Appendix 4

Site Walkover Checklist and Photographic Log

Knockcronaghan Walkover Survey Checklist – 12th June 2018

Information	Checked	Comment (include distances from site boundary)
1. What is the current land use?	√	The site is vegetated with trees and grassland and can be classified currently under agricultural use.
2. What are the neighbouring land uses?	√	Agricultural fields surround the site with farm buildings present to the northeast of the site.
3. What is the size of the site?	√	The site occupies approximately 9 hectares.
4. What is the topography?	√	The topography can be split into two profiles. There is a rising hill on the southern section of the site with the remainder consisting of flat, slightly undulating land.
5. Are there potential receptors (if yes, give details)?	√	Yes
Houses	√	No
Surface water features (if yes, distance and direction of flow)	√	The Kilgormly river bounds the site to the southeast, east and north. The Ulster canal bounds the site to the northwest. Surface water ditches bound southern sections of the site.
Any wetland or protected areas	√	No
Public water supplies	√	No
Private wells	√	No
Services	√	No
Other buildings	√	Farm buildings present near site entrance
Other	√	No
6. Are there any potential sources of contamination (if yes, give details)?	√	Yes, waste from former landfill
Surface waste (if yes, what type?)	√	No
Surface ponding of leachate	√	No
Leachate seepage	√	Some evidence of leachate seepage in one area of field
Landfill gas odours	√	No
7. Are there any outfalls to surface water? (If yes, are there discharges and what is the nature of discharge?)	√	No

Information	Checked	Comment (include distances from site boundary)
8. Are there any signs of impact on the environment? (If yes, take photographic evidence)	√	Yes
Vegetation die off, bare ground	√	No
Leachate seepages	√	Some evidence of leachate seepage in one area of field
Odours	√	No
Litter	√	No
Gas bubbling through water	√	No
Signs of settlement	√	No
Subsidence, water logged areas	√	No
Drainage or hydraulic issues	√	Blocked surface water ditch to the southeast of the site from roadworks - stagnant water in ditch
Downstream water quality appears poorer than upstream water quality	√	No clear evidence
9. Are there any indications of remedial measures? (Provide details)	√	No, 6 inches of soil cover placed over waste body upon closure
Capping	√	No
Landfill gas collection	√	No, 2 disused methane wells present onsite
Leachate collection	√	No
10. Describe fences and security features (if any)	√	Electric fence and barb wire around most of site, Hedgerows and walls also present in places
Any other relevant information?	√	Old ulster canal previously ran through this site with the derelict Lemmon's Bridge over the former canal present onsite.

PHOTOGRAPHIC LOG

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www.fehilytimoney.ie

FEHILY TIMONEY & COMPANY

Client Name: Monaghan County Council	**Site Location:** Knockcronaghan	**Project Number:** P1655

Photo No. 1	**Date:** 12/06/2018

Description:

Farm building near site entrance

Photo No. 2	**Date:** 12/06/2018

Description:

Farm building near site entrance

PHOTOGRAPHIC LOG

Consultants in Engineering and Environmental Sciences

www.fehilytimoney.ie

FEHILY TIMONEY & COMPANY

Client Name: Monaghan Co. Co.	**Site Location:** Knockcronaghan	**Project Number:** P1655

Photo No. 3 | **Date:** 12/06/2018

Description:

Kilgormly river at eastern site boundary

Photo No. 4 | **Date:** 12/06/2018

Description:

Old concrete bridge over Kilgormly river along eastern site boundary

PHOTOGRAPHIC LOG

Consultants in Engineering and Environmental Sciences

www.fehilytimoney.ie

FEHILY TIMONEY & COMPANY

Client Name: Monaghan Co. Co.	**Site Location:** Knockcronaghan	**Project Number:** P1655

Photo No. 5 | **Date:** 12/06/2018

Description:

Derelict Lemmon's Bridge over old canal towards northern end of the site

Photo No. 6 | **Date:** 12/06/2018

Description:

Kilgormly river along northern site boundary

PHOTOGRAPHIC LOG

Consultants in Engineering and Environmental Sciences

www.fehilytimoney.ie

FEHILY TIMONEY & COMPANY

Client Name: Monaghan Co. Co.

Site Location: Knockcronaghan

Project Number: P1655

Photo No. 7

Date: 12/06/2018

Description:

Confluence of Kilgormly river and Ulster canal

Photo No. 8

Date: 12/06/2018

Description:

View of western section of site.

PHOTOGRAPHIC LOG

Consultants in Engineering and Environmental Sciences

www.fehilytimoney.ie

FEHILY TIMONEY & COMPANY

Client Name: Monaghan Co. Co.

Site Location: Knockcronaghan

Project Number: P1655

Photo No. 9

Date: 12/06/2018

Description:

Surface water ditch along southwestern site boundary

Photo No. 10

Date: 12/06/2018

Description:

View northwards from top of hill at southern section of site

PHOTOGRAPHIC LOG

Consultants in Engineering and Environmental Sciences

www.fehilytimoney.ie

FEHILY TIMONEY & COMPANY

Client Name: Monaghan Co. Co.	**Site Location:** Knockcronaghan	**Project Number:** P1655

Photo No. 11	**Date:** 12/06/2018

Description:

View of southern and eastern sections of site

Photo No. 12	**Date:** 12/06/2018

Description:

Surface water ditch to southeast of site

PHOTOGRAPHIC LOG

Consultants in Engineering and Environmental Sciences

www.fehilytimoney.ie

FEHILY TIMONEY & COMPANY

Client Name: Monaghan Co. Co.	**Site Location:** Knockcronaghan	**Project Number:** P1655

Photo No. 13 | **Date:** 12/06/2018

Description:

Old methane well toward northern section of the site

Photo No. 14 | **Date:** 12/06/2018

Description:

Second old methane well towards the western section of the site

PHOTOGRAPHIC LOG

Consultants in Engineering and Environmental Sciences

www.fehilytimoney.ie

FEHILY TIMONEY & COMPANY

Client Name: Monaghan Co. Co.	**Site Location:** Knockcronaghan	**Project Number:** P1655

Photo No. 15	**Date:** 12/06/2018

Description:

Section of water logged area near the centre of the site

Photo No. 16	**Date:** 12/06/2018

Description:

Evidence of leachate seepage at waterlogged section

Appendix 5

APEX Geoservices Geophysical Survey

AGL18165_01

REPORT

ON THE

GEOPHYSICAL SURVEY

AT

KILLYCRONAGHAN

CO. MONAGHAN

FOR

FEHILLY TIMONEY & CO.

16TH NOVEMBER 2018

APEX GEOSERVICES LIMITED
Unit 6 Knockmullen Business Pk.,
Gorey,
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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	AGL18165		
AUTHOR	**CHECKED**	**REPORT STATUS**	**DATE**
EurGeol Peter O'Connor M.Sc. (geophysics), P.Geo. Dip EIA Mgt.	EurGeol Yvonne O'Connell Ph.D., M.Sc. (geophysics), P.Geo.	v1	16TH November 2018

CONTENTS

1. EXECUTIVE SUMMARY

APEX Geoservices Ltd. was requested by Fehilly Timoney & Co. to carry out a geophysical survey at a landfill site in Killycronaghan, County Monaghan. The purpose of the investigation is to determine the extent, thickness and type of imported material across the site.

The Killycronaghan historic landfill is located approximately 8km north-east of Clones town circa 1km off the N54 National road, close to the village of Smithboro. The area to be investigated covers 9.2 Ha.

The site is underlain by gravels with alluvium to the north-west and limestone till to the south-west, and the underlying bedrock comprises of the Cooldaragh formation mudstone and the Feranaght formation conglomerate/sandstone.

Fifteen trial pits and 3 monitoring wells were completed at the site in a previous investigation. The trial pit logs show thin topsoil over made ground consisting of mixed waste material to > 4.8m. Where bottomed out the waste is underlain by sand or gravel.

The geophysical investigation consisted of reconnaissance EM ground conductivity mapping with follow-up Electrical Resistivity Tomography, Seismic Refraction and MASW profiling.

The geophysical data indicates MADE GROUND/WASTE (predominantly organic) over SAND/GRAVEL with LEACHATE to be present in approximately **2.2 Ha** in the centre of the survey area (Zone A). There is also a small area (0.08 Ha) on the southern border (Zone B), adjacent to TP 15, where waste may also be present. The average thickness of the Zone A waste is 5.0m based on the trial pit and MASW data.

The ERT profiles show that low resistivities extend up to 10m below the bottom of the waste. This has been interpreted as **leachate** extending into the underlying sandy gravelly clay.

Possible leachate plumes to the north-west (Zone C) and north (Zone D) been outlined but may be due to increased alluvium content in the area.

The geophysical data indicates that the waste is soft to very soft. The underlying sandy gravelly clay material is firm-stiff.

The volumes of waste calculated using the extents and thicknesses discussed above are as follows:

Zone	Extent (sq. m.)	Thickness (m.)	Volume (cu. m.)	Tonnes (@ 1.4 tonnes/cu.m.)
A	21,112	5.0	105,560	147,784
B*	800	0.4	320	448

* based on EM only.

Bedrock elevation is around 37-45 mOD. Combined waste and soil thicknesses range from around 15m to 20m.

To confirm the findings of the geophysical report three boreholes and two trial pits are recommended. The geophysical report should be reviewed after the completion of any direct investigation.

2. INTRODUCTION

APEX Geoservices Ltd. was requested by Fehilly Timoney & Co. to carry out a geophysical survey at a landfill site in Killycronaghan, County Monaghan. A Tier 2 environmental risk assessment is being carried out at the site. As part of the risk assessment there is a requirement for a geophysical investigation. The purpose of the investigation is to determine the extent, thickness and type of imported material across the site.

2.1 Project Objectives

The objectives of the survey were to provide information on:

- The extent of the waste body,
- The type of waste present,
- The thickness of the waste and presence of any anomalous features,
- A volume calculation,
- Depth to bedrock (if within limits of the survey),
- Proposed location of direct investigation points.

2.2 Site Background

The Kinockcronaghan historic landfill is located approximately 8km north-east of Clones town circa 1km off the N54 National road, close to the village of Smithboro. Anecdotal evidence suggests landfilling of the site commenced in the 1970s and operations ceased in 1984. The site is bounded to the southeast, east and north by the Kilgormly River. The Magheramey River bounds the site to the northwest (Fehilly Timoney & Co. 2018).

A Tier 1 environmental risk assessment (ERA) in June 2018 concluded that a high-risk classification (Class A) can be assigned to the site and that further investigation was warranted. The area to be investigated covers approximately 9.4Ha (Fig. 2.1). Site topography varies between 55 – 57 mOD.

Figure 2.1. Site location indicated by red boundary.

2.3 Geology & Soils

The Teagasc soils map for the area (Fig. 2.2) indicates that the site is underlain by gravels with alluvium to the north-west and limestone till to the south-west.

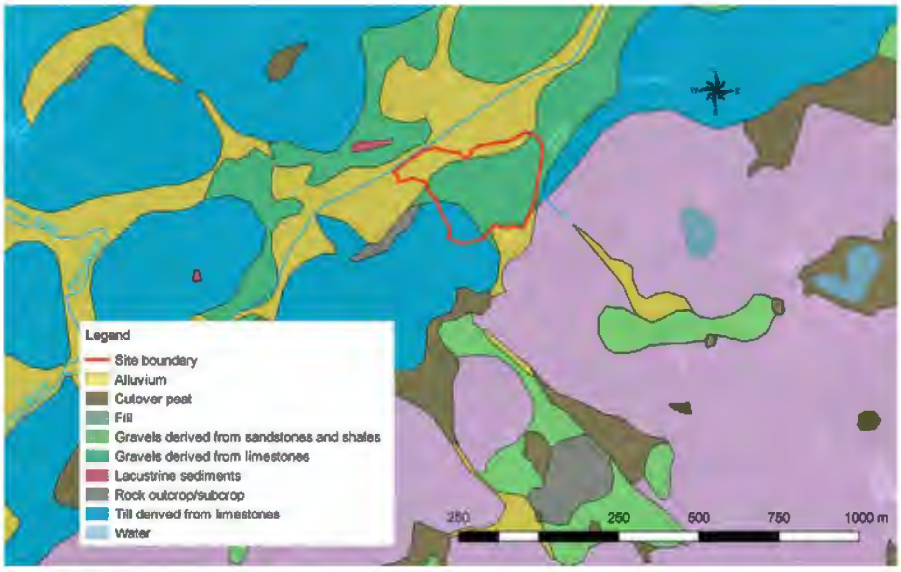

Figure 2.2 – Soils map (site indicated by red boundary).

The Geological Survey of Ireland (GSI) 1:100,000 Bedrock Geology map for the area (Figure 2.3) indicates that the site is underlain by the Cooldaragh formation (CH) which consists of '*pale brown-grey flaggy, silty mudstone'*. The southern and eastern sections of the site are underlain by the Feranaght formation (FT), which is described as '*pale conglomerate & red sandstone'*. A NW-SE trending fault is shown to the west of the site.

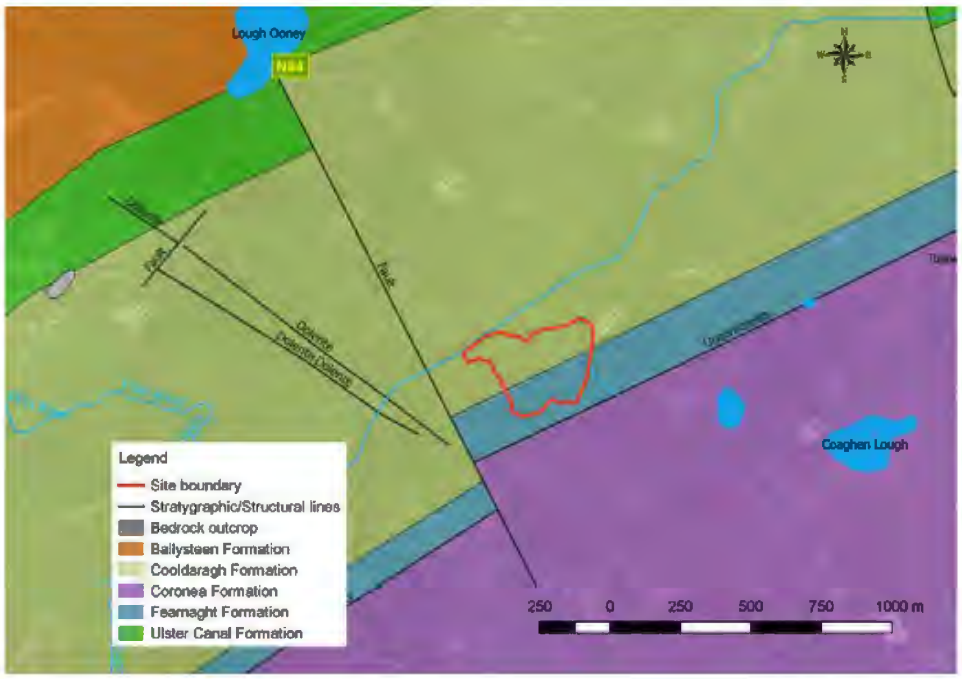

Figure 2.3. Bedrock geological map for the survey area (site indicated by red boundary).

Examination of the GSI 6'' geology sheet for the site (Fig. 2.4) shows rock at the river around 100m south-west of the site which is described as *'dark-grey shaly limestone'*

Figure 2.4. Geological Survey of Ireland 6'' sheet for the area (site indicated by red boundary).

2.4 Site Investigation

Fifteen trial pits and 3 monitoring wells were completed at the site in a previous investigation. The trial pit logs show the following general stratigraphy; thin topsoil (0.1m) over made ground consisting of mixed waste material to between 1.7 and 4.8m below ground level (bgl) or greater. Where 'bottomed out', the waste is underlain by sand or gravel. The trial pit data have been incorporated into the geophysical interpretation presented in this report.

The locations of the trial pits are shown on AGL18165_01. A number of trial pits record 'black waste' on the logs. These locations are designated with a 'K' after the trial pit number.

2.5 Survey Rationale

The investigation consisted of reconnaissance EM ground conductivity mapping with follow-up Electrical Resistivity Tomography (ERT), Seismic Refraction profiling and MASW:

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 extent of any shallow bedrock.

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 depths dependent on the length of the

profile. Each pseudo-section is interpreted to determine the material type along the profile based on the typical resistivities returned for Irish ground materials.

Seismic Refraction Profiling measures the P-wave 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. This method profiles the depth to the top of the stiff soils and bedrock, and provides information on the quality/strength of the bedrock.

The **MASW** method is used to estimate shear-wave velocities (Vs) in the ground material. Overburden material with a Vs <175 m/s is generally classified as soft/loose.

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 A: DETAILED METHODOLOGY**.

3 RESULTS & INTERPRETATION

The geophysical survey locations are indicated on Drawing AGL18165_01 (Appendix B). The survey area extends to approximately 9.2 Ha.

3.1 EM Ground Conductivity Mapping

The EM31 conductivity survey locations are shown on Drawing AGL18165_01. The recorded EM31 conductivity values are contoured on Drawing AGL18165_02. The conductivity values range from 5-120 milliSiemens/metre (mS/m). The conductivity values have been interpreted as follows:

Conductivity (mS/m)	Interpretation
5 - 30	TOPSOIL over SANDY GRAVELLY CLAY
30- 40	Possible LEACHATE plume/thin MADE GROUND/WASTE
40 - 125	TOPSOIL over MADE GROUND/WASTE (predominantly organic) over SANDY GRAVEL **with LEACHATE**

Note: EM31 measurements refer to the bulk electrical conductivity of the upper 6m of ground.

3.2 Electrical Resistivity Tomography

Nine resistivity profiles were recorded across the site (Profiles R1 to R9). The locations are shown on Drawing AGL18165_01. Interpreted cross sections were compiled for the profiles and are presented on Drawings AGL18165_R1-R9.

In determining the various types of imported material present from the resistivity sections R1-R9 it should be noted that:

- typical resistivities of Irish soils range from 20 ohm-m (clays) to around 3000 Ohm-m (dry gravel),
- the resistivity generally increases as the sand/gravel content increases,
- silt/clay typically has values in the range 30-50 Ohm-m ,
- silty gravelly clay typically has resistivity values in the range 50-100 Ohm-m,
- deposits of predominantly organic waste such as those occurring in municipal landfills typically have resistivities in the range 5-30 Ohm-m.
- leachate saturated soils originating from predominantly organic waste have a similar resistivity range to organic waste, but will be influenced by the resistivities of the host material and the degree of dilution and dispersion of the leachate,
- inert C & D waste such as concrete, brick and mixed rock fill, stone and clay will usually have resistivities similar to gravelly material (50-500 Ohm-m).

The resistivity values recorded at this site ranged from 10-960 Ohm-m and have been interpreted as follows:

Resistivity (Ohm-m)	Interpretation
5-30	MADE GROUND/WASTE (predominantly organic) over SAND/GRAVEL **with LEACHATE**
40-350	SANDY GRAVELLY CLAY with occasional SAND/GRAVEL
30-80	MUDSTONE
80-800	SANDSTONE/CONGLOMERATE

3.3 Seismic Refraction Profiling

Six seismic refraction profiles (S1-S6) were recorded across the site. The locations are shown on Drawing AGL18165_01 and the results are included on the interpreted cross sections in Drawings AGL18165_R1-R5 and in Appendix C.

The P-wave seismic velocities have been interpreted as follows:

Layer	Velocity (m/s)	Interpretation
1	200-600	Soft-firm/loose-med.dense MADE GROUND/WASTE/SANDY CLAY
2	800-1600	Firm-stiff sandy gravelly CLAY/weathered ROCK.
3	2200-3800	Weak to occasionally moderately strong MUDSTONE, moderately strong-strong SANDSTONE/CONGLOMERATE

NB. Data quality on S4, located over the made ground/waste was very poor.

3.4 MASW

Shear wave (S-wave) velocity (Vs) and G_{max} values were determined for the made ground/waste and soil material. Vs velocities and corresponding soil cohesion ranges are summarised in Figure 3.1.

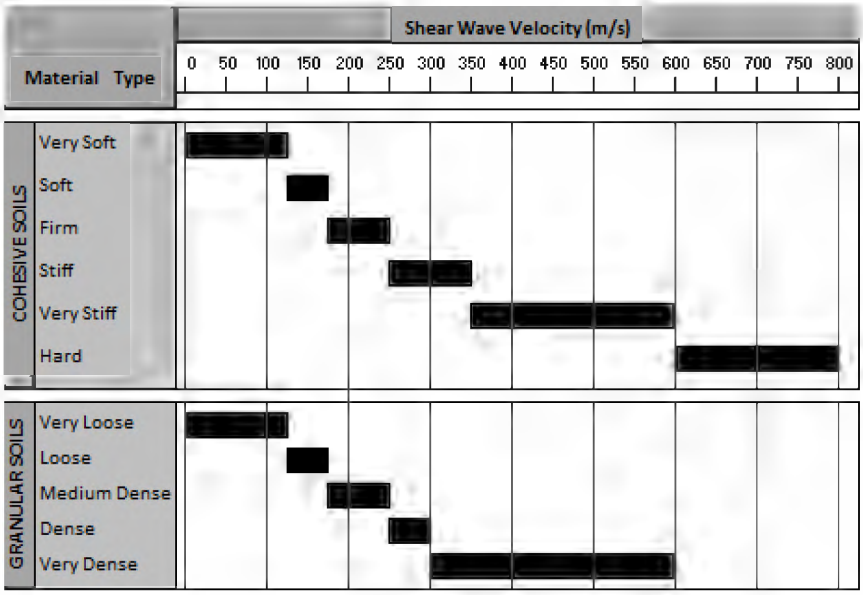

Fig 3.1: Vs velocities and corresponding soil cohesion ranges

The S-wave seismic velocities from this site are plotted in Fig. 3.2 and have been interpreted as follows:

Layer	Velocity (m/s)	Interpretation
1	100 - 190	Soft/Loose MADE GROUND/WASTE, sandy gravelly CLAY
2	190 - 300	Firm-stiff sandy gravelly CLAY

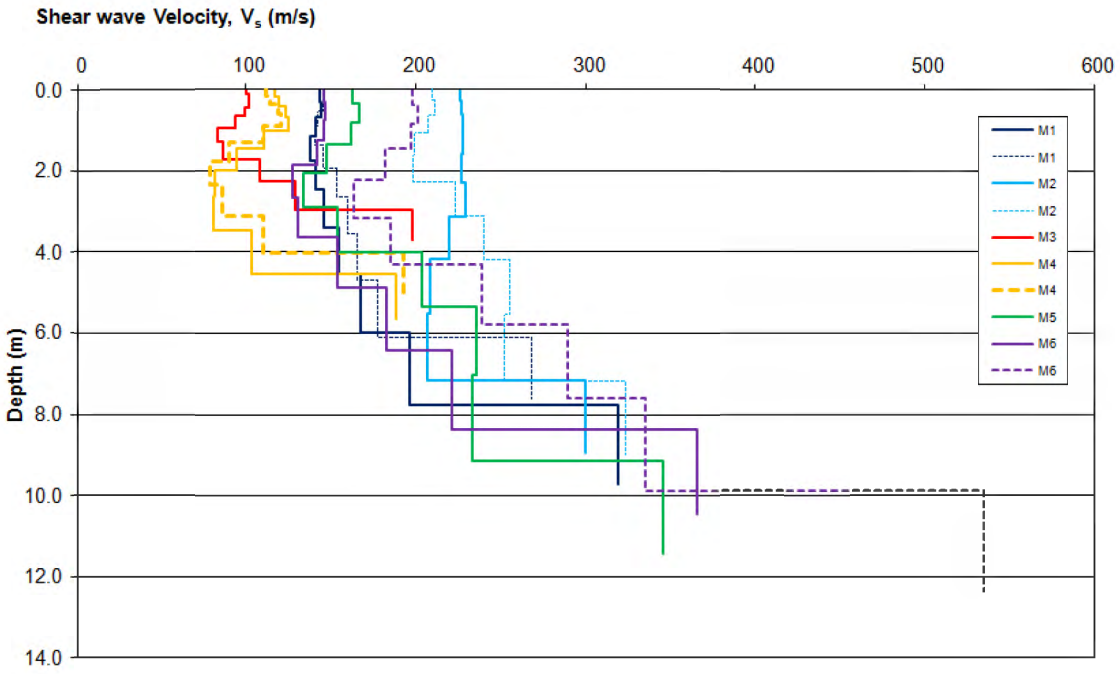

Fig 3.2: Vs velocities across site (M1-M6)

3.5 Discussion

The interpretation of the geophysical data is plotted on Drawings AGL18165_R1 to AGL18165_R5 and summarised on Drawings AGL18165_03.

3.5.1 Extent of the waste

The elevated EM conductivity readings show the waste to be present in approximately **2.2 Ha** in the centre of the survey area (Zone A). This zone coincides with the 'black waste' recorded on the trial pit logs.

There is also a small area (0.08 Ha) on the southern border (Zone B), adjacent to TP 15, where waste may also be present.

3.5.2 Type of waste

The EM Conductivity and the ERT profiles have characterised the waste present in these zones as:

TOPSOIL over MADE GROUND/WASTE (predominantly organic) over SAND/GRAVEL with LEACHATE

3.5.3 Thickness of waste and other information.

Electrical contrasts between both the waste material and the underlying sandy gravelly clay with leachate are poor and the best thickness information comes from the trial pit and MASW data.

The average thickness of the Zone A waste is 5.0m. The thickness of the Zone B waste is unknown but nearby TP15 records 0.4m of waste.

All of the ERT profiles in Zone A show the low resistivity zone to extend up to 10m below the bottom of the waste as found on the trial pit logs and MASW. This has been interpreted as **leachate** beneath the waste body extending into the underlying sandy gravelly clay.

A **possible leachate plume** in the direction of the river is indicated by the ERT data on profile R6 and in the adjoining EM data, and has been outlined on Drawing AGL18165_03 (Zone C). It is probable that the low resistivity on this profile is entirely due to leachate (no waste was recorded on TP1) but this should be confirmed by a borehole.

A similar zone of elevated EM readings occurs at the north-western end of R7 (Zone D) and has been indicated as a possible leachate plume on Drawing AGL18165_03 but may be due to increased alluvium content in area.

The average S-wave velocity for the waste on profile S4/M4 is 110m/s indicating that the waste material is soft to very soft and that the underlying sandy gravelly clay material is firm-stiff.

3.5.4 Volume calculation

The volumes of waste calculated using the extents and thicknesses interpreted above are as follows:

Zone	Extent (sq. m.)	Thickness (m.)	Volume (cu. m.)	Tonnes (@ 1.4 tonnes/cu.m.)
A	21,112	5.0	105,560	147,784
B*	800	0.4	320	448

* based on EM only.

3.5.5 Bedrock

The ERT profiles show a break in bedrock resistivity in the south-eastern part of the site, with decreasing resistivity to the north-west (R1, R2, R3, R7 and R9). This break corresponds approximately to the change from Fearnaght sandstone/conglomerate to Cooldaragh mudstone as indicated on the GSI geology map for the area (see Fig. 2.3).

Bedrock elevation is around 37-45 mOD. Combined waste and soil thicknesses range from around 15m to 20m. Due to the poor resistivity and seismic velocity contrasts between the weathered mudstone in the north-western part of the site and overlying sandy gravelly clays, the exact bedrock profile is difficult to interpret with certainty in places.

4 RECOMMENDATIONS

To confirm the findings of the geophysical report the following boreholes and trial pits are recommended:

No.	Easting	Northing	Northing
PBH1	656837.5	828643.7	to investigate predominantly organic waste and underlying leachate
PBH2	656642.7	828687.6	to investigate possible leachate plume
PBH3	656757.8	828663.0	to investigate predominantly organic waste and underlying leachate
PTP1	656858.1	828754.5	to investigate possible leachate plume
PTP2	656917.8	828525.8	to investigate possible buried waste

The geophysical report should be reviewed after the completion of any direct investigation.

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APPENDIX A: DETAILED METHODOLOGY

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

A.1 EM Ground Conductivity Mapping

Principles

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 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.

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 9 program (Golden Software, 2009). 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.

A.2 Electrical Resistivity Tomography

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 electrodes connected to a resistivity meter, using computer software to control the process of data collection and storage.

Data Collection

The data were recorded using a Tigre resistivity meter, imaging software, a 32 takeout multicore cables and 32 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.

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.

A.3 Seismic Refraction Profiling

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.

Data Collection

Seismic spreads were recorded using a Geode high-resolution 24 channel digital seismograph with geophone spacings of 2 m and 3 m. The source of the seismic waves was a sledgehammer. Records from up to seven different positions were taken on each spread (2 x off-end, 2 x end, 3 x middle) to ensure optimum coverage of all refractors.

Data Processing

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 intercept-time and plus-minus methods, to acquire depths to boundaries and the P-wave velocities of these layers, using the GREMIX programme from INTERPEX.

Approximate errors for 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 may also occur (Soske, 1959).

A.4 Multichannel Analysis of Surface Waves

Principles

The Multi-channel Analysis of Surface Waves (MASW) (Park et al., 1998, 1999) utilizes Surface waves (Rayleigh waves) to determine the elastic properties of the shallow subsurface (<15m). Surface waves carry up to two/thirds of the seismic energy but are usually considered as noise in conventional body wave reflection and refraction seismic surveys.

The penetration depth of surface waves changes with wavelength, i.e. longer wavelengths penetrate deeper. When the elastic properties of near surface materials vary with depth, surface waves then become dispersive, i.e. propagation velocity changes with frequency. The propagation (or phase) velocity is determined by the average elastic property of the medium within the penetration depth. Therefore the dispersive nature of surface waves may be used to investigate changes in elastic properties of the shallow subsurface.

The MASW method employs the multi-channel recording and processing techniques (Sheriff and Geldart, 1982) that have similarities to those used in a seismic reflection survey and which allow

better waveform analysis and noise elimination. The following procedure is followed to produce a shear wave velocity (Vs) profile and a stiffness profile of the subsurface using surface waves:

(i) A point source (eg. a sledgehammer) is used to generate vertical ground motions,
(ii) the ground motions are measured using low frequency geophones, which are deposited along a straight line directed toward the source,
(iii) the ground motions are recorded using a seismograph,
(iv) a dispersion curve is produced from spectral analysis of the data showing the variation of surface wave velocity with wavelength,
(v) the dispersion curve in inverted using a modelling and least squares minimization process to produce a subsurface profile of the variation of shear wave velocity with depth.

Data Collection

The recording equipment consisted of a Geode 24 channel digital seismograph, 24 no. 4HZ vertical geophones, hammer energy source with mounted trigger and a 24 take-out cable, with geophone spacings of 2 m and 3 m.

Data Processing

MASW processing was carried out using the SURFSEIS processing package developed by Kansas Geological Survey (KGS, 2000). SURFSEIS data processing involves three steps:

(i) Preparation of the acquired multichannel record. This involves converting data file into the processing format.
(ii) Production of a dispersion curve from a spectral analysis of the data showing the variation of Raleigh wave phase velocity with wavelength. Confidence in the dispersion curve can be estimated through a measure of signal to noise ratio (S/N), which is obtained from a coherency analysis. Noise includes both body waves and higher mode surface waves. To obtain an accurate dispersion curve the spectral content and phase velocity characteristics are examined through an overtone analysis of the data.
(iii) Inversion of the dispersion curve is then carried out to produce a subsurface profile of the variation of shear wave velocity with depth. The bedrock P-wave velocities were converted to S-wave velocities using the following equation:

Vs=(((Vp^2)-2*v*(Vp^2))/((1-v)*2))^0.5

Where Vs = S-wave velocity in m/s, Vp = P-wave velocity in m/s and v = Poisson's ratio.

A.5 Spatial Relocation

All the geophysical investigation locations were acquired using Trimble Geo 7X high-accuracy GNSS handheld GPS system using the settings listed below. This system allows collecting 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 B: DRAWINGS

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

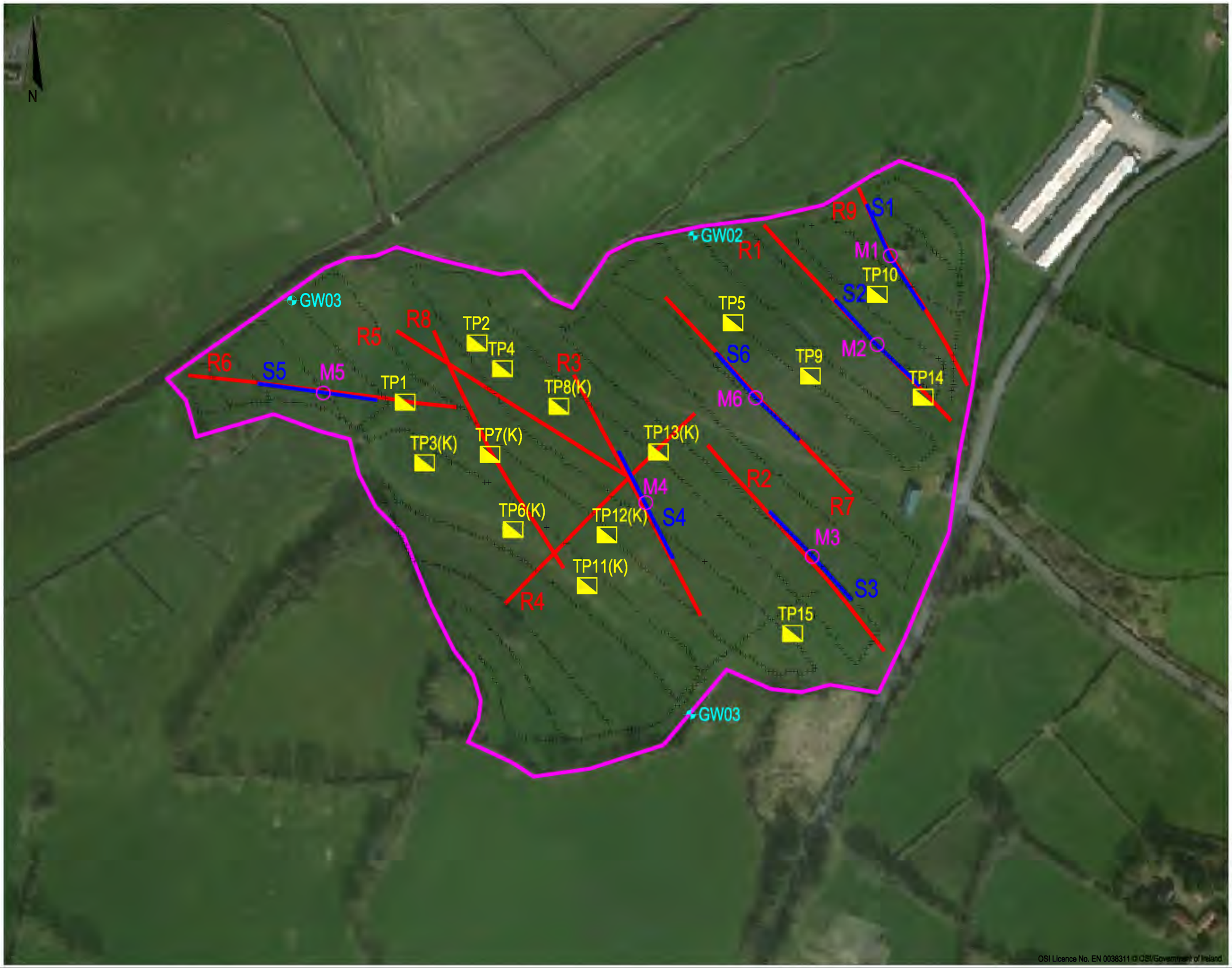
AGL18165_01	Geophysical Investigation Locations	Scale 1:2000 @ A4
AGL18165_02	EM Conductivity Contours (mS/m)	Scale 1:2000 @ A4
AGL18165_03	Summary Interpretation Map	Scale 1:2000 @ A4

The ERT and seismic refraction data with geological interpretations are presented in the following drawings:

Drawing AGL18165_R1	Results and Interpretation R1	Scale 1: 1000 @ A4
Drawing AGL18165_R2	Results and Interpretation R2	Scale 1: 1000 @ A4
Drawing AGL18165_R3	Results and Interpretation R3	Scale 1: 1000 @ A4
Drawing AGL18165_R4	Results and Interpretation R4	Scale 1: 1000 @ A4
Drawing AGL18165_R5	Results and Interpretation R5	Scale 1: 1000 @ A4
Drawing AGL18165_R6	Results and Interpretation R6	Scale 1: 1000 @ A4
Drawing AGL18165_R7	Results and Interpretation R7	Scale 1: 1000 @ A4
Drawing AGL18165_R8	Results and Interpretation R8	Scale 1: 1000 @ A4
Drawing AGL18165_R9	Results and Interpretation R9	Scale 1: 1000 @ A4

GEOPHYSICAL INVESTIGATION LOCATIONS

SCALE 1:2000



INDEX MAP:

LEGEND:

- Site
- EM conductivity/gravity reading
- R1 — 2D resistivity profile
- S1 — Seismic refraction profile
- M1 — MASW sounding
- TP1 — Previous Trial Pit (K denotes 'black waste' on log.)
- GW02 — Monitoring Well

The information displayed here is to be used in conjunction with Report AGL18165_0 1 Report on the Geophysical Investigation at Knockcronaghan Landfill, Co. Monaghan, APEX Geoservices Ltd. 16-11-2018.

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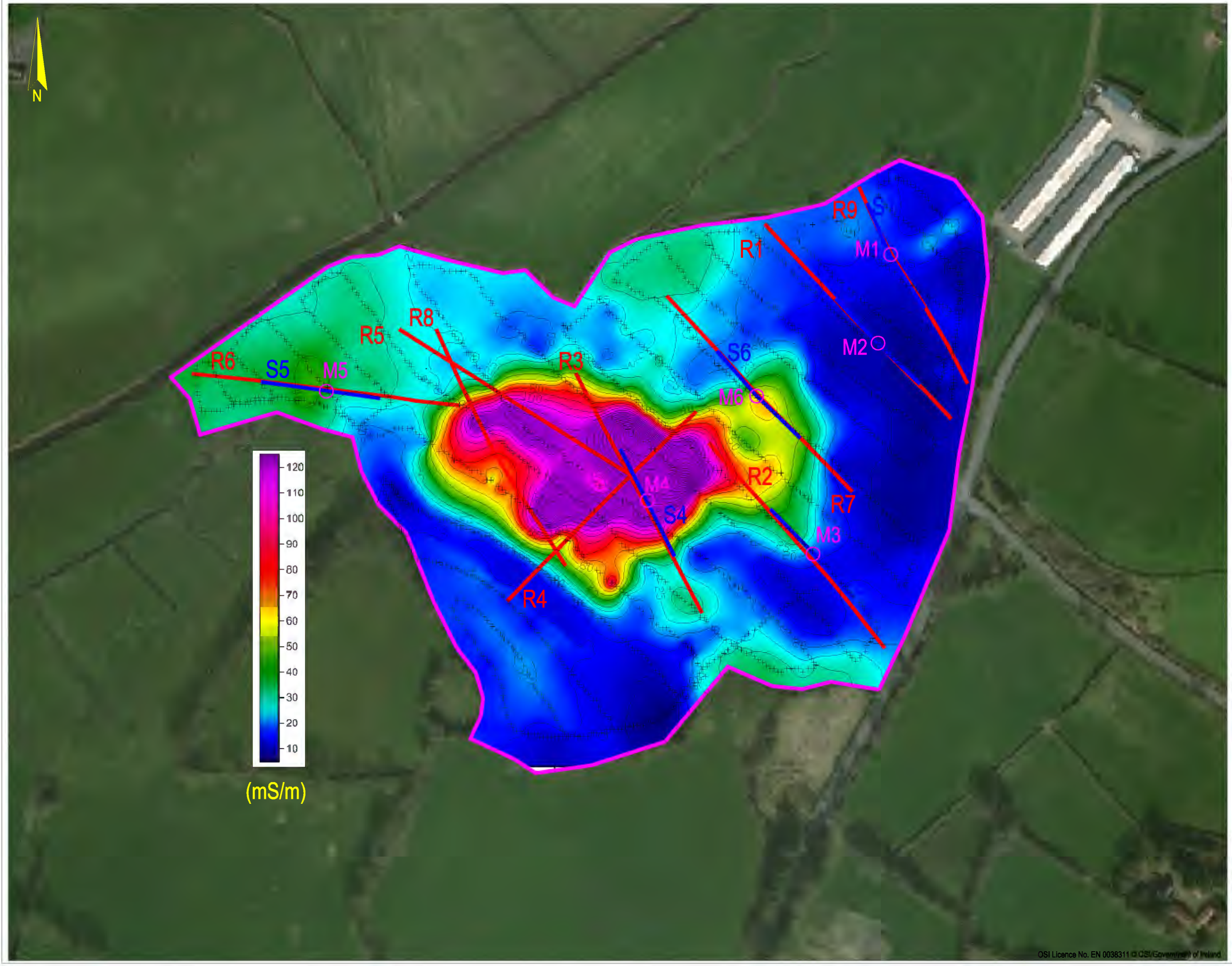
PROJECT:	KILLYCRONAGHAN LANDFILL GEOPHYSICAL INVESTIGATION
CLIENT:	FEHILY TIMONEY & CO.
DRAWING NO:	AGL18165_01
SCALE:	AS INDICATED @ A3
DATE:	16-11-2018

Version:	Date:	Drawn By:	Checked:
01	16-11-2018	POC	YOC

EM CONDUCTIVITY CONTOURS (mS/m)

SCALE 1:2000



INDEX MAP:

LEGEND:

- Site
- EM conductivity/gravity reading
- R1 — 2D resistivity profile
- S1 — Seismic refraction profile
- M1 — MASW sounding

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DRAWING NO:	AGL18165_02
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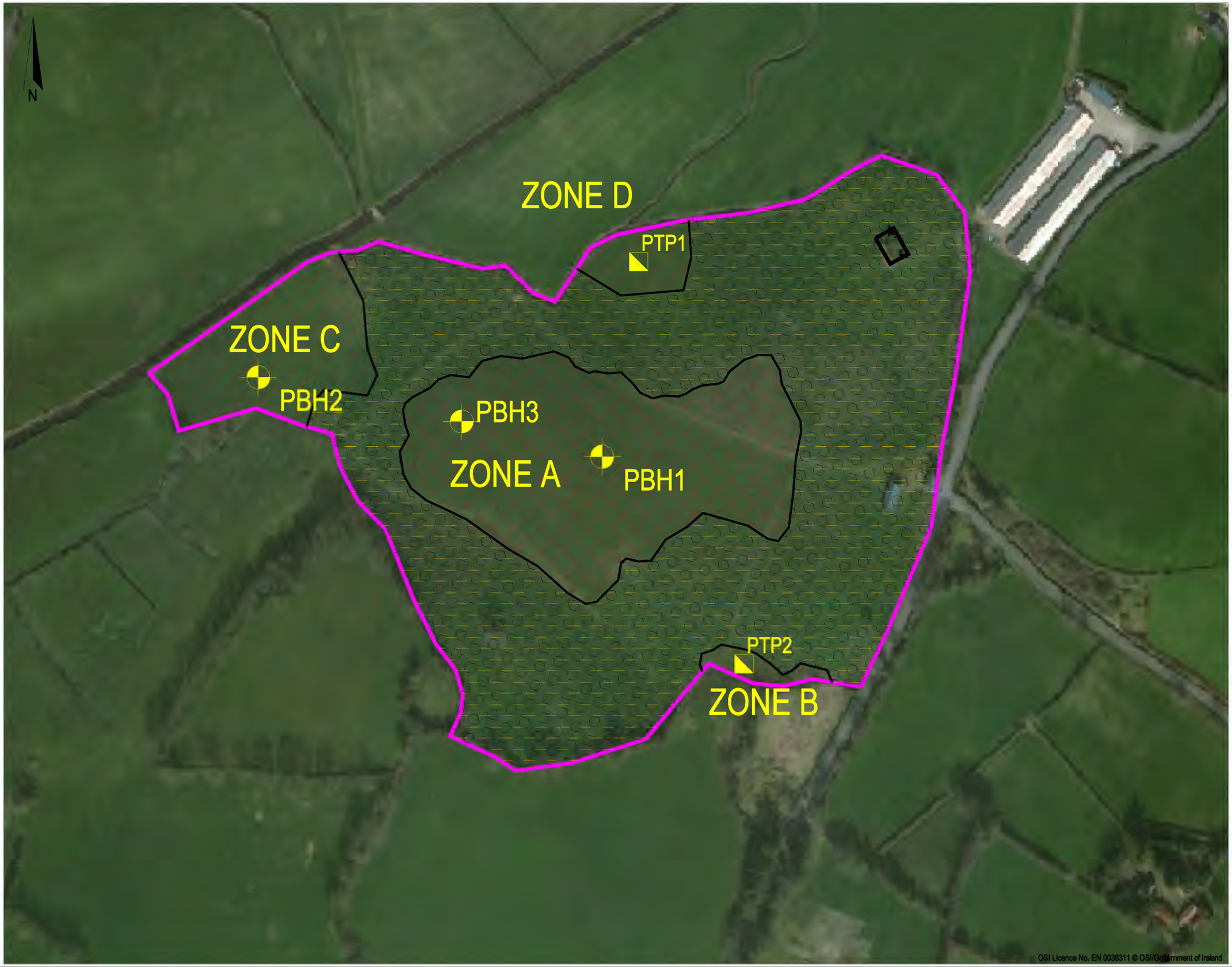
DATE:	16-11-2018

Version:	Date:	Drawn By:	Checked:
01	16-11-2018	POC	YOC

SUMMARY INTERPRETATION MAP

SCALE 1:2000



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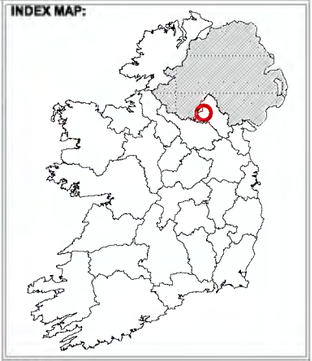

LEGEND:

- SITE
- MADE GROUND/WASTE (PRED. ORGANIC) OVER SAND/GRAVEL WITH LEACHATE
- SANDY GRAVELLY CLAY WITH POSSIBLE LEACHATE PLUME
- SANDY GRAVELLY CLAY/W. ROCK AT BASE
- PBH1 PROPOSED BOREHOLE
- PTP2 PROPOSED TRIAL PIT
- PDP1 Proposed dynamic probe/Shell
- PST1 Proposed slit trench

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DRAWING NO:	AGL18165_03
SCALE:	AS INDICATED @ A3
DATE:	16-11-2018

Version:	Date:	Drawn By:	Checked:
01	16-11-2018	POC	YOC

ERT RESULTS & INTERPRETATION - R1

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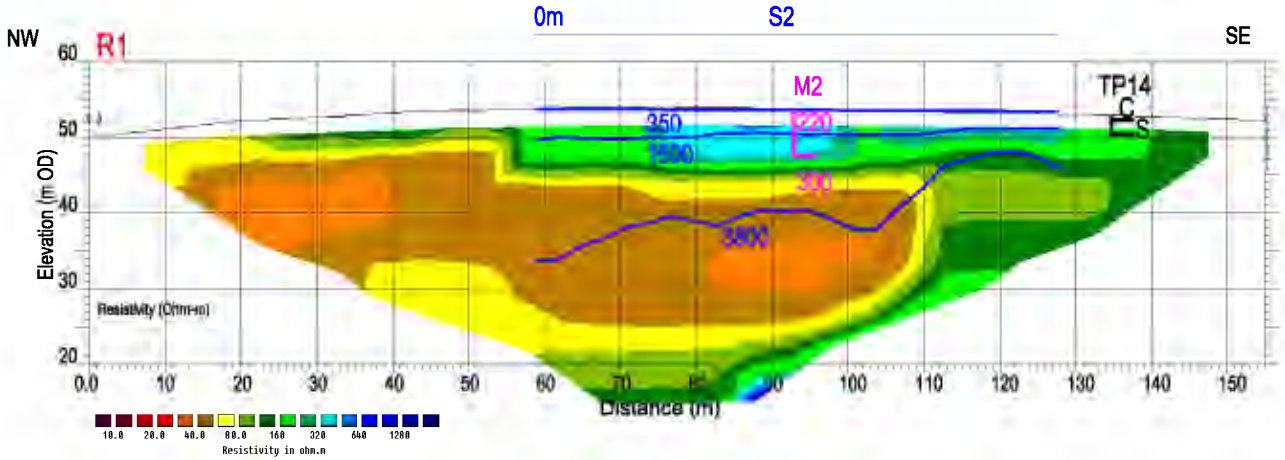

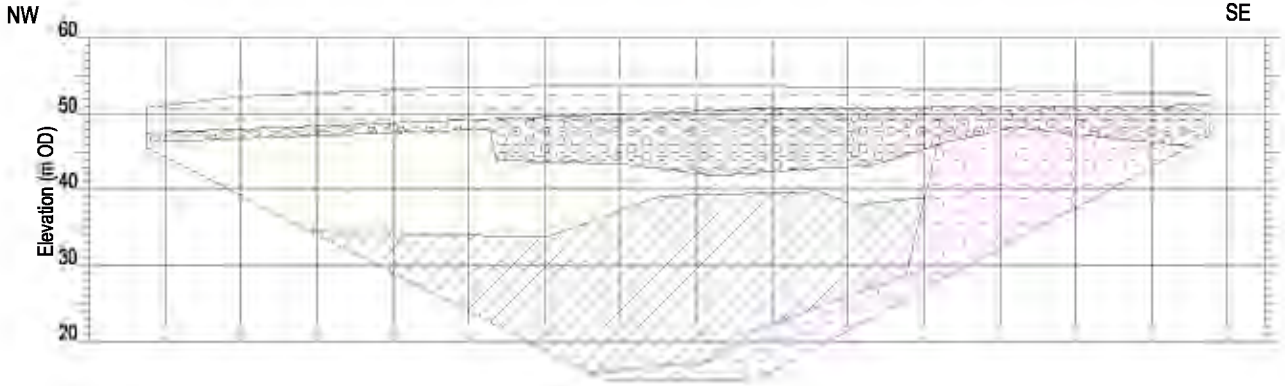

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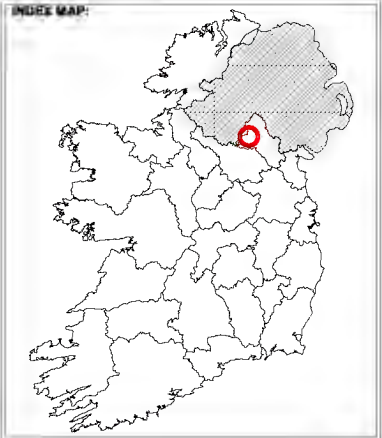

LEGEND:

- MADE GROUND/WASTE (PRED. ORGANIC) OVER SAND/GRAVEL WITH LEACHATE
- SOFT-FIRM SANDY CLAY
- FIRM-STIFF SANDY GRAVELLY CLAY/W. ROCK
- WEATHERED MUDSTONE
- MUDSTONE
- SANDSTONE/CONGLOMERATE
- TP1 — Previous Trial Pit Summary **MG(Made Ground/Waste), S(Sand),C(Clay L(Silt)**
- Base of waste (from Trial Pits & MASW)
- 1288 — Seismic refraction layer with interpreted P-wave velocity (m/s)
- 145 — MASW with S-wave velocity (m/s)
- PBH1 — Proposed borehole

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DATE:	16-11-2018

Version:	Date:	Drawn By:	Checked:
01	16-11-2018	POC	YOC

ERT RESULTS & INTERPRETATION - R2

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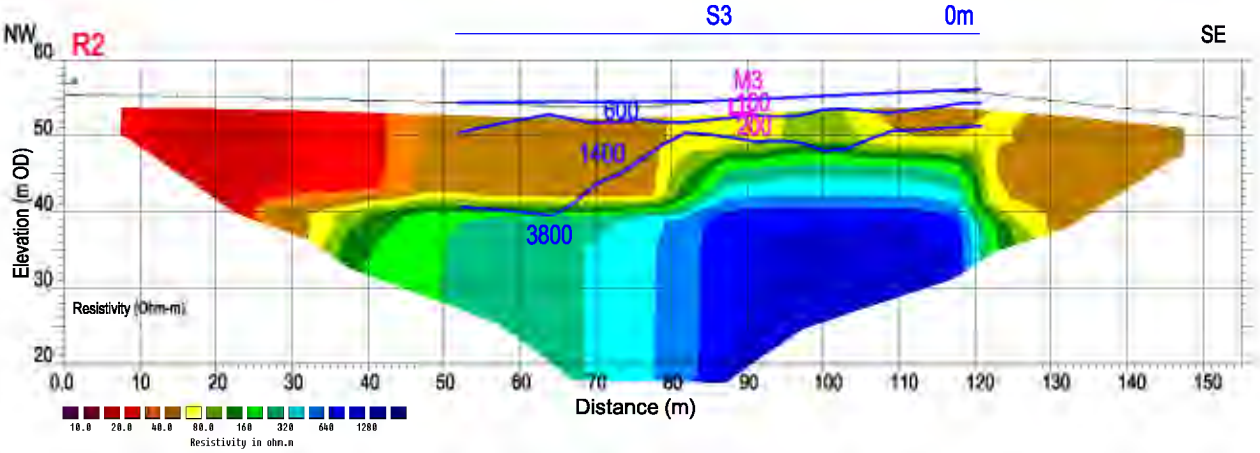

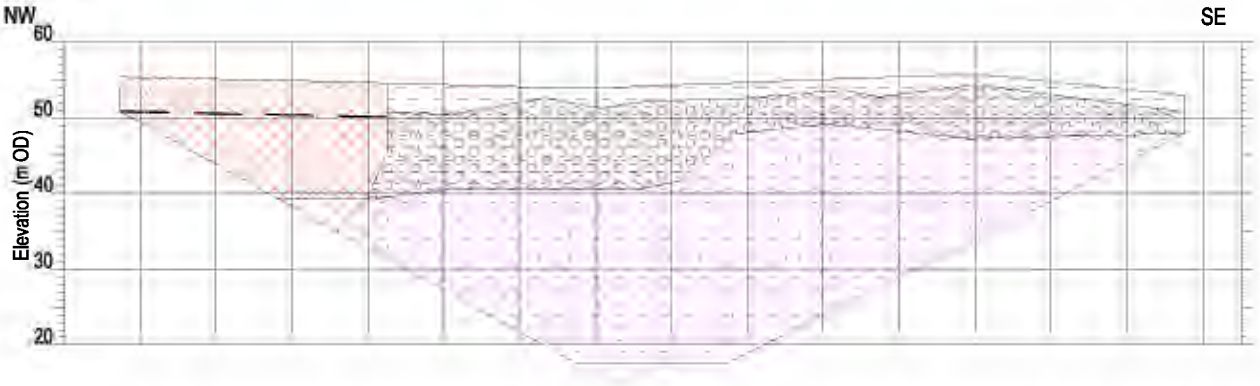

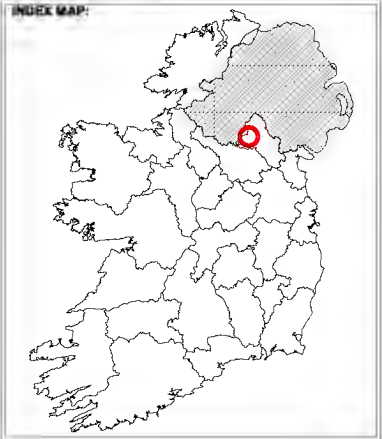

LEGEND:

- MADE GROUND/WASTE (PRED. ORGANIC) OVER SAND/GRAVEL WITH LEACHATE
- SOFT-FIRM SANDY CLAY
- FIRM-STIFF SANDY GRAVELLY CLAY/W. ROCK
- WEATHERED MUDSTONE
- MUDSTONE
- SANDSTONE/CONGLOMERATE
- TP1 — Previous Trial Pit Summary MG(Made Ground/Waste), S(Sand),C(Clay L(Silt)
- Base of waste (from Trial Pits & MASW)
- 1288 — Seismic refraction layer with interpreted P-wave velocity (m/s)
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SCALE:	AS INDICATED @ A4
DATE:	16-11-2018

Version:	Date:	Drawn By:	Checked:
01	16-11-2018	POC	YOC

ERT RESULTS & INTERPRETATION - R3

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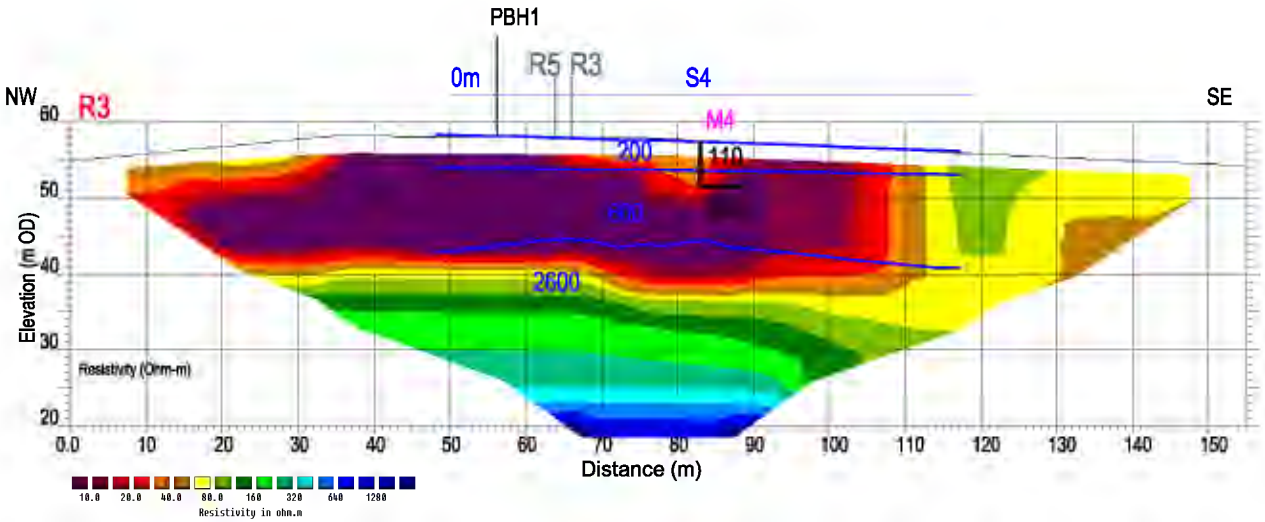

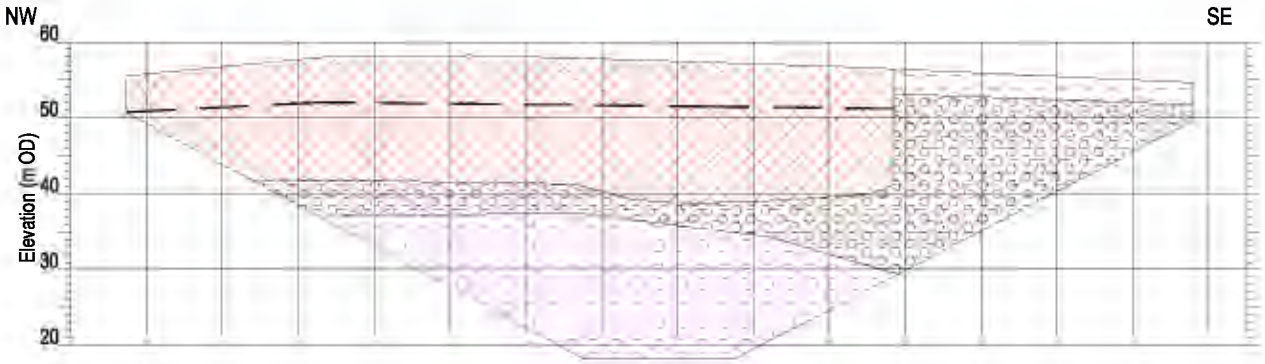

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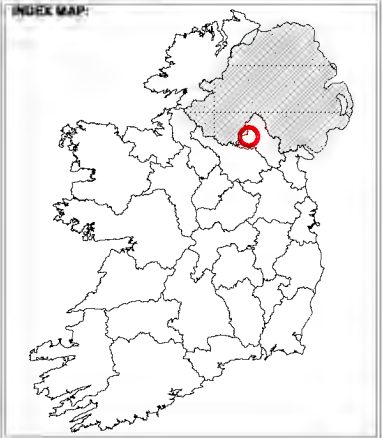

LEGEND:

- MADE GROUND/WASTE (PRED. ORGANIC) OVER SAND/GRAVEL WITH LEACHATE
- SOFT-FIRM SANDY CLAY
- FIRM-STIFF SANDY GRAVELLY CLAY/W. ROCK
- WEATHERED MUDSTONE
- MUDSTONE
- SANDSTONE/CONGLOMERATE
- TP1 — Previous Trial Pit Summary **MG(Made Ground/Waste), S(Sand),C(Clay L(Silt)**
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- PBH1 — Proposed borehole

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SCALE:	AS INDICATED @ A4
DATE:	16-11-2018

Version:	Date:	Drawn By:	Checked:
01	16-11-2018	POC	YOC

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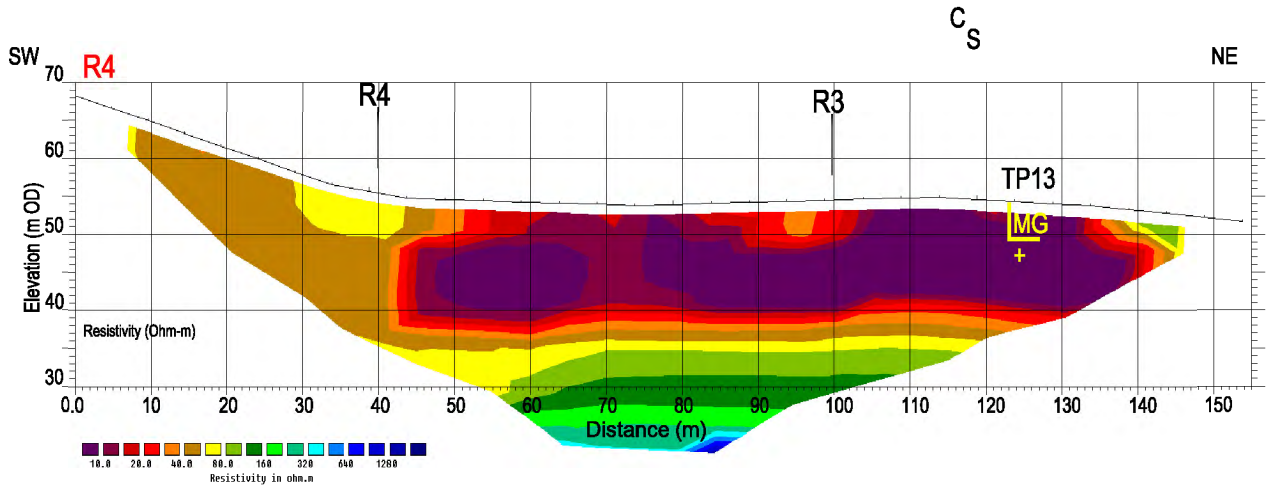

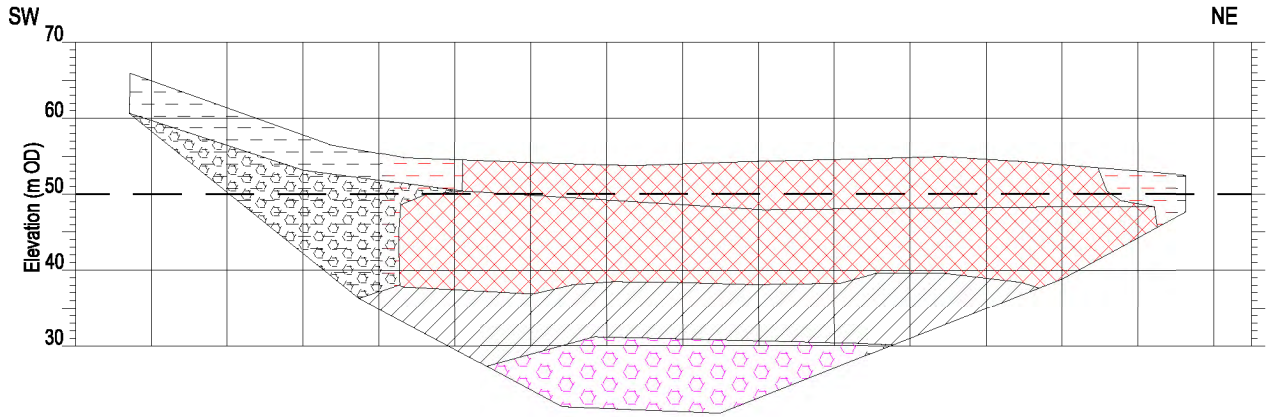

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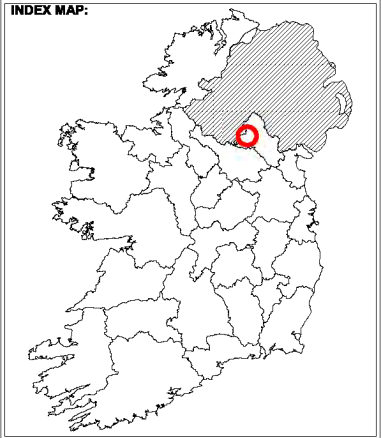

LEGEND:

- MADE GROUND/WASTE (PRED. ORGANIC) OVER SAND/GRAVEL WITH LEACHATE
- SOFT-FIRM SANDY CLAY
- FIRM-STIFF SANDY GRAVELLY CLAY/W. ROCK
- WEATHERED MUDSTONE
- MUDSTONE
- SANDSTONE/CONGLOMERATE
- TP1 — Previous Trial Pit Summary **MG(Made Ground/Waste), S(Sand),C(Clay L(Silt)**
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- 1288 — Seismic refraction layer with interpreted P-wave velocity (m/s)
- 145 — MASW with S-wave velocity (m/s)
- PBH1 — Proposed borehole

The information displayed here is to be used in conjunction with Report AGL18165_0 1 Report on the Geophysical Investigation at Knockcronaghan landfill, Co. Monaghan, APEX Geoservices Ltd. 16-11-2018.

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CLIENT.:	FEHILY TIMONEY & CO.
DRAWING NO:	AGL18165_R4
SCALE:	AS INDICATED @ A4
DATE:	16-11-2018

Version:	Date:	Drawn By:	Checked:
01	16-11-2018	POC	YOC

ERT RESULTS & INTERPRETATION - R5

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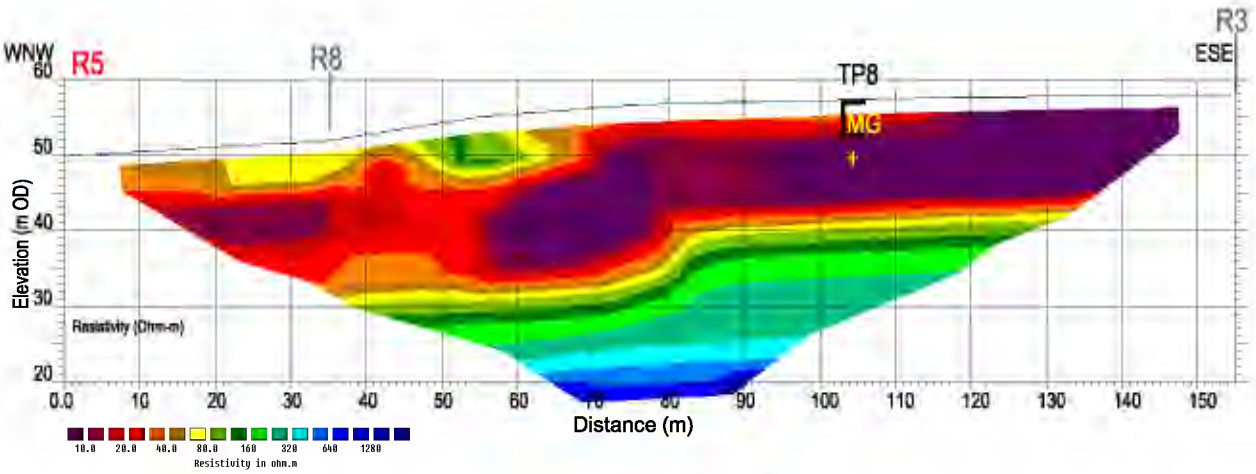

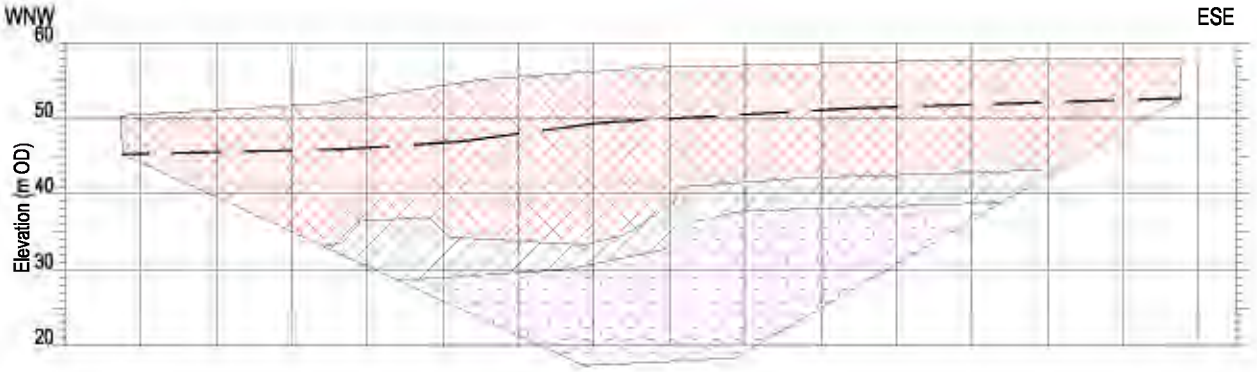

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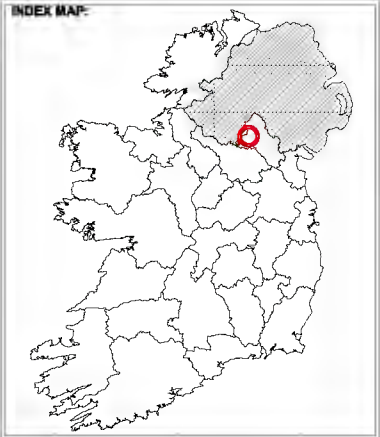

LEGEND:

- MADE GROUND/WASTE (PRED. ORGANIC) OVER SAND/GRAVEL WITH LEACHATE
- SOFT-FIRM SANDY CLAY
- FIRM-STIFF SANDY GRAVELLY CLAY/W. ROCK
- WEATHERED MUDSTONE
- MUDSTONE
- SANDSTONE/CONGLOMERATE
- TP1 — Previous Trial Pit Summary **MG(Made Ground/Waste), S(Sand),C(Clay L(Silt)**
- Base of waste (from Trial Pits & MASW)
- 1288 — Seismic refraction layer with interpreted P-wave velocity (m/s)
- 145 — MASW with S-wave velocity (m/s)
- PBH1 — Proposed borehole

The information displayed here is to be used in conjunction with Report AGL18165_01 Report on the Geophysical Investigation at Knockcronaghan landfill, Co. Monaghan, APEX Geoservices Ltd. 16-11-2018.

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CLIENT:	FEHILY TIMONEY & CO.
DRAWING NO:	AGL18165_R5
SCALE:	AS INDICATED @ A4
DATE:	16-11-2018

Version:	Date:	Drawn By:	Checked:
01	16-11-2018	POC	YOC

ERT RESULTS & INTERPRETATION - R6

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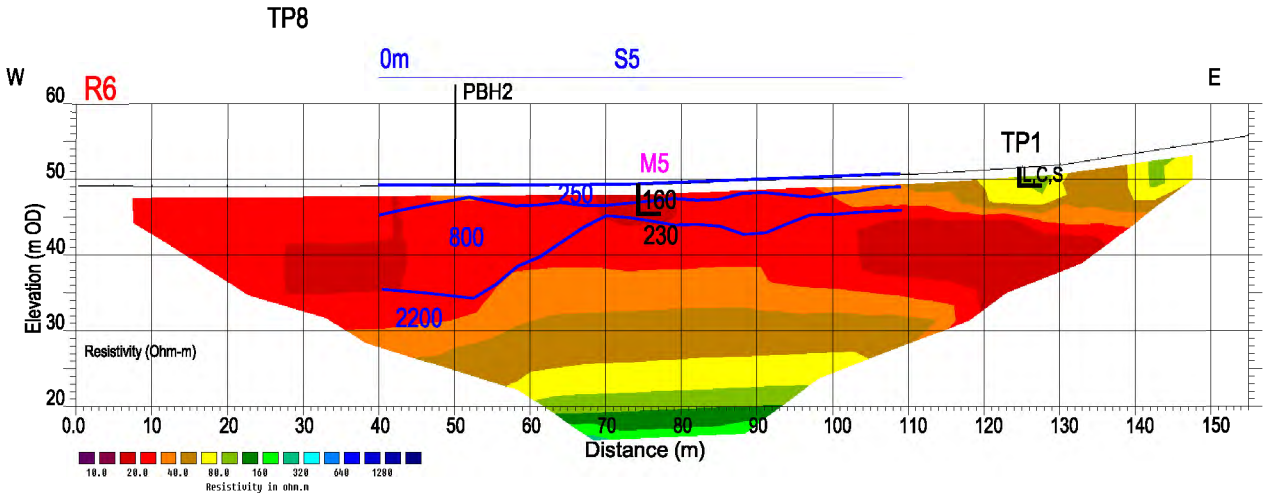

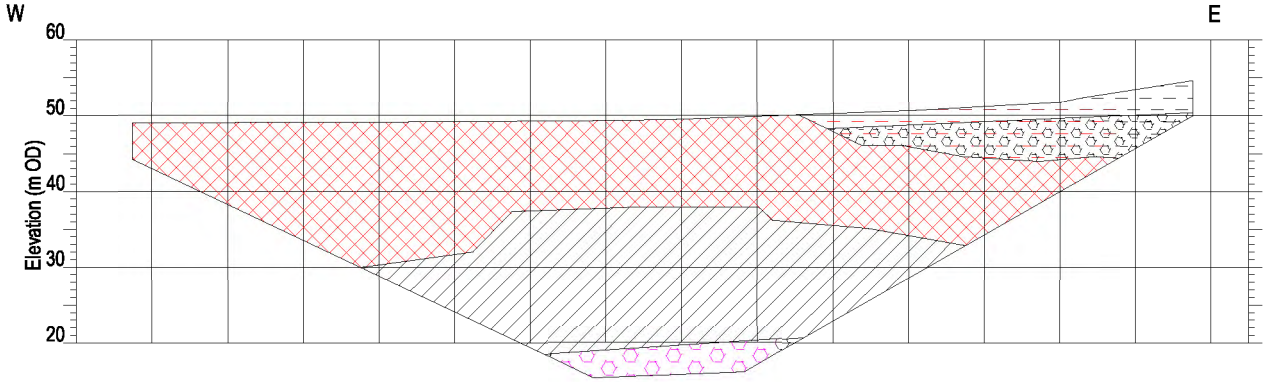

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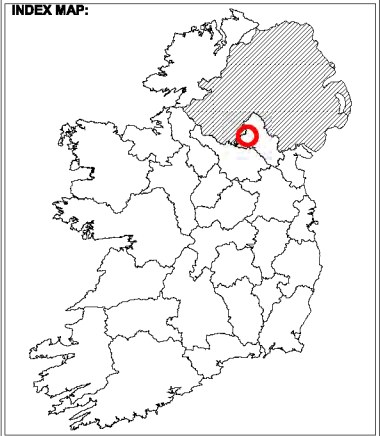

LEGEND:

- MADE GROUND/WASTE (PRED. ORGANIC) OVER SAND/GRAVEL WITH LEACHATE
- SOFT-FIRM SANDY CLAY
- FIRM-STIFF SANDY GRAVELLY CLAY/W. ROCK
- WEATHERED MUDSTONE
- MUDSTONE
- SANDSTONE/CONGLOMERATE
- TP1 — Previous Trial Pit Summary MG(Made Ground/Waste), S(Sand),C(Clay L(Silt)
- Base of waste (from Trial Pits & MASW)
- 1288 — Seismic refraction layer with interpreted P-wave velocity (m/s)
- 145 — MASW with S-wave velocity (m/s)
- PBH1 — Proposed borehole

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PROJECT:	KILLYCRONAGHAN LANDFILL GEOPHYSICAL INVESTIGATION
CLIENT:	FEHILY TIMONEY & CO.
DRAWING NO:	AGL18165_R6
SCALE:	AS INDICATED @ A4
DATE:	16-11-2018

Version:	Date:	Drawn By:	Checked:
01	16-11-2018	POC	YOC

ERT RESULTS & INTERPRETATION - R7

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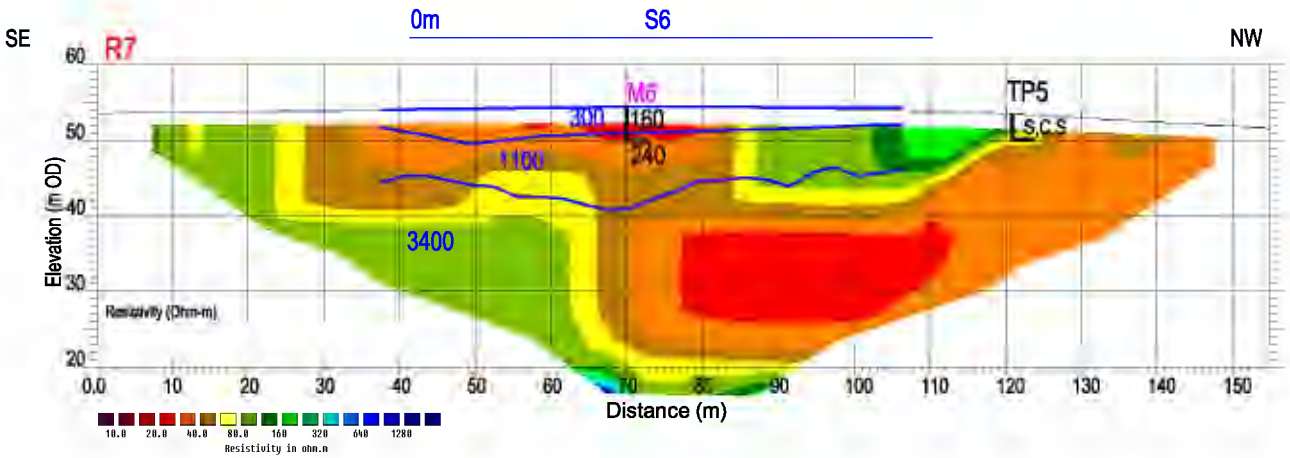

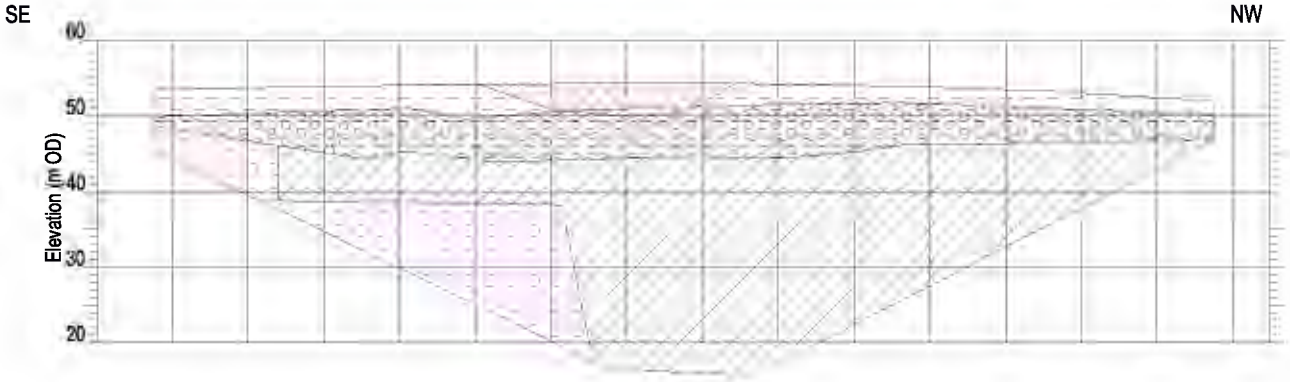

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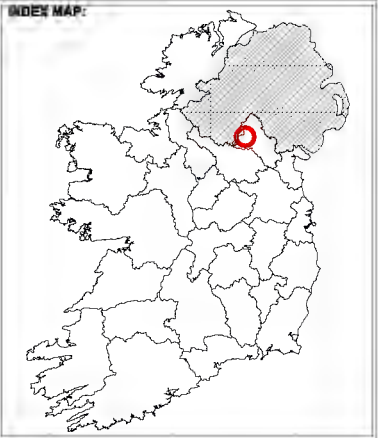

LEGEND:

- MADE GROUND/WASTE (PRED. ORGANIC) OVER SAND/GRAVEL WITH LEACHATE
- SOFT-FIRM SANDY CLAY
- FIRM-STIFF SANDY GRAVELLY CLAY/W. ROCK
- WEATHERED MUDSTONE
- MUDSTONE
- SANDSTONE/CONGLOMERATE
- TP1 — Previous Trial Pit Summary MG(Made Ground/Waste), S(Sand),C(Clay L(Silt)
- Base of waste (from Trial Pits & MASW)
- 1288 — Seismic refraction layer with interpreted P-wave velocity (m/s)
- 146 — MASW with S-wave velocity (m/s)
- PBH1 — Proposed borehole

The information displayed here is to be used in conjunction with Report AGL18165_01 Report on the Geophysical Investigation at Knockcronaghan landfill, Co. Monaghan, APEX Geoservices Ltd. 16-11-2018.

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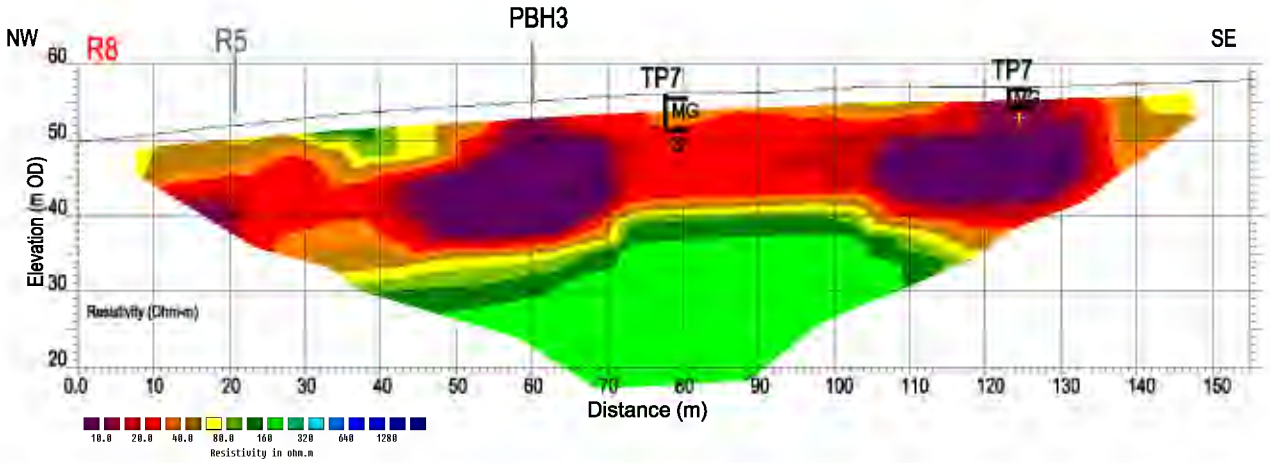
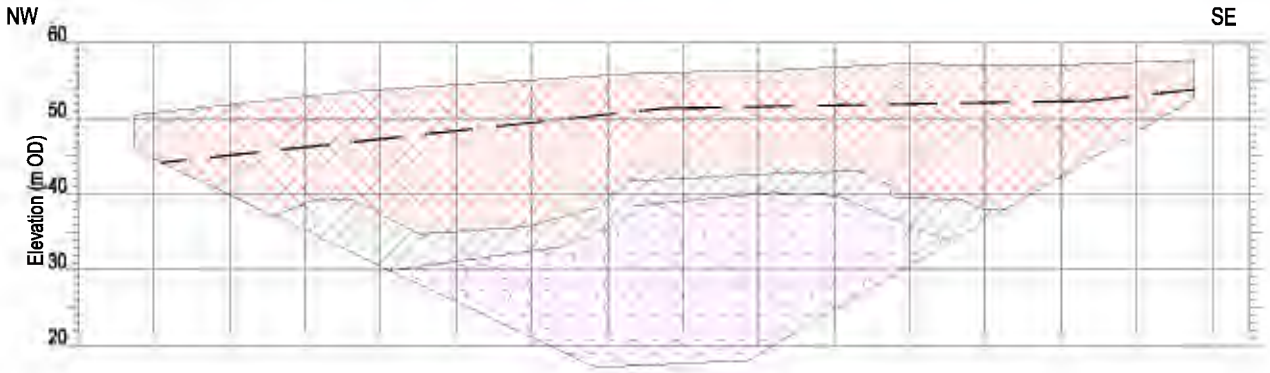
PROJECT:	KILLYCRONAGHAN LANDFILL GEOPHYSICAL INVESTIGATION
CLIENT:	FEHILY TIMONEY & CO.
DRAWING NO:	AGL18165_R7
SCALE:	AS INDICATED @ A4
DATE:	16-11-2018

Version:	Date:	Drawn By:	Checked:
01	16-11-2018	PDC	VDC

ERT RESULTS & INTERPRETATION - R8

SCALE 1:1000





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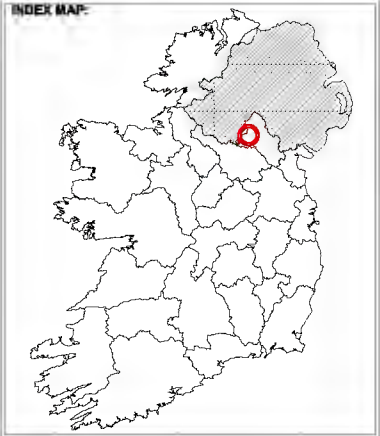

LEGEND:

- MADE GROUND/WASTE (PRED. ORGANIC) OVER SAND/GRAVEL WITH LEACHATE
- SOFT-FIRM SANDY CLAY
- FIRM-STIFF SANDY GRAVELLY CLAY/W. ROCK
- WEATHERED MUDSTONE
- MUDSTONE
- SANDSTONE/CONGLOMERATE
- TP1 — Previous Trial Pit Summary **MG(Made Ground/Waste), S(Sand),C(Clay L(Silt)**
- Base of waste (from Trial Pits & MASW)
- 1268 — Seismic refraction layer with interpreted P-wave velocity (m/s)
- 145 — MASW with S-wave velocity (m/s)
- PBH1 — Proposed borehole

The information displayed here is to be used in conjunction with Report AGL18165_01 Report on the Geophysical Investigation at Knockcronaghan landfill, Co. Monaghan, APEX Geoservices Ltd. 16-11-2018.

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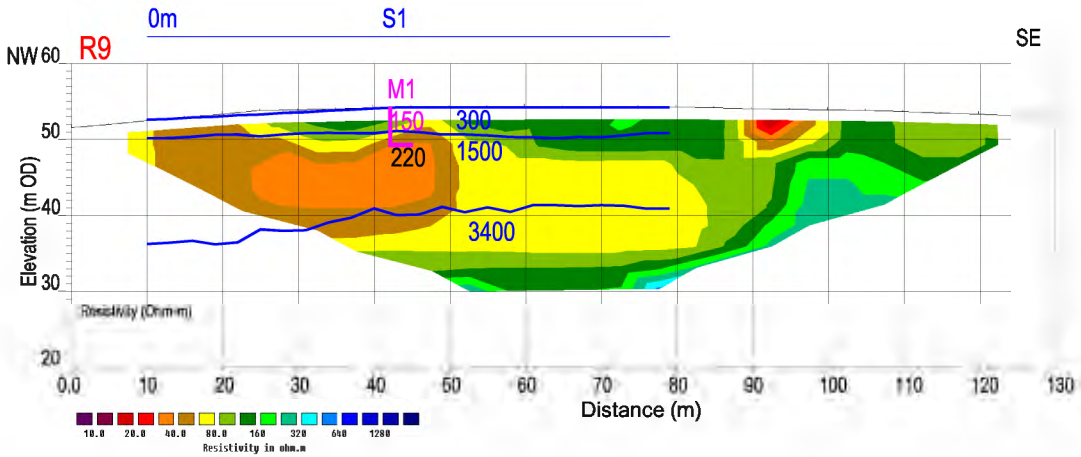
www.apexgeoservices.ie

PROJECT:	KILLYCRONAGHAN LANDFILL GEOPHYSICAL INVESTIGATION
CLIENT:	FEHILY TIMONEY & CO.
DRAWING NO:	AGL18165_R8
SCALE:	AS INDICATED @ A4
DATE:	16-11-2018

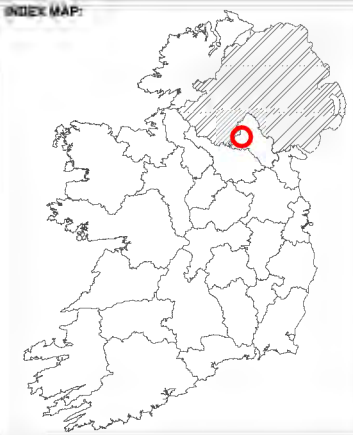
Version:	Date:	Drawn By:	Checked:
01	16-11-2018	PDC	YOC

ERT RESULTS & INTERPRETATION - R9

SCALE 1:1000



INDEX MAP:



LEGEND:

- MADE GROUND/WASTE (PRED. ORGANIC) OVER SAND/GRAVEL WITH LEACHATE
- SOFT-FIRM SANDY CLAY
- FIRM-STIFF SANDY GRAVELLY CLAY/W. ROCK
- WEATHERED MUDSTONE
- MUDSTONE
- SANDSTONE/CONGLOMERATE
- TP1 — Previous Trial Pit Summary **MG(Made Ground/Waste), S(Sand),C(Clay L(Silt)**
- Base of waste (from Trial Pits & MASW)
- 1288 — Seismic refraction layer with interpreted P-wave velocity (m/s)
- 146 — MASW with S-wave velocity (m/s)
- PBH1 — Proposed borehole

The information displayed here is to be used in conjunction with Report AGL18165_01 Report on the Geophysical Investigation at Knockcronaghan landfill, Co. Monaghan, APEX Geoservices Ltd. 16-11-2018.

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PROJECT:	KILLYCRONAGHAN LANDFILL GEOPHYSICAL INVESTIGATION
CLIENT:	FEHILY TIMONEY & CO.
DRAWING NO:	AGL18165_R9
SCALE:	AS INDICATED @ A4
DATE:	16-11-2018

Version:	Date:	Drawn By:	Checked:
01	16-11-2018	POC	YOC

APPENDIX C: SEISMIC PLATES

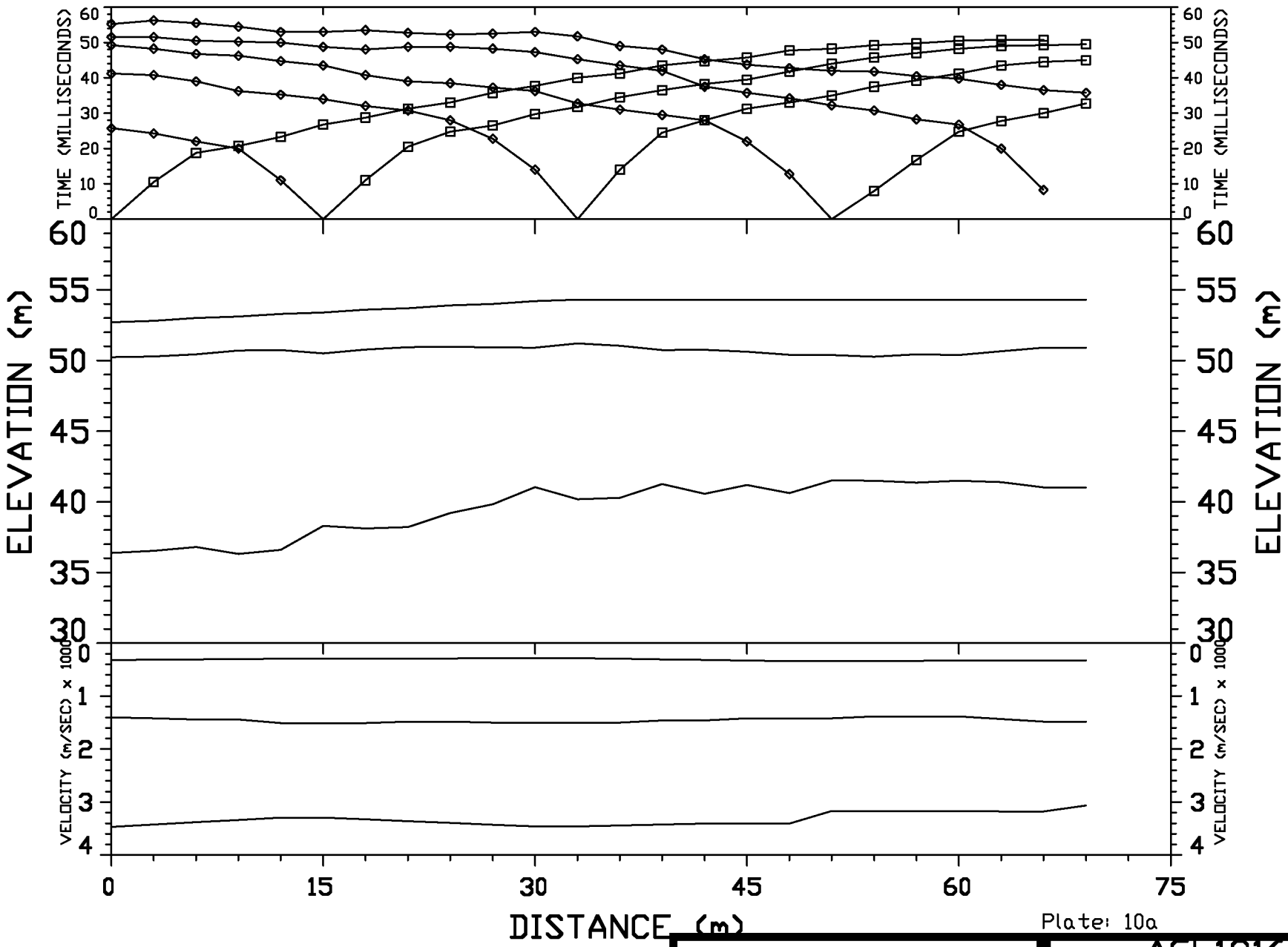


Plate: 10a

for: Fehilly Timoney & Co.	AGL18165
by: APEX Geoservices Ltd.	KILLYCRONAGHAN Monaghan
Data SetS1 / Date: 5-10-18	
Equipment: Geode / Spread: S1	Azimuth:

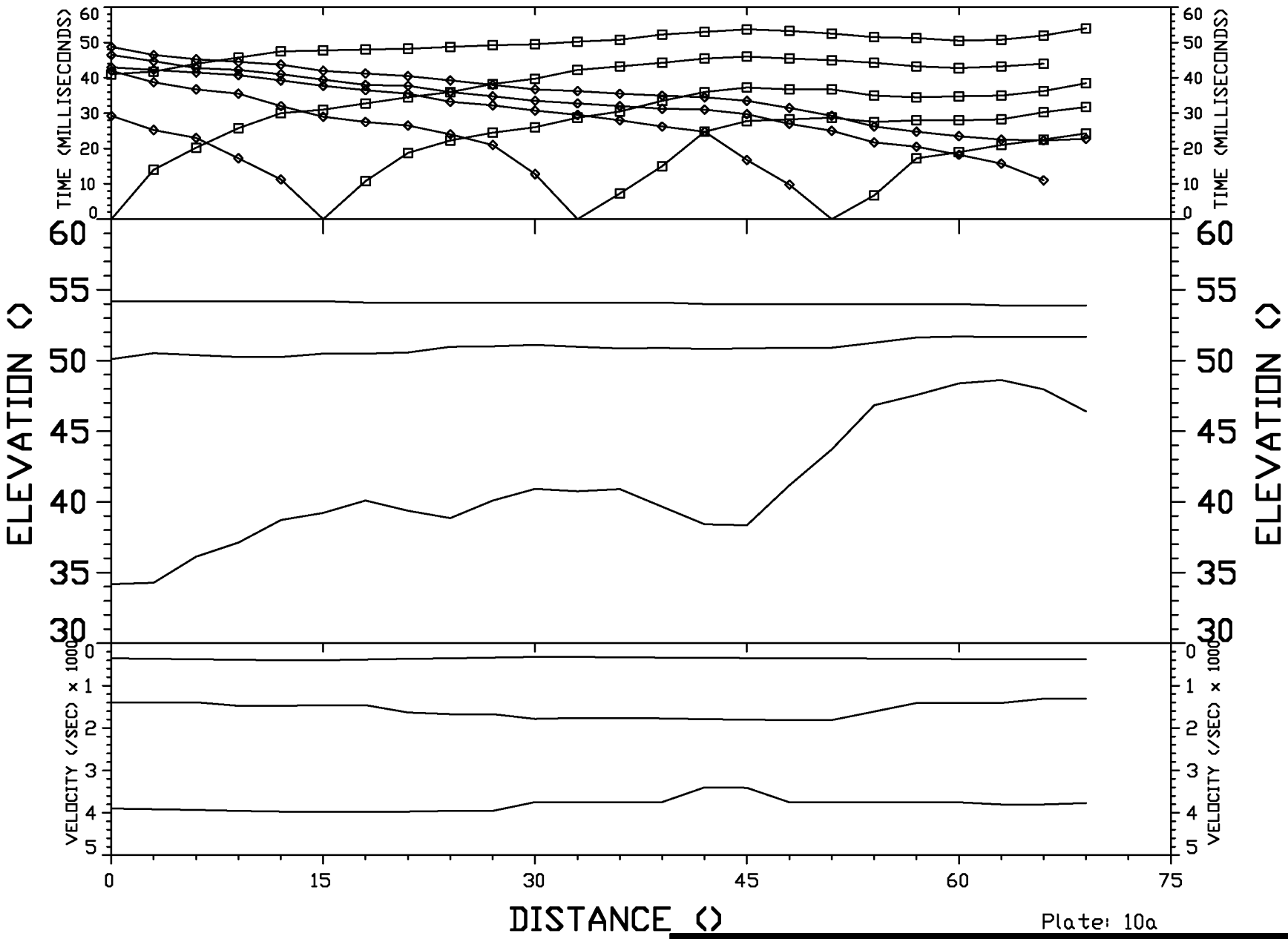


Plate: 10a

for: Fehilly Timoney & Co.	AGL18165
by: APEX Geoservices Ltd.	KILLYCRONAGHAN Monaghan
Data SetS2 / Date: 5-10-18	
Equipment: Geode / Spread: S2	Azimuth:

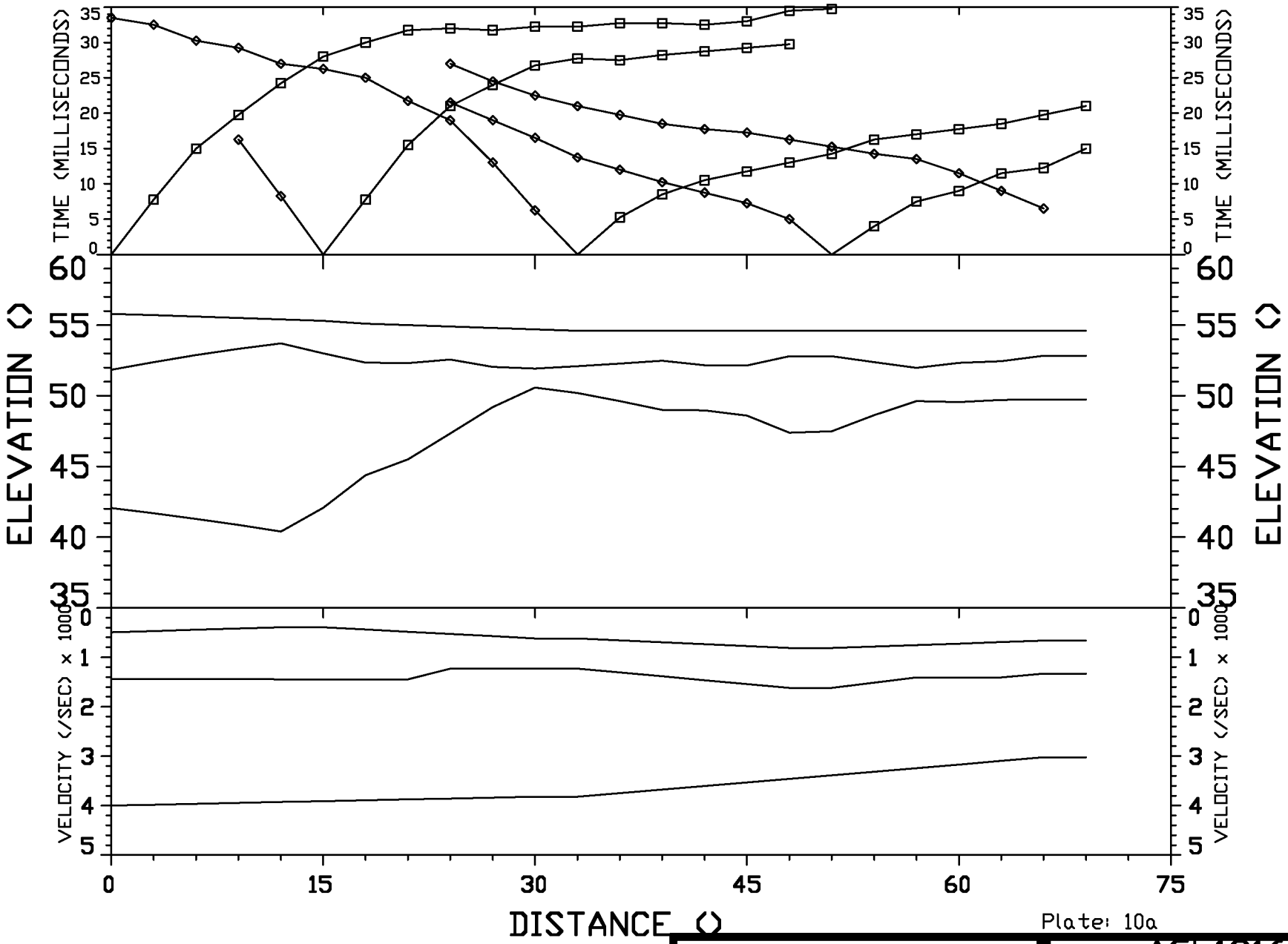


Plate: 10a

for: Fehilly Timoney & Co.	AGL18165
by: APEX Geoservices Ltd.	KILLYCRONAGHAN Monaghan
Data SetS3 / Date: 5-10-18	
Equipment: Geode / Spread: S3	Azimuth:

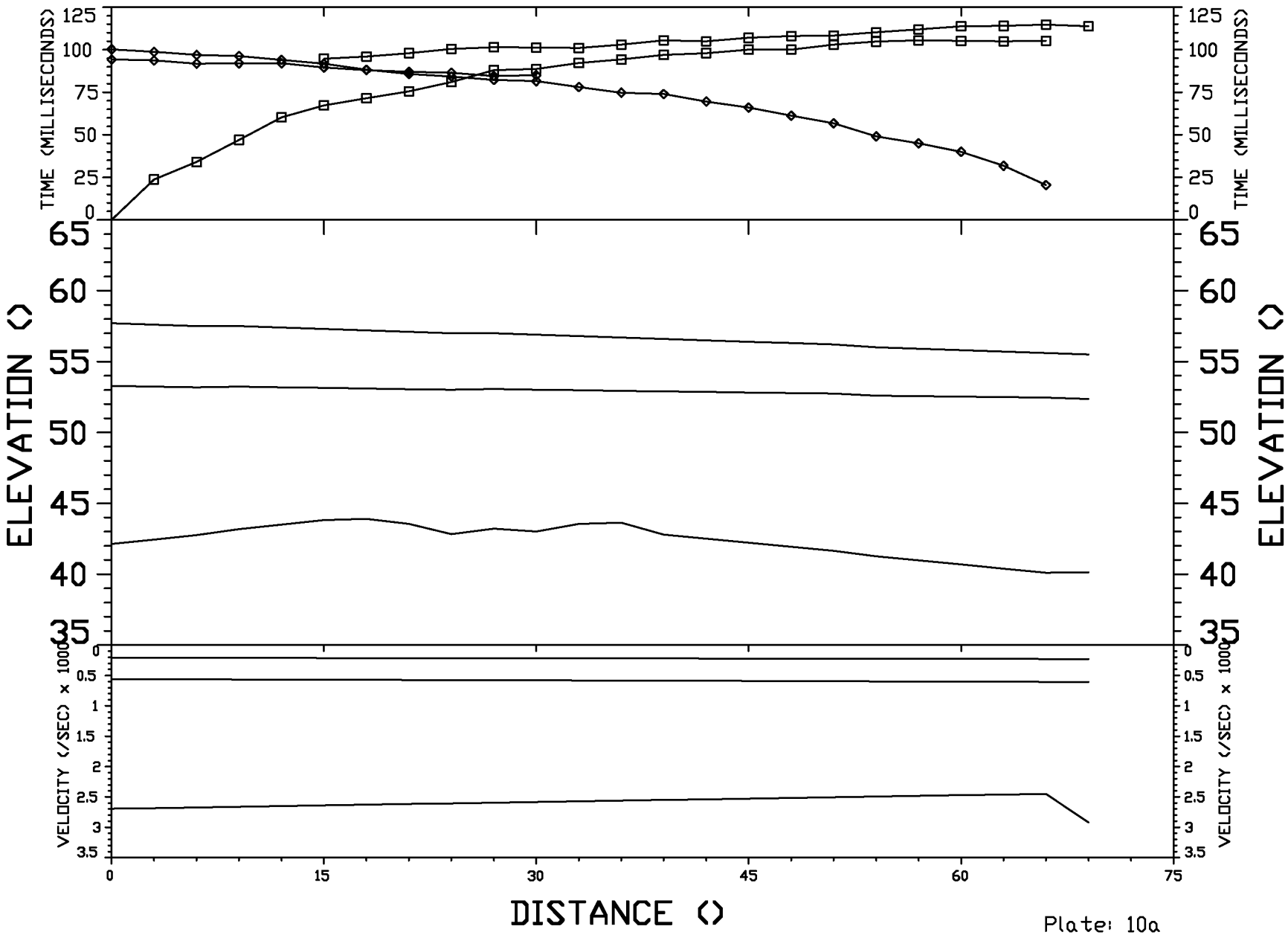


Plate: 10a

for: Fehilly Timoney & Co.	AGL18165
by: APEX Geoservices Ltd.	KILLYCRONAGHAN Monaghan
Data SetS4 / Date: 5-10-18	
Equipment: Geode / Spread: S4	Azimuth:

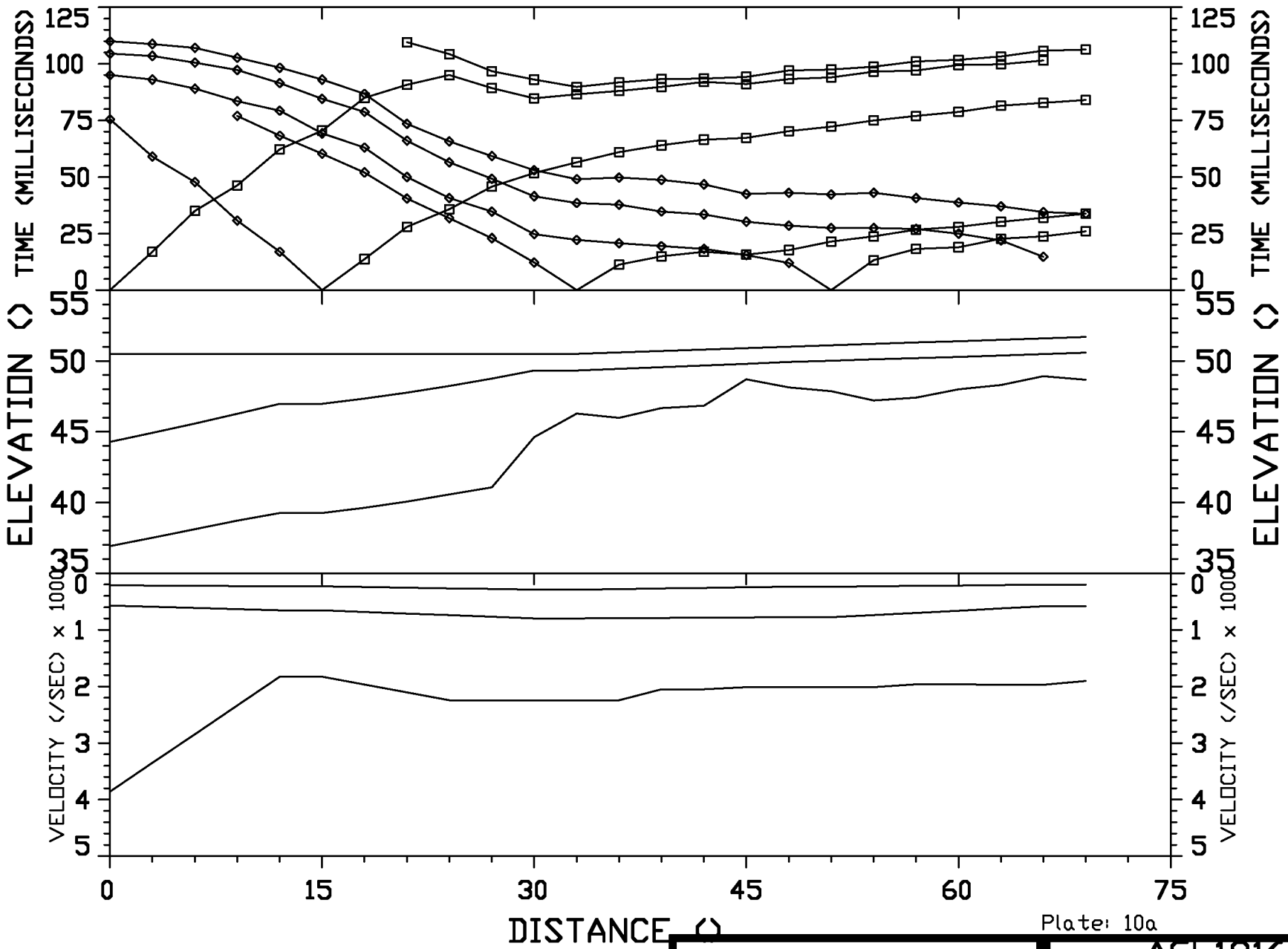


Plate: 10a

for: Fehilly Timoney & Co.	AGL18165
by: APEX Geoservices Ltd.	KILLYCRONAGHAN Monaghan
Data SetS5 / Date: 5-10-18	
Equipment: Geode / Spread: S5	Azimuth:

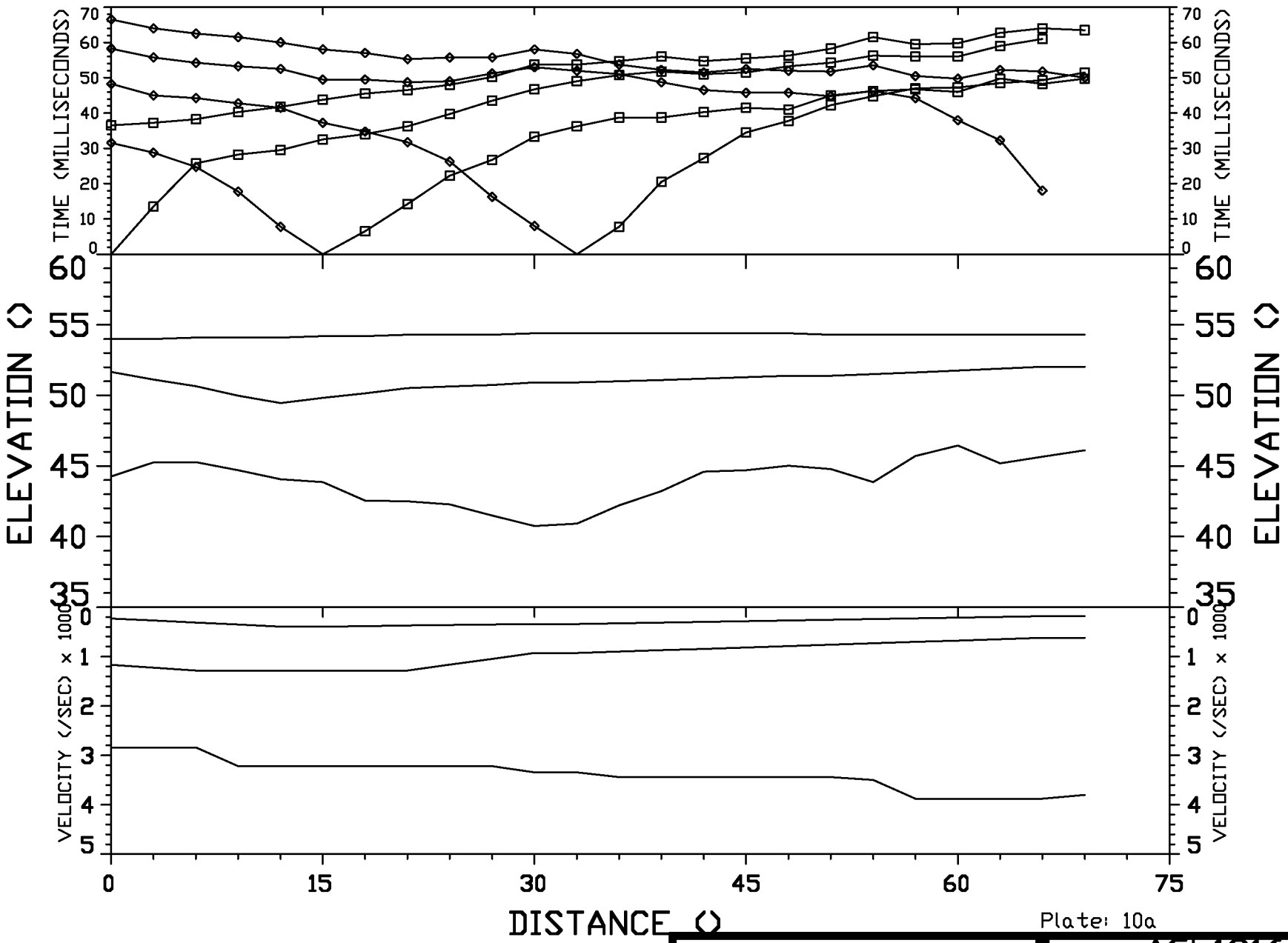
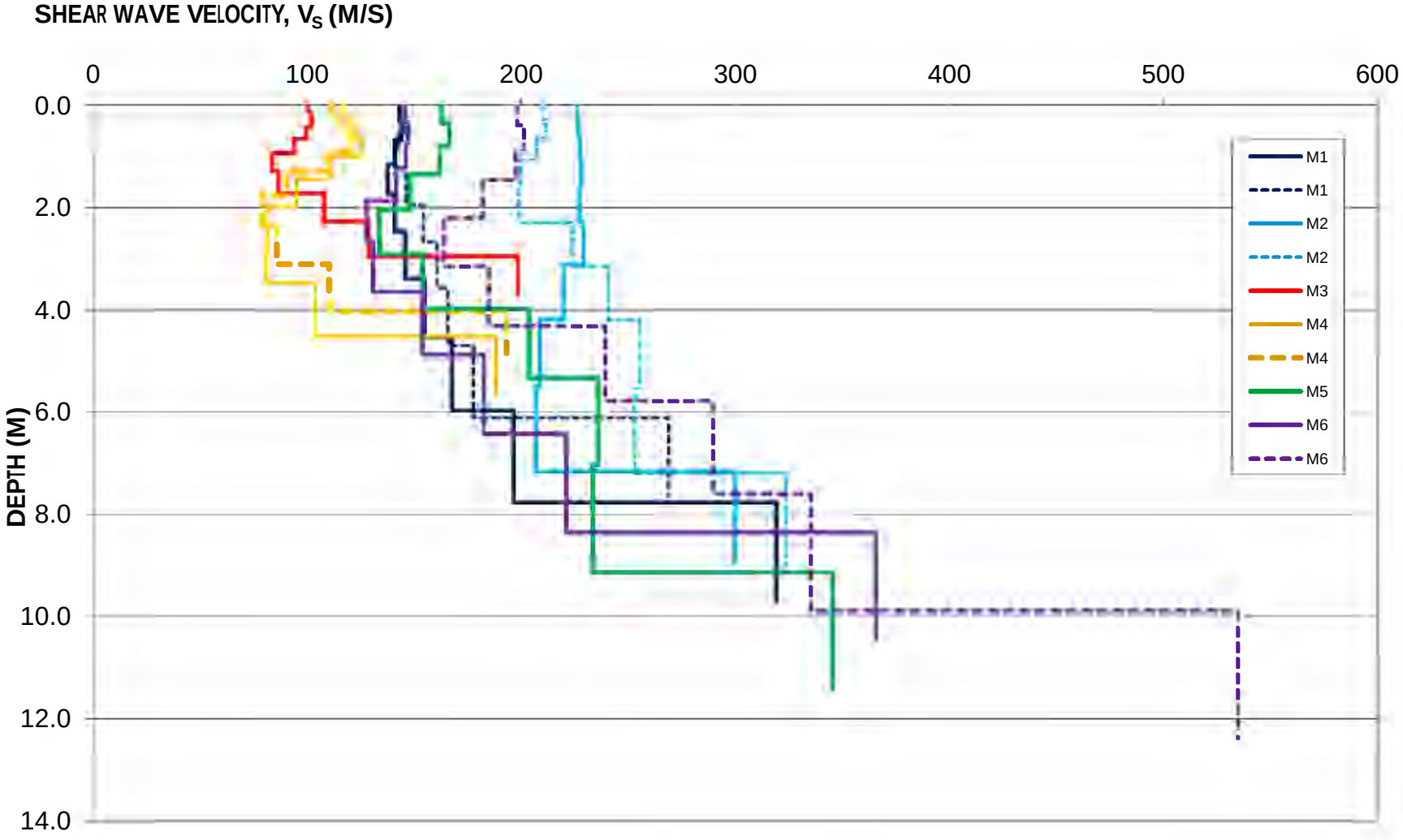


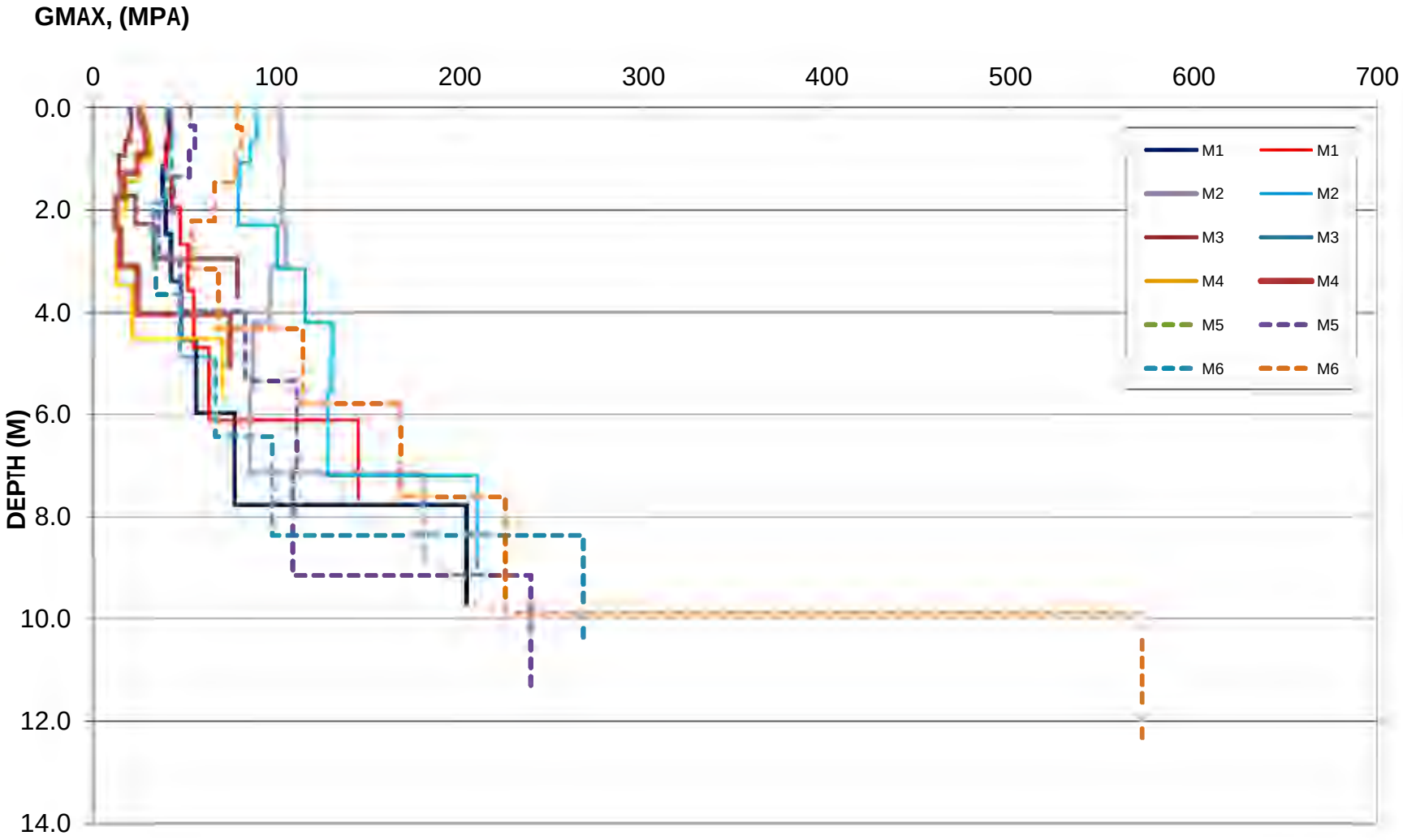
Plate: 10a

for: Fehilly Timoney & Co.	AGL18165
by: APEX Geoservices Ltd.	KILLYCRONAGHAN Monaghan
Data SetS6 / Date: 5-10-18	
Equipment: Geode / Spread: S6	Azimuth:

APPENDIX D: MASW DATA

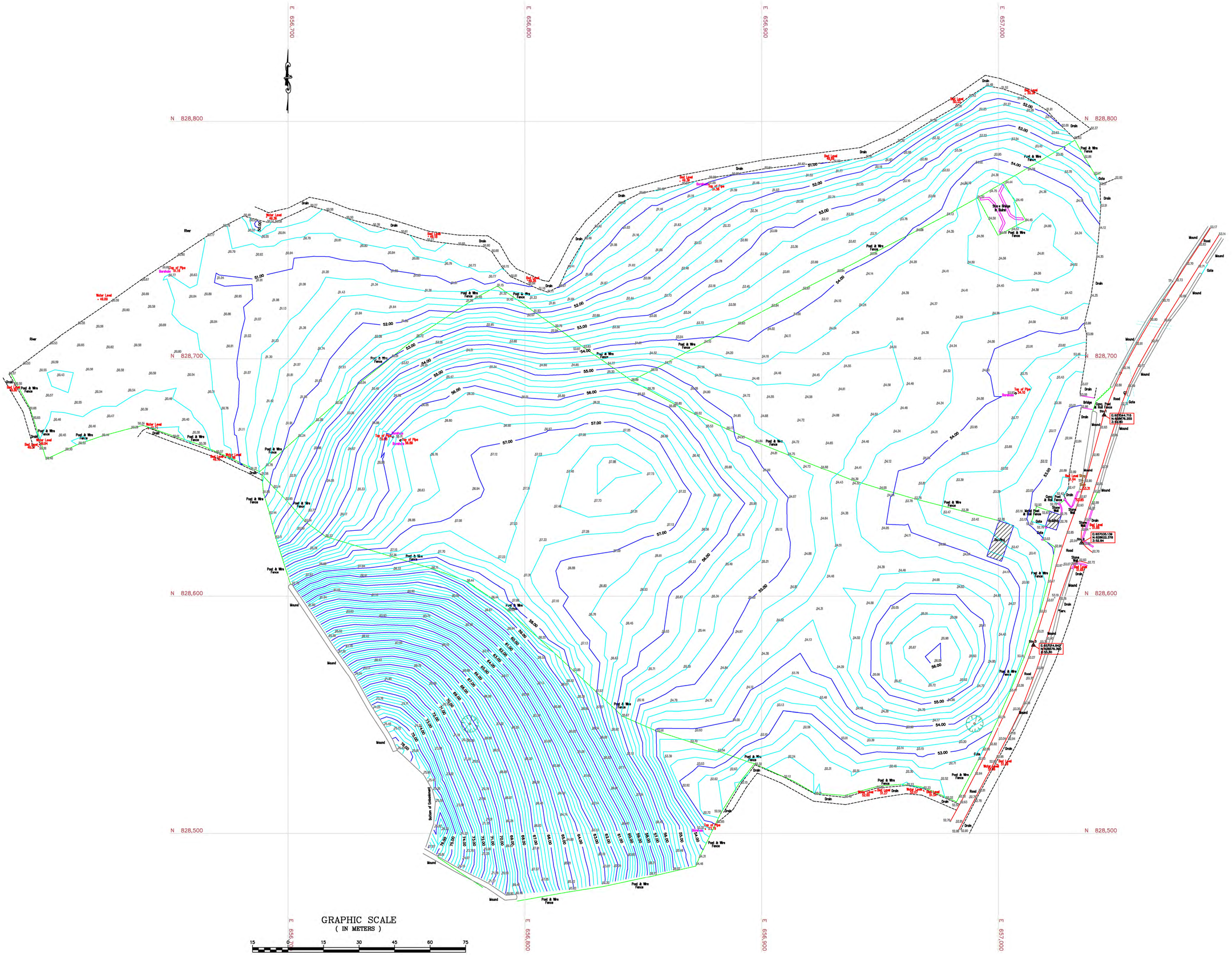
M1	1010	G1	M1	1001	G24	M2	1024	G1	M2	1016	G24	M3	1038	G1	M4	1052	G1	M4	1044	G24	M5	1059	G24	M6	1084	G1	M6	1074	G24
DEPTH	VS	GMAX	DEPTH	VS	GMAX	DEPTH	VS	GMAX	DEPTH	VS	GMAX	DEPTH	VS	GMAX	DEPTH	VS	GMAX	DEPTH	VS	GMAX	DEPTH	VS	GMAX	DEPTH	VS	GMAX	DEPTH	VS	GMAX
M	M/S	MPA	M	M/S	MPA	M	M/S	MPA	M	M/S	MPA	M	M/S	MPA	M	M/S	MPA	M	M/S	MPA	M	M/S	MPA	M	M/S	MPA	M	M/S	MPA
0.0	143	41	0.0	145	42	0.0	226	102	0.0	210	88	0.0	100	20	0.0	117	27	0.0	112	25	0.0	163	53	0.0	145	42	0.0	198	78
0.3	143	41	0.2	145	42	0.3	226	102	0.3	210	88	0.1	100	20	0.2	117	27	0.2	112	25	0.4	163	53	0.3	145	42	0.4	198	78
0.3	144	41	0.2	146	43	0.3	227	103	0.3	211	89	0.1	102	21	0.2	119	28	0.2	114	26	0.4	166	55	0.3	147	43	0.4	201	81
0.7	144	41	0.5	146	43	0.6	227	103	0.6	211	89	0.3	102	21	0.4	119	28	0.4	114	26	0.8	166	55	0.7	147	43	0.9	201	81
0.7	141	40	0.5	142	41	0.6	227	103	0.6	207	86	0.3	102	21	0.4	124	31	0.4	119	28	0.8	162	52	0.7	146	43	0.9	197	78
1.1	141	40	0.9	142	41	1.1	227	103	1.1	207	86	0.4	102	21	0.7	124	31	0.6	119	28	1.4	162	52	1.2	146	43	1.5	197	78
1.1	138	38	0.9	141	40	1.1	228	104	1.1	199	79	0.4	99	20	0.7	125	31	0.6	120	29	1.4	148	44	1.2	141	40	1.5	182	66
1.7	138	38	1.4	141	40	1.6	228	104	1.6	199	79	0.7	99	20	1.0	125	31	0.9	120	29	2.0	148	44	1.9	141	40	2.2	182	66
1.7	141	40	1.4	146	43	1.6	227	103	1.6	199	79	0.7	94	18	1.0	111	24	0.9	110	24	2.0	134	36	1.9	128	33	2.2	164	54
2.5	141	40	1.9	146	43	2.3	227	103	2.3	199	79	0.9	94	18	1.4	111	24	1.3	110	24	2.9	134	36	2.7	128	33	3.1	164	54
2.5	146	42	1.9	154	47	2.3	229	105	2.3	224	100	0.9	83	14	1.4	95	18	1.3	90	16	2.9	154	47	2.7	131	34	3.1	185	68
3.4	146	42	2.7	154	47	3.1	229	105	3.1	224	100	1.3	83	14	2.0	95	18	1.8	90	16	4.0	154	47	3.6	131	34	4.3	185	68
3.4	155	48	2.7	161	52	3.1	220	96	3.1	240	116	1.3	87	15	2.0	81	13	1.8	79	12	4.0	204	83	3.6	154	47	4.3	239	114
4.5	155	48	3.6	161	52	4.2	220	96	4.2	240	116	1.7	87	15	2.6	81	13	2.4	79	12	5.3	204	83	4.9	154	47	5.8	239	114
4.5	167	56	3.6	166	55	4.2	209	87	4.2	255	131	1.7	108	23	2.6	81	13	2.4	86	15	5.3	236	111	4.9	183	67	5.8	290	168
6.0	167	56	4.7	166	55	5.5	209	87	5.5	255	131	2.3	108	23	3.5	81	13	3.1	86	15	7.0	236	111	6.4	183	67	7.6	290	168
6.0	196	77	4.7	178	63	5.5	207	85	5.5	253	128	2.3	129	33	3.5	103	21	3.1	110	24	7.0	233	109	6.4	221	98	7.6	335	225
7.8	196	77	6.1	178	63	7.2	207	85	7.2	253	128	3.0	129	33	4.5	103	21	4.0	110	24	9.1	233	109	8.4	221	98	9.9	335	225
7.8	319	204	6.1	269	144	7.2	300	180	7.2	324	209	3.0	198	79	4.5	188	71	4.0	193	75	9.1	345	239	8.4	365	267	9.9	535	572
9.7	319	204	7.6	269	144	9.0	300	180	9.0	324	209	3.7	198	79	5.7	188	71	5.0	193	75	11.4	345	239	10.4	365	267	12.4	535	572


SHEAR WAVE VELOCITY, V_S (M/S)
0
100
200
300
400
500
600
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
DEPTH (M)
M1
M1
M2
M2
M3
M4
M4
M5
M6
M6


GMAX, (MPA)
0
100
200
300
400
500
600
700
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
DEPTH (M)
M1
M1
M2
M2
M3
M3
M4
M4
M5
M5
M6
M6

Appendix 6

Control Surveys Topographical Mapping



NOTES:
1. All levels are relative to Ordnance Datum Malin Head
2. 50m sq grid relative to Irish Transverse Mercator Co-ordinate reference system
3. Contours are at .25m intervals

SYMBOL LEGEND

AV	Air Valve	SV	Sluice Valve
V	Valve	WV	Water Valve
FH	Fire Hydrant	WM	Water Meter
IC	Inspection Chamber	Post	Post
TC	Telecom Duct	ESB	ESB Duct
TC Box	Telcom Box	ESB Box	ESB Box
T	Tree	EP	ESB Pole
	Tree Spread	TP	Telecom Pole
	Bush/Shrub	LS	Lamp Standard
Sign	Sign	T Sign	Traffic Sign
AJ	Armstrong Junction	GY	Gully
ER	Earth Rod	Gas	Gas
TL	Traffic Light	B	Bollard
CATV	Cable TV Duct	Bin	Bin
G	Gate	Stay	Stay
MH	Manhole & Cover Level	Serv	Service
SS	Survey Station	Pipe	Pipe
RH + 6.27	Ridge Height	CH + 6.73	Coping Height
FFL + 6.49	Finished Floor Level	GH + 6.37	Gutter Height
EH + 6.72	Eaves Height	RH + 6.73	Roof Height
6.78	Boundary Height	.9.55	Spot Height

LINE TYPES LEGEND

	Wall		Concrete Edge
	Fence		Centerline of Trees
	Footpath		Hedge
	Drain/River		Step
	Flower Bed		Plinth
	ESB Line		Telecom Line
	Mound		Building
	Kerb		Road
11.00	Contour Major	10.75	Contour Minor
	Bottom of Bank		Top of Bank
	Yellow Line		White Line

REVISIONS

No.	Date	Description

Control Surveys
land and building surveyors
No. 562
6 Crestwood, Kilteragh, Dooradoyle, Limerick.
Tel: 087 2659112 email: cian@controlsurveys.ie
website: www.controlsurveys.ie
- Topographical Surveys
- Measured Building Surveys
- Legal Mapping
- As Built Surveys
- GPS Surveys
- Setting Out

Client:

Professional:
Fehily Timoney & Co.

Project Title:
Topographical Survey of Historical Landfill at Knockcronaghan, Co. Monaghan.

Drawn:	J.B.	Dwg No:	18-307-01
Scale:	1:750	Date:	05-10-18