

# Hydrogeological and Hydrological Review

Proposed Coolnabacky Sub-station site Timahoe



**February 2021**

# Hydrogeological and Hydrological Review

Location: Proposed Coolnabacky Sub-station site, Timahoe

Date: 16<sup>th</sup> February 2021

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## 1. INTRODUCTION

IE Consulting were engaged to conduct an independent audit of the process undertaken (during planning) to assess the potential impact on the hydrological and hydrogeological environment from the proposed construction of a substation at Coolnaback, near Timahoe, Co. Laois. The Substation is an element of an overall network improvement scheme for the Laois-Kilkenny Area.

IE Consulting were invited by Irish Rural Link to submit a Tender for the following brief

*The scope for the independent review for Coolnaback (also known as Laois-Kilkenny) would broadly involve reviewing the planning documentation, in particular:*

- *To review scheme as planned from a hydrological/ hydrogeologic risk point of view*
- *Review of relevant planning information*
- *Recommendations on any gaps in the scheme as planned (e.g. Bunding arrangements, dealing with contaminated runoff, flooding risk etc.)*
- *Comment on whether the scheme is in line with best international practice*
- *Assessment of risk to aquifer*
- *Additional areas to focus on or any further pre-construction site investigations etc.*
- *Provide information of site specific mitigation measures for construction stage*

*The main issues of concern are the potential risks to the groundwater water supply.*

Irish Rural Link, requested that IE Consulting confirm that they had not undertaken work for Eirgrid or ESB in the recent past or in any way connected to the proposed scheme. This we were happy to confirm.

Irish Rural Link also stressed that IE should confirm that the audit was independent and not influenced in any way by Eirgrid or ESB. This we are happy to confirm.

## 2. APPROACH TO STUDY

This report is based on a review of the following;

- Documents at the public link: <http://eirgridlaoiskilkenny.ie/environmental.html>
- A review of the information provided on the An Bord Pleanala website, when a search for VA0015 was made  
[http://www.pleanala.ie/search/index.php?q=va0015&case\\_scope=all&include\\_reports\\_etc=0](http://www.pleanala.ie/search/index.php?q=va0015&case_scope=all&include_reports_etc=0)
- Eirgrid and ESB reports and drawings-provided on request.
- Assessment reports By SLR and Tobins associated with the unauthorised development in
- 2017 Tobins report (Report to assess the impact of the unauthorized development on the Aquifer at Coolnabacky Construction site) 2017
- 2018 SLR Hydrogeological assessment of excavations for the construction of a substation prepared for: Eirgrid SLR Ref: 180720 00357 00004
- GSI 2000- Kyle & Orchard Springs Source Protection report
- GSI 2018 assessment and response to RTS presentation to Minister Naughten
- GSI public viewer maps
- Site walk-over visit under taken by J Keohane on 18<sup>th</sup> December 2020
- Lyons & Kelly 2016 Monitoring Guidelines for the Assessment of Petrifying Springs in Ireland. Irish Wildlife Manual No. 94 NPWS
- ESBI site drainage report PE687-F0261-R261-016 which included Traynor Environmental Site suitability assessment 2012
- 2012 Soil Mechanics Report No Y2012-12A factual report on ground investigation.

## 3. TOPOGRAPHY AND SURFACE WATER DRAINAGE

The site lies in a low lying, mostly flat area which extends to the east and north of the site. The surrounding land to the south and west becomes hummocky within 150m to 200m of the site. The geomorphology appears to be glacio-fluvial in origin.

The main surface water drainage feature in the area is the Timahoe River which flows in an approximately northerly direction 500m east of the site. The Timahoe River in turn joins the Honey Stream which flows in from the east and the combined flow becomes the Bauteoge River.

The watercourses in the area appear to have been modified and canalised in places, and arterial drainage has been used to improve the land and direct run-off towards the streams and rivers.

A natural unnamed watercourse skirts the northern boundary of the site, and there are also drains along the western southern and eastern boundaries of the site which were noted to be carrying some flow on the day of the site visit. The perimeter drains are typically 1.0m to 1.5m deep, and seem mainly to run to the North towards the stream.

Apart from occasional water logging after heavy rain, I am satisfied that there is no evidence of a flood risk to site from fluvial or groundwater sources. The modified drainage network in the area, does appear to work efficiently to remove water from the land.

There is surface water hydraulic connectivity between the site and an SAC (The River Barrow and River Nore SAC site code 002162), and I am satisfied that this has been adequately considered through the EIAR and consideration by the An Bord Pleanála Inspector.

I am satisfied that the proposed safeguards for surface water quality management during construction and the operational phase surface water management approach for managing run-off from paved and covered areas for the proposed development is robust. Any new information arising out of the recommended further works detailed below or the construction works when they commence should be reviewed, in the context of surface water management to ensure ultimate protection for water resources.

## **4. GROUNDWATER**

An Bord Pleanála has approved the proposed development after an oral hearing and review of documentation. The Inspectors report (11.VA0015) states that “It appears that the substation at Coolnabacky can be constructed without undue risk to local groundwater sources. The development could be carried out and operated satisfactorily from an ecological standpoint”. I have considered this decision in the context of both bedrock and shallow aquifers.

### **4.1 Bedrock Aquifer**

I do agree that there is no significant risk posed by the development to the Kyle spring, because of the following factors

- Significant consistent thickness (8m approx.) of low permeability cohesive subsoil overlying the rock aquifer. This effectively isolates any on-site activities from the bedrock aquifer, since

there will be no excavations deeper than 2m. I am satisfied that site tests have demonstrated very low permeability for this Clay material.

- The GSI source protection report (2000- Kyle & Orchard Springs Source Protection report) concludes that the Kyle Spring is generically a bedrock derived spring, (although the output may flow through overlying gravel for a short period).
- There is no groundwater pathway linking the site and the spring.
- The site is outside of the mapped source protection zone, even though the GSI report does state that that some groundwater may pass beneath the Timahoe/Bauteoge River through bedrock en route to the Kyle Spring.
- There is no hydraulic connectivity between the surface water features in the area and the Kyle Spring since all surface water from the site ultimately enters the Timahoe River System and the GSI report (2000- Kyle & Orchard Springs Source Protection report) states that surface water features are hydraulically isolated from the bedrock Aquifer.

#### **4.2 Sand and Gravel Aquifer**

The GSI have mapped a locally important Sand and Gravel Aquifer (Timahoe-Stradbally Aquifer) in the area, which includes the site. The GSI have stated in their review (response 2018) that work is in progress on better defining the boundaries and characteristics of this aquifer as part of the Groundwater 3D project.

I understand that the information available to the Hydrogeology Team preparing the EIS in 2013, suggested that the site was outside of the mapped Sand and Gravel aquifer area at the time. The Inspectors report confirms and accepts this. The fact that this has been changed by and is under further review by the GSI does warrant some scrutiny.

The 2017 Tobins report (Report to assess the impact of the unauthorized development on the Aquifer at Coolnabacky Construction site) prepared for ESB acknowledges this boundary change but argues that *"no significant saturated sand and gravel deposit was encountered in the vicinity of the sub-station site"*.

This is consistent with the 2018 report by SLR (Hydrogeological assessment of excavations for the construction of a substation) prepared for Eirgrid which states:

*“the site investigation showed that granular sand and gravel deposits at the site are very thin, laterally impersistent and contain limited groundwater; they are not therefore a significant groundwater source or aquifer. This conclusion is supported by GSI advice that states that gravel deposits must exceed 10m to be considered an aquifer. The subsoils at the site are not classified as an aquifer or a groundwater body due to their low permeability characteristics, shown to be typical of silt. This reflects the description of the subsoils as granular gravelly clay / clayey sand and gravel deposits and cohesive stiff – very stiff gravelly clay deposits”. “The site investigations at the site have shown that there is no gravel aquifer (i.e. sands and gravels to a thickness exceeding 10m) at the site.*

*Therefore, the shallow water ingress encountered in the subsoils at the site is representative of pore water or isolated pockets of groundwater that are not connected to the bedrock aquifer”.*

The GSI (GSI [www.gsi.ie](http://www.gsi.ie)) does indeed state that the sand and gravel deposit must be 10m in thickness to be considered an aquifer. I therefore expect, based on this observation, that the GSI will not include this site within a revised sand and gravel aquifer boundary.

Apart from the thickness constraint which appears to be definitive, the EIAR (Chapters 9 and 10 2013) presents a number of other pieces of evidence to state why the sand and gravel deposits on the site do not comprise an aquifer.

*The sand and gravel deposits at the site not found to be saturated during the site investigation of 2012.*

*In most cases, groundwater strikes were not recorded in the Sand and Gravel deposits.*

*It is noted that, due to the presence of low permeability Clay deposits beneath the sand and gravel, the inflow volumes of groundwater encountered during drilling was minimal.*

*As the sand and gravel was not saturated, this indicates that the quantities of groundwater present are not significant.*

*During a subsequent intrusive site investigation carried out by AWN Consulting in 2013, 4 no. boreholes were installed around the boundary of the site, up gradient and down gradient of the*



*predicted groundwater flow direction. (Appendix 10.1 Site Investigation and Hydrogeological report).*

*The ground conditions consisted of soft to stiff sandy gravelly Clay and silty sandy Clay to approximately 3m bgl. At approximately 3m bgl, low permeability stiff to firm boulder Clay was encountered. At borehole BH4 Boulder Clay was found to extend to 8.6m bgl when returns were of angular rock suggesting boulders or bedrock.*

*No fast inflow groundwater strikes were recorded during the site investigation.*

*Data loggers were installed to record the static groundwater levels at hourly intervals. Based on data, to date the groundwater level at the site is typically less than c.1m bgl. (See Appendix 10.1 for more detailed information)*

*Permeability tests carried out at each groundwater monitoring well (borehole) indicate that the hydraulic conductivity is typical of silt and clay soils.*

*Therefore, the water present in the deposits represents pore water, rather than groundwater. The Sand and Gravel deposits at the centre of the site which would be expected to have a higher permeability were also found to be unsaturated.*

The 2018 SLR report suggests based on this information

*“therefore, the shallow groundwater present in the subsoils represents pore water or isolated pockets of groundwater, rather than a groundwater resource, as defined by the EPA. It may not be feasible to define a water table in the subsoils as lateral movement is impeded, and so a shallow water table is not shown on the Conceptual Site Model. Should there be any flow in the granular subsoils, this flow is expected to follow the topography to the south east.”*

I have reviewed the site investigation undertaken in February-March 2012. I examined the borehole and trial pit logs, which indicates reasonably consistent ground conditions across the site, comprising topsoil of approximately 300mm underlain by upto 1.9m of varying grades of granular material, which is described as Alluvium on the GSI maps. Alluvium because it is deposited by rivers (in this case probably glacial outwash rivers), often tends to be haphazard in a lateral sense.

It is accepted that the four groundwater monitoring borehole logs (from the 2013 investigation) show no granular material. However it does appear anomalous that these four boreholes around the periphery of the site encountered no granular material, and the boreholes and trial pits excavated in the middle of the site as part of a previous investigation phase did. The possible reasons for this anomaly may be of glacial origin and therefore natural, or may be related to a variation in the drilling methodology deployed in each phase. I am recommending that further investigation is undertaken to

confirm the original findings. It is suggested that a geophysical survey would be the most appropriate approach to clarifying this anomaly.

I note that groundwater strikes were recorded in 8 out of 10 boreholes in 2012. In most cases no inflows were recorded, but the mode of drilling (Shell and Auger) can effectively seal out the water with casing, particularly when the granular interval is thin, thus giving the impression of no inflows.

I consider that because the method of drilling can quickly case out water, the trial pits give a better view of shallow groundwater conditions as follows

<b>TRIAL PIT</b>	<b>GROUNDWATER OBSERVATIONS</b>
S1	ROSE
S2	NONE
S3	STEADY INFLOW
1	SLIGHT SEEPAGE
2	STEADY INFLOW
3	NONE
4	NONE
5	STEADY INFLOW
6	NONE
7	STRUCK
8	STRUCK
9	SLOW TRICKLE
10	QUICK INFLOW
11	BASE OF PIT FILLED
12	NONE

I would suggest that these observations suggest some groundwater activity.

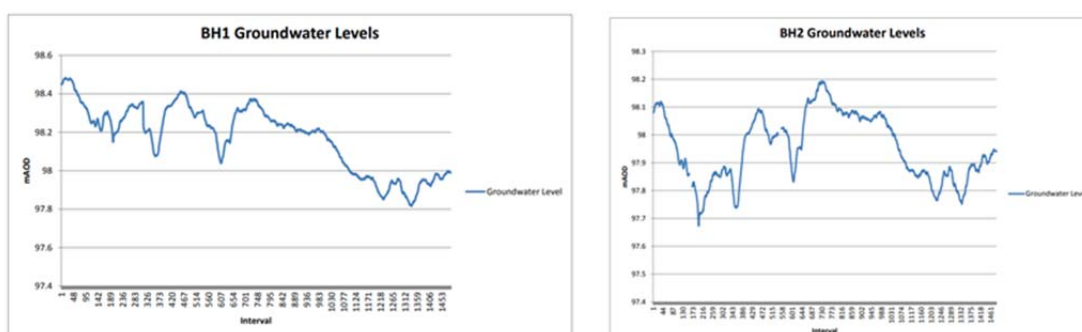
It is accepted that the borehole logs from 2013 indicate that no groundwater was encountered. However it is noted that February and March 2013, and indeed the same months in the previous year (2012) were dry months. I suspect that the Sands and Gravels on this site are actually quite free draining, and drain quite readily when there is little to no rain. The hydraulic controlling horizon is the stiff low permeability CLAY layer at 1.5m to 3m depth, which does not allow any vertical percolation.

I note the comments made by GSI in their review of the RTS presentation which highlighted the connection between the dry period and the lack of groundwater, but I suggest that conditions on this site comprise relatively free draining material close the surface, which is readily recharged by incident

rainfall, but drains away quickly. The mainly dry condition of the field on the day of my site visit, with only minor water logging supports this view.

It is noted that the site assessment undertaken by Traynor Environmental (2012) noted T values and P of 16 and 29 respectively, which indicates excellent percolation. However it is also noted that the soakaway tests did not indicate available infiltration capacity for soakaways.

The 2013 boreholes were fitted with standpipes to allow groundwater levels to be measured. It is stated in the EIAR report that the boreholes were fitted with data logger water level transducers. I examined the data in appendix 10.1 and I noted that the boreholes were instrumented for June and July 2013. Data for BH4 was not presented, but plots for boreholes 1-3 do seem to indicate some fluctuations in groundwater levels as shown below and in fact BH1 and BH2 display very similar patterns. I am surprised that no comment was made on this in the EIAR, although it does have more significance in the context of the hydrological system supporting the Tufa Springs than any significance in the overall impact assessment on drinking water supplies.



I therefore do not fully agree with the conclusion, that the Sands and Gravels on the site are not active in the groundwater sense because;

- The T and P tests indicate permeable deposits
- The groundwater monitoring undertaken indicates fluctuations in groundwater levels, albeit in the small range.
- The relatively dry topsoil layer suggests that incident rainfall does percolate into the sand and gravel layer

I expect that there will be a gradient towards the un-named watercourse to the north east, with some lateral movement to drains. I suspect that the groundwater throughput has some influence on the

tufa springs, and I have recommended that further work is undertaken on this to understand it better.

Despite this anomaly, my conclusion is that the sands and gravels on this site, are not substantially hydraulically connected with the Locally Important Sand and Gravel aquifer, for the following reasons.

1. The deposits are thin and underlain by an impermeable layer and
2. The perimeter drains and the permanent watercourse effectively intercept any flow.

The potential risk of impacts on groundwater resources beyond the site are therefore not considered significant, as a result of this lack of connectivity.

However I do feel that the groundwater from the site does have some influence/connection with the Tufa formations. Petrifying springs are lime-rich water sources that deposit tufa, a porous calcareous rock. They constitute a specialised habitat with a distinctive flora, typically dominated by bryophytes and often containing rare species. Their small extent and their vulnerability are recognised by their designation as a priority habitat in Annex I of the European Union Habitats Directive (92/43/EEC); whereby member states are obliged to monitor and report on the conservation status of such annexed habitats.

## **5. PETRIFYING SPRINGS-with TUFA FORMATION**

The Tufa Springs were mentioned in the An Bord Pleanála Inspectors report which notes that an observer to the Oral hearing stated that a screening of these should have been undertaken in the context of the habitats directive on the basis of petrifying springs being designated a priority habitat under Annex 1 of the habitats directive. The Inspector did not agree with the argument and I fully concur with the conclusion of the Inspector, but nonetheless, I do feel that a more in depth assessment of the springs should be undertaken in the context that groundwater from the site, may have some influence on them as discussed above. This recommendation does not suggest any lacunae in the EIAR or NIS, that would have influenced the overall decision, but is a recommendation that ESB adopts an enhanced awareness of the connectivity of the site with a priority habitat.

Member states are required to monitor and report on the conservation status of such annexed habitats. An important stipulation within the habitats directive manual (Lyons and Kelly 2016) when

referring to Petrifying Springs is that “ in order to preserve this habitat of very limited expanse in the field it is essential to preserve its surroundings and whole hydrological system concerned” . The presence of Tufa deposits in close proximity (along the watercourse that forms the northern boundary) to the site, and their dependence on the hydrological conditions on the site, suggests that there is a requirement to better understand the interrelationship between the site conditions and the deposits. The 2016 NPWS publication “monitoring guidelines for the protection of petrifying springs in Ireland” should be referred to for guidance.

## **6. PROPOSED CONSTRUCTION AND OPERATIONAL CONTROLS TO PROTECT GROUNDWATER AND SURFACE WATER**

The proposed mitigation measures for dealing with potential impacts to groundwater and surface water are best international practice, provided they are adhered to and overseen and signed off by a competent person during construction.

One of the key concerns (expressed by the RTS group) relates to the storage and use of oil in the proposed transformers. I am satisfied that the proposed infrastructure and operational protocols afford the optimum security for the prevention of loss to the environment. No absolute guarantees can be provided that there will never be accidental loss of oil to the environment.

In the event of any environmental incident the ESB Networks Emergency Response Procedure will be activated.

For minor spillages that enter the drainage network, the oil water separator will provide an adequate mitigation control measure.

For other spillages, on the basis of the proposed site topography, it is expected the oil will be easy to control on the site, and an appropriate remediation strategy would involve recovery and disposal of any free product, and appropriate disposal of any oil contaminated soil, backed up by validation sampling and analysis.

If some oil were to run across the surface or become mobilised in the shallow groundwater, it will migrate towards the surrounding drainage ditches approximately 40m from the nearest proposed transformer, and ultimately the natural Stream and surface water network. Again, appropriate oil remediation strategies will limit any environmental damage. I am satisfied that any loss of oil on the site will not present a significant risk to either the Bedrock or Sand and Gravel aquifers and as a result the proposed use of oil on the site, does not present a significant risk to any drinking water supplies.

Dewatering may be required for foundations, but inflows are expected to be manageable and will not create any lasting impacts.

## **7. CONCLUSIONS**

- I am satisfied that the proposed development does not present a significant risk to drinking water sources in the area.
- I am satisfied that adequate controls have been proposed to mitigate any potential accidental spillages or discharges, and to ensure that the proposed site development does not present any on-going impacts.
- The substantial thickness of low permeability CLAY on the site eliminates any significant pathway developing to the bedrock aquifer, and hence the Kyle spring.
- The shallow depth of the sand and gravels on the site and the fact that they are effectively intercepted by drainage ditches, means they are not hydraulically connected to off-site sand and gravel deposits.
- The sands and gravels on this site cannot be considered an aquifer and are not considered to be more widely connected to the mapped Sand and Gravel Aquifer.
- I suspect the GSI will not include the site in the Locally Important Aquifer when they consider the boundary of the Timahoe-Stradbally Sand and Gravel Aquifer.
- I am not convinced that the lateral extent and hydraulic properties of the granular material above the CLAY is fully understood and I am therefore recommending further investigation to better understand the dynamics.
- The information from this investigation, should be reviewed by the site drainage designers to ensure full compatibility with the proposed design approach to surface water management.

- I consider that the petrifying springs-tufa deposits are not fully understood, in the context of their dependence on site hydrology and hydrogeology, and in the context that the Sands and Gravels on site may be more active than previously understood. This warrants further investigation.

## **8. RECOMMENDATIONS**

1. I would recommend that a geophysical survey is undertaken using electromagnetic surveying (such as EM31) to map the subsurface shallow deposits to better understand the subsoil profile and to enhance the original ground model.
2. I would recommend that 5 No. shallow groundwater monitoring points are installed around the site at locations away from the proposed footprint. These can comprise simple standpipes installed in trial pits, or shallow drilled boreholes to maximum 3m depth away from the building footprint or any areas where accommodation works are planned. These should be levelled to a common datum, and groundwater levels measured every six hours using water level transducers. This monitoring period should extend over two seasons at least ideally from the Winter period into Spring until construction of the substation proper commences. This will help to better understand the groundwater hydraulics of the shallow deposits on the site and inform the further assessment of the Tufa Springs.
3. A round of groundwater samples should be taken from the shallow wells and analysed for Nitrate, Nitrite, Phosphorous, Ammonia, Chloride, Potassium and Sodium, Conductivity, pH. This will provide a baseline for any future monitoring. The wells should be sampled twice per year, for the same range of parameters. The tufa springs are very sensitive to nutrient loading, and this monitoring will provide information to assist in the protection of the habitat.
4. A more in depth ecological assessment of the tufa springs should be undertaken in the context of it being an Annex 1 habitat using the above data, and following the NPWS guidelines. This will enhance the understanding of the tufa springs and their connectivity to the site.
5. Once items 1-4 are completed I would recommend that the design of the stormwater management system be reviewed in the context of ensuring the existing hydrological system is optimised to support the tufa springs as required under the habitats directive.
6. Once drilled, groundwater quality from the proposed supply well should be monitored twice per year.

# **Appendix B**

## **Geophysical Survey**



Proposed Substation  
Coolnabacky, Co. Laois  
**Geophysical Survey**

Report Status: Draft

*MGX Project Number: 6555*

*MGX File Ref: 6555d-005.doc*

30<sup>th</sup> April 2021

**Confidential Report To:**

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Subsurface Geophysical Investigations

## EXECUTIVE SUMMARY

1. Minorex Geophysics Ltd. (MGX) carried out a geophysical survey consisting of EM31 Ground Conductivity surveying for the ground investigation for the proposed ESB substation at Coolnabacky, Co. Laois.
2. The main objectives of the survey were to determine ground conditions under the substation site and access road, to determine relative variations in subsoils and material type, to establish relative permeability and areas of higher and lower permeability.
3. Ground conductivities were measured and displayed on maps.
4. The interpretation shows that the subsoils vary in the material content between clayey silty Sand and Gravel (lowest conductivities) and slightly sandy and slightly gravelly Clay and Silt (highest conductivities).
5. At the substation site it has been shown that the ground is quite homogeneous with measurements representing a small change in overburden material between sandy and gravelly Clay and Silt and slightly sandy and slightly gravelly Clay and Silt.
6. The access road shows a larger variations of materials with Sand and Gravel occurring closest to the quarry.
7. The lowest ground water permeabilities occur at the highest conductivity values because the clay and silt content is highest here. The highest permeabilities occur where the conductivities are lowest because there the subsoils have the largest amount of Sand and Gravel.

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### List of Tables, Maps and Figures:

Title	Pages	Document Reference
Table 1: Geophysical Survey Locations and Acquisition Parameters	In Text	In Text
Map 1: EM31 Ground Conductivity Contour Map	1 x A3	6555d_Maps.dwg
Map 2a: EM31 Ground Conductivity Contour Map (Substation Site)	1 x A3	6555d_Maps.dwg
Map 2b: EM31 Ground Conductivity Contour Map (Access Road)	1 x A3	6555d_Maps.dwg

## **1. INTRODUCTION**

### **1.1 Background**

Minerex Geophysics Ltd. (MGX) carried out a geophysical survey for the proposed ESB substation at Coolnabacky, Co. Laois. The survey consisted of EM31 ground conductivity measurements. The survey was requested by ESB based on recommendations of their hydrogeological consultant.

### **1.2 Objectives**

The main objectives of the geophysical survey were:

- Determine the ground conductivities under the substation site and access road
- Map shallow subsoils to determine lateral variations and relative type (clay/silt or sand/gravel)
- Determine relative permeability of the subsoils
- Identify zones with higher and lower intergranular permeability

### **1.3 Geology**

The online bedrock geological map of Ireland (GSI, 2021) indicates that the survey area is underlain by the Ballyadams Formation described as crinoidal wackestone/packstone limestone. The quaternary sediments are described as alluvium under the substation site and as gravels along the access road.

A previous geotechnical report (Soil Mechanics, 2012) describes the ground investigation work done and the results of direct investigation and laboratory testing. Boreholes show that rock is deeper than 6 m and does not play a role in the current investigation with the EM31.

Ten boreholes on the substation site indicate mainly sandy gravelly clay with some lenses of sand or gravel. Most trial pits also show sandy gravelly clay with some silt, sand and gravel lenses. Trial pits 10 and 11 indicate sand while trial pit 12 indicates silt over sand.

### **1.4 Report**

This report includes the results and interpretation of the geophysical survey. Maps and a table are included to illustrate the results of the survey. More detailed descriptions of geophysical methods and measurements can be found in GSEG (2002), Milsom (1989) and Reynolds (1997).

The description of soil, rock and the use of geotechnical terms follows Eurocode (2007) and BSI (2015) standards. The terms are defined in the standards and the physical parameters are related from experience.

This geophysical survey has been acquired, processed, interpreted and reported in accordance with these guidelines.

The client provided maps of the site and the digital version was used as the background map in this report. Elevations were surveyed on site and are used in the vertical sections.

The interpretative nature and the non-invasive survey methods must be taken into account when considering the results of this survey and Minerex Geophysics Limited, while using appropriate practice to execute, interpret and present the data, give no guarantees in relation to the existing subsurface.

## **2. GEOPHYSICAL SURVEY**

### **2.1 Methodology**

The methodology was outlined in the tender documents and consisted of EM31 Ground Conductivity measurements.

The survey locations are within the colour contoured areas in the maps.

### **2.2 EM31 Ground Conductivity**

The EM31 ground conductivity survey was carried out in the field containing the proposed substation (approx. 7 ha) and along the access road (approx. 3 ha).

The survey was done on lines nominally 10 m apart. Along each line a reading of ground conductivity was taken every second while walking along, thereby resulting in a survey grid of nominally 10 x 2 m. The locations were measured with a sub-meter accuracy SERES DGPS system attached to the EM31 and all data was jointly stored in a data logger. The conductivity meter was a GEONICS EM31 with Allegro data logger and NAV31 data acquisition software. The instrument was compared to base station readings and no EM drift was recorded.

The conductivity is typical for certain geological material types. Dry and clean Sand and Gravel and most rock types (Granite, Sandstone and clean Limestone) have relatively low conductivities while peat, clay and clay-rich rock types (mudstone, shale) have high conductivities.

EM31 ground conductivity determines the bulk conductivity of the subsurface over a typical depth between 0 and 6m bgl. and over a radius of approx. 5m around the instrument. In areas of thick overburden the instrument distinguished between clay/silt and sand/gravel.

The measurements can be disturbed by metal and other conductive objects in close proximity to the instrument, and therefore no geological interpretations can be made in the vicinity of such man-made objects. Either readings were not taken near sources of interference, or notes were taken by the surveyor in order to remove these during processing or to account for these in the interpretation.

The survey was done on the 23<sup>rd</sup> of April 2021 in good weather conditions. The instrument was checked repeatedly at a base station and the reading were very stable.

### **3. RESULTS AND INTERPRETATION**

The interpretation of geophysical data was executed utilizing the known response of geophysical measurements, typical physical parameters for subsurface features that may underlay the site, and the experience of the authors.

The EM31 ground conductivity values were merged into one data file for the entire survey area and contoured and gridded with the SURFER contouring package. The contours are created by gridding and interpolation and care must be taken when using the data. The contour map is overlaid over the location and base map (Map 1) and the values in milliSiemens/metre (mS/m) are indicated on the colour scale bar.

Maps 2a and 2b display the same data as Map 1 but are displayed at a larger scale split for the substation site and access road.

The data indicates ground conductivities between 4 and 14 mS/m (MilliSiemens/meter). Because the electrical conductivity is the inverse of the electrical resistivity this can be also expressed as ground resistivity with 70 to 250 Ohmm (Ohmmeter).

Low conductivities indicate mainly sandy and gravelly overburden while high conductivities indicate clayey and silty overburden. The highest readings on the contour map occur close to the quarry and the main road, there may be some component caused by metal of fencing and other object involved.

An interpretation can be made by allocating the overburden material to conductivity and resistivity ranges. Values of conductivity less than 5 mS/m (resistivity > 200 Ohmm) represent clayey silty Sand and Gravel within the depth reach (6m) of the EM31. Values between conductivity 5 - 10 mS/m (resistivity 100 – 200 Ohmm) can be described as sandy gravelly Clay and Silt. Values of conductivity higher than 10 mS/m (resistivity < 100 Ohmm) are typical for slightly sandy and slightly gravelly Clay and Silt.



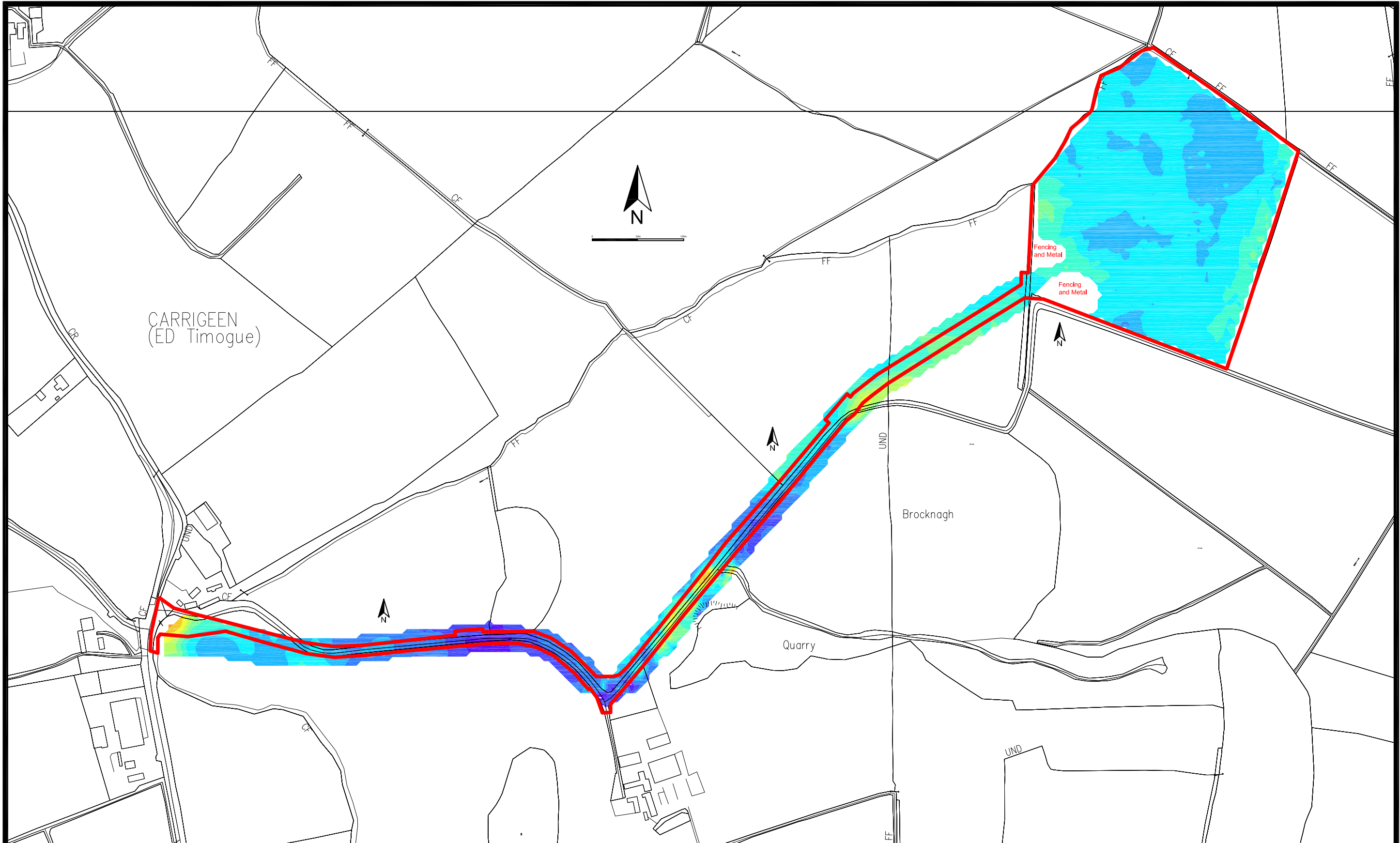
#### **4. CONCLUSIONS**

The following conclusions and recommendations are made:

- The EM31 survey was done over the substation site and the access road while avoiding some small areas with metal fencing.
- The subsoils under the site vary in the content between clayey silty Sand and Gravel (lowest conductivities) and slightly sandy and slightly gravelly Clay and Silt (highest conductivities).
- At the substation site ground conductivity values between 7 and 11 mS/m (resistivities from 90 to 143 Ohm) have been determined. This shows that the site is quite homogeneous. Rock occurs deeper than 6 m bgl (as is known from the boreholes) so that the measurements are representing the change in overburden material.
- The interpretation shows sandy and gravelly Clay and Silt over most of the field with the proposed substation site. Some slightly sandy and slightly gravelly Clay and Silt occurs around the western and eastern edges of the field.
- The access road shows a larger variations of conductivities. The lowest occur closest to the quarry indicating a high content of Sand and Gravel in the overburden.
- The lowest ground water permeabilities occur at the highest conductivity values because the clay and silt content is highest here. The highest permeabilities occur where the conductivities are lowest because there the subsoils have the largest amount of Sand and Gravel.

## 5. REFERENCES

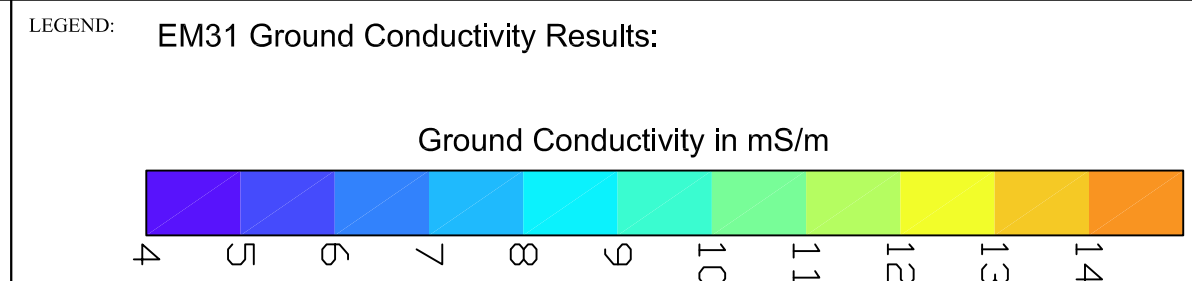
1. **BSI, 2015.** BS5930, Code of Practice for Ground Investigations, British Standards Institute 2015.
2. **Eurocode, 2007:** EN 1997-2:2007. Eurocode 7. Part 2 Ground Investigation and Testing 2007.
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4. **GSI, 2021.** Online Bedrock Geological Map of Ireland. Geological Survey of Ireland 2021.
5. **Milsom, 1989.** Field Geophysics. John Wiley and Sons.
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CLIENT	ESB Networks Projects Delivery
PROJECT	Coolnabacky, County Laois Geophysical Survey
TITLE	Map 1: EM31 Ground Conductivity Contour Map

SCALE:	1:4000 @ A3
PROJECT:	6555
DRAWN:	HK
DATE:	28/04/2021
MGX FILE:	6555d_Maps.dwg
STATUS:	Draft

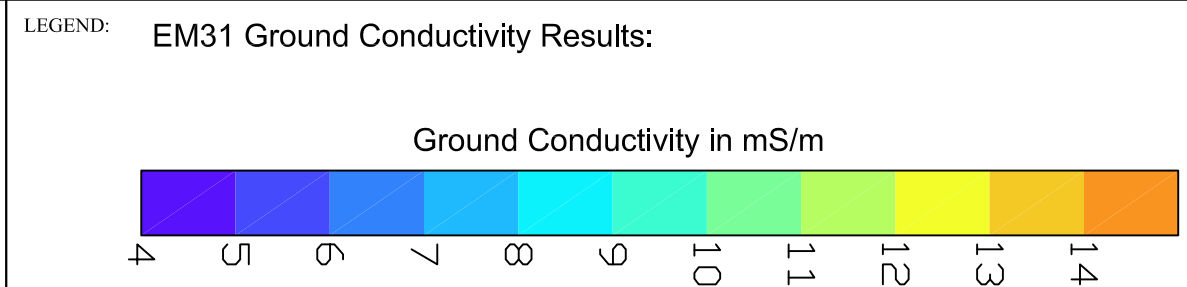


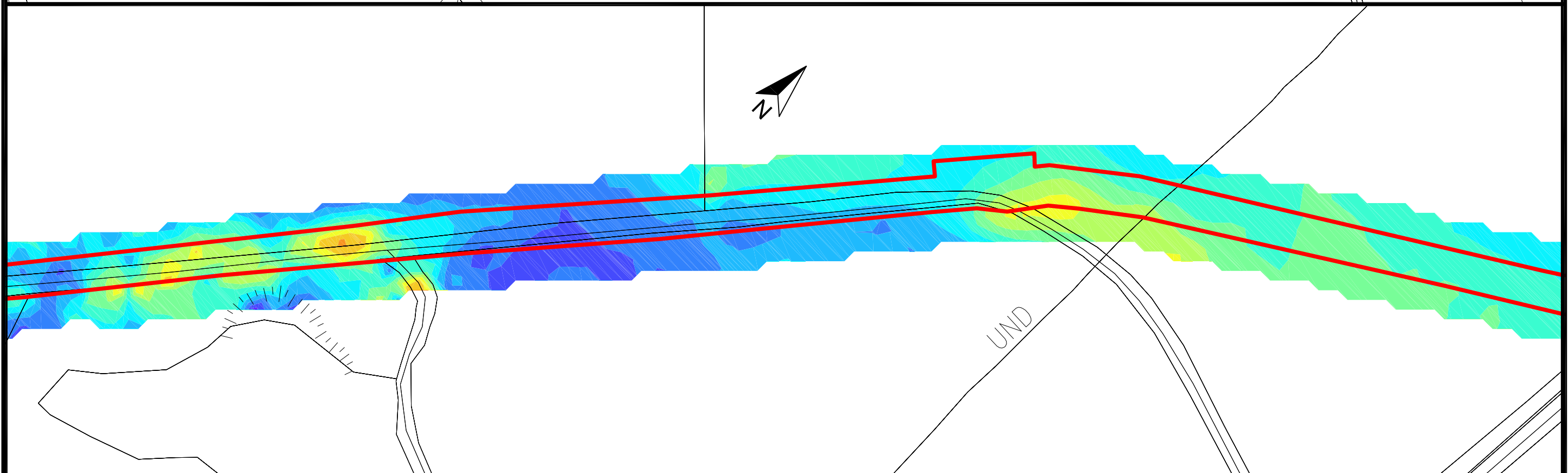
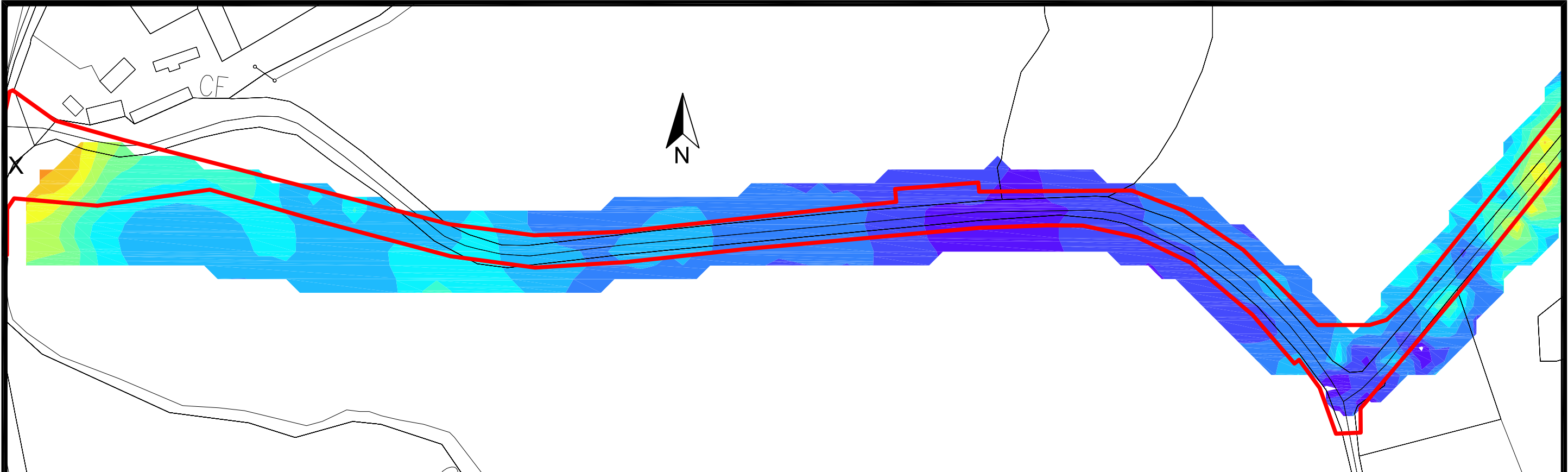


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CLIENT	ESB Networks Projects Delivery
PROJECT	Coolnabacky, County Laois Geophysical Survey
TITLE	Map 2a: EM31 Ground Conductivity Contour Map (Substation Site)

SCALE:	1:1500 @ A3
PROJECT:	6555
DRAWN:	HK
DATE:	28/04/2021
MGX FILE:	6555d_Maps.dwg
STATUS:	Draft

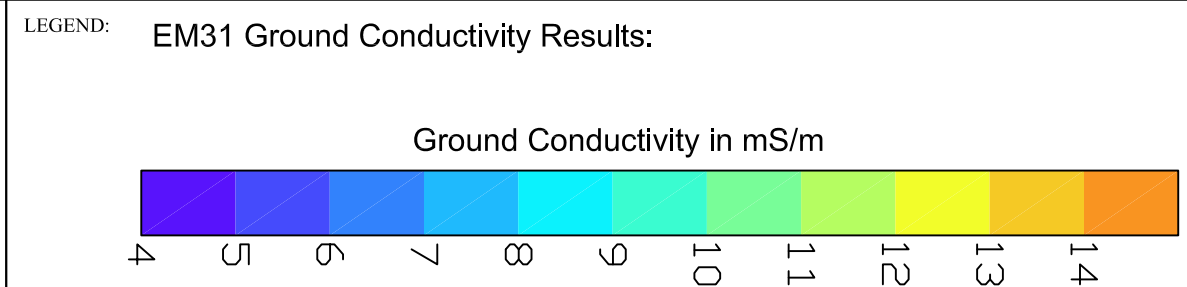




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CLIENT ESB Networks Projects Delivery  
PROJECT Coolnabacky, County Laois  
Geophysical Survey  
TITLE Map 2b: EM31 Ground Conductivity  
Contour Map (Access Road)

SCALE: 1:1500 @ A3  
PROJECT: 6555  
DRAWN: HK  
DATE: 28/04/2021  
MGX FILE: 6555d\_Maps.dwg  
STATUS: Draft



# Appendix C

## Borehole Logs



Priority Geotechnical Ltd.  
 Tel: 021 4631600  
 Fax: 021 4638690  
 www.prioritygeotechnical.ie

Drilled By  
 KC  
 Logged By

Borehole No.  
**BH01**  
 Sheet 1 of 1

Project Name: Coolnabackey - Groundwater      Project No. P21124      Co-ords:      Hole Type CP

Location: Co. Laois      Level: m OD      Scale 1:50

Client: ESB      Date: 26/05/2021 - 26/05/2021

Well Backfill	Water Strike (m bgl)	Sample and In Situ Testing			Depth (m bgl)	Level (mOD)	Legend	Stratum Description	
		Depth (m bgl)	Type	Results					
					1.00		Driller described: CLAY with cobble content.	1	
							Driller described: Dense GRAVEL.	2	
					3.00		End of Borehole at 3.000m	3	
								4	
								5	
								6	
								7	
								8	
								9	

<b>Groundwater:</b>					<b>Hole Information:</b>			<b>Chiselling Details:</b>			
Struck (m bgl)	Rose to (m bgl)	After (mins)	Sealed (m bgl)	Comment	Depth (m bgl)	Hole Dia (mm)	Casing Dia (mm)	Top (m)	Base (m)	Duration (hh:mm)	Tool
				None encountered.	3.00	200	200	2.40	2.60	01:00	Chisel.
					<b>Equipment:</b>						
					Dando 2000						

<b>Remarks:</b> Borehole terminated at 3.00m bgl, required depth. 50mm standpipe installed. Response zone from 0.50m to 3.00m bgl.	<b>Shift Data:</b>		<b>GW (m bgl)</b>	<b>Shift</b>	<b>Depth (m bgl)</b>	<b>Remarks</b>
				26/05/2021 08:00	0.00	Start of shift.
			Dry.	26/05/2021 18:00	3.00	End of borehole.



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 Fax: 021 4638690  
 www.prioritygeotechnical.ie

Drilled By  
 KC  
 Logged By

Borehole No.  
**BH02**  
 Sheet 1 of 1

Project Name: Coolnabackey - Groundwater      Project No. P21124      Co-ords:      Hole Type CP

Location: Co. Laois      Level: m OD      Scale 1:50

Client: ESB      Date: 26/05/2021 - 26/05/2021

Well Backfill	Water Strike (m bgl)	Sample and In Situ Testing			Depth (m bgl)	Level (mOD)	Legend	Stratum Description	
		Depth (m bgl)	Type	Results					
					1.00		Driller described: CLAY with cobble content.	1	
							Driller described: Dense GRAVEL.	2	
					3.00		End of Borehole at 3.000m	3	
								4	
								5	
								6	
								7	
								8	
								9	

<b>Groundwater:</b>					<b>Hole Information:</b>			<b>Chiselling Details:</b>			
Struck (m bgl)	Rose to (m bgl)	After (mins)	Sealed (m bgl)	Comment	Depth (m bgl)	Hole Dia (mm)	Casing Dia (mm)	Top (m)	Base (m)	Duration (hh:mm)	Tool
				None encountered.	3.00	200	200	2.60	2.80	00:30	Chisel.
					<b>Equipment:</b>						
					Dando 2000						

<b>Remarks:</b> Borehole terminated at 3.00m bgl, required depth. 50mm diameter standpipe installed. Response zone from 0.50m - 3.00m bgl.	<b>Shift Data:</b>		<b>GW (m bgl)</b>	<b>Shift</b>	<b>Depth (m bgl)</b>	<b>Remarks</b>
				26/05/2021 08:00	0.00	Start of shift.
		Dry		26/05/2021 18:00	3.00	End of borehole.





Priority Geotechnical Ltd.  
 Tel: 021 4631600  
 Fax: 021 4638690  
 www.prioritygeotechnical.ie

Drilled By  
 KC  
 Logged By

Borehole No.  
**BH03**  
 Sheet 1 of 1

Project Name: Coolnabackey - Groundwater      Project No. P21124      Co-ords:      Hole Type CP

Location: Co. Laois      Level: m OD      Scale 1:50

Client: ESB      Date: 26/05/2021 - 26/05/2021

Well Backfill	Water Strike (m bgl)	Sample and In Situ Testing			Depth (m bgl)	Level (mOD)	Legend	Stratum Description	
		Depth (m bgl)	Type	Results					
					1.00		Driller described: CLAY with cobble content.	1	
							Driller described: GRAVEL.	2	
					3.00		End of Borehole at 3.000m	3	
								4	
								5	
								6	
								7	
								8	
								9	

<b>Groundwater:</b>					<b>Hole Information:</b>			<b>Chiselling Details:</b>			
Struck (m bgl)	Rose to (m bgl)	After (mins)	Sealed (m bgl)	Comment	Depth (m bgl)	Hole Dia (mm)	Casing Dia (mm)	Top (m)	Base (m)	Duration (hh:mm)	Tool
				None encountered.	3.00	200	200	1.90	2.00	01:00	Chisel.
					<b>Equipment:</b>						
					Dando 2000						

<b>Remarks:</b> Borehole terminated at 3.00m bgl, required depth. 50mm diameter standpipe installed. Response zone from 0.50m to 3.00m bgl.	<b>Shift Data:</b>			
	GW (m bgl)	Shift	Depth (m bgl)	Remarks
	Dry	26/05/2021 08:00 26/05/2021 18:00	0.00 3.00	Start of shift. End of borehole.

## **Appendix D**

# **Onsite Raw Water Quality Data**

IE Consulting  
Innovation Centre  
Green Road  
Carlow  
Co Carlow



**Attention :** Kevin Murphy  
**Date :** 19th January, 2022  
**Your reference :** IE2219  
**Our reference :** Test Report 21/20239 Batch 1  
**Location :** ESB Coolnabacky  
**Date samples received :** 16th December, 2021  
**Status :** Final Report  
**Issue :** 1

Four samples were received for analysis on 16th December, 2021 of which four were scheduled for analysis. Please find attached our Test Report which should be read with notes at the end of the report and should include all sections if reproduced. Interpretations and opinions are outside the scope of any accreditation, and all results relate only to samples supplied. All analysis is carried out on as received samples and reported on a dry weight basis unless stated otherwise. Results are not surrogate corrected.

**Authorised By:**

**Hayley Prowse**  
Project Manager

Please include all sections of this report if it is reproduced



**Element Materials Technology**

**Client Name:** IE Consulting  
**Reference:** IE2219  
**Location:** ESB Coolnabacky  
**Contact:** Kevin Murphy  
**EMT Job No:** 21/20239

**Report : Liquid (Duplicate results)**

**Liquids/products:** V=40ml vial, G=glass bottle, P=plastic bottle  
 H=H<sub>2</sub>SO<sub>4</sub>, Z=ZnAc, N=NaOH, HN=HNO<sub>3</sub>

EMT Sample No.	7-9												Please see attached notes for all abbreviations and acronyms
Sample ID	BH3												
Depth													
COC No / misc													
Containers	H HN P												
Sample Date	14/12/2021												
Sample Type	Ground Water												
Batch Number	1												
Date of Receipt	16/12/2021												
		LOD/LOR	Units	Method No.									
pH #	8.07	<0.01	pH units	TM73/PM0									

**Client Name:** IE Consulting  
**Reference:** IE2219  
**Location:** ESB Coolnaback  
**Contact:** Kevin Murphy

**Matrix :** Liquid

EMT Job No.	Batch	Sample ID	Depth	EMT Sample No.	Analysis	Reason
21/20239	1	BH3		7-9	Alkalinity, pH	Sample holding time exceeded

Please note that only samples that are deviating are mentioned in this report. If no samples are listed it is because none were deviating. Only analyses which are accredited are recorded as deviating if set criteria are not met.

# NOTES TO ACCOMPANY ALL SCHEDULES AND REPORTS

EMT Job No.: 21/20239

## SOILS and ASH

Please note we are only MCERTS accredited (UK soils only) for sand, loam and clay and any other matrix is outside our scope of accreditation.

Where an MCERTS report has been requested, you will be notified within 48 hours of any samples that have been identified as being outside our MCERTS scope. As validation has been performed on clay, sand and loam, only samples that are predominantly these matrices, or combinations of them will be within our MCERTS scope. If samples are not one of a combination of the above matrices they will not be marked as MCERTS accredited.

It is assumed that you have taken representative samples on site and require analysis on a representative subsample. Stones will generally be included unless we are requested to remove them.

All samples will be discarded one month after the date of reporting, unless we are instructed to the contrary. Asbestos samples are retained for 6 months.

If you have not already done so, please send us a purchase order if this is required by your company.

Where appropriate please make sure that our detection limits are suitable for your needs, if they are not, please notify us immediately.

All analysis is reported on a dry weight basis unless stated otherwise. Limits of detection for analyses carried out on as received samples are not moisture content corrected. Results are not surrogate corrected. Samples are dried at 35°C ±5°C unless otherwise stated. Moisture content for CEN Leachate tests are dried at 105°C ±5°C. Ash samples are dried at 37°C ±5°C.

Where Mineral Oil or Fats, Oils and Grease is quoted, this refers to Total Aliphatics C10-C40.

Where a CEN 10:1 ZERO Headspace VOC test has been carried out, a 10:1 ratio of water to wet (as received) soil has been used.

% Asbestos in Asbestos Containing Materials (ACMs) is determined by reference to HSG 264 The Survey Guide - Appendix 2 : ACMs in buildings listed in order of ease of fibre release.

Sufficient amount of sample must be received to carry out the testing specified. Where an insufficient amount of sample has been received the testing may not meet the requirements of our accredited methods, as such accreditation may be removed.

Negative Neutralization Potential (NP) values are obtained when the volume of NaOH (0.1N) titrated (pH 8.3) is greater than the volume of HCl (1N) to reduce the pH of the sample to 2.0 - 2.5. Any negative NP values are corrected to 0.

The calculation of Pyrite content assumes that all oxidisable sulphides present in the sample are pyrite. This may not be the case. The calculation may be an overestimate when other sulphides such as Barite (Barium Sulphate) are present.

## WATERS

Please note we are not a UK Drinking Water Inspectorate (DWI) Approved Laboratory .

ISO17025 accreditation applies to surface water and groundwater and usually one other matrix which is analysis specific, any other liquids are outside our scope of accreditation.

As surface waters require different sample preparation to groundwaters the laboratory must be informed of the water type when submitting samples.

Where Mineral Oil or Fats, Oils and Grease is quoted, this refers to Total Aliphatics C10-C40.

## STACK EMISSIONS

Where an MCERTS report has been requested, you will be notified within 48 hours of any samples that have been identified as being outside our MCERTS scope. As validation for Dioxins and Furans and Dioxin like PCBs has been performed on XAD-2 Resin, only samples which use this resin will be within our MCERTS scope.

Where appropriate please make sure that our detection limits are suitable for your needs, if they are not, please notify us immediately.

## DEVIATING SAMPLES

All samples should be submitted to the laboratory in suitable containers with sufficient ice packs to sustain an appropriate temperature for the requested analysis. The temperature of sample receipt is recorded on the confirmation schedules in order that the client can make an informed decision as to whether testing should still be undertaken.

## SURROGATES

Surrogate compounds are added during the preparation process to monitor recovery of analytes. However low recovery in soils is often due to peat, clay or other organic rich matrices. For waters this can be due to oxidants, surfactants, organic rich sediments or remediation fluids. Acceptable limits for most organic methods are 70 - 130% and for VOCs are 50 - 150%. When surrogate recoveries are outside the performance criteria but the associated AQC passes this is assumed to be due to matrix effect. Results are not surrogate corrected.

## DILUTIONS

A dilution suffix indicates a dilution has been performed and the reported result takes this into account. No further calculation is required.

## BLANKS

Where analytes have been found in the blank, the sample will be treated in accordance with our laboratory procedure for dealing with contaminated blanks.

Please include all sections of this report if it is reproduced

All solid results are expressed on a dry weight basis unless stated otherwise.

## NOTE

Data is only reported if the laboratory is confident that the data is a true reflection of the samples analysed. Data is only reported as accredited when all the requirements of our Quality System have been met. In certain circumstances where all the requirements of the Quality System have not been met, for instance if the associated AQC has failed, the reason is fully investigated and documented. The sample data is then evaluated alongside the other quality control checks performed during analysis to determine its suitability. Following this evaluation, provided the sample results have not been effected, the data is reported but accreditation is removed. It is a UKAS requirement for data not reported as accredited to be considered indicative only, but this does not mean the data is not valid.

Where possible, and if requested, samples will be re-extracted and a revised report issued with accredited results. Please do not hesitate to contact the laboratory if further details are required of the circumstances which have led to the removal of accreditation.



**REPORTS FROM THE SOUTH AFRICA LABORATORY**

Any method number not prefixed with SA has been undertaken in our UK laboratory unless reported as subcontracted.

**Measurement Uncertainty**

Measurement uncertainty defines the range of values that could reasonably be attributed to the measured quantity. This range of values has not been included within the reported results. Uncertainty expressed as a percentage can be provided upon request.

**ABBREVIATIONS and ACRONYMS USED**

#	ISO17025 (UKAS Ref No. 4225) accredited - UK.
SA	ISO17025 (SANAS Ref No.T0729) accredited - South Africa
B	Indicates analyte found in associated method blank.
DR	Dilution required.
M	MCERTS accredited.
NA	Not applicable
NAD	No Asbestos Detected.
ND	None Detected (usually refers to VOC and/SVOC TICs).
NDP	No Determination Possible
SS	Calibrated against a single substance
SV	Surrogate recovery outside performance criteria. This may be due to a matrix effect.
W	Results expressed on as received basis.
+	AQC failure, accreditation has been removed from this result, if appropriate, see 'Note' on previous page.
>>	Results above calibration range, the result should be considered the minimum value. The actual result could be significantly higher.
*	Analysis subcontracted to an Element Materials Technology approved laboratory.
AD	Samples are dried at 35°C ±5°C
CO	Suspected carry over
LOD/LOR	Limit of Detection (Limit of Reporting) in line with ISO 17025 and MCERTS
ME	Matrix Effect
NFD	No Fibres Detected
BS	AQC Sample
LB	Blank Sample
N	Client Sample
TB	Trip Blank Sample
OC	Outside Calibration Range

## HWOL ACRONYMS AND OPERATORS USED

HS	Headspace Analysis.
EH	Extractable Hydrocarbons - i.e. everything extracted by the solvent.
CU	Clean-up - e.g. by florisil, silica gel.
1D	GC - Single coil gas chromatography.
Total	Aliphatics & Aromatics.
AL	Aliphatics only.
AR	Aromatics only.
2D	GC-GC - Double coil gas chromatography.
#1	EH_Total but with humics mathematically subtracted
#2	EU_Total but with fatty acids mathematically subtracted
_	Operator - underscore to separate acronyms (exception for +).
+	Operator to indicate cumulative e.g. EH+HS_Total or EH_CU+HS_Total
MS	Mass Spectrometry.

EMT Job No: 21/20239

Test Method No.	Description	Prep Method No. (if appropriate)	Description	ISO 17025 (UKAS/S ANAS)	MCERTS (UK soils only)	Analysis done on As Received (AR) or Dried (AD)	Reported on dry weight basis
TM30	Determination of Trace Metals by ICP-OES (Inductively Coupled Plasma – Optical Emission Spectrometry): WATERS by Modified USEPA Method 200.7, Rev. 4.4, 1994; Modified EPA Method 6010B, Rev.2, Dec 1996; Modified BS EN ISO 11885:2009: SOILS by Modified USEPA 6010B, Rev.2, Dec.1996; Modified EPA Method 3050B, Rev.2, Dec.1996	PM14	Preparation of waters and leachates for metals by ICP OES/ICP MS. Samples are filtered for Dissolved metals, and remain unfiltered for Total metals then acidified	Yes			
TM38	Soluble Ion analysis using Discrete Analyser. Modified US EPA methods: Chloride 325.2 (1978), Sulphate 375.4 (Rev.2 1993), o-Phosphate 365.2 (Rev.2 1993), TON 353.1 (Rev.2 1993), Nitrite 354.1 (1971), Hex Cr 7196A (1992), NH4+ 350.1 (Rev.2 1993) – All anions comparable to BS ISO 15923-1: 2013l	PM0	No preparation is required.				
TM38	Soluble Ion analysis using Discrete Analyser. Modified US EPA methods: Chloride 325.2 (1978), Sulphate 375.4 (Rev.2 1993), o-Phosphate 365.2 (Rev.2 1993), TON 353.1 (Rev.2 1993), Nitrite 354.1 (1971), Hex Cr 7196A (1992), NH4+ 350.1 (Rev.2 1993) – All anions comparable to BS ISO 15923-1: 2013l	PM0	No preparation is required.	Yes			
TM73	Modified US EPA methods 150.1 (1982) and 9045D Rev. 4 - 2004) and BS1377-3:1990. Determination of pH by Metrohm automated probe analyser.	PM0	No preparation is required.	Yes			
TM75	Modified US EPA method 310.1 (1978). Determination of Alkalinity by Metrohm automated titration analyser.	PM0	No preparation is required.	Yes			
TM76	Modified US EPA method 120.1 (1982). Determination of Specific Conductance by Metrohm automated probe analyser.	PM0	No preparation is required.	Yes			

## **Appendix E**

# **Ecological Assessment of Tufa Spring**



## Memo

**To:** Jerome Keohane

**From:** Dr Joanne Denyer (Denyer Ecology)

**Cc:**

**Date:** 24 June 2021

**Subject:** Summary of Coolnabacky, Co. Laois site visit and petrifying springs survey

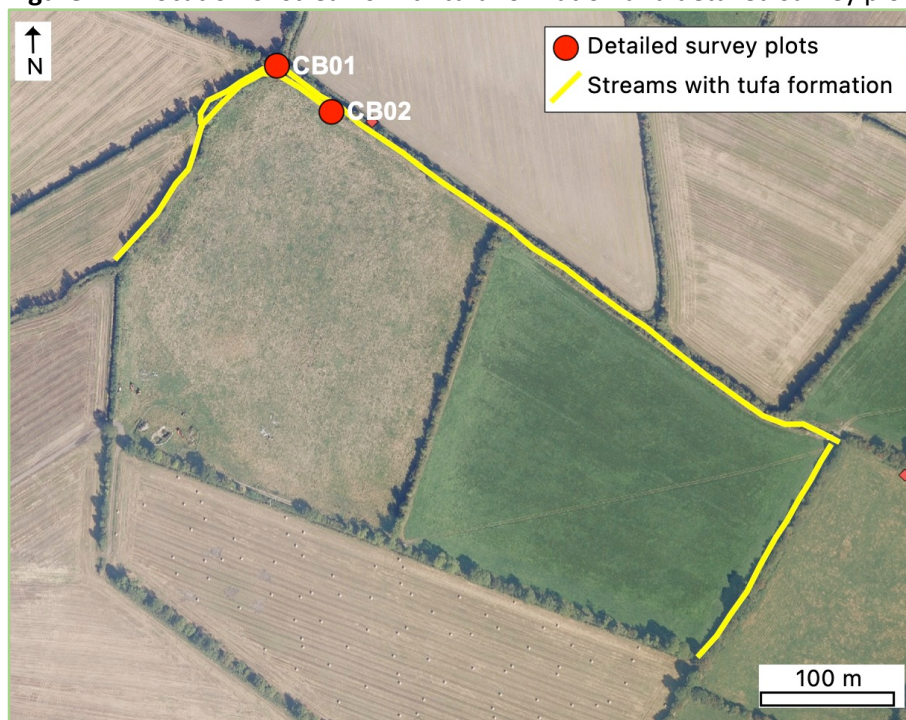
---

Today I visited the above site with Jerome Keohane (hydrogeologist) and undertook a petrifying spring survey. Petrifying springs with tufa formation (Cratoneurion) [\*7220] are an EC Habitats Directive Annex I priority habitat.

Several small streams surrounding the site (Figure 1.1) were found to have a high pH and to support tufa formation as stream crust, paludal tufa, oncoids and ooids and cascade tufa. pH values of 8.30, 8.16 and 8.22 were recorded which is high for lowland streams. Cover of tufa ranged from absent to 90% of the stream bed. The streams had a good flow, despite the season and are highly likely to be largely groundwater fed. Positive indicator species for the Annex I priority habitat were rare. This is likely to be because the streams also act as drainage ditches and receive some surface water (and nutrients) from adjacent lands, increasing water depth at certain times of the year.

The surveyed streams with tufa deposition along some/ all of their length are shown in Figure 1.1.

**Figure 1.1.** Location of streams with tufa formation and detailed survey plots



RGB Aerial Photography - © Bluesky Geospatial Limited

Two detailed survey plots were undertaken following the methodology of Lyons and Kelly (2016) and Denyer (In press) (CB01 and CB02, Figure 1.1).

- CB01 had significant tufa formation (total 45% of cascade, stream crust and paludal tufa) but only one positive indicator species for \*7220 habitat was recorded. Although this plot would not be considered a clear example of the \*7220 habitat, it has high tufa formation and therefore has affinity to Annex I priority Petrifying spring habitat [\*7220]
- CB02 had significant tufa formation (total 85% oncoids and ooids) and three positive indicator species for \*7220 habitat were recorded. This section of stream is considered to be an example of Annex I priority Petrifying spring habitat [\*7220]

The streams surrounding the site are groundwater fed and highly tufa producing. They are mostly lacking the species required to be clear examples of Annex I priority Petrifying spring habitat [\*7220], but these species are present occasionally throughout the system.

A full report will be produced. Recommendations for the spring/ stream system include suitable measures to control surface water run-off from the site so that the groundwater in the spring/ stream system is not diluted, which would reduce it's tufa forming capacity.

#### References:

- Denyer, J. (In press) Guidelines for the Assessment of Annex I Priority Petrifying Springs in Ireland. *Irish Wildlife Manuals*, No. XXX. National Parks and Wildlife Service, Department of Housing, Local Government and Heritage, Ireland.
- Lyons, M.D. & Kelly, D.L. (2016) Monitoring guidelines for the assessment of petrifying springs in Ireland. *Irish Wildlife Manuals*, No. 94. National Parks and Wildlife Service, Department of Arts, Heritage, Regional, Rural and Gaeltacht Affairs, Ireland



## **Appendix 2**

### **Water Monitoring Programme (including results to date)**