AGL09247_01

REPORT

ON THE

GEOPHYSICAL SURVEY

AT

TIPPERARY TOWN LANDFILL, CARROWNREDDY, TIPPERARY

FOR

O'CALLAGHAN MORAN & ASSOCIATES

5th November 2009

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.

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AUTHOR	**CHECKED**	**REPORT STATUS**	**DATE**
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1. SUMMARY

- APEX Geoservices Ltd. was requested by O'Callaghan Moran & Associates to carry out a geophysical survey of the Tipperary Town Landfill Site located in the townland of Carrownreddy.

- The site covers an area of approximately 1.8 Ha. It is estimated that waste has been delivered to the site since the 1940's, ceasing in 1990. A variety of wastes are thought to have been deposited here including municipal and commercial wastes. It is also known that wastewater sludge has also been disposed on the site.

- The extent of the landfill is defined by the steep slopes of its boundary.

- The landfill material has been interpreted as comprising organic waste and C&D waste. The landfill stratigraphy typically includes a cap of C & D material and mixed C & D and organic waste material up to 6m thick underlain by organic waste material over lacustrine sediments and sandy gravelly silt/clay.

- The combined thickness of the landfill material ranges from 6.7m to possibly up to 17m.

- In the landfill area, the contrast between leachate saturated lacustrine sediments and infilled waste is poor. A possible leachate zone has also been identified where the made ground (east of the landfill) and outlet stream meet.

- Bedrock has been interpreted at levels of approx. 71.5mOD. The geophysical data indicate that the bedrock it is likely to be argillaceous/shaly and therefore is unlikely to be prone to extensive karstification.

- The geophysical data indicate indicate thick deposits of sandy gravelly silt/clay with a likely medium to low permeability overlying the bedrock.

- Monitoring wells are recommended at the following four locations:

MW	Easting	Northing
1	189404.0	136794.7
2	189451.4	136768.2
3	189400.9	136850.2
4	189566.8	136768.0

- Areas of possible buried metal have been identified. Trial pits are recommended at the following three locations to investigate possible buried metal:

TP	Easting	Northing
1	189363.1	136807.4
2	189439.0	136742.8
3	189403.7	136725.7

- The geophysical data should be reviewed on completion of any direct investigation.

2. INTRODUCTION

APEX Geoservices Ltd. was requested by O'Callaghan Moran & Associates to carry out a geophysical survey of the Tipperary Town Landfill Site.

2.1 Survey Objectives

The objectives of the geophysical survey are:

- Assess the sub-surface conditions including thickness and extent of the buried waste, nature of subsurface material and depth to bedrock;
- Identify leachate plumes into surface drains or underlying karstic limestone ;
- Locate any local anomalies (buried drums, etc) within the waste material.

2.2 Site Background

The site is located in the townland of Carrownreddy adjacent to the R610 Tipperary-Dundrum Road. The site covers an area of approximately 1.8 Ha. It is estimated that waste has been delivered to the site since the 1940's, ceasing in 1990. A variety of wastes are thought to have been deposited here including municipal and commercial wastes. It is also known that wastewater sludge has also been disposed on the site. Stockpiles of C & D waste are evident on much of the site (see photos below).

The site is located in a marshy and overgrown area (see photos below) which once formed Carrownreddy Lough. The site drains to the southeast along the stream shown on Drawing 9247_01, Figure 1. There was a strong odour in the vicinity of the stream and lake sediments at this point. Some dieback of marsh reeds was noted.

An area of previous marsh to the east of the landfill has been recently backfilled with imported gravelly clay material. The approximate location of the made ground is indicated on Drawing 9247_01, Figure 1.

The underlying limestone is thought to be karstified. The geological map for the area (Geological Survey of Ireland) indicates that the survey area is underlain by the Knockordon Formation comprising pale cherty crinoidal limestone. The contact with the Ballynash member cherty limestone and thin shale lies approx. 100m northwest of the site and the contact with the Athassel Formation shaly cherty limestone lies approx. 20m southeast of the site.

2.3 Methodology

The geophysical survey proposed to assess the sub-surface conditions across the site included EM31 ground conductivity surveying at nominal 5 m line separations. The recorded data provides information on variations in the bulk conductivity value which reflects variation in the composition of the material in the top 6m of the subsurface. The conductivity and inphase data provides information on the extent of the waste and highlights any significant buried metal material objects.

Six 2D resistivity profiles were carried out on review of the conductivity data. Four profiles were recorded across the landfill to provide information on the nature and thickness of the deposit, the extent of capping material and the nature of the underlying soils and rock. Two profiles were recorded east and west of the landfill in order to confirm the depth to and type of bedrock.

3. INTERPRETED RESULTS

The integrated geophysical results from each of the methods used are summarized on Drawing 9247_01.

3.1 EM31 Conductivity

The EM31 conductivity survey locations are shown on Drawing 9247_01, Figure 1. The recorded EM31 conductivity values are contoured on Drawing 9247_01, Figure 2. 1558 readings were recorded across the site.

The EM31 conductivity values ranged from 0-590 milliSiemens/metre (mS/m). The majority of the values (95%) were in the range 30 to 150 mS/m with 84% in the range 30 to 100 mS/m. The conductivity values have been broadly interpreted on the following basis:

Conductivity (mS/m)	**Interpretation of 0-6m Below Ground Level**
20-50	Organic Waste Material mixed with C&D Waste
50 - 150	Organic Waste Material
	Conductive/metallic material on surface of the site
	Interference related to Metallic Objects

The presence of metallic objects and interference from cultural noise such as fences, pipes, tanks, buildings, etc. produce both very high and very low conductivity values. In addition, during the survey an inphase component value was acquired simultaneously with the EM31 conductivity data. Variations in this component are indicative of the presence of metallic objects. The EM31 inphase values are contoured on Drawing 9247_01, Figure 3.

The EM31 inphase ratio ranged from 0-1250 with a background value of approximately 800 to 850ppm. The inphase values have been broadly interpreted on the following basis:

In–Phase	**Interpretation of 0-6m Below Ground Level**
0-800	Areas indicative of surface or buried metal
800-850	Background Values
850-1000	Areas indicative of High Concentrations of Organic Waste Material
1000-1250	Areas indicative of surface or buried metal

3.2 2D Resistivity Profiling

Four 2D resistivity profiles were recorded across the site at locations selected based on review of the conductivity data and accessibility. Two profiles were recorded east and west of the landfill. The locations are indicated on Drawing 9247_01, Figure 1. The interpreted sections are included on Drawing 9247_01, Figure 5.

The recorded resistivity values have been interpreted on the following basis:

Resistivity (ohm-m)	Interpretation
10-30	LANDFILL (Organic Waste)
	LEACHATE (in Lacustrine Sediments)
30-100	LANDFILL comprising C&D Waste mixed with and Organic Waste Material
100-250	LANDFILL comprising C&D Waste
30-75	MADE GROUND
30-50	Lacustrine Sediments
50-250	Sandy gravelly SILT/CLAY
250-400	Silty clayey SAND/GRAVEL
150-400	BEDROCK

3.3 Integrated Interpretation

The geophysical interpretation is summarized on Drawing 9247_01, Figure 4.

- The extent of the landfill is defined by the steep slopes of its boundary. The top of the slope and base of the slope of the landfill has been indicated on Figure 4.
- The landfill material has been interpreted as comprising organic waste and C&D waste.
- The landfill stratigraphy typically includes a cap of C & D material and mixed C & D and organic waste material up to 6m thick underlain by organic waste material over lacustrine sediments and sandy gravelly silt/clay.
- On the recorded profiles, the combined thickness of the landfill material ranges from 6.7m on Profile R2 to possibly up to 17m on R4.
- Localized increases in resistivity values within the organic landfill material indicate an increase in the C&D content and a decrease in the organic waste content of the fill.
- In the landfill area, the resistivity contrast between leachate saturated lacustrine sediments and infilled waste is poor. Approximate locations are shown on profiles R1, R2 and R3 in Figure 5.
- Bedrock has been interpreted at levels of approx. 71.5mOD on profiles R5 and R6.
- The resistivity values of the rock are relatively low (<400 Ohm-m) indicating that it is likely to be argillaceous/shaly and therefore is unlikely to be prone to extensive karstification.
- The resistivity data indicate thick deposits of sandy gravelly silt/clay with a likely medium to low permeability.
- A possible leachate zone has also been identified on profile R6 (Figure 5) where the made ground and outlet stream meet.
- Areas of possible buried metal have been identified on Figure 4. The metal in the area of concrete is likely to be rebar.

4. RECOMMENDATIONS

Monitoring wells are recommended at the locations indicated on Drawing 9427_01, Figure 4, on Drawing 89427_01, Figure 5 and listed below:

MW	Easting	Northing
1	189404.0	136794.7
2	189451.4	136768.2
3	189400.9	136850.2
4	189566.8	136768.0

Trial pits are also recommended at the locations indicated on Drawing 9247_01, Figure 4 and listed below to target possible buried metal identified by the EM31 conductivity survey:

TP	Easting	Northing
1	189363.1	136807.4
2	189439.0	136742.8
3	189403.7	136725.7

The geophysical data should be reviewed on completion of any direct investigation.

5. REFERENCES

Campus Geophysical Instruments, 2000;
'RES2DINV ver. 3.4 Users Manual', Birmingham, England.

Golden Software, 1994;
'SURFER 7 Surface Mapping System Users Manual', Golden Software, CO., USA.

M1. EM31 Conductivity Mapping

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). As the effective penetration of this method is around 6m below ground level the measured conductivity is a function of the different overburden layers and/or rock from 0 to 6m below ground level.

The equipment used was a GF EM31 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. 1558 conductivity readings were recorded on the 29th October 2009.

Conductivity and in-phase values were recorded on an approximate 2.5m x 5m grid in all accessible areas. Local conditions and variations were recorded.

The data were downloaded and plotted. Data which was contaminated by metallic objects was removed. Assignation of material types and possible anomaly sources was carried out, with cross-reference to other data. A scaled plot of conductivity against distance was prepared (Drawing 9247_01, Figure 2). The contoured inphase results are also shown (Drawing 9247_01, Figure 3).

M2. 2D Resistivity Profiling

2D Resistivity profiling 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 32 electrodes connected to a resistivity meter, using computer software to control the process of data collection and storage

Six spreads were recorded on the 30th November 2009. The profiles were recorded using a Tigre resistivity meter, imaging software, two 32 takeout multicore cables and up to 32 stainless steel electrodes. The recorded data was processed and viewed immediately after the survey.

2D-Resistivity profiles R1 to R4 were 93m in length with a depth of penetration of approximately 16m. 2D-Resistivity profiles R5 and R6 were 155m in length with a depth of penetration of approximately 30m.

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 as Profiles R1- R6 on Drawing 9247_02, Figure 5. The distance is indicated along the horizontal axis of the profile. All profiles have been contoured using the same contour intervals and colour codes.

FIGURE 1: Geophysical Survey Locations

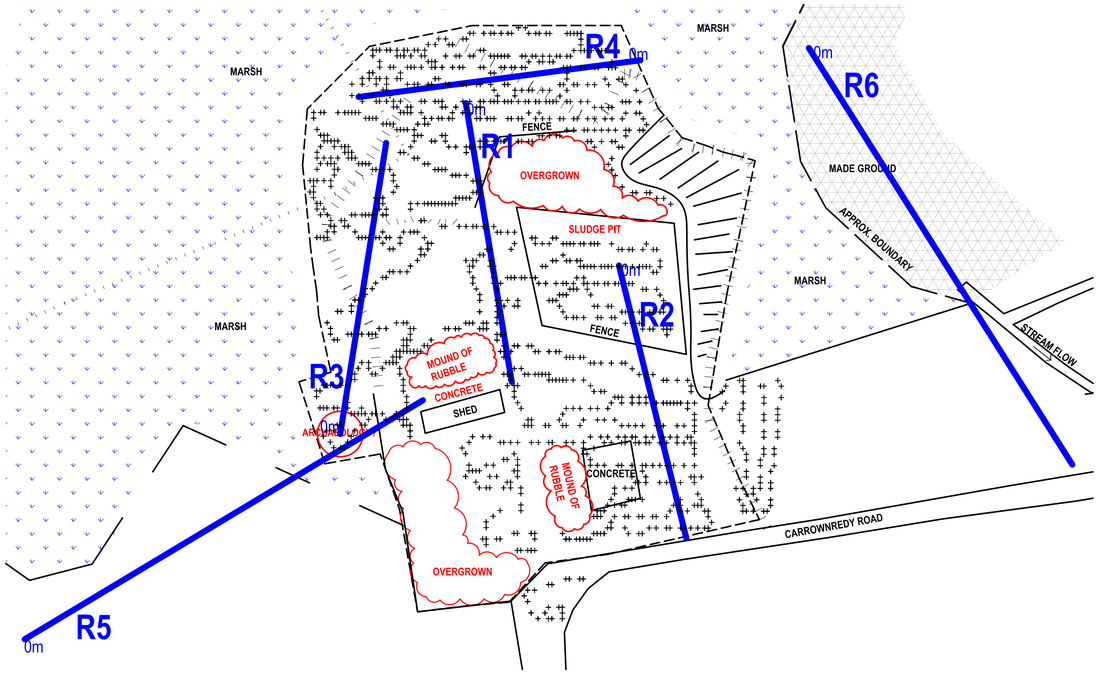


FIGURE 2: Electromagnetic Conductivity Contours (mS/m)

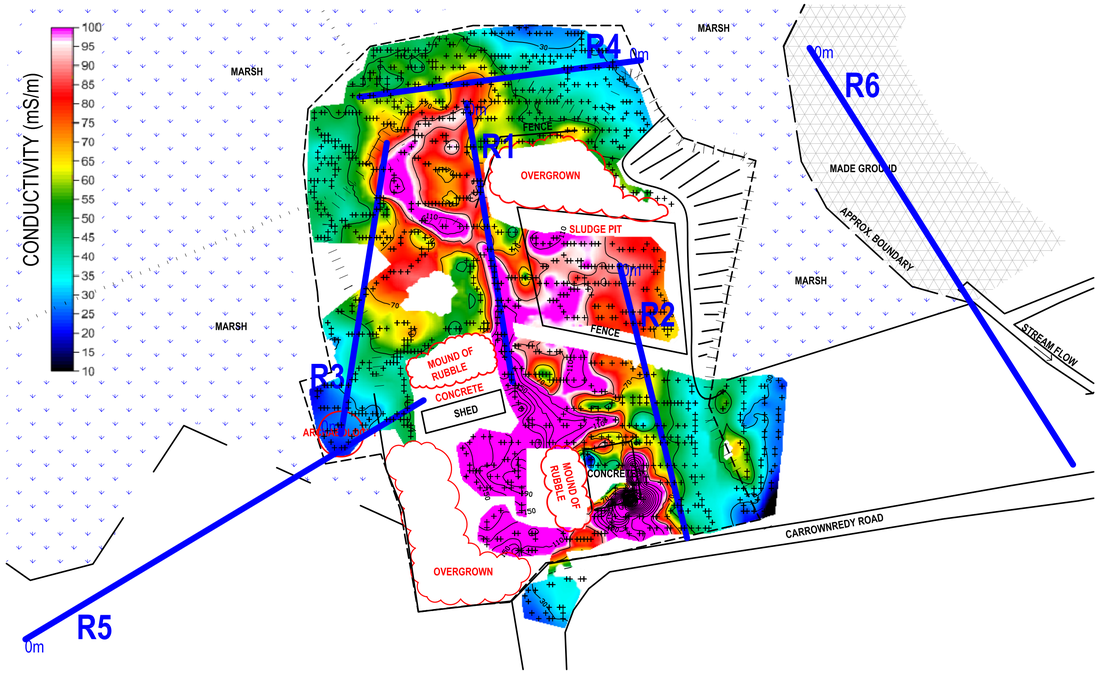


FIGURE 3: Electromagnetic Inphase Ratio

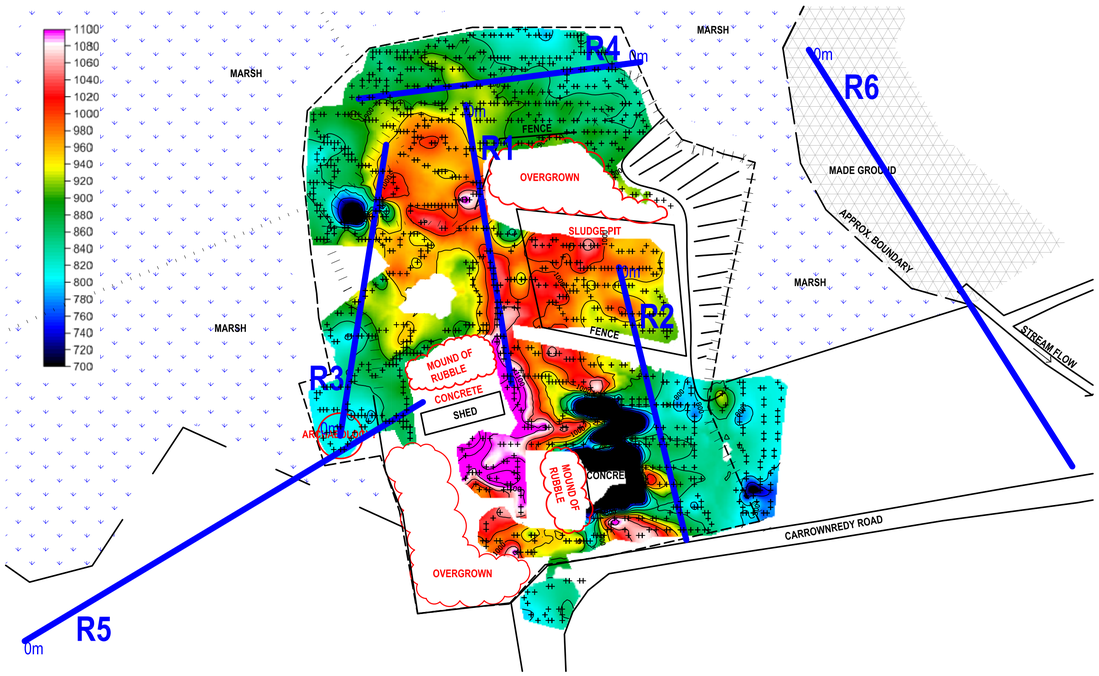


FIGURE 4: Summary Map

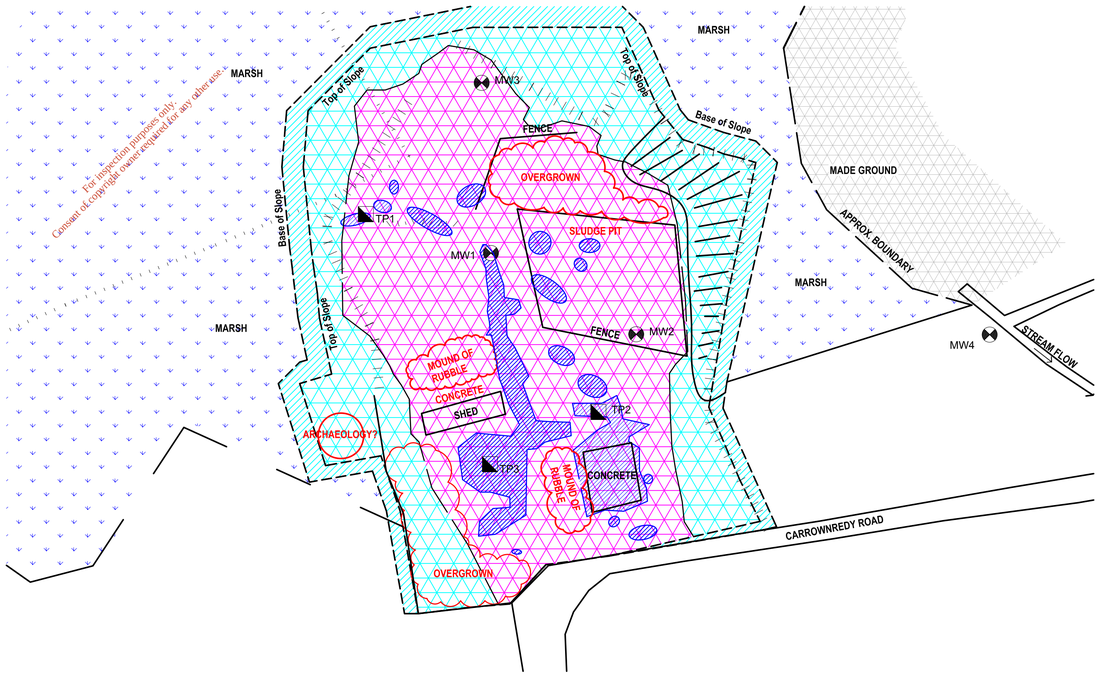
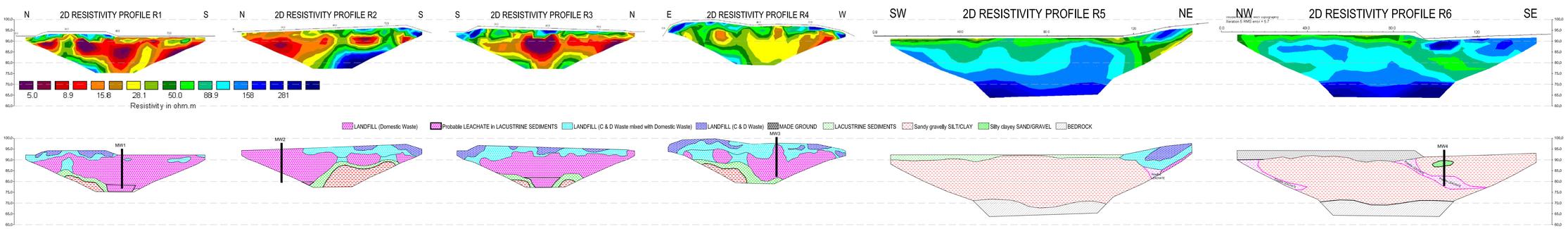
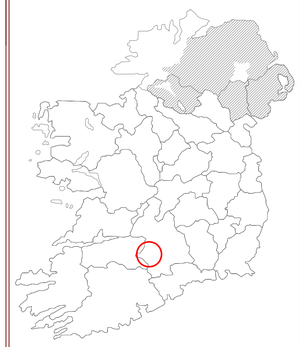


FIGURE 5: 2D Resistivity Profiles & Interpretation



INDEX MAP:



LEGEND:

- EM Conductivity Station
- 2D Resistivity Profile
- Marsh
- Predominantly Organic Waste
- Organic mixed with C & D Waste/Capping
- Slope of Landfill
- Possible Buried Metal
- Proposed Trial Pit
- Proposed Monitoring Well

NOTES:

TITLE: GEOPHYSICAL SURVEY

PROJECT: TIPPERARY TOWN LANDFILL

CLIENT: O'CALLAGHAN MORAN & ASSOCIATES

DRAWING: MAPS & SECTIONS

DRAWING NUMBER: 9247_01

SCALE: 1:1000

DATE: 5TH NOVEMBER 2009

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