Summary and Risk Impact Assessment of Historic Ground Investigations

Coolnabacky, Timahoe, Co. Laois

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IE CONSULTING
WATER-ENVIRONMENTAL-CIVIL

Summary and Risk Impact Assessment of Historic Ground Investigations

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1. Review of Historic Investigations

1.1. Introduction

IE Consulting were engaged by ESB Engineering and Major Projects (EMP), on behalf of ESB Networks to support a response to Laois County Council (Discharge of Planning Condition 11 for Laois Kilkenny Electricity Reinforcement Project – ABP Reg. Ref. VA0015 – Unit 1) in relation to hydrogeological information detailed in the Construction and Environmental Management Plan (CEMP), issued on 3rd Jul 2023.

1.2. List of Relevant Documentation

Table 1 details the documentation associated with the historic site investigations completed at Coolnabacky. These will be referenced throughout this report.

Document Ref	Document Name	Issued Date	Details
Y2012-12A	Factual Report on Ground Investigation	Jul 2012	Ground Investigation competed by Soil Mechanics as detailed in Table 2
DB/09/ 4848HR02	Site Investigation and Hydrogeological Assessment, Proposed Coolnabacky 400 / 100 kV GIS Substation, Co. Laois	Jul 2013	Appendix 10.1 to EIA for Laois County Council completed by AWN Consulting Ltd.
10310-01	Report to assess the impact of the unauthorized development on the Aquifer at Coolnabacky Construction site	Sep 2017	Hydrological/Hydrogeological study completed by Tobin Consulting Engineers in response to Enforcement notice dated 31st July 2017
17-0439	Coolnabacky 400kV GIS Substation	Jul 2018	Ground Investigation competed by Causeway Geotech as detailed in Table 2
IE2019-4840	Hydrogeological and Hydrological Review	Feb 2021	Assessment completed by IE Consulting
Addendum to IE2019-4840	Hydrogeological and Hydrological Review	26 Feb 2021	Letter issued to Seamus Boland (CEO, Irish Rural Link) for clarification of impact of proposed enabling works on recommendations of IE independent Hydrogeological and Hydrological review for

Document Ref	Document Name	Issued Date	Details
			proposed Coolnabacky substation site
ie2219-5242	Assessment of Tufa Springs	Mar 2022	Assessment of Tufa Springs adjacent to the proposed ESB substation including the details of boreholes installed by Priority Drilling in 2021 as detailed in Table 2
IE2219-5370	Proposed Water Monitoring Programme	Jun 2022	Context, locations, parameters measured in-situ, analysis, frequency and reporting of monitoring programme
DE2188-RO1a	Petrifying Spring Survey and Assessment Coolnabacky, Co. Laois	Dec 2022	Report produced by Denyer Ecology to detailing mapped petrifying springs at Coolnabacky
ie2219-5766	Proposal to Decommission 2 No. Boreholes (BH04 & BH05) and installation of 1 No. replacement borehole (BH04b)	17 May 2023	decommissioning/installation works and associated RAMs

Table 1 – Documentation associated with hydrogeological assessments and site investigations

1.3. List of Historic Investigations

A history of Borehole and Trial pits installed on the site are summarised in Table 2. There are currently 5 No. existing boreholes on the site referred to as; BH01, BH02, BH03, BH04 and BH05. Two boreholes currently labelled BH04 and BH05 were legacy boreholes installed during the 2018 works detailed in the Causeway Geotech Report (No.: 17-0439). BH01 to BH03 were installed in 2021 (installed by Priority Geotech in 2021, as documented in the IE Consulting in report *Assessment of Tufa Springs* – Report No.: ie2219-5242). Table 2 provides a list of all the installed boreholes and trial pit investigations on the site to date with the aim of providing a chronological history of exploratory works at the site.

Generally it can be summarised that the site underwent three campaigns of site investigations including the following:

1. Soil Mechanics (2012) – 10 No. borehole and 15 No. trial pits were installed and decommissioned. These works are documented in Report No.: Y2012-12A; *Factual Report on Ground Investigation*.
2. AWN investigation (2013) – Hydrogeological Investigation and comprised 4 No. boreholes around the perimeter of the site.
3. Causeway Geotech (2018) – 9 No. boreholes and 16 No. trial pits were installed. 5 No. boreholes were decommissioned and all 16 No. trials pits were decommissioned. See Section 1.3.1 for explanation of the remaining 4 No. boreholes (BH01, BH02, BH03 and BH04) for which a standpipe was installed. Existing boreholes BH04 and BH05 utilised in the quarterly monitoring programme were adopted as legacy boreholes from these works.
4. Priority Geotech (2021) – 3 No. boreholes were installed which are currently utilised for the quarterly monitoring program; BH01 to BH03. See Section 1.3.2 for further information.

A plan view of the locations is provided in Figure 1.

Table 2 – History of Boreholes and Trial Pits

Priority, 2021 - Active borehole monitoring wells	Causeway Geotech, 2018 – decommissioned	Causeway Geotech, 2018 – adopted into quarterly monitoring programme	Causeway Geotech, 2018 – decommissioning unknown	AWN Consulting, 2013 - decommissioned	Soil Mechanics, 2012– decommissioned

Name	Coordinates (I.T.M.)		Level (mOD)	Category (BH / TP)	Installation Date	Depth of Exploration Hole (m)	Bedrock Encountered (Yes / No)	Borehole	Trial Pit	Status Details	Reference Report/(s)
	Easting (m)	Northing (m)						Groundwater Strikes (m) / Depth sealed (m)	Groundwater Strikes (m) / Post strike behaviour		
BH-01	653730.67	692898.79	+99.66	BH	14/03/2012	6.50	No	Dry	-	Decommissioned on 14/03/2012	**Y2012-12A** - Factual Report on Ground Investigations by Soil Mechanics (July, 2012)
BH-02	653754.75	692921.31	+98.45	BH	15/03/2012	8.50	No	1.20 m / 4.00 m	-	Decommissioned on 15/03/2012	
BH-03	653774.70	692922.08	+98.27	BH	15/03/2012	5.80	No	0.80m / 3.00m	-	Decommissioned on 20/03/2012	
BH-04	653789.81	692940.62	+98.17	BH	13/03/2012	6.44	No	1.10m / 1.20m	-	Decommissioned per Borehole Log, date not specified	
BH-05	653712.52	692938.97	+98.90	BH	21/03/2012	7.40	No	1.20m / 2.00m	-	Decommissioned on 21/03/2012	
BH-06	653734.32	692954.80	+98.58	BH	20/03/2012	5.90	No	1.10m / 1.50m	-	Decommissioned on 20/03/2012	
BH-07	653759.87	692970.81	+98.39	BH	20/03/2012	5.80	No	5.20m / 5.50m	-	Decommissioned on 20/03/2012	
BH-08	653694.68	692966.94	+98.92	BH	12/03/2012	5.47	No	1.50m / N/A	-	No backfill noted on log, end date 12/03/2012	
BH-09	653718.84	692981.19	+98.75	BH	21/03/2012	7.60	No	1.20m / 2.00m	-	Decommissioned on 22/03/2012	
BH-10	653737.73	692998.07	+98.55	BH	12/03/2012	5.50	No	None observed	-	Decommissioned on 12/03/2012	
TP-S1	653735.74	692861.89	+98.85	TP	08/03/2012	1.60	No	-	1.50m / rose 10 1.20m after 20	Decommissioned on 08/03/2012	

Table 2 – History of Boreholes and Trial Pits

Priority, 2021 - Active borehole monitoring wells	Causeway Geotech, 2018 – decommissioned	Causeway Geotech, 2018 – adopted into quarterly monitoring programme	Causeway Geotech, 2018 – decommissioning unknown	AWN Consulting, 2013 - decommissioned	Soil Mechanics, 2012– decommissioned

Name	Coordinates (I.T.M.)		Level (mOD)	Category (BH / TP)	Installation Date	Depth of Exploration Hole (m)	Bedrock Encountered (Yes / No)	Borehole	Trial Pit	Status Details	Reference Report/(s)
	Easting (m)	Northing (m)						Groundwater Strikes (m) / Depth sealed (m)	Groundwater Strikes (m) / Post strike behaviour		
									minutes		
TP-S2	653853.95	692943.02	+97.52	TP	08/03/2012	1.70	No	-	None observed	Decommissioned on 08/03/2012	
TP-S3	653831.91	692775.11	+97.90	TP	08/03/2012	1.60	No	-	1.30m / steady inflow	Decommissioned on 08/03/2012	
TP-01	653664.19	692955.15	+98.13	TP	08/03/2012	3.00	No	-	1.00m / slight seepage	Decommissioned on 08/03/2012	
TP-02	653745.33	693013.31	+98.37	TP	08/03/2012	3.00	No	-	1.00m / steady inflow	Decommissioned on 08/03/2012	
TP-03	653782.00	692963.62	+98.31	TP	08/03/2012	3.00	No	-	None observed	Decommissioned on 08/03/2012	
TP-04	653700.19	692907.17	+99.46	TP	08/03/2012	3.00	No	-	None observed	Decommissioned on 08/03/2012	
TP-05	653736.53	692945.56	+98.53	TP	08/03/2012	3.00	No	-	1.60m / steady inflow	Decommissioned on 08/03/2012	
TP-06	653658.96	692878.73	+99.25	TP	07/03/2012	3.00	No	-	None observed	Decommissioned on 07/03/2012	
TP-07	653622.65	692851.93	+99.63	TP	07/03/2012	3.00	No	-	2.30m	Decommissioned on 07/03/2012	
TP-08	653591.84	692829.08	+99.74	TP	07/03/2012	3.00	No	-	1.70m	Decommissioned on 07/03/2012	
TP-09	653532.01	692795.09	+100.80	TP	07/03/2012	3.00	No	-	1.80m / slow trickle	Decommissioned on 07/03/2012	
TP-10	653482.02	692759.57	+102.21	TP	07/03/2012	2.80	No	-	2.00m / quick inflow	Decommissioned on 07/03/2012	
TP-11	653444.60	692722.42	+104.21	TP	07/03/2012	3.00	No	-	3.00m / base of pit filled	Decommissioned on 07/03/2012	
TP-12	653171.09	692421.67	+113.44	TP	07/03/2012	3.00	No	-	None observed	Decommissioned on 07/03/2012	

Table 2 – History of Boreholes and Trial Pits

Priority, 2021 - Active borehole monitoring wells	Causeway Geotech, 2018 – decommissioned	Causeway Geotech, 2018 – adopted into quarterly monitoring programme	Causeway Geotech, 2018 – decommissioning unknown	AWN Consulting, 2013 - decommissioned	Soil Mechanics, 2012– decommissioned

Name	Coordinates (I.T.M.)		Level (mOD)	Category (BH / TP)	Installation Date	Depth of Exploration Hole (m)	Bedrock Encountered (Yes / No)	Borehole	Trial Pit	Status Details	Reference Report/(s)
	Easting (m)	Northing (m)						Groundwater Strikes (m) / Depth sealed (m)	Groundwater Strikes (m) / Post strike behaviour		
BH-01	653641.4	692866.5	-	BH	29/05/2013	4.00	No	None observed	-	Standpipe installed	DB/09/4848HR02 – AWN Site Investigation Report, 2013
BH-02	653684.5	692989.5	-	BH	30/05/2013	5.00	No	None observed	-	Standpipe installed	
BH-03	653786.6	693050.0	-	BH	30/05/2013	4.00	No	None observed	-	Standpipe installed	
BH-04	653894.8	692974.7	-	BH	28/05/2013 to 29/05/2013	9.00	Driller described "possible rock"	None observed	-	Standpipe installed	
BH-01	653744.29	692847.44	+101.53	BH	22/06/2018	6.50	No	1.30m / N/A	-	Standpipe installed – adopted as BH5 in quarterly monitoring programme	**17-0439** - Coolnabacky - 400kV GIS Substation Ground Investigation by Causeway Geotech (July, 2018)
BH-02	653763.55	692855.61	+101.02	BH	21/06/2018	6.50	No	1.60m / N/A	-	Standpipe installed – decommissioning information unknown	
BH-03	653793.75	692877.00	+100.92	BH	20/06/2018	8.50	No	5.70m / N/A	-	Standpipe installed - decommissioning information unknown	
BH-04	653775.62	692876.75	+100.93	BH	22/06/2018	9.50	No	1.80m / N/A	-	Standpipe installed – adopted as BH04 in quarterly	

Table 2 – History of Boreholes and Trial Pits

Priority, 2021 - Active borehole monitoring wells	Causeway Geotech, 2018 – decommissioned	Causeway Geotech, 2018 – adopted into quarterly monitoring programme	Causeway Geotech, 2018 – decommissioning unknown	AWN Consulting, 2013 - decommissioned	Soil Mechanics, 2012– decommissioned

Name	Coordinates (I.T.M.)		Level (mOD)	Category (BH / TP)	Installation Date	Depth of Exploration Hole (m)	Bedrock Encountered (Yes / No)	Borehole	Trial Pit	Status Details	Reference Report/(s)
	Easting (m)	Northing (m)						Groundwater Strikes (m) / Depth sealed (m)	Groundwater Strikes (m) / Post strike behaviour		
										monitoring programme	
BH-06	653761.06	692899.36	+101.02	BH	19/06/2018	9.00	No	None observed	-	Decommissioned on 19/03/2012	
BH-07	653739.97	692885.11	+101.70	BH	18/06/2018	6.00	No	None observed	-	Decommissioned on 18/03/2012	
BH-08	653723.11	692880.20	+101.81	BH	15/06/2018	9.00	No	None observed	-	Decommissioned on 15/03/2012	
BH-09	653714.90	692899.34	+102.48	BH	13/06/2018	10.70	No	None observed	-	Decommissioned on 14/06/2018	
BH-10	653768.14	692928.33	+100.77	BH	12/06/2018	9.30	No	None observed	-	Decommissioned on 13/06/2018	
TP-01	652762.54	692473.30	+120.31	TP	13/06/2018	2.10	No	-	None observed	Decommissioned on 13/06/2018	
TP-02	652858.96	692449.29	+119.87	TP	13/06/2018	1.50	No	-	None observed	Decommissioned on 13/06/2018	
TP-03	652957.52	692451.18	+117.37	TP	13/06/2018	2.30	No	-	None observed	Decommissioned on 13/06/2018	
TP-04	653059.67	692459.07	+117.08	TP	13/06/2018	1.50	No	-	None observed	Decommissioned on 13/06/2018	
TP-05	653151.86	692414.82	+116.08	TP	13/06/2018	2.50	No	-	None observed	Decommissioned on 13/06/2018	
TP-06	653233.63	692471.63	+111.55	TP	13/06/2018	2.50	No	-	None observed	Decommissioned on 13/06/2018	
TP-07	653297.01	692547.95	+110.02	TP	12/06/2018	2.50	No	-	None observed	Decommissioned on 12/06/2018	
TP-09	653427.96	692700.83	+106.81	TP	12/06/2018	2.50	No	-	None observed	Decommissioned on 12/06/2018	
TP-10	653504.09	692762.58	+102.65	TP	12/06/2018	2.00	No	-	1.80m / seepage at 1.80m	Decommissioned on 12/06/2018	

Table 2 – History of Boreholes and Trial Pits

Priority, 2021 - Active borehole monitoring wells	Causeway Geotech, 2018 – decommissioned	Causeway Geotech, 2018 – adopted into quarterly monitoring programme	Causeway Geotech, 2018 – decommissioning unknown	AWN Consulting, 2013 - decommissioned	Soil Mechanics, 2012– decommissioned

Name	Coordinates (I.T.M.)		Level (mOD)	Category (BH / TP)	Installation Date	Depth of Exploration Hole (m)	Bedrock Encountered (Yes / No)	Borehole	Trial Pit	Status Details	Reference Report/(s)
	Easting (m)	Northing (m)						Groundwater Strikes (m) / Depth sealed (m)	Groundwater Strikes (m) / Post strike behaviour		
TP-11	653587.91	692815.56	+100.21	TP	12/06/2018	1.50	No	-	1.50m / seepage at 1.50m	Decommissioned on 12/06/2018	
TP-12	653685.71	692843.84	+100.91	TP	12/06/2018	2.50	No	-	1.30m / seepage at 1.30m	Decommissioned on 12/06/2018	
TP-13	653844.10	692856.30	+100.63	TP	11/06/2018	2.60	No	-	None observed	Decommissioned on 11/06/2018	
TP-14	653727.14	692828.78	+101.57	TP	12/06/2018	2.50	No	-	2.30m / seepage at 2.30m	Decommissioned on 12/06/2018	
TP-15	653811.99	692890.35	+100.21	TP	11/06/2018	2.00	No	-	None observed	Decommissioned on 11/06/2018	
TP-16	653757.40	693080.19	+98.48	TP	11/06/2018	2.30	No	-	1.00m / rapid inflow at 1.00m	Decommissioned on 11/06/2018	
TP-28	653757.40	693080.19	+98.48	TP	12/06/2018	0.70	No	-	None observed	Decommissioned on 12/06/2018	
BH-01	653762.00	692995.00	+98.905	BH	26/05/2021	3.00	No	None observed	-	Active - quarterly monitoring point	**IE2219-5242** - Appendix C for Borehole Logs from PGI (May, 2021)
BH-02	653750.00	693080.00	+98.899	BH	26/05/2021	3.00	No	None observed	-	Active - quarterly monitoring point	
BH-03	653833.00	693031.00	+98.484	BH	26/05/2021	3.00	No	None observed	-	Active - quarterly monitoring point	

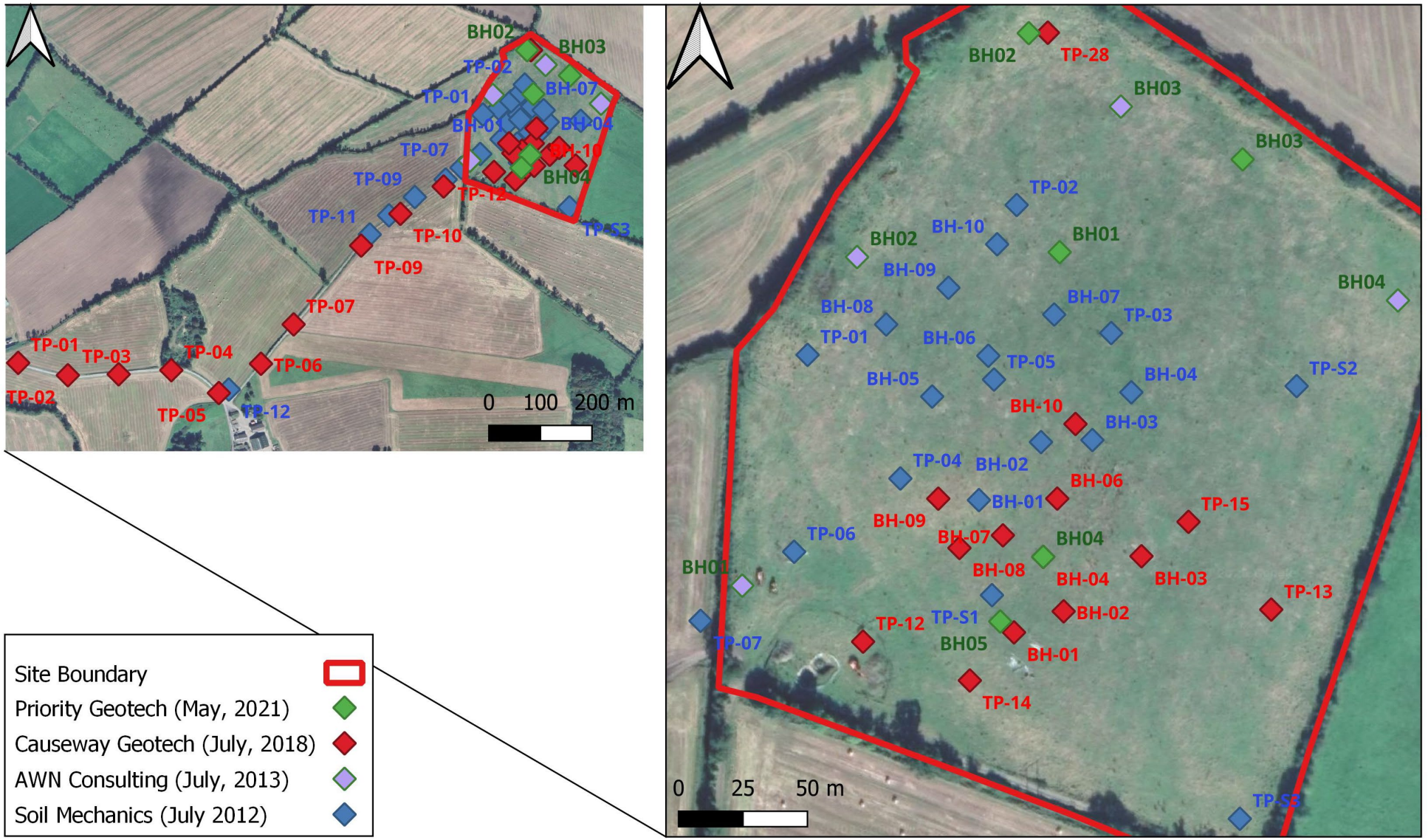


Figure 1 – Locations of historic investigation boreholes and trial pits across the site

1.3.1. Soil Mechanics Site Investigations, 2012

As detailed in Table 2 all borehole and trial pits were decommissioned post data collection. Standard industry practice following a site investigation is to decommission trial pits and boreholes by backfilling of the excavated material, with the originally extracted soil from that location. This provides a low impact method as the backfilled material is of the same composition and identical to the existing stratigraphic material. There is therefore minimal impact.

The only residual impact is there might be a slight area of weakness as the backfilled material will not be as compacted as the surrounding subsoil. However, this is not an issue in terms of impact to the bedrock aquifer as none of the boreholes in this site investigation or subsequent investigations penetrated the groundwater aquifer, instead they reached the shallow water gravel aquifer (BH02 being the deepest borehole at 8.5 m depth).

The Clay encountered during the site investigations is described as grey stiff to very stiff at depth. The grey colour is significant in that it indicates lack of oxygen, which would normally be introduced by vertical percolation of oxygenated rainwater. This, associated with a typical large fines (Silt and Clay) value of 30% to 50% from PSD analysis confirms the low permeability of the clay. The 2012 Ground Investigation report found clay deposits at all locations and did not indicate the possible presence of bedrock. Laboratory tests were undertaken on samples recovered from boreholes and trial pits.

1.3.2. AWN supplementary Investigation 2013

This involved the construction of 4 No. boreholes around the perimeter of the site. One borehole was taken to 8.6 m and encountered angular rock fragments, but was not confirmed as rock. All of these boreholes were fitted with standpipes, but it appears that they were decommissioned following the conclusion of the planning phase.

1.3.3. Causeway Geotech Site Investigations, 2018

In order to optimise the geotechnical design of the structures and access roads Causeway Geotech were engaged by Killeen Civil Engineering acting on behalf of ESB Networks to undertake a supplementary ground investigation. The boreholes were mainly concentrated within the proposed building footprint to provide location specific

ground property values. The deepest borehole drilled during the Causeway Geotech site investigations was BH09, drilled to 10.70 m and did not encounter bedrock. However groundwater strikes ranging from 0.80 m (BH03) to 5.2 m (BH07) were encountered in many of the boreholes indicating that there was a shallow localised perched water table underlying the site. This information forms the basis that the bedrock aquifer is > 10 m depth below the site and that there is the presence of a local perched water table at shallow depths below the site, perched on a low permeability clay layer that is typically 6-7m thick.

From the Causeway Geotech 2018 Report (No.: 17-0439), standpipes were installed for 4 No. boreholes only; BH01, BH02, BH03 and BH04. All other boreholes and trial pits were decommissioned at the time of the works.

The coordinates for BH01 which was installed by Causeway Geotech as per the Borehole Log are 653744.29 E, 692847.44 N. It was noted that when this borehole location, was plotted in plan view as per Figure 1, lies 7 m south-east of the existing borehole demarked as "BH05" on site. The coordinates of BH05 (653738.95 E, 692851.67 N) were verified by an IE Consulting geologist on the 9th May 2023 (see Report IE2219-5866). This was the only observed borehole in the immediate area. It is therefore surmised that BH01 of the Causeway Geotech study was adopted as "BH05" in the quarterly monitoring programme. It is thought that there may have been an error transcribing the GPS coordinates recorded in the Causeway Geotech 2018 Report (No.: 17-0439), as this is the only explanation to derive the existence of BH05. BH05 has since collapsed so will be decommissioned and described in further detail in the subsequent sections.

BH02 and BH03 were drilled to depths of 6.5 m and 8.5 m respectively, with standpipes installed, but subsequent decommissioning was not documented in the borehole logs of the report. During the site visit by an IE Consulting geologist on the 9th May 2023 the standpipes associated with these boreholes were not observed. It is likely these were covered over during subsequent activities or that the standpipes were removed at a later date and the boreholes have since collapsed in on themselves. None of these boreholes penetrated the groundwater aquifer, so there is no potential pollution pathway to the bedrock aquifer.

BH04 from the Causeway 2018 investigation was documented at coordinates 653775.62 E, 692876.75 N. However an IE Consulting site visit on the 9th of May 2023 (see Report IE2219-5866) confirmed the monitoring location of BH04 to be 653755.62 E, 692876.75 N.

Therefore it was confirmed that BH04 was the borehole adopted from the Causeway 2018 investigation into the quarterly monitoring data as an additional data point. However because it was not originally located as a construction monitoring borehole, it will need to be re-located outside of the footprint area.

Similar to the 2012 investigation, infiltration tests were undertaken to establish percolation rates through the grey CLAY layer. All tests confirmed low infiltration permeability, but an actual value could not be determined, because the percolation rate was too slow. Similarly laboratory tests comprising PSD analysis indicated fines percentages of 30% to 50%, which would be consistent with a low permeability value.

1.3.4. BH01 to BH03, (Priority, 2021)

3 No. Boreholes were installed in 2021 by Priority Drilling and documented in Tufa Spring Assessment Report ie2219-5242. These boreholes are referred to BH01, BH02 and BH03 in the Borehole Monitoring Programme. See Section 2 for full details. These boreholes were installed to a shallow depths of 3m.

1.4. Conclusions

Bedrock was not encountered or confirmed in any of the site investigation locations. The deepest borehole drilled was BH09 of the Causeway Geotech site investigation, drilled to 10.70 m. It can therefore be extrapolated that the bedrock aquifer is considered as typically > 10 m below the site. Consequently, the bedrock aquifer mapped as Rkd (Regionally Important Aquifer – Karstified diffuse) was not compromised by any of the ground investigations See cross-sections for reference in section 3 below.

The bedrock is overlain by a consistent layer of 6-7m of low permeability Clay. This layer limits any interconnectivity between surface/near surface activities and the bedrock aquifer.

The shallow groundwater is perched on low permeability clay.

The low permeability nature of the clay layer was confirmed by the inability to determine an infiltration rate, the grey colour of the clay and the high percentage of fines in samples of the clay tested by PSD analysis.

The perched watertable can be intercepted at depths of typically 0.80 m but this varies greatly across the site. All existing boreholes are installed within the shallow water aquifer as an effort to understand as a baseline how groundwater hydraulics of the shallow deposits on the site informs the further assessment of the tufa springs.

For boreholes BH02 and BH03 of the Causeway Geotech site investigations where the standpipe was not removed and the decommissioning details are unknown, there is no impact to the bedrock aquifer as these boreholes did not encounter bedrock at depths of 6.5 m and 8.5 m respectively.

2. Existing Boreholes onsite and Monitoring Programme Data

2.1. Borehole locations and Rationale

Table 3 provides a tabulated summary of the existing boreholes onsite and their associated attributes.

Table 3 – Existing Boreholes

Borehole Name	Depth (m)	Installation	Rationale
BH01	3.00	Priority drilling, 2021	Per IE2219-5242; the 3 No. boreholes were selected based on a geophysical survey showing these as locations of higher permeability, having sand and gravel rich lenses. They were installed to understand how the hydraulics of the site interact with the tufa deposits on the stream base in the northern perimeter of the site.
BH02	3.00	Priority drilling, 2021	
BH03	3.00	Priority drilling, 2021	
BH04	9.50	Legacy from Causeway Geotech site investigations in 2018	To collect baseline groundwater level data in the immediate vicinity of the substation building.
BH05	6.50	Legacy from Causeway Geotech site investigations in 2018; referred to as BH01 in Causeway Geotech report; renamed BH05 in the Monitoring Programme	To collect baseline groundwater level data in the immediate vicinity of the substation – note prior to initiation of the monitoring program it was observed that this borehole had collapsed to 2.5m depth and was not a viable monitoring point. It was therefore decided to eliminate this point and utilise the four above listed locations instead.

2.1.1. BHO1 to BH03

A Hydrogeological and Hydrological Review was performed by IE Consulting documented per IE2219-4840, issued 16th February 2021. Recommendation number two (2) from the report included the following:

"*I would recommend that 5 No. shallow groundwater monitoring points are installed around the site at locations away from the proposed footprint*"

The purpose of these monitoring boreholes was to help better understand the groundwater hydraulics of the shallow deposits on the site to inform the further assessment of the tufa.

Subsequent to this in April 2021 Minerex performed a geophysical survey producing EM31 Ground Conductivity Contour Maps which were utilised to select borehole monitoring points. Subsequently the three boreholes BH01, BH02 and BH03 were installed in May 2021. On the 24 June 2021 Denyer Ecology undertook a survey of the petrifying springs with tufa formations. It was established that the streams surrounding the site were groundwater fed. All these activities are detailed in report IE2219-5242 *Assessment of Tufa Springs*.

Based on the report IE2219-5242 it was established through the geophysical survey that the ground underlying the proposed substation site was relatively homogeneous, mostly underlain by sandy and gravelly clay and silt with slightly gravelly clay, confirming that bedrock was > 6 m depth (the maximum depth of penetration of the geophysical method). This is consistent with borehole depth data.

The three boreholes BH01, BH02 and BH03 which were drilled in sand and gravel rich lenses, encountered stiff boulder clay at 3 m depth. Water level monitoring of these boreholes over a six month period showed a fluctuating water table, in response to incident rainfall and a groundwater gradient from southwest to northeast. It was concluded that streams along the northern perimeter of the site were partly fed by groundwater seepage from the site and via a nearby spring as well as from ground to the west of the site.

The tufa streams did not qualify as a clear example of Annex I priority petrifying spring, because of the poor baseline flora population, but have nonetheless been afforded a high

level of protection as part of the proposed works, and are annually monitored to ensure that there is no deterioration in their status.

The recommendations from IE2219-5242 included continued groundwater monitoring to ensure no excessive nutrient loading and continued groundwater and surface water monitoring as a strategy to ensure continued protection of the tufa.

2.1.2. Decommissioning of BH04 and BH05

BH4 and BH5 were both installed in an area where excavations and concrete pouring will be required. They were both initially located to provide specific geotechnical design data in the immediate footprint of the substation. These boreholes were subsequently incorporated into the baseline monitoring program as legacy data points and to provide baseline groundwater level and quality data in advance of construction.

However because borehole BH04 sits on the footprint of a proposed building it will be required to be decommissioned and a new borehole BH04b (replacement monitoring well) is proposed to be installed further south of the existing monitoring well. BH05 is also in construction footprint of the substation 110kV building so will therefore also need to be decommissioned. As noted in Table 3 above, this borehole has collapsed at depth, and is no longer viable as a monitoring point.

A method statement Report IE2219-5766 was generated to provide a specification for the decommissioning of 2 No. Boreholes (BH04 & BH05) and the installation of 1 No. replacement borehole (BH04b), together with a site specific environmental and health and safety risk assessment RAMs.

Protection measures will be put in place prior to the main construction works which shall include installation of timber fencing around newly constructed boreholes as well as existing boreholes, plus a silt mesh around the base of the fence to secure well head protection.

BH04b is proposed to be installed as per available guidelines such as Environment Agency, Institute of Geologists of Ireland (IGI) and EPA. BH04b will be drilled to an approximate depth of 6 m. The location is not adjacent to the tufa springs (located to the north of the site), or feeder streams and the target depth is well above the depth of expected bedrock. It will have no connectivity with the bedrock aquifer and will therefore have no impact on the bedrock groundwater aquifer.

2.2. Monitoring Programme

The monitoring program comprises both groundwater and surface water monitoring. This requirement originated from the EIS Sections 12 mitigation measures and 14 Schedule of Commitments. The proposed sample plan and schedule was submitted to Laois County Council and subsequently approved by Laois County Council (LCC) in June 2022.

Document IE2219-5370 set out the monitoring programme, based on collecting samples from the four (4 No) existing monitoring wells (BH1, BH2, BH3 and BH4). During a quarterly monitoring event, visual inspection of the borehole protection will be performed. Any issues with the borehole protection will be reported and documented in the applicable report.

See Table 4 for list of monitoring completed to date on the site. All reports and monitoring completed to date comprises part of the baseline study.

None of the baseline data collected per the listed studies indicate that the existing boreholes or decommissioned boreholes serve as a potential pathway receptors to the bedrock aquifer, this is because of their shallow depths and the low permeability of the clay subsoil.

Table 4 – Monitoring Programme Documentation to date

Monitoring Period	Issued Report Reference	Monitoring Type	Results
2022 Q1	Baseline Surface Water Sampling 30th Mar 2022	Routine	Refer to Appendix A
2022 Q2	Surface Water Sampling 18th May 2022	Routine	
2022 Q2	Surface Water Sampling 20th Jun 2022	Routine	
2022 Q3	Surface Water Sampling 6th Sep 2022	Routine	
2022 Q4	IE2219-5555	Routine	
2023 Q1	IE2219-5752	Routine	
2023 Q1	Baseline Groundwater and Surface Water Report for Kilwex Ltd. By Coyle Environmental	Coyle Environmental Ltd. were commissioned by Kilwex Ltd. to	

Monitoring Period	Issued Report Reference	Monitoring Type	Results
		undertake Baseline compliance monitoring per Planning Permission reference VA0015.	
2023 Q2	IE2219-5796	Routine	
2023 Q2	IE2219-5833	Integration and Assessment of Kilwex Baseline Groundwater and Surface water Report with IE Consulting Quarterly Monitoring Data	

3. Conceptual Model Review

3.1. Evolution of the Conceptual Model

3.1.1. AWN Report (Section 10.1)

AWN prepared a conceptual model labelled Figure 2 for the site. This cross section was produced based on the Soil Mechanics site investigation in 2012. The following points are notable in relation to this schematic:

- BH02 was the deepest borehole drilled during the 2012 site investigations at 8.50 m depth and did not encounter bedrock. BH04 is depicted as being the deepest borehole; however the log shows that BH04 was only drilled to 6.44 m.
- The Clay encountered during the site investigations is described as stiff to very stiff at depth. The 2012 Ground Investigation report found clay deposits at all locations and did not indicate the possible presence of bedrock. The Clay is described as grey, which is consistent with low oxygen concentrations (indicative of poor percolation rates). Similarly PSD analysis of samples from the boreholes found 30% to 50% fines, which would be consistent with low permeability values.
- The shallow water aquifer or perched water in the clayey sand and sandy clay is not depicted even though groundwater strikes were recorded as shallow as depths of 0.80m in BH03.

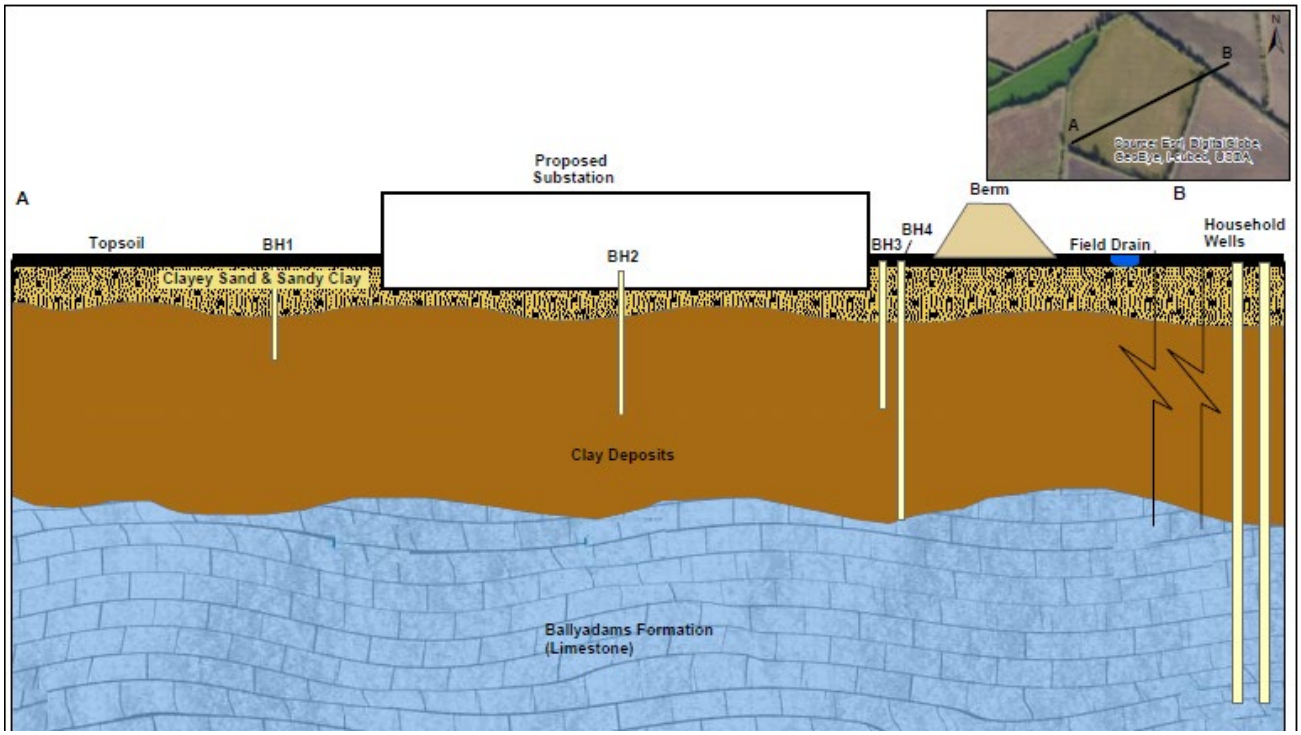


Figure 2 – Conceptual Model Presented in AWN Consulting Ltd. Report (DB/09/4848HR02)

3.1.2. Tobin Report, Sep 2017 (Figure 2-2)

The conceptual model presented in the AWN consulting report was utilised and modified in the Tobin Report to include the following:

- Depth to bedrock was presented as 8.5 m below ground level i.e. 2.5 m foundation depth below ground level plus subsoil of >6 m of subsoil underlying this.

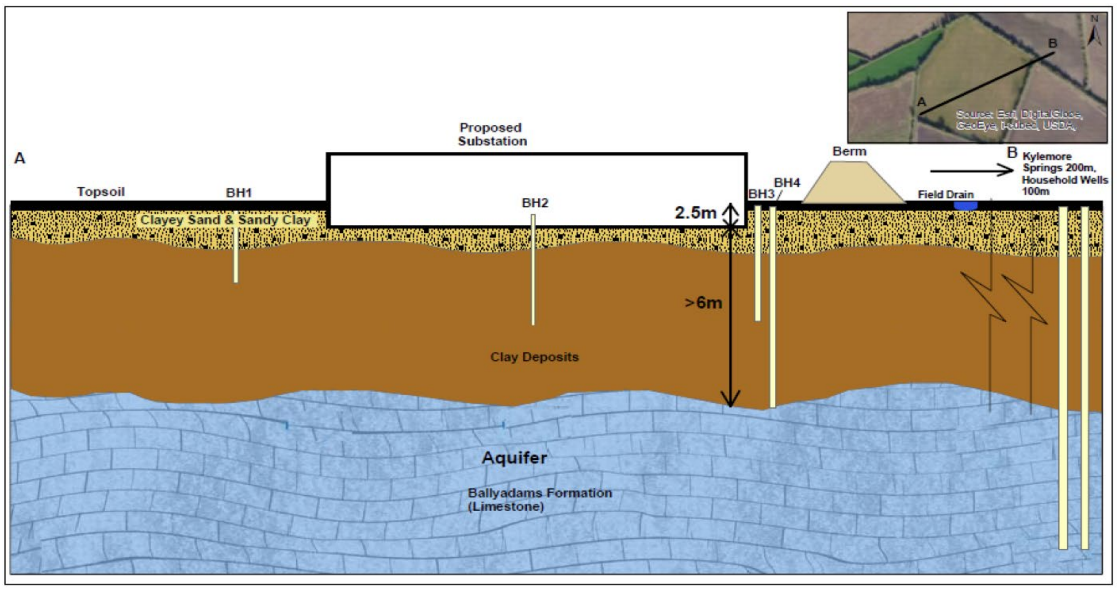


Figure 3– Conceptual Model Presented in Tobin Report (Sep, 2017)

3.2. Current Conceptual Model refinement

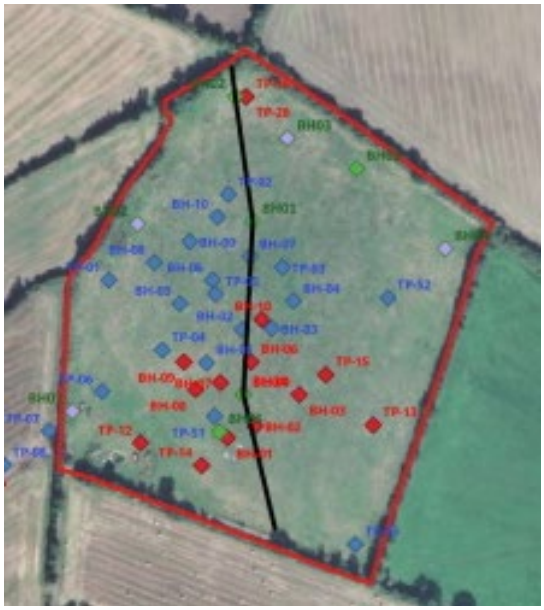
Figure 4 and Figure 5 show the cross sections illustrating the latest understanding of potential interaction between infrastructure units and the shallow aquifer.

The shallow water aquifer is interpreted based on the highest water level recorded during the quarterly monitoring baseline programme at the applicable monitoring borehole point. This is represented by the upper blue dashed line. The lower line is water levels recorded during the Q2 2023 monitoring on the 24/05/2023.

Please note in relation to the labelling of the boreholes:

- P, 2021 = Priority Geotech, boreholes used for quarterly monitoring programme (see Section 1.3.4)
- C, 2018 = Causeway Geotech exploratory boreholes or trial pits (see status in Table 2 and Section 1.3.3 for installation details)
- S, 2012 = Soil Mechanics exploratory borehole or trial pit (see status in Table 2 and Section 1.3.1)

  Note: none of the AWN Consulting boreholes were intersected by the cross section.



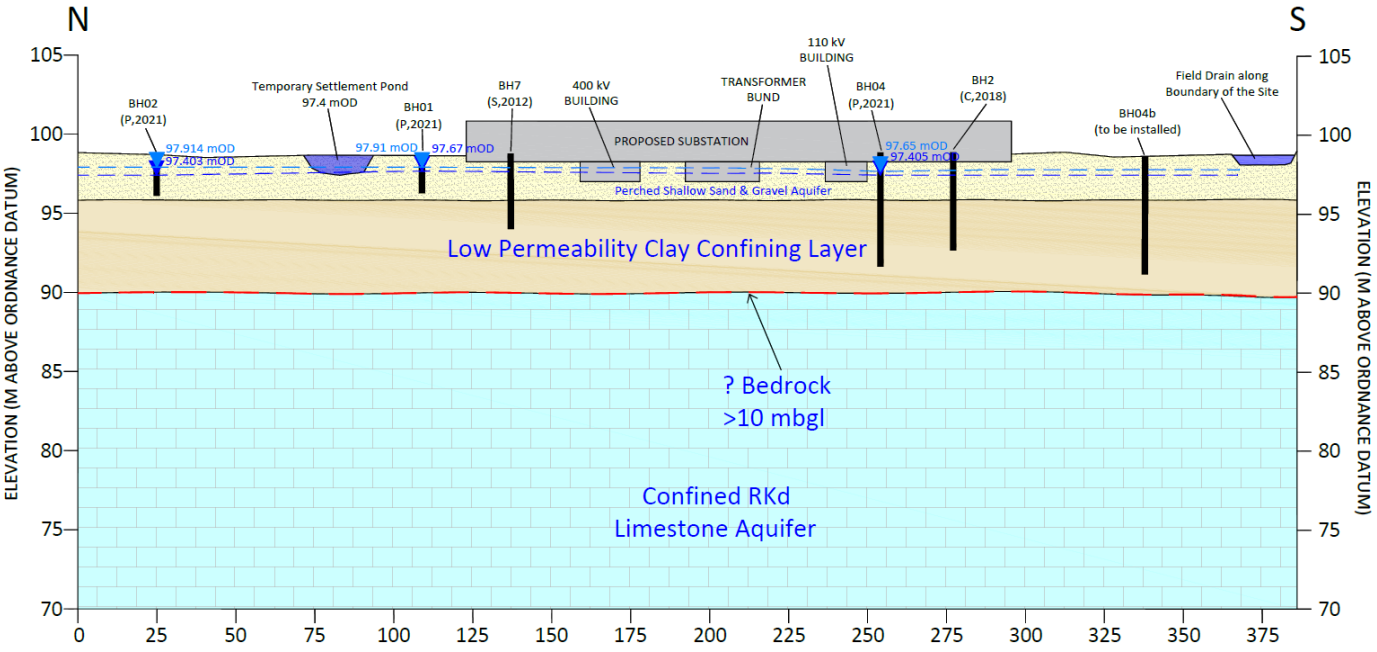
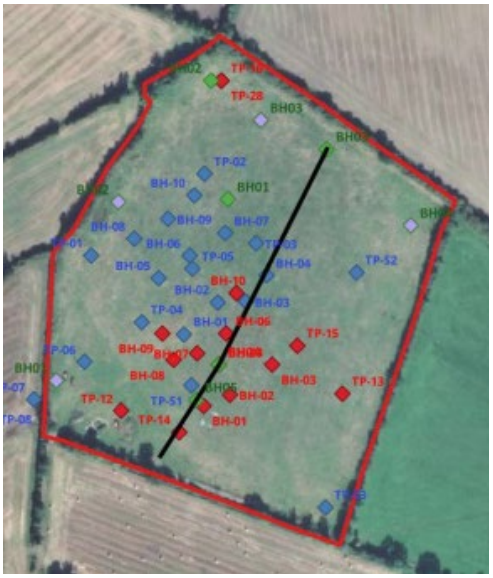


Figure 4 – North-South Cross Section



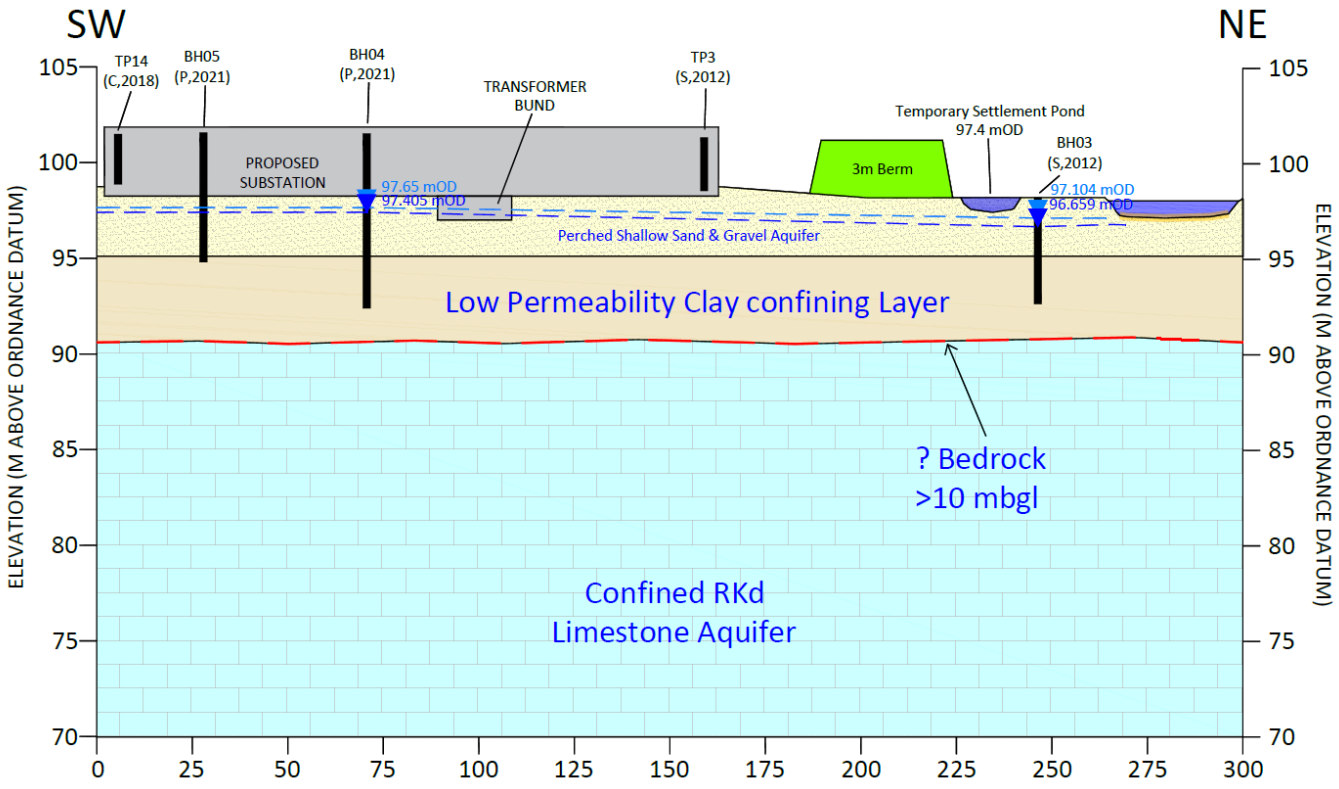


Figure 5 – Southwest-Northeast Cross Section

3.3. Summary Conceptual Model

- The bedrock aquifer was not encountered in any investigation undertaken on the site.
- The bedrock aquifer is protected by a 6-7m thick low permeability confining clay layer.
- There are no borehole derived water supplies within 500 m of the site. However any abstractions are likely to be from the underlying Limestone bedrock, and because this aquifer was not encountered in any investigations and no dewatering of this aquifer will be required during construction, there will be no impact to the drinking water abstractions in the area.
- A Geophysical survey on the site shows the site is homogeneous with the low permeability clay occurring consistently from approximately 3 m below ground level, and that bedrock is a least 6m deep (the limit of penetration for the geophysical method deployed).
- The Clay layer is grey in colour, which is consistent with low permeability rates, the fines content of the clay determined from laboratory testing is high, ranging from 30% to 50%, which again is consistent with low permeability rates, and infiltration tests undertaken in-situ were unable to determine a permeability value, because the rate of infiltration was too low. This confirms the important role that the clay has as a consistent protective 7m thick layer over the bedrock aquifer.
- Groundwater in the sand and gravel deposits on the site will not be in hydraulic continuity with the bedrock aquifer underlying the site because of the low permeability of the intervening 6m+ of Clay. The groundwater in the sand and gravel deposits will take the easier pathway and move in a horizontal direction rather than vertically.
- The maximum depth of excavation will be 2.14m below ground level, and based on groundwater level data, this will require some dewatering of the shallow gravel aquifer.
- There may be some minimal loss of recharge to the tufa, during the construction period, but this will be temporary and minor in nature., Based on the interpreted groundwater flow direction, the recharge area of the tufa springs will be mostly concentrated in the agricultural land to the west of the site, with only approximately 10% recharge from the site area. The impact of any dewatering will therefore be small.
- Recharge from the shallow perched aquifer on the site, will support diffuse baseflow in the adjacent stream, and will be responsible for some of the tufa deposition along this watercourse. However any impacts from construction dewatering on the site, will be less

significant on this feature, because of the diffuse nature of this baseflow component, as opposed to the concentrated point discharge from the springs.

- The recharge pattern will re-establish after construction and the shallow depth of the structure, will not disrupt shallow groundwater flow patterns to any significant extent.
- Dewatering at the site will have no impact on deep water bedrock aquifer therefore no interference to nearby wells.

4. Conclusions

- A review of decommissioned boreholes and trial pits from historic site investigations shows that there was no impact to the deeper aquifer as the bedrock was not encountered in any of the studies. The relatively homogeneous, low permeability clay layer from 3 m depth, and extending for a further 6-7m across the site further protects the deep aquifer in the unlikely event of the boreholes acting as a contamination pathway.
- In situ observations and testing, supported by laboratory testing, confirms the low permeability nature of this clay layer, and its effectiveness as a protective layer for the underlying bedrock aquifer.
- There is no impact to nearby domestic, farm or public drinking water supply wells as these are served by the deep bedrock aquifer.
- Dewatering at the site may have a slight effect on the shallow aquifer which could subsequently impact the supply of groundwater to the tufa streams. However this will be short term and of small magnitude, and will be monitored during construction.
- Dewatering at the site will have no impact on deep water bedrock aquifer therefore no interference to nearby wells
- Any excavation deeper than 0.80 m below ground level would expect to encounter groundwater. Where groundwater needs to be controlled to allow construction to proceed, a dewatering procedure will be implemented (Refer to Section X for the dewatering procedure)

5. References

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

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 18th 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

Appendices

Appendix A.

Groundwater and Surface Water Monitoring Data

See Appendix 10 of the CEMP