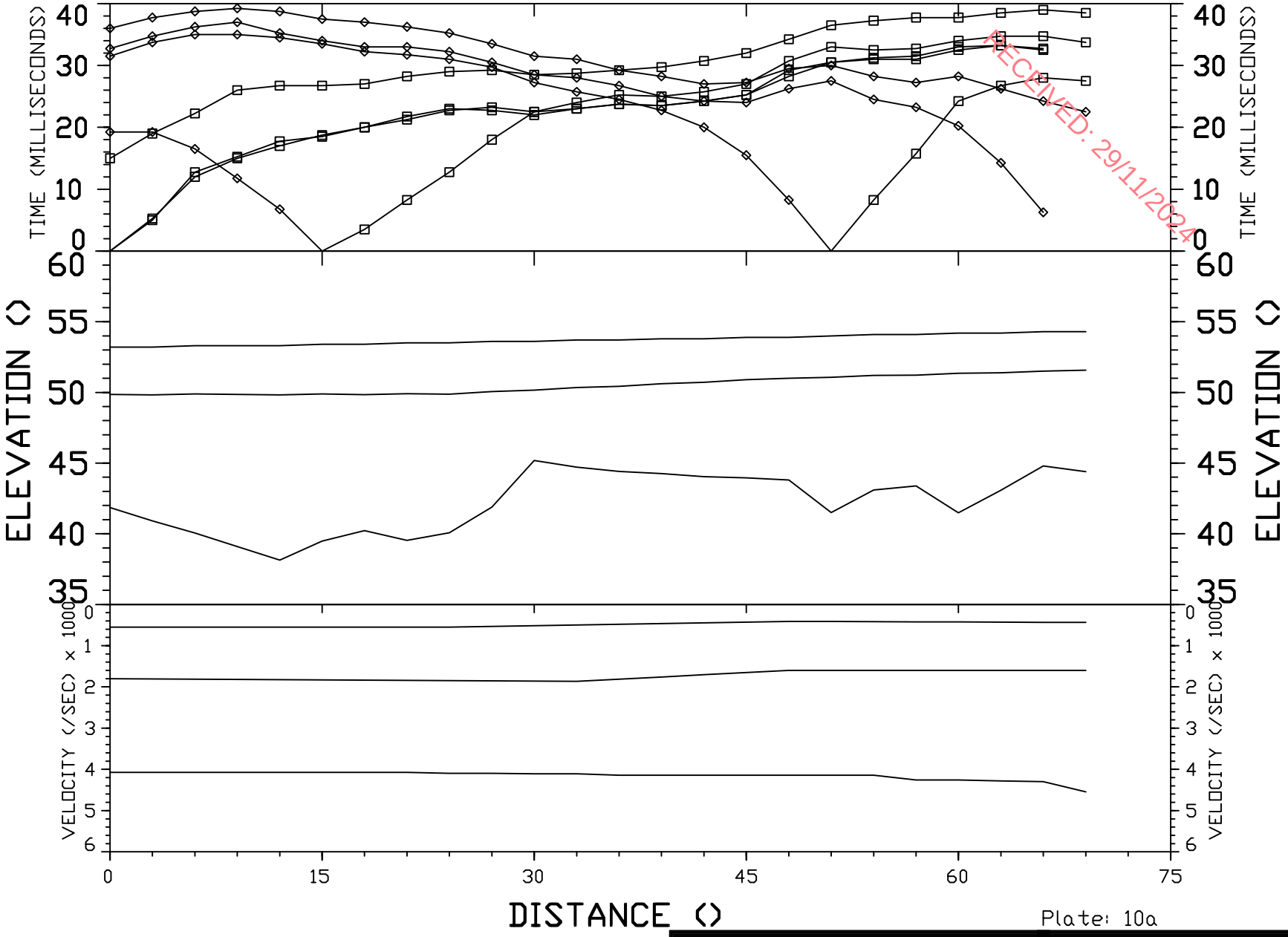

Plate: 10a

for: Roadstone Limited	AGP19178
by: APEX Geophysics Ltd.	Ballyquin Clare
Data SetS6 / Date: 29/10/19	
Equipment: Geode / Spread: S6	Azimuth:

APPENDIX D: 2013 REPORT

AGL13211

Report for Geophysical Investigation

at

Ballyquinn

for

Roadstone Wood Limited

30TH OCTOBER 2013

APEX Geoservices Limited
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PRIVATE AND CONFIDENTIAL

THE FINDINGS OF THIS REPORT ARE THE RESULT OF A GEOPHYSICAL SURVEY USING NON-INVASIVE SURVEY TECHNIQUES CARRIED OUT AT THE GROUND SURFACE. INTERPRETATIONS CONTAINED IN THIS REPORT ARE DERIVED FROM A KNOWLEDGE OF THE GROUND CONDITIONS, THE GEOPHYSICAL RESPONSES OF GROUND MATERIALS AND THE EXPERIENCE OF THE AUTHOR. APEX GEOSERVICES LTD. HAS PREPARED THIS REPORT IN LINE WITH BEST CURRENT PRACTICE AND WITH ALL REASONABLE SKILL, CARE AND DILIGENCE IN CONSIDERATION OF THE LIMITS IMPOSED BY THE SURVEY TECHNIQUES USED AND THE RESOURCES DEVOTED TO IT BY AGREEMENT WITH THE CLIENT. THE INTERPRETATIVE BASIS OF THE CONCLUSIONS CONTAINED IN THIS REPORT SHOULD BE TAKEN INTO ACCOUNT IN ANY FUTURE USE OF THIS REPORT.

PROJECT NUMBER	AGL13211		
AUTHOR	**CHECKED**	**REPORT STATUS**	**DATE**
MALCOLM FITZELL B.SC. (GEOL)	KEVIN GALVIN B.A (MOD)	V.01	30TH OCTOBER 2013

CONTENTS

1. EXECUTIVE SUMMARY

APEX Geoservices Limited was requested by Roadstone Wood Limited to carry out a geophysical investigation adjacent to the Ballyquin Sand & Gravel Pit, Co. Clare. The purpose of the geophysical investigation was to identify the sand and gravel extents and thickness across the site. The site is c.12 acres in extents and is currently divided up into three fields as shown in Figure 2.2 below. The fields are adjacent to the existing sand & gravel quarry.

The investigation consisted of Conductivity Mapping Seismic Refraction and 2D Electrical Resistivity Tomography (ERT).

The survey area comprises a c.6.6 Ha (c.16.3 acres) area to the south-east of the existing quarry.

The geophysical survey has outlined a sand/gravel body which ranges in thickness generally between 7.4m and 14.6m body across the survey area and is considered an economic resource subject to confirmation by direct intrusive site investigation.

The resource has been calculated based on an average thickness of 9.0m for the interpreted clean sand/gravel to comprise

A resource of 891,000 tonnes has been estimated for the site.

It is recommended that four boreholes be drilled through the gravel and underlying material (clayey/silty sand/gravel and saturated sand/gravel) to rock head to confirm the thickness of the resource and to confirm the type and thickness of the underlying material.

2. INTRODUCTION

APEX Geoservices Limited was requested by Roadstone Wood Limited to carry out a geophysical investigation adjacent to the Ballyquin Sand & Gravel Pit, Co. Clare. The purpose of the geophysical investigation was to identify the sand and gravel extents and thickness across the site. The site is c.4.9 Ha (c.12 acres) in extent and is currently divided up into three fields as shown in Figure 2.2 below. The fields are adjacent to the existing sand & gravel quarry.

The investigation consisted of Conductivity Mapping, 2D Electrical Resistivity Tomography (ERT) and Seismic Refraction profiling.

2.1 Survey Objectives

The objectives of the survey were to:

1. Outline the sand and gravel deposits across the site
2. Estimate the thickness and volume of the sand and gravel deposits
3. Provide targets for intrusive investigations.

2.2 Site Background

The site is located about 1.5 Km north-west of the village of Bridgetown, Co. Clare and the present survey area covers approximately 4.6Ha of the existing 16Ha quarry.

Ballyquinn Sand and Gravel Pit is situated immediately to the north-west of the survey area.

2.2.1 Topography

The topography of the survey area comprises a low, rounded hill approximately 95mOD with moderate-steep slopes down to the south and east to approximately 52mOD (Fig. 2.1). The survey area is situated immediately to the east of Ballyquinn Sand and Gravel Pit and there is a pit face immediately to the west of the survey area.

2.2.2 Geology

The digital Geological Survey of Ireland Bedrock Geology map (www.gsi.ie) indicates that the survey area is underlain by the Old Red Sandstone (Devonian) comprising conglomerate, sandstone and mudstone. Lower Limestone Shale (Carboniferous) is shown to the south-east of the survey area.

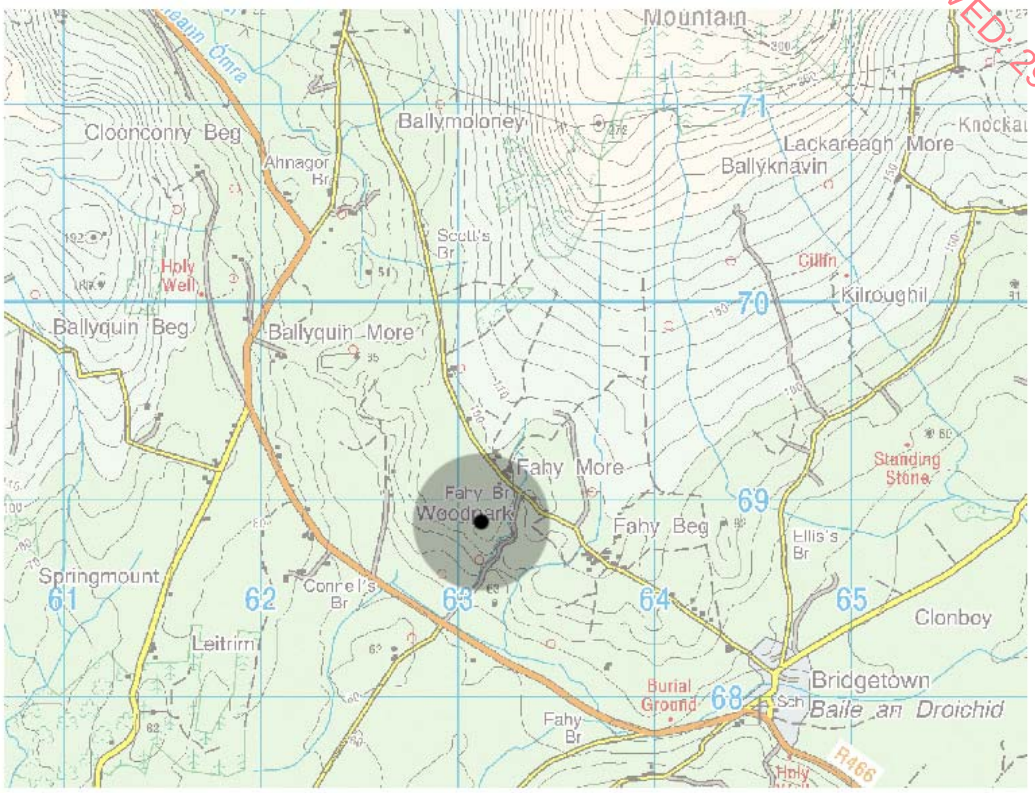

Figure 2.1 Location map of the survey area

2.2.2 Superficial Deposits

The digital Geological Survey of Ireland Quaternary (Subsoils) map (www.gsi.ie) indicates that the superficial deposits of the survey area consist of gravels with glacial till (boulder clay) in the extreme north-west.

2.2.4 Hydrogeology

The digital Geological Survey of Ireland Groundwater Aquifer map (www.gsi.ie) classifies the aquifer underlying the area as a Locally Important Aquifer (Gravel).

The digital Geological Survey of Ireland Groundwater Vulnerability map classifies the aquifer underlying the area as having high vulnerability to contamination.

Fig.2.2 Aerial view of Ballyquinn Sand and Gravel Pit showing the area of investigation.

2.3 Survey Rationale

Electrical Resistivity Tomography (ERT) soundings image the resistivity of the materials in the subsurface along a profile to produce a pseudo-section showing the variation in resistivity to 27m bgl for a 155m long profile and to 58m bgl-58m bgl for a 315m profile. Each pseudo-section is interpreted to determine the material type along the profile at increasing depth, based on the typical resistivities returned for Irish ground materials. Sand & gravel can be expected to have a resistivity greater than approx. 1000 ohm-m, silty/clayey gravel approx. 600-1000 ohm-m, and clay/silt can be expected to have a resistivity of 25-100 ohm-m.

Conductivity Mapping works on the same geophysical principle as ERT, and in this case materials with a low resistivity will have a high conductivity. Conductivity mapping is carried out using an EM31 Conductivity Meter, which is carried across the ground in set pattern, to provide conductivity values for the materials from 0 – 6.0m bgl.

Seismic Refraction Profiling measures the velocity of refracted seismic waves through the overburden and rock material and allows an assessment of the thickness and quality of the materials present to be made. Stiffer and stronger materials usually have higher seismic velocities while soft, loose or fractured materials have lower velocities. Readings are taken using geophones connected via multi-core cable to a seismograph. This method should allow profiling of the depth to the top of the bedrock, along profiles across the site.

3. RESULTS & INTERPRETATION

3.1 Seismic Refraction Profiling

One seismic refraction spread (Profile S1) was recorded across the site. Profile S1 was 46m in length with a depth of investigation of approx. 20m. Profile S1 was recorded on ERT (Resistivity) Profile R1 between R1/220m and 266m.

The seismic data has outlined three velocity layers and has been interpreted on the following basis:

Layer	P-wave Seismic Velocity (m/s)	Thickness (m)	Interpretation	Stiffness/Rock Quality	Excavatibility
1	310-430	0-2.6	Overburden	Soft/Loose	Diggable
2	520-620	11.8-15.0	Overburden	Medium Dense	Diggable
3	1380-1690		Moderately-Slightly Weathered Bedrock	Fair-Good	Marginally Rippable – Break/Blast

Table 1: Interpretation of seismic refraction data

3.2 2D Electrical Resistivity Tomography (ERT)

Six 2-D ERT Profiles (R1-R6) have been acquired across the site and are displayed on Drawing AGL 13211_01. The profiles have been interpreted on the following basis:

Resistivity (Ohm-m)	Interpretation
>1000	Sand/Gravel
450-1000	Saturated Sand/Gravel
450-1000	Silty/Clayey Sand/Gravel
150-450	Rock (Conglomerate/Sandstone/Shale)

Table 2: Interpretation of ERT data

Sand/Gravel: The material in this layer has resistivity values in excess of 1000 ohm-m and is present on all survey profiles at or close to the surface. This layer ranges in thickness generally between 7.4m and 14.6m. This sand/gravel is expected to have economic potential subject to confirmation by direct intrusive investigation (e.g. trial pits, boreholes).

Silty/Clayey Sand/Gravel: This layer has resistivity values of 450-1000 ohm. This material has been interpreted on all profiles as discontinuous lenses mostly at or near the base of the sand/gravel layer. This unit may have some economic potential subject to clay/silt content.

Saturated Sand/ Gravel: The resistivity range of this layer is 450-1000 ohm-m and it has been interpreted as occurring on Profiles R1, R3 and R4. The depth to the top of this layer is approx.

7.6-14.5m bgl. On Profile R1 this layer has been interpreted as up to approx. 20m thick and appears to be situated in a bedrock depression or overburden channel. This layer may have some economic value subject to dewatering requirement.

Rock: Resistivity values of 150-450 ohm-m at depth have been interpreted as bedrock of interbedded conglomerate, sandstone and shale. The depth to bedrock is interpreted as 6.3m-28.7m bgl.

3.3 Conductivity Mapping

The conductivity results are indicative of the bulk conductivity of the ground materials from 0-6.0m bgl and have been interpreted as follows:

Conductivity (milliSiemens/m)	Interpretation for 0-6m bgl
0-4.0	SAND/ GRAVEL
4.0-8.0	Silty/clayey SAND/GRAVEL

Table 3: Interpretation of Conductivity data

The conductivity data are mostly low (<4 milliSiemens/m) across the survey area and correlate well with high resistivity values on the ERT profiles indicating the presence of sand/gravel across the site.

3.4 Discussion

Resistivity values >1000 ohm-m define the sand/gravel layer which is interpreted as occurring down to depths of 7.4-14.6m bgl. An area of deeper rock or possible overburden channel has been interpreted as occurring in the central part of the survey area and is well seen on ERT Profile R1/85-210m.

An area of relatively shallow rock is apparent around ERT Profile R2/72-83m where the rock occurs at approx 9m bgl. This shallow rock feature may correspond with a zone of shallower rock towards the north-eastern end of ERT Profile R1 along the north-eastern side of the area of deeper rock/overburden channel.

ERT Profiles R5 and R6, recorded in the southern part of the survey area where there is a pronounced slope off to the south, indicate that the sand/gravel body largely retains its thickness here and appear to drape the bedrock surface which also slopes in the same direction.

Resource – geophysical survey area

The sand/gravel resource in the geophysical survey area has been calculated based on an average thickness of 9.0m for the interpreted clean sand/gravel. Interpreted silty/clayey sand/gravel has not been included in the resource calculation except for minor intercalations. A bulk density of 1.8 tonnes/cu.m. has been used. The area has been taken from the boundary with the existing sand and gravel pit to the top of the slope at the eastern side of the survey area.

Area (Ha)	Sand/Gravel Thickness (m)	Volume (cu. m.)	Tonnage (at 1.8t/cu. m tonnes)
5.5	9.0	495,000	891,000

Table 3: Estimation of resource over geophysical survey area (as shown on Drawing 13211_09).

4. RECOMMENDATIONS

Four boreholes and four trial pits (Drawing 13211-_05) are recommended to confirm the geophysical results. The report should be revised after the completion of the direct investigation. The boreholes are intended to confirm the presence of gravel and to investigate saturated gravel and silty/clayey sand/gravel material shallow rock. The trial pits are sited to confirm the presence and quality of sand/gravel across the survey area.

Proposed Borehole	Easting	Northing	Depth to drill (m)	Objective
PBH1	163171	168835	15	To investigate depth to base of gravel/depth to saturated/silty/clayey sand/ gravel
PBH2	163239	168866	13	To investigate possible shallow rock
PBH3	163232	168930	18	To investigate possible shallow rock
PBH4	163140	168796	20	To investigate silty/clayey/saturated gravel and possible shallow rock

Proposed Trial Pit	Easting	Northing	Depth (m)	Objective
PTP1	163192	168871	3-4	To confirm presence and quality of gravel
PTP2	163251	169001		
PTP3	163116	168718		
PTP4	163164	168932		

5. REFERENCES

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6. APPENDIX A: DETAILED METHODOLOGY

6.1 Seismic Refraction Profiling

6.1.1 Principles

The seismic refraction profiling method measures the velocity of refracted seismic waves through the overburden and rock material and allows an assessment of the thickness and quality of the materials present to be made. Stiffer and stronger materials usually have higher seismic velocities while soft, loose or fractured materials have lower velocities. Readings are taken using geophones connected via multi-core cable to a seismograph.

6.1.2 Data Collection

One seismic spread was recorded using a Geode high-resolution 24 channel digital seismograph with geophone spacings of 3m. The source of the seismic waves was a sledgehammer. See Drawing 13211_01

6.1.3 Data Processing

The recorded data was interpreted using the ray-tracing and intercept time methods, to acquire depths to layer boundaries and the P-wave velocities of these layers, using the FIRSTPIX and GREMIX programs.

GREMIX interprets seismic refraction data as a laterally varying layered earth structure. It incorporates the slope-intercept method, parts of the Plus-Minus Method of Hagedoorn (1959), Time-Delay Method, and features the Generalized Reciprocal Method (GRM) of Palmer (1980). Up to four layers can be mapped, one deduced from direct arrivals and three deduced from refractions. Phantoming of all possible travel time pairs can be carried out by adjusting reciprocal times of off shots.

6.1.4 Relocation

All data were referenced using a Pro-XS Differential GPS system with c.20mm accuracy.

6.3 Electrical Resistivity Tomography (ERT)

6.3.1 Principles

This surveying technique makes use of the Wenner resistivity array. The 2D-resistivity profiling method records a large number of resistivity readings in order to map lateral and vertical changes in material types. The 2D-resistivity profiling method involves the use of 1-32/1-64 electrodes connected to a resistivity meter, using computer software to control the process of data collection and storage.

6.3.2 Data Collection

Profiles R1-R6 were recorded using a Tigre resistivity meter, imaging software, one or two 32 takeout multicore cable and up to 64 stainless steel electrodes. Saline solution was used at the electrode\ground interface in order to gain a good electrical contact

required for the technique to work effectively. The recorded data were processed and viewed immediately after the survey.

6.3.3 Data Processing

The field readings were stored in computer files and inverted using the RES2DINV package (Campus Geophysical Instruments, 1997) with up to 5 iterations of the measured data carried out for each profile to obtain a 2D-Depth model of the resistivities.

The inverted 2D-Resistivity models and corresponding interpreted geology are displayed on the accompanying drawings. Distance is indicated along the horizontal axis of the profiles. Profiles have been contoured using the same contour intervals and colour codes.

6.3.4 Relocation

All data were referenced using a Pro-XR Differential GPS system with c.20mm accuracy.

6.4 Ground Conductivity Mapping

6.4.1 Principles

This is an electromagnetic technique used to investigate lateral variations in overburden material and to assist with the indication of the depth to bedrock.

This method operates on the principle of inducing currents in conductive substrata and measuring the resultant secondary electro-magnetic field. The strength of this secondary EM field is calibrated to give apparent ground conductivity in milliSiemens/metre (mS/m). Readings over material such as organic waste and silt/clay give high conductivity values while readings over dry materials with a low clay mineral content such as gravels, limestone or quartzite give low readings.

The EM31 survey technique determines the apparent conductivity of the ground material from 0-6m bgl depending on the dipole mode used. Depending on the dipole mode used, the measured conductivity is a function of the different overburden layers and/or rock from 0 to 6m below ground level.

6.4.2 Data Collection

The EM31 equipment used was a GF CMD-4 conductivity meter equipped with data logger. This instrument features a real time graphic display of the previous 20 measurement points to monitor data quality and results. Conductivity and in-phase values were recorded one each side of the roadway which surrounds the TMF. Local conditions and variations were recorded.

6.4.3 Data Processing

The conductivity and inphase field readings were downloaded, contoured and plotted using the SURFER 8 program (Golden Software, 2008). Data which was affected by metallic objects was removed. Assignation of material types and possible anomaly

sources was carried out, with cross-reference to other data. The contoured conductivity data are displayed on Drawing 13211_04.

6.4.4 Relocation

All data were referenced using a Garmin handheld system with sub 3m accuracy. All positions are given in Irish National Grid coordinates.

7. APPENDIX C: SEISMIC REFRACTION PLATES

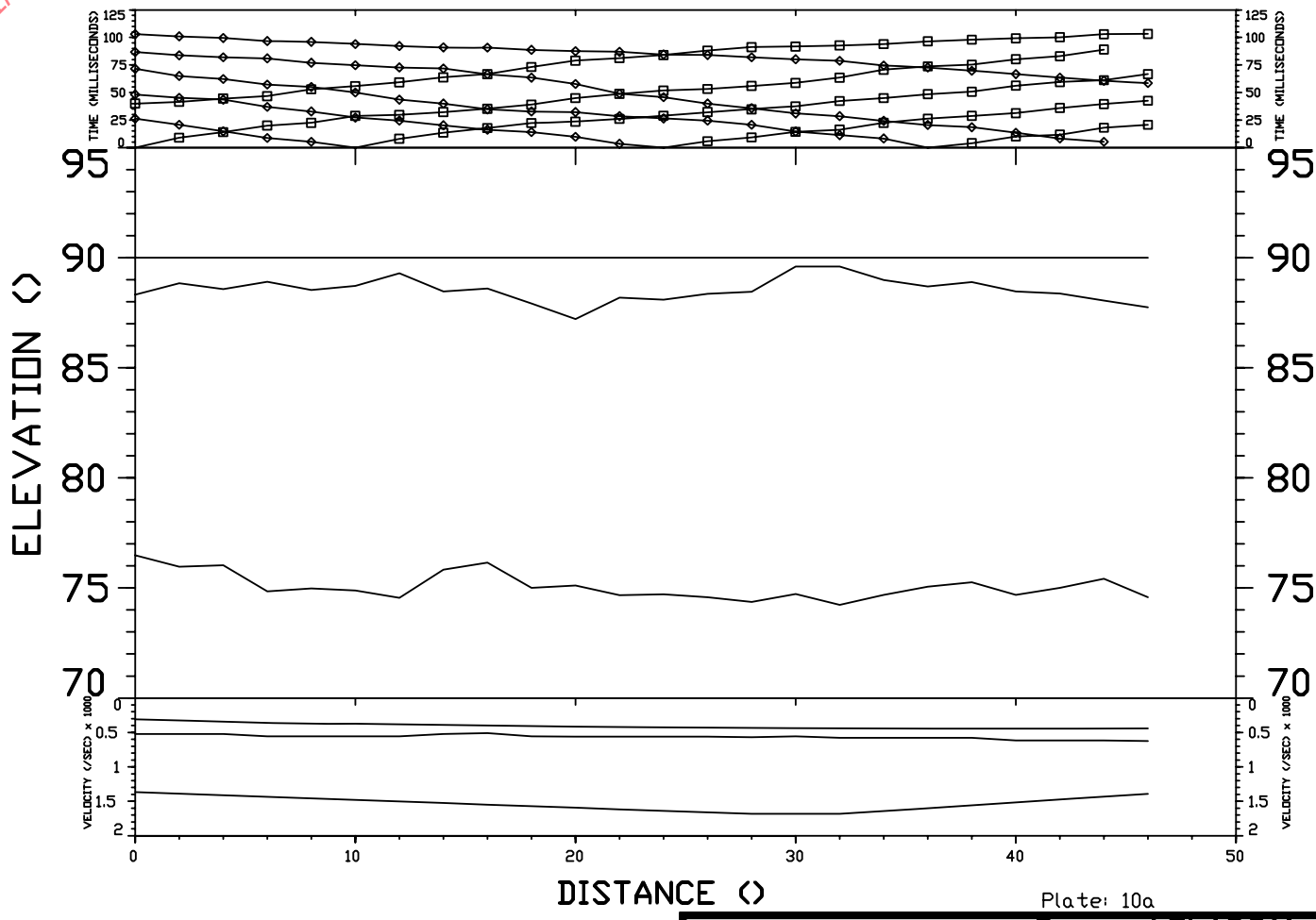


Plate: 10a

for: ROADSTONE WOOD	AGL13211
by: APEX Geoservices Ltd.	Ballyquinn Clare
Data SetS1 / Date: Sep 2013	
Equipment: Geode / Spread: S1	Azimuth:

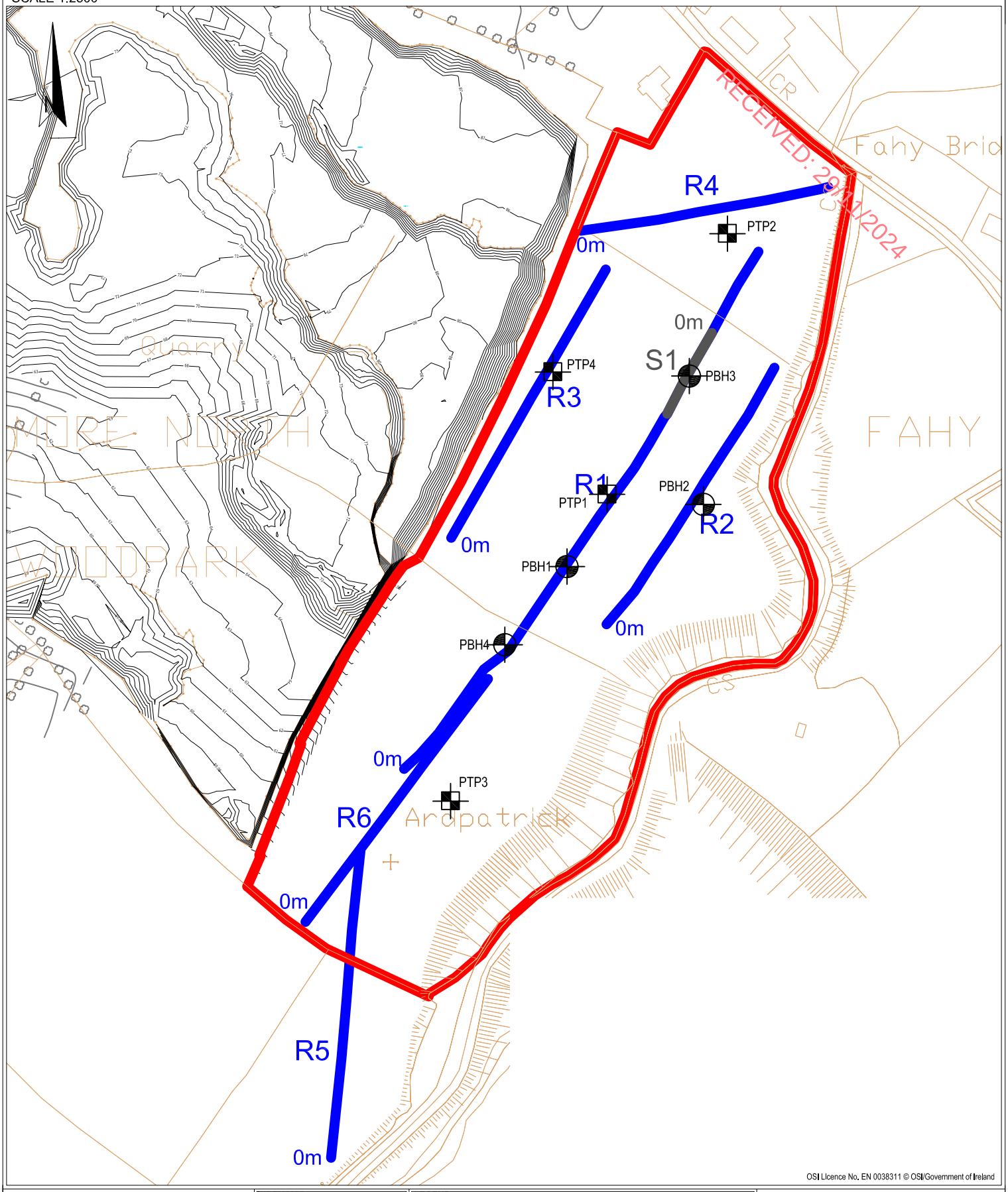
8. APPENDIX D: DRAWINGS

The information derived from the geophysical investigation is presented in the following drawings:

13211_01	Geophysical Location Map	1:10000 @ A4
13211_02	Conductivity Results	1:10000 @ A4
13211_03	Resistivity Profile R1	1:2000 @ A4
13211_04	Resistivity Profile R2	1:1000 @ A4
13211_05	Resistivity Profile R3	1:1000 @ A4
13211_06	Resistivity Profile R4	1:1000 @ A4
13211_07	Resistivity Profile R5	1:1000 @ A4
13211_08	Resistivity Profile R6	1:1000 @ A4
13211_09	Summary Map	1:10000 @ A4

FIGURE 1: GEOPHYSICAL LOCATIONS

SCALE 1:2500



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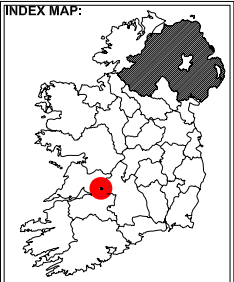
INDEX MAP:



LEGEND:

R1 — Electrical Resistivity Profile

S1 — Seismic Refraction Profile

BH1 — Proposed Borehole

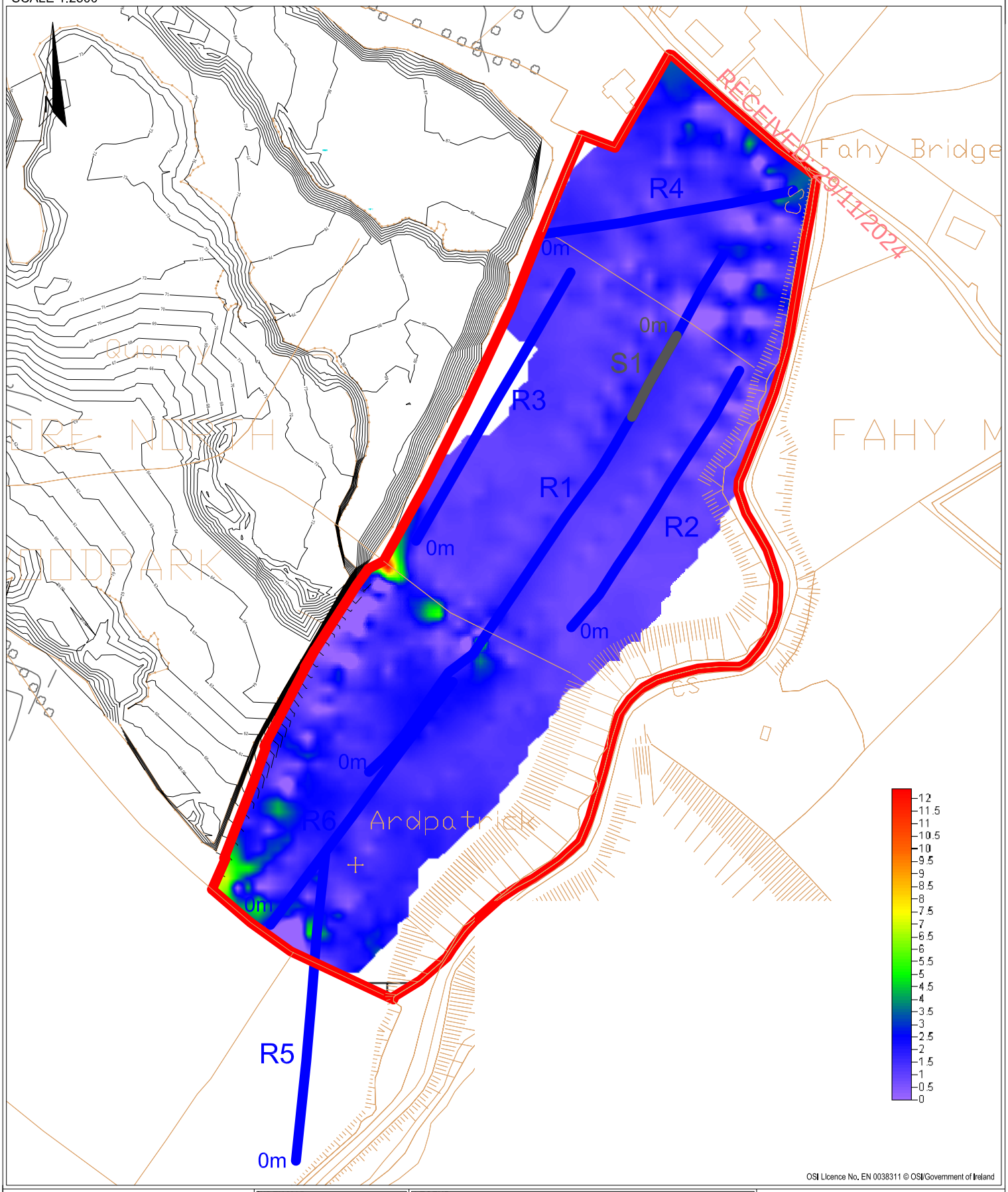
TP1 — Proposed Trial pit

PROJECT:	BALLYQUINN SAND & GRAVEL GEOPHYSICAL SURVEY LOCATIONS
DRAWING No.:	AGL13211_01
DATE:	October 2013
CLIENT:	ROADSTONE WOOD LIMITED
SCALE:	AS INDICATED @ A4

Version:	Date:	Drawn By:	Checked:
No	2013	MF	POC

FIGURE 1: Conductivity Values

SCALE 1:2500



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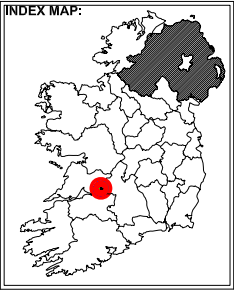
INDEX MAP:



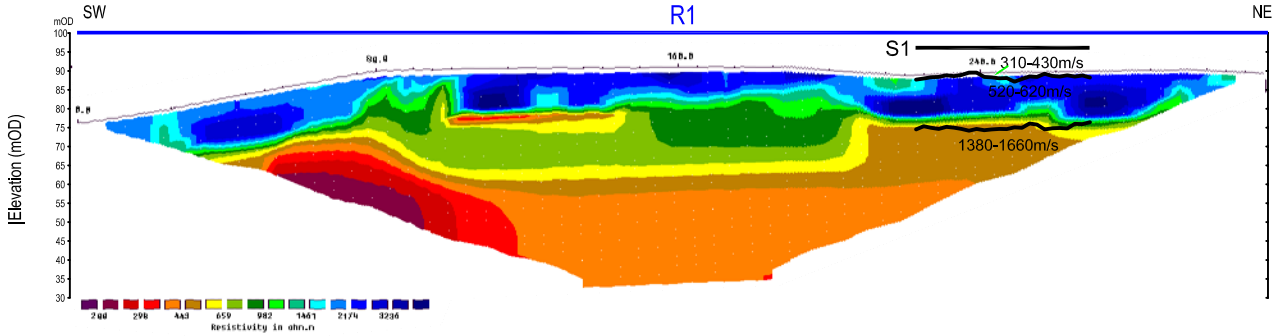
LEGEND:

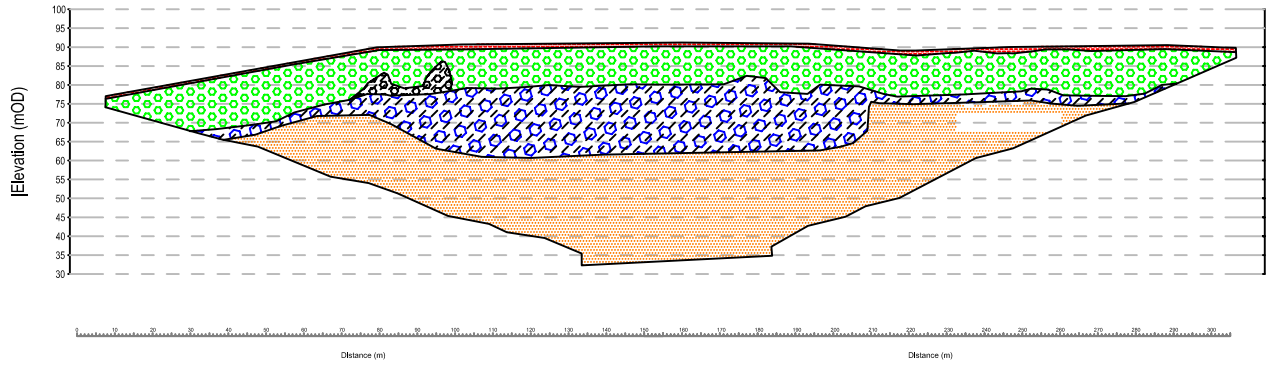
PROJECT:	BALLYQUINN SAND & GRAVEL GEOPHYSICAL SURVEY LOCATIONS
DRAWING No.:	AGL13211_02
DATE:	October 2013
CLIENT:	ROADSTONE WOOD LIMITED
SCALE:	AS INDICATED @ A4

Version:	Date:	Drawn By:	Checked:
No	2013	MF	POC

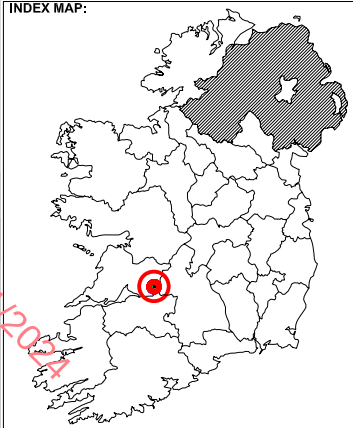
FIGURE 1: RESISTIVITY PROFILE R1

SCALE 1:2000





INDEX MAP:



LEGEND:

- Gravelly SILT/CLAY
- Silty/clayey SAND/GRAVEL
- SAND/GRAVEL
- Saturated/clayey SAND/GRAVEL
- ROCK (CONGLOMERATE/ SANDSTONE/ MUDSTONE)

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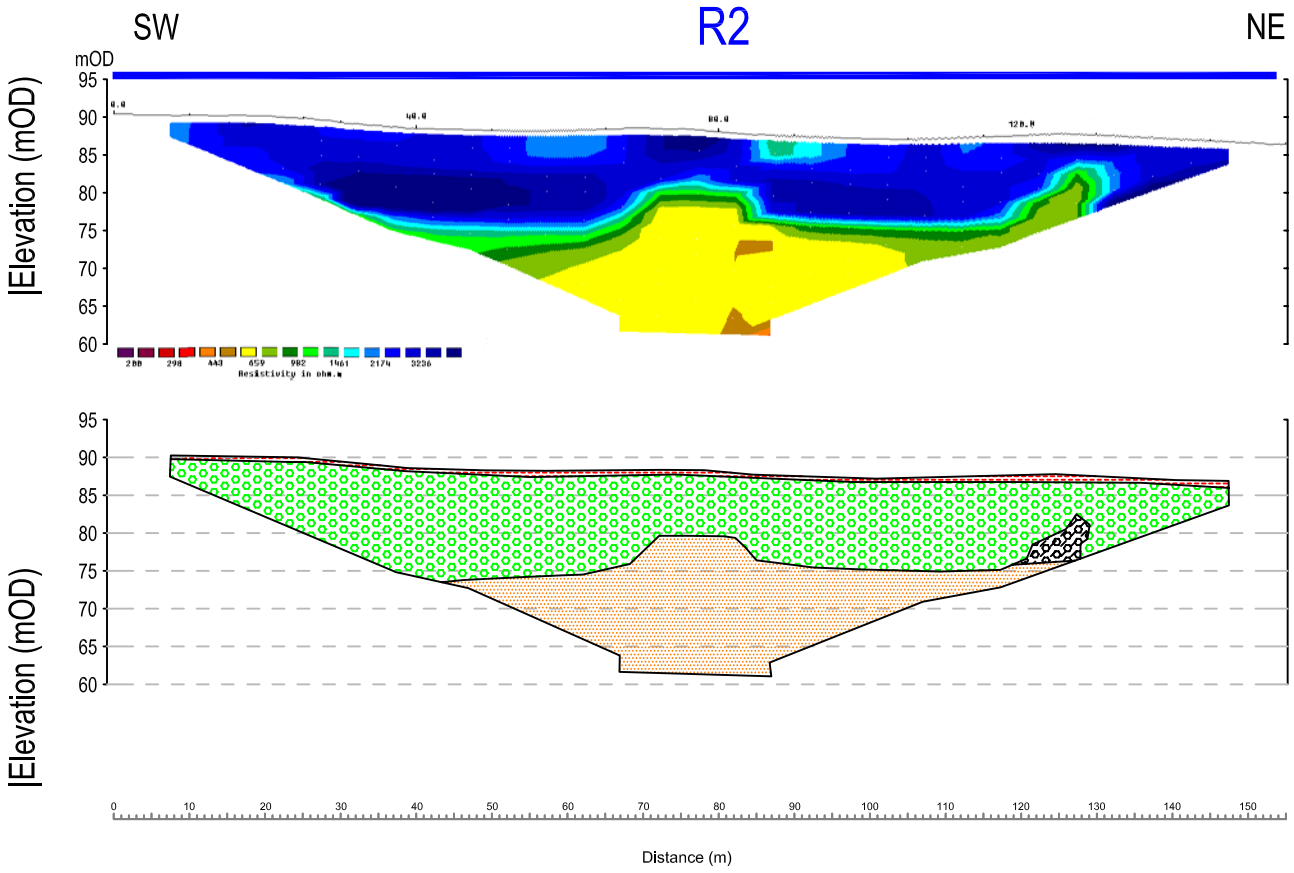
PROJECT:	BALLYQUINN SAND & GRAVEL SURVEY RESISTIVITY PROFILE R1
DRAWING No.:	AGL13211_03
DATE:	2013
CLIENT:	ROADSTONE WOOD LIMITED
SCALE:	As indicated on Figure.

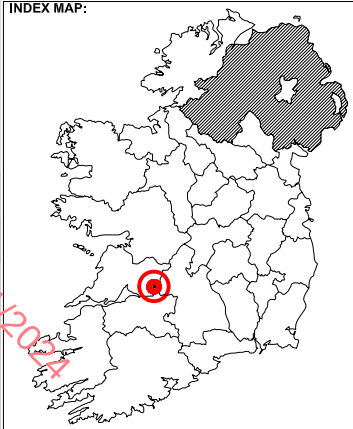
Version:	Date:	Drawn By:	Checked:
No	2013	MF	POC

FIGURE 1: RESISTIVITY PROFILE R2

SCALE 1:1000



INDEX MAP:



LEGEND:

- Gravelly SILT/CLAY
- Silty/clayey SAND/GRAVEL
- SAND/GRAVEL
- Saturated/clayey SAND/GRAVEL
- ROCK (CONGLOMERATE/ SANDSTONE/ MUDSTONE)

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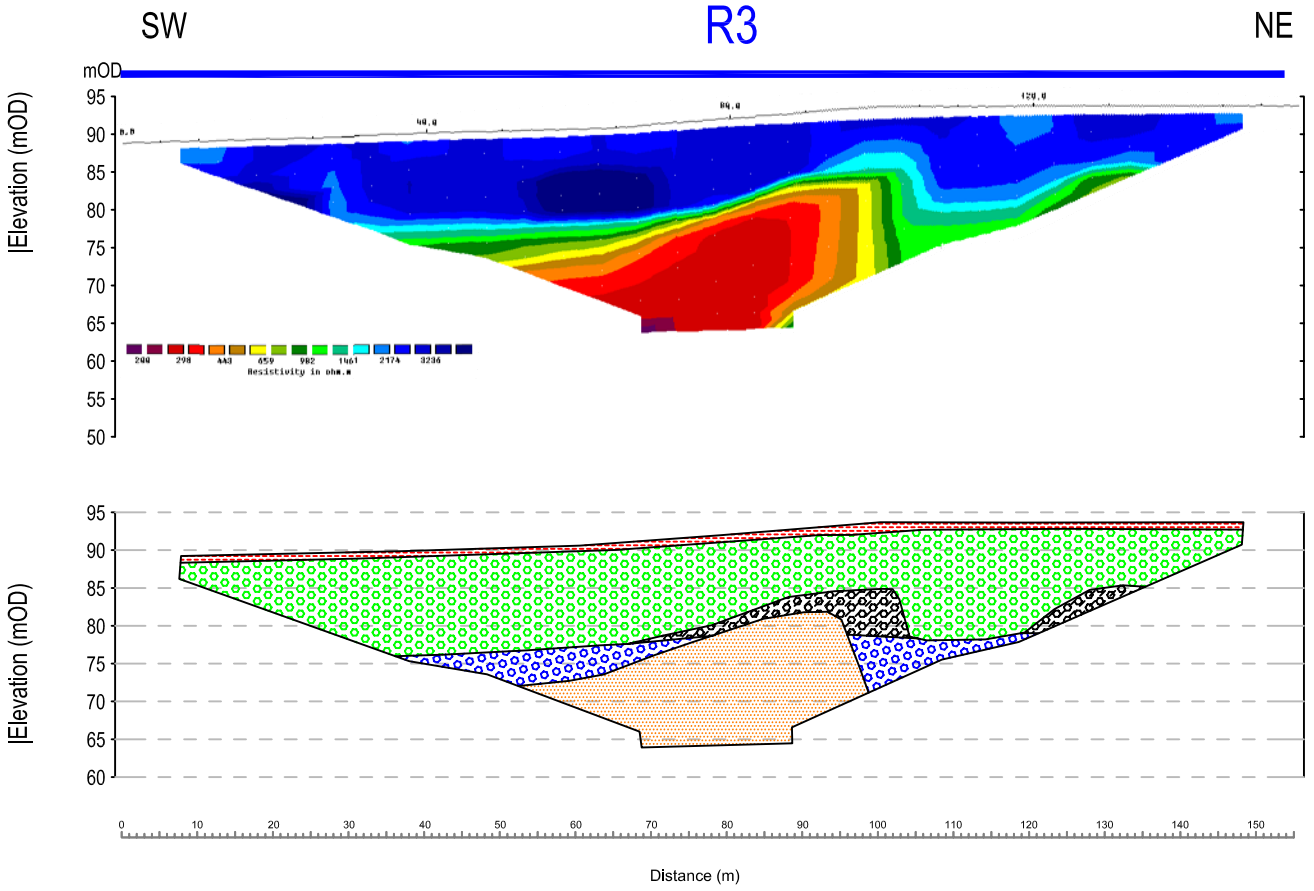
PROJECT:	BALLYQUINN SAND & GRAVEL SURVEY RESISTIVITY PROFILE R2
DRAWING No.:	AGL13211_04
DATE:	October 2013
CLIENT:	ROADSTONE WOOD LIMITED
SCALE:	As indicated on Figure.

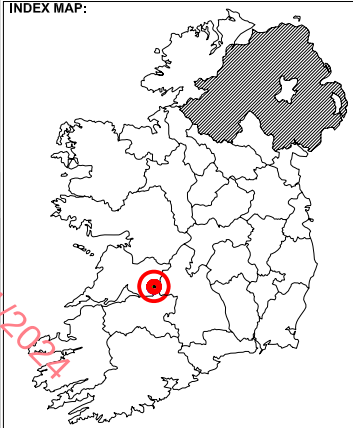
Version:	Date:	Drawn By:	Checked:
No	2013	MF	POC

FIGURE 1: RESISTIVITY PROFILE R3

SCALE 1:1000



INDEX MAP:



LEGEND:

- Gravelly SILT/CLAY
- Silty/clayey SAND/GRAVEL
- SAND/GRAVEL
- Saturated/clayey SAND/GRAVEL
- ROCK (CONGLOMERATE/ SANDSTONE/ MUDSTONE)

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PROJECT:	BALLYQUINN SAND & GRAVEL SURVEY RESISTIVITY PROFILE R3
DRAWING No.:	AGL13211_05
DATE:	October 2013
CLIENT:	ROADSTONE WOOD LIMITED
SCALE:	As indicated on Figure.

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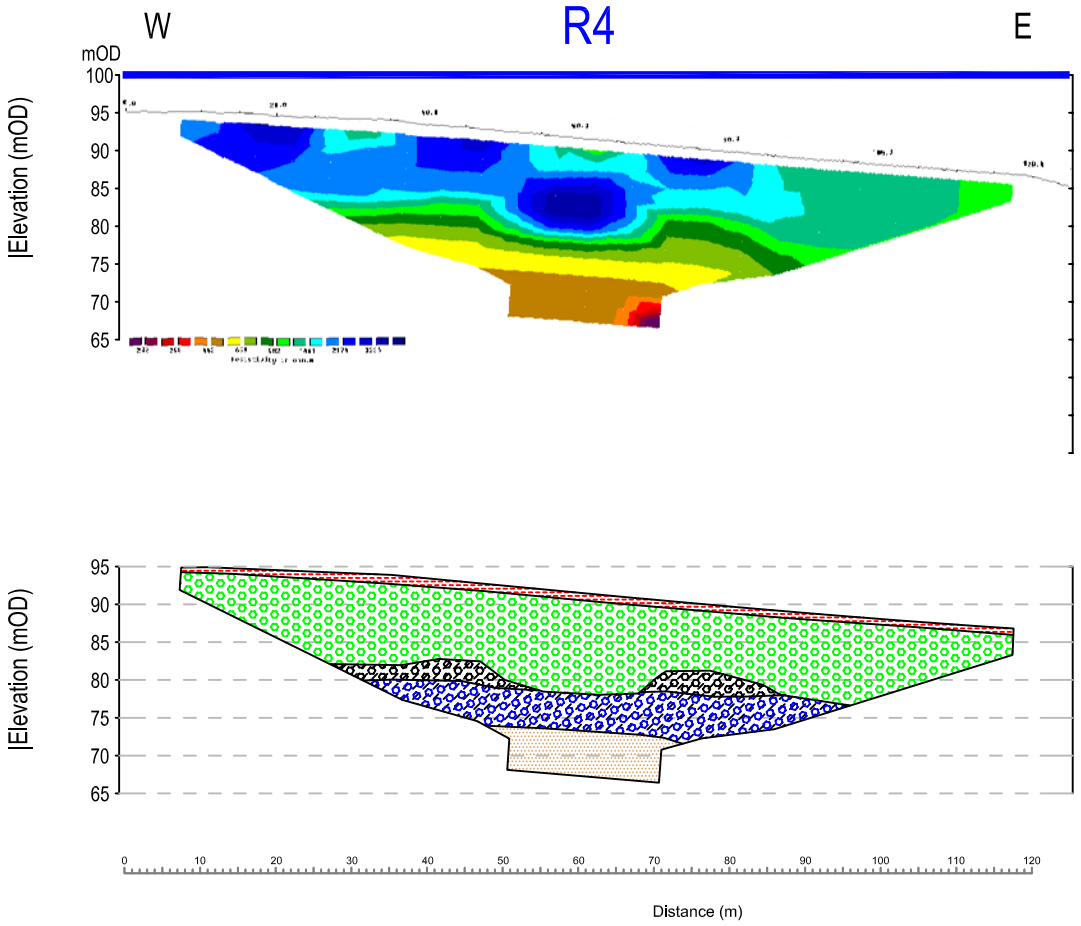
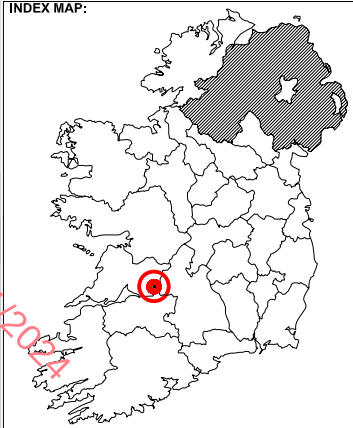
No	2013	MF	POC

FIGURE 1: RESISTIVITY PROFILE R4

SCALE 1:1000



INDEX MAP:



LEGEND:

- Gravelly SILT/CLAY
- Silty/clayey SAND/GRAVEL
- SAND/GRAVEL
- Saturated/clayey SAND/GRAVEL
- ROCK (CONGLOMERATE/ SANDSTONE/ MUDSTONE)

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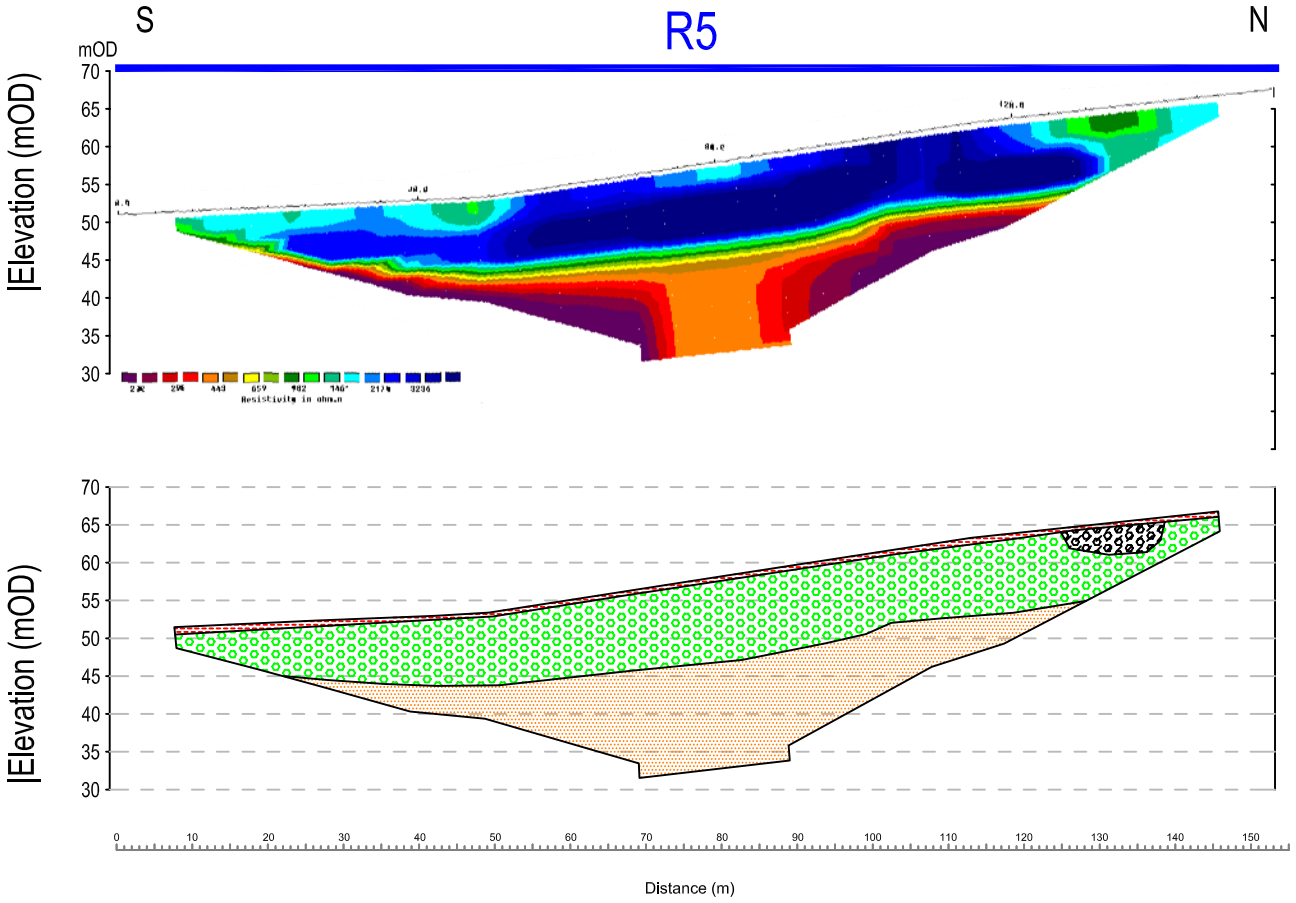
PROJECT:	BALLYQUINN SAND & GRAVEL SURVEY RESISTIVITY PROFILE R4
DRAWING No.:	AGL13211_06
DATE:	October 2013
CLIENT:	ROADSTONE WOOD LIMITED
SCALE:	As indicated on Figure.

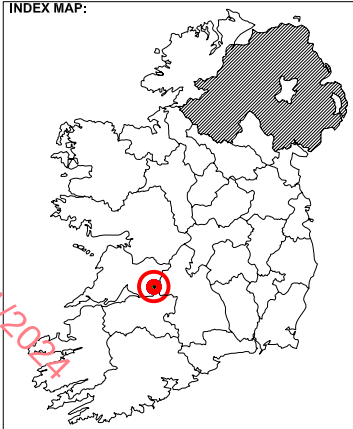
Version:	Date:	Drawn By:	Checked:
No	2013	MF	POC

FIGURE 1: RESISTIVITY PROFILE R5

SCALE 1:1000



INDEX MAP:



LEGEND:

- Gravelly SILT/CLAY
- Silty/clayey SAND/GRAVEL
- SAND/GRAVEL
- Saturated/clayey SAND/GRAVEL
- ROCK (CONGLOMERATE/ SANDSTONE/ MUDSTONE)

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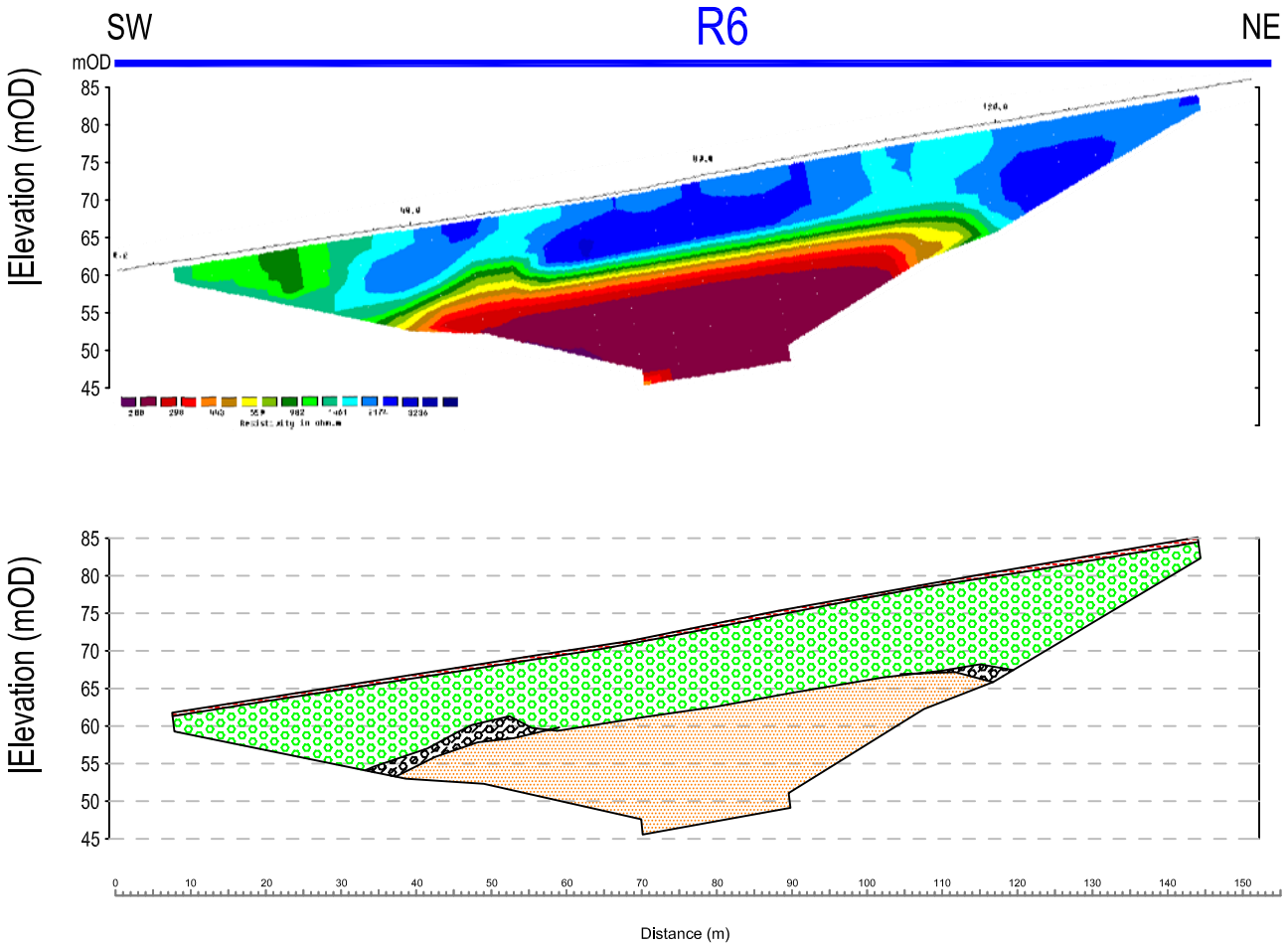
PROJECT:	BALLYQUINN SAND & GRAVEL SURVEY RESISTIVITY PROFILE R5
DRAWING No.:	AGL13211_07
DATE:	October 2013
CLIENT:	ROADSTONE WOOD LIMITED
SCALE:	As indicated on Figure.

Version:	Date:	Drawn By:	Checked:
No	2013	MF	POC

FIGURE 1: RESISTIVITY PROFILE R6

SCALE 1:1000



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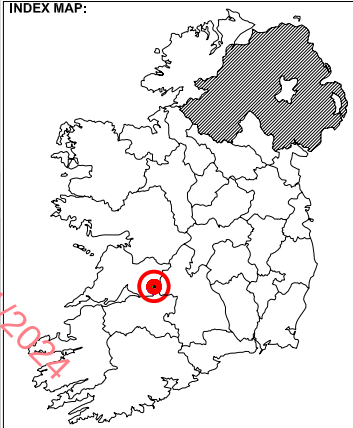

LEGEND:

- Gravelly SILT/CLAY
- Silty/clayey SAND/GRAVEL
- SAND/GRAVEL
- Saturated/clayey SAND/GRAVEL
- ROCK (CONGLOMERATE/ SANDSTONE/ MUDSTONE)

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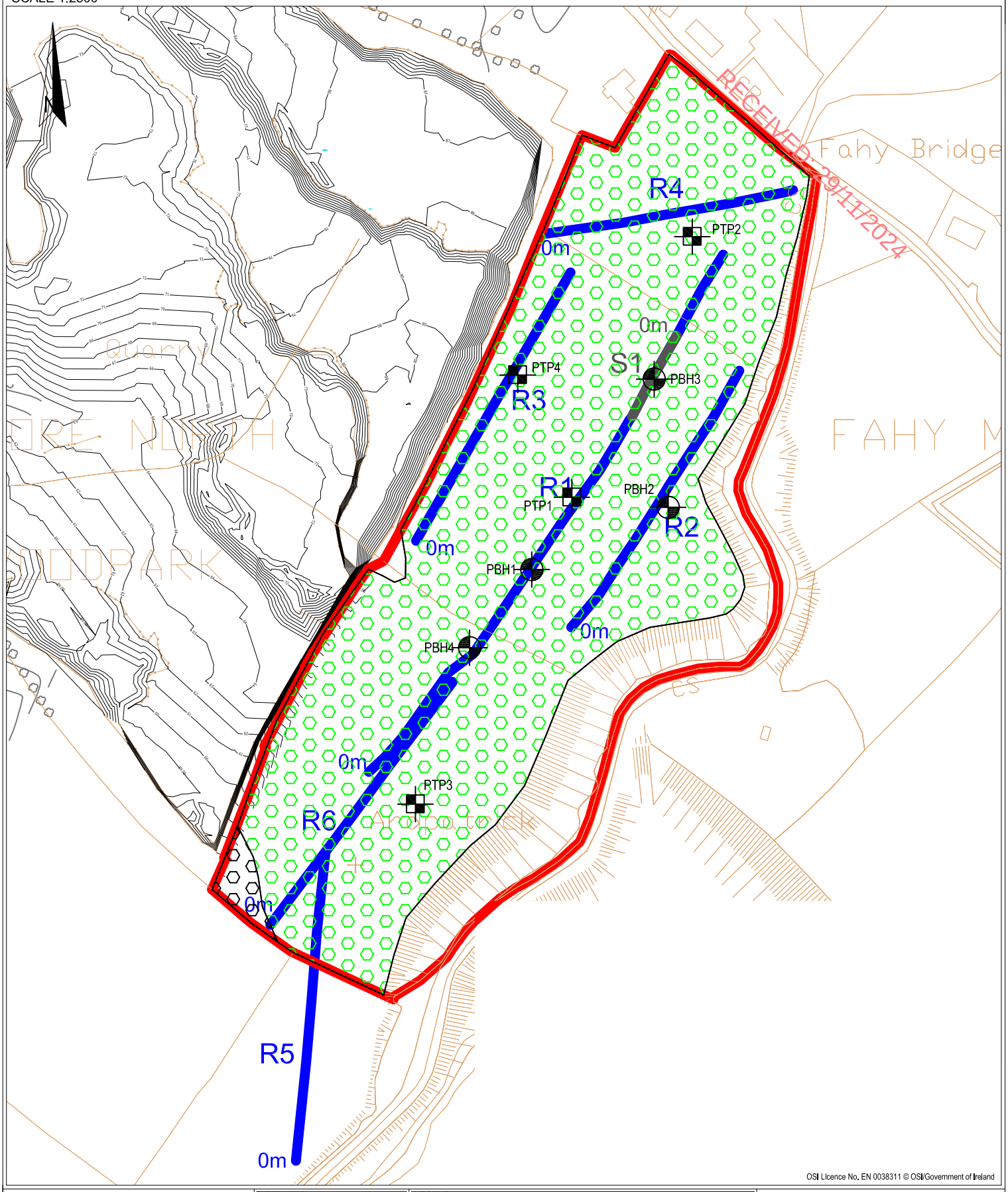
PROJECT:	BALLYQUINN SAND & GRAVEL SURVEY RESISTIVITY PROFILE R6
DRAWING No.:	AGL13211_08
DATE:	October 2013
CLIENT:	ROADSTONE WOOD LIMITED
SCALE:	As indicated on Figure.

Version:	Date:	Drawn By:	Checked:
No	2013	MF	POC

FIGURE 1: GEOLOGICAL INTERPRETATION

SCALE 1:2500



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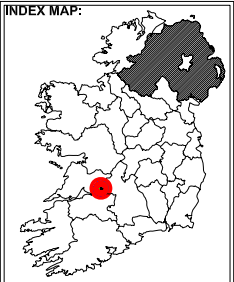
INDEX MAP:



LEGEND:

Silty/clayey SAND/GRAVEL

Topsoil over c.9.0m SAND/GRAVEL

PROJECT:	BALLYQUINN SAND & GRAVEL GEOPHYSICAL SURVEY LOCATIONS
DRAWING No.:	AGL13211_09
DATE:	October 2013
CLIENT:	ROADSTONE WOOD LIMITED
SCALE:	AS INDICATED @ A4

Version:	Date:	Drawn By:	Checked:
No	2013	MF	POC