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Lagan Materials Limited, trading as Breedon Ireland

Proposed Deepening & Southerly Extension at Aughnacliffe Quarry

Townlands of Aghamore Upper and Derreenavoggy, County Longford

Planning Application for Mineral Extraction

Hydrological & Hydrogeological Impact Assessment

April 2023

BCL HYDRO
Consultant Hydrogeologists Limited

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BCL CONSULTANT HYDROGEOLOGISTS' EXPERIENCE & QUALIFICATIONS

BCL is an independent consultancy specialising in various aspects of hydrogeology and hydrology as they relate to minerals extraction, waste disposal, water supply and related industries.

Henry Lister (the author of this report) holds a joint honours Bachelor of Science Degree (Applied Geology B.Sc.) conferred by Plymouth University, Devon, United Kingdom (UK) in 1992 and a Master of Science Degree (Groundwater Engineering M.Sc.) received in 1994 from the Civil Engineering Department of Newcastle University, Newcastle upon Tyne, UK.

BCL has provided specialist services, advice and reporting to the extractive, waste and related industries since 1990. During this time, 25+ years of experience has been earned from involvement with wide variety of assignments. BCL's work has included:

- Installation and management of hydrometric data collection systems;
- Data interpretation;
- Conceptualisation of hydrogeological systems;
- Identification of potential impacts;
- Formulation of mitigation measures;
- Management and undertaking of operational impact monitoring and impact assessment;
- Review and auditing of contingency mitigation schemes;
- Reporting in connection with proposed developments within varying hydrogeological terrains at over 250 quarries throughout the United Kingdom and Republic of Ireland, and;
- Client representation at Planning Committee and Public Inquiry regarding hydrological and hydrogeological matters connected with proposed quarry developments, including prospective hard-rock quarries within green-field sites.

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1 INTRODUCTION

1.1 Background

1.1.1 Lagan Materials Limited, trading as Breedon Ireland (the Applicant) is seeking planning permission for the winning and working of the greywacke mineral resource which has been identified at Aughnacliffe Quarry (the Site), in a phased manner which includes extending workings at the existing quarry southwards, with a deepening of the existing quarry floor levels. The Application Site is situated in the Townlands of Aghamore Upper and Derreenavoggy, County Longford.

1.1.2 The Applicant has appointed a specialist planning consultancy, Quarryplan Limited (Quarryplan), to coordinate the production of the Environmental Impact Assessment Report (EIAR) .

1.1.3 Quarryplan has instructed BCL Consultant Hydrogeologists Limited (BCL) to assess the potential Hydrological and Hydrogeological Impacts associated with the Proposed Development.

1.2 Aim, Scope and Methodology of Assessment

1.2.1 This report presents the findings of the Baseline Study and Impact Assessment that is intended to inform consultations both prior to submission of the Planning Application and during its determination.

1.2.2 The collection and interpretation of baseline data has facilitated a detailed understanding of the nature of, and interactions between, the groundwater and surface water systems operating in and around the Site.

1.2.3 The understanding of hydrological and hydrogeological conditions has been applied to assess the likely primary impacts of the Proposed Development upon the water environment.

1.2.4 Significant potential impacts identified during the course of investigations have been addressed by the incorporation, at the planning stage, of mitigation measures into the design of the Proposed Development.

1.2.5 Where appropriate, outline monitoring protocols have been advanced to facilitate validation / modification of the effectiveness of mitigation measures.

1.2.6 The scope of investigations has been informed by both mineral and local planning policies, which reinforce the need to pay due regard to the likely effect of development upon various aspects of the water environment.

1.3 Policy & Guidance

1.3.1 The key policy documents and associated guidance that have been consulted during Assessment include:

- Institute of Geologists of Ireland (IGI 2013) ‘Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements’;
- IGI (2007) ‘Recommended Collection, Presentation and Interpretation of Geology and Hydrogeological Information for Quarry Developments and Geology in Environmental Impact Statements – A Guide’;

- National Roads Authority (2008) 'Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Roads Schemes';
- Working Group on Groundwater (2004) Guidance document GW8: 'Methodology for risk characterisation of Ireland's groundwater';
- EU Floods Directive (2007/ 60/ EC) of the European Parliament and of the Council of 23rd October 2007 on the assessment and management of flood risk: Official Journal L288/ 27-34;
- EPA (2003) 'Advice Notes on Current Practice in the Preparation of Environmental Impact Assessments', and;
- EPA (2002) 'Guidelines on the Information to be contained in Environmental Impact Assessments'.

1.4 Data Sources

1.4.1 Site specific data include the following:

- Topographic surveying supplied by QPL;
- Groundwater level data collected at the Applicant's piezometer network;
- Falling head tests conducted at 5-no. piezometers;
- Walk over surveys of the Site (October 2022 and January 2023);
- Borehole logs completed by Dempsey Drilling.
- Environmental Impact Statement (EIS) for Doranrock Quarry, Aughnacliffe, County Longford for CEMEX (ROI) Limited; Chapter 5 (Soils and Geology) and Chapter 6 (Water) of the EIS, prepared by Golder Associates; dated July 2007. Hereafter referred to as Reference 1.

1.4.2 The following published and unpublished documents and other sources of information have been examined:

- Mapping published by the Ordnance Survey of Ireland (OSI), Geological Survey of Ireland (GSI) and Environmental Protection Agency (EPA);
- GSI Well Records;
- "Longford Ballinalee Groundwater Body (GWB): Summary of Initial Characterisation", published by GSI, not dated;
- "1st Draft Cavan GWB Description", published by GSI, July 2004;
- EPA water quality data;
- Water Framework Directive (WFD) river basin management planning report: "WFD Cycle 2, Catchment Upper Shannon, Subcatchment Camlin_SC_010" completed by the EPA, with input from Local Authorities and other public bodies, and with support from RPS consultants, dated November 2018;
- WFD river basin management planning report: "WFD Cycle 2, Catchment Erne, Subcatchment Erne_SC_020" completed by the EPA, with input from Local Authorities and other public bodies, and with support from RPS consultants, dated January 2019;
- Flood Mapping published by the Office of Public Works (OPW);
- National Parks and Wildlife Service (NPWS): Spatial mapping & citation information for Designated Sites of ecological interest;
- Met Éireann: Rainfall data.

1.4.3 At the time of report preparation, in addition to topographic site survey data, information relating to the proposed development of the quarry, as supplied by Quarryplan, or their agents, comprises:

- *Drawing 220912Dwg01r4*: "Topo Survey - 27/04/22";
- *Drawing 220912Dwg02r5*: "Phase 1";
- *Drawing 220912Dwg03r5*: "Phase 2";
- *Drawing 220912Dwg04r5*: "Phase 3";
- *Drawing 220912Dwg05r5*: "Phase 4";
- *Drawing 220912Dwg06r5*: "Phase 5".

1.5 Report Structure

1.5.1 The topography, geology, hydrology and hydrogeology of the study area are described in *section 2*.

1.5.2 An account of the Proposed Development, including description of intended working methods and water management measures, is given in *section 3*.

1.5.3 Assessment of the potential impacts of the Proposed Development and description of mitigation measures proposed to ameliorate such impacts are made in *section 4*.

1.5.4 Report conclusions and recommendations are given in *section 5*.

2 BASELINE CONDITIONS

2.1 Location

2.1.1 The Application Site is located in the townlands of Aghamore Upper and Derreenavoggy, *circa* 12 km to the northeast of Longford town. The village of Aughnacliffe is located c.3 km to the northeast of the Site, with the village of Ballinalee located c.6 km to the south.

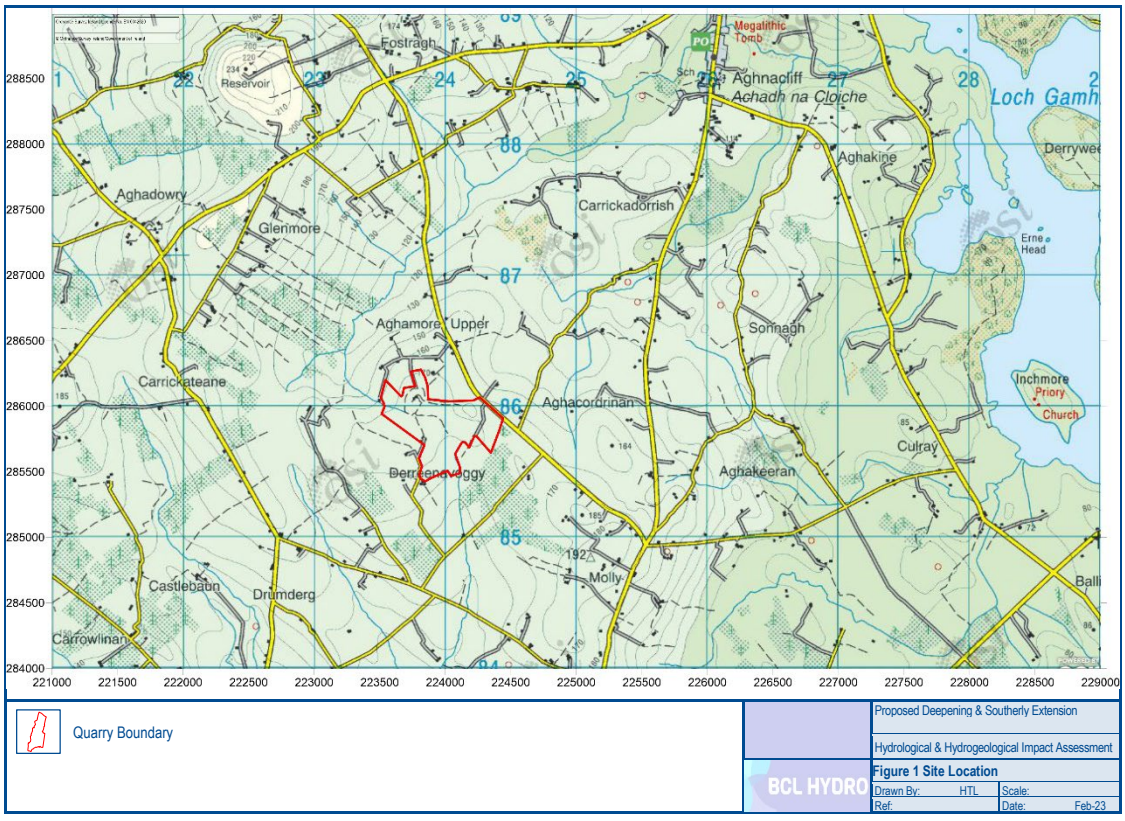
2.1.2 The planning application area occupies some 36.8 hectares (ha), of which c.22 ha comprises the existing quarry and associated overburden storage and landscaping areas. The remainder of the Site (c.15 ha), which is located to the south of the existing quarry void, is comprised of lands in agricultural use. A cluster of farm buildings, under the ownership of the Applicant, is located along the southern boundary of the Site.

2.1.3 The Application Site is located in an undulating rural setting characterised by agricultural fields interspersed with blocks of forestry. There are a small number of residential properties located sporadically throughout the surrounding area. The Application Site itself is surrounded by agricultural fields on all sides, with boundaries comprised of hedgerows.

2.1.4 The existing quarry is accessed via the existing and approved quarry entrance, located along the north-eastern boundary of the Site, which provides access to a local road network, which ultimately connects to the R198 to the north and R194 to the south.

2.1.5 Access to the farm buildings in the southern part of the Site is afforded via an un-named single lane road to the southeast of the buildings.

2.1.6 The Irish National Grid Coordinates for the centre of the Application Site are easting [2]23980, northing [2]85855.



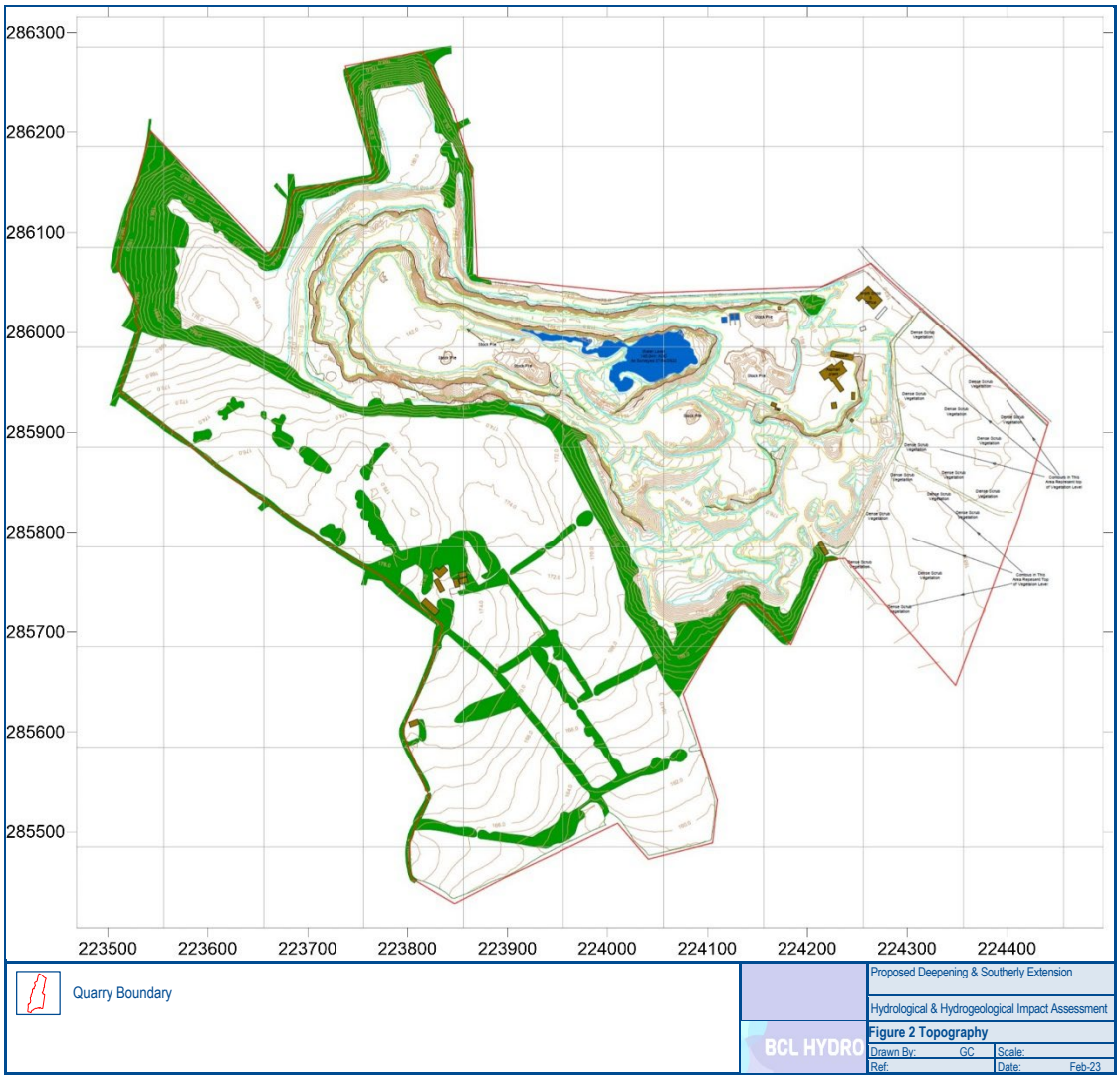
2.2 Topography

2.2.1 The topography across the northern part of the Site is dictated by quarry workings to date, with ground levels ranging from c.162 metres above Ordnance Datum (maOD) at the quarry entrance to c.141 maOD on the quarry floor.

2.2.2 Previous overburden landforms are located at the eastern and western ends of the quarry void and have become vegetated and greened up over time. The eastern end of the quarry is used for the stockpiling of processed materials, with extraction works focussed on the western part of the quarry.

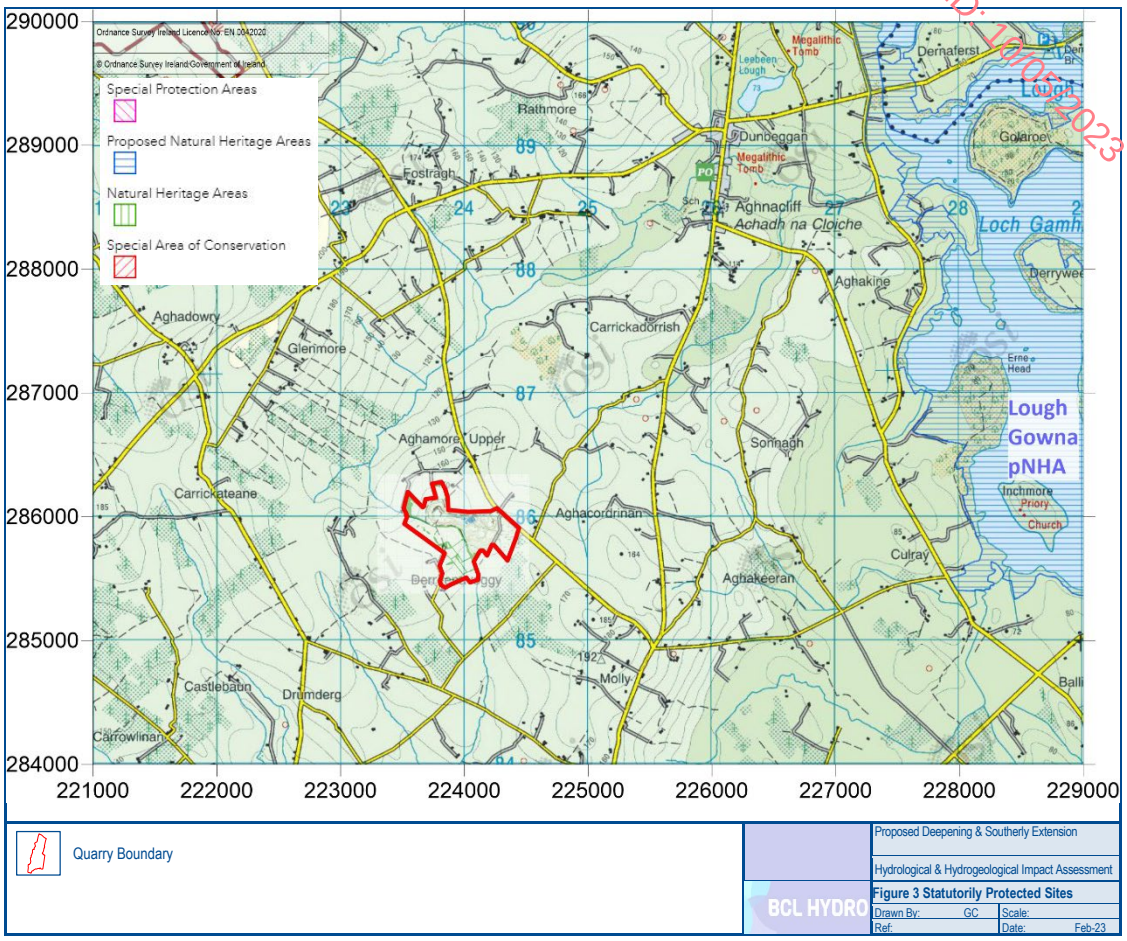
2.2.3 Levels across the southern part of the Application Site (the undeveloped agricultural lands) range from 159 maOD along the eastern boundary and 165 maOD along the western boundary, rising to c.178 maOD in the central part of the extension lands.

2.2.4 The quarry resides on a broad topographic ridge, which also forms a surface water divide. The topography falls to the north northeast and to the south southwest on either side of the ridge; and the area is well-drained by streams. The streams to the north flow to Lough Gowna (Loch Gamhna) at 61 maOD, while those to the south form tributaries to Camlin River, which flows in a westerly direction, passing to the north of Ballinalee at c.50 maOD.



2.3 Statutorily Protected Sites

2.3.1 NPWS mapping has been consulted to check for sites with the following status: Special Area of Conservation (SAC), Special Protection Area (SPA), Natural Heritage Area (NHA) and proposed Natural Heritage Area (pNHA).



2.3.2 Lough Gowna pNHA (Site Code: 000992) is *circa* 3.25 km to the east northeast of the Site, at closest approach.

2.3.3 The Site Synopsis (dated November 2009) states that "It is a medium-sized lake, which is divided into two main sections by a narrow channel at Dernaferst Bridge. The substrate is Silurian grits and slates, and it is situated in a drumlin-filled basin with many bays and inlets. Nearby Sean Lough is of similar habitat and included in the pNHA."

2.3.4 "With its importance for wintering waterfowl and the presence of interesting oligotrophic plant communities which are scarce in the midlands, this site has high scientific interest."

2.3.5 The citation documents are attached at Appendix 1.

2.4 Waste Facilities and Sustainable Economy (EPA Mapping)

2.4.1 Mapping published by the EPA has been consulted to check for IPPC (Integrated Pollution Prevention Control), IPC (Integrated Pollution Control), IEL (Industrial Emissions Licensing) facilities in the vicinity of the Application Area. There are no waste facilities with 5 km radius of the Site.

2.4.2 Local authorities license smaller discharges of trade effluent and wastewater to ground or surface waters ("Section 4 Discharges"). There are no Section 4 Discharge locations with 5 km radius of the Site.

2.5 Geology

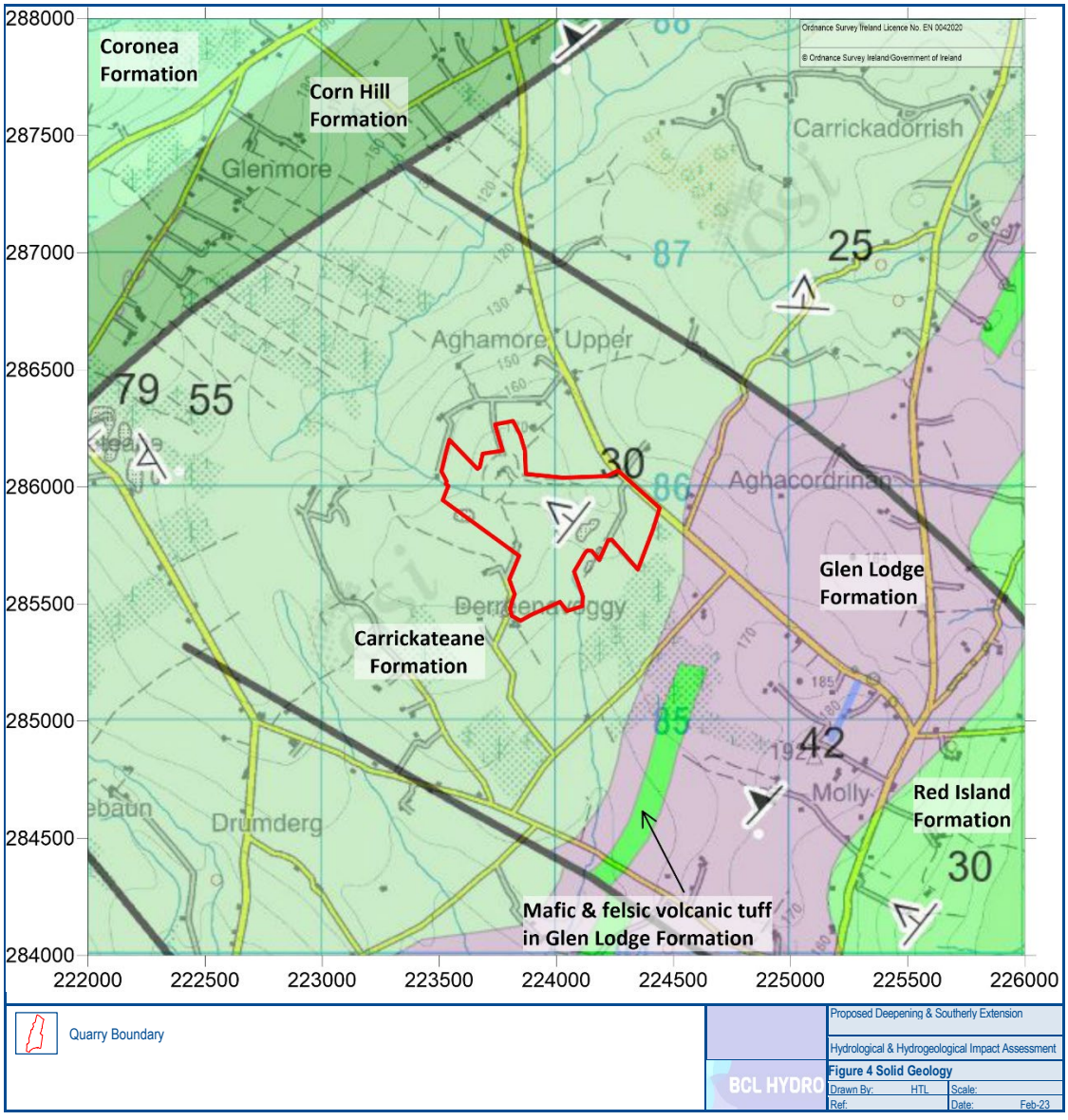
2.5.1 Background

2.5.1.1 The geology of the district has been characterised by reference to the following:

- GSI maps and memoirs;
- Geological logs of investigatory boreholes (Appendix 2) drilled within and surrounding the Site, and;
- Walk-over reconnaissance survey.

2.5.2 Solid Geology

2.5.2.1 The distribution of the solid strata is illustrated by an extract from GSI mapping below at Figure 4. Lithological descriptions are taken from the Geological Survey Ireland Spatial Resources Mapping.



2.5.2.2 Two main lithological units are exposed within the quarry site.

2.5.2.3 The older underlying unit is the Glen Lodge Formation (Ordovician age), which is described by the GSI as being "*predominantly composed of grey, green to black shales with minor amounts of greywacke, spilitic lava and broken pillow lava breccias.*"

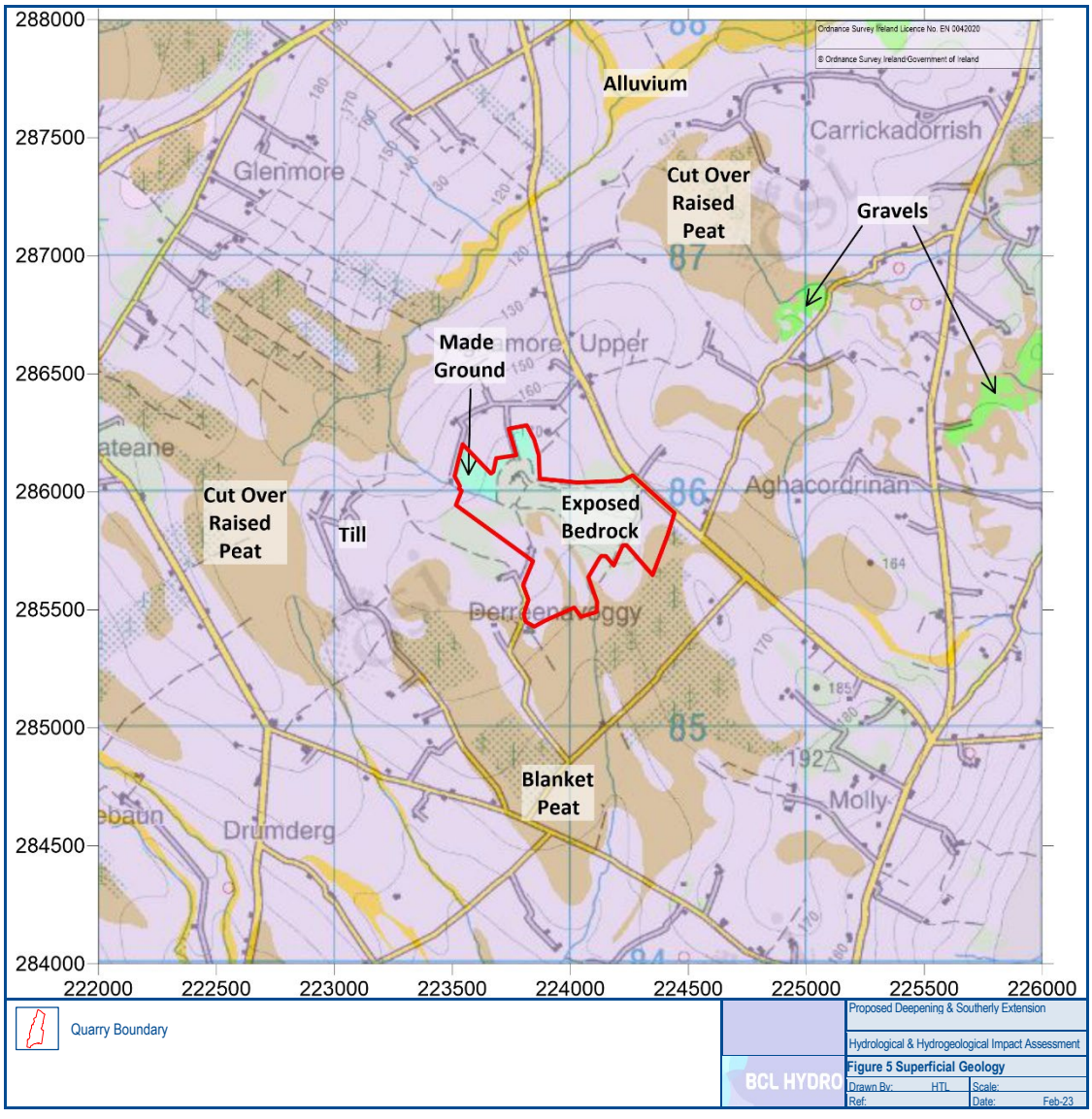
2.5.2.4 The younger overlying unit is the Carrickateane Formation (Ordovician age), which is described by the GSI as "*greywacke with minor shale and carbonate nodules. The greywackes are grey/greyish green, massive or thick bedded arenite which may contain black argillite/chert clasts that often have brown calcareous-weathering haloes.*"

2.5.2.5 The bedrock within the quarry is shown to have a dip direction of 30 degrees to the northwest.

2.5.2.6 The borehole logs have been reproduced at Appendix 2.

2.5.3 Superficial Deposits

2.5.3.1 The distribution of superficial deposits is illustrated by an extract from GSI mapping reproduced at Figure 5.



2.5.3.2 Beyond the exposed bedrock in the quarry void and the made ground (stockpiles) in the northwest part of the landholding, the surrounding lands have an extensive cover of Till (derived from Lower Palaeozoic sandstones and shales).

2.5.3.3 Large areas of Blanket Peat and Cut Over Raised Peat are encountered on the slopes of the ridgeline, feeding the headwaters of the Aghnacliffe Stream (north side of the quarry) and the tributaries draining into the Camlin valley.

2.5.3.4 The mid-lower reach of the Aghnacliffe Stream is underlain by a narrow corridor of Alluvium together with Gravels derived from Lower Palaeozoic sandstones and shales.

2.6 Rainfall

2.6.1 Long Term Area Averages

2.6.1.1 Met Éireann mapping indicates that the average annual rainfall at the Application Site (for the period 1981 to 2010) is *circa* 1,135 millimetres per year (mm/yr). Corrected for evapotranspiration, the effective rainfall rate is estimated at 725 mm/yr.

2.6.1.2 The actual annual recharge to the groundwater depends on the relative rates of infiltration and surface runoff. In many areas, recharge is likely to be lower than 10% of the potential recharge. GSI mapping indicates that the average recharge rate would be *circa* 70 mm/yr.

2.6.2 Rainfall Return Period Table

2.6.2.1 Met Éireann's Depth-Duration-Frequency (DDF) model allows for the estimation of point rainfall frequencies for a range of durations for any location in Ireland.

2.6.2.2 Return Period Rainfall Depths for sliding Durations at the Application Site are presented at Appendix 3.

2.6.2.3 Total rainfall occurring on Site during the design storm (6-hour duration and 100-year return period) is 64.1 mm.

2.7 Hydrology

2.7.1 Background

2.7.1.1 Information concerning the surface watercourses and water bodies of the area has been obtained from:

- EPA data-sets;
- OSI digital mapping;
- Water Features Survey and Site Reconnaissance undertaken in October 2022 and January 2023.

2.7.2 Regional Setting

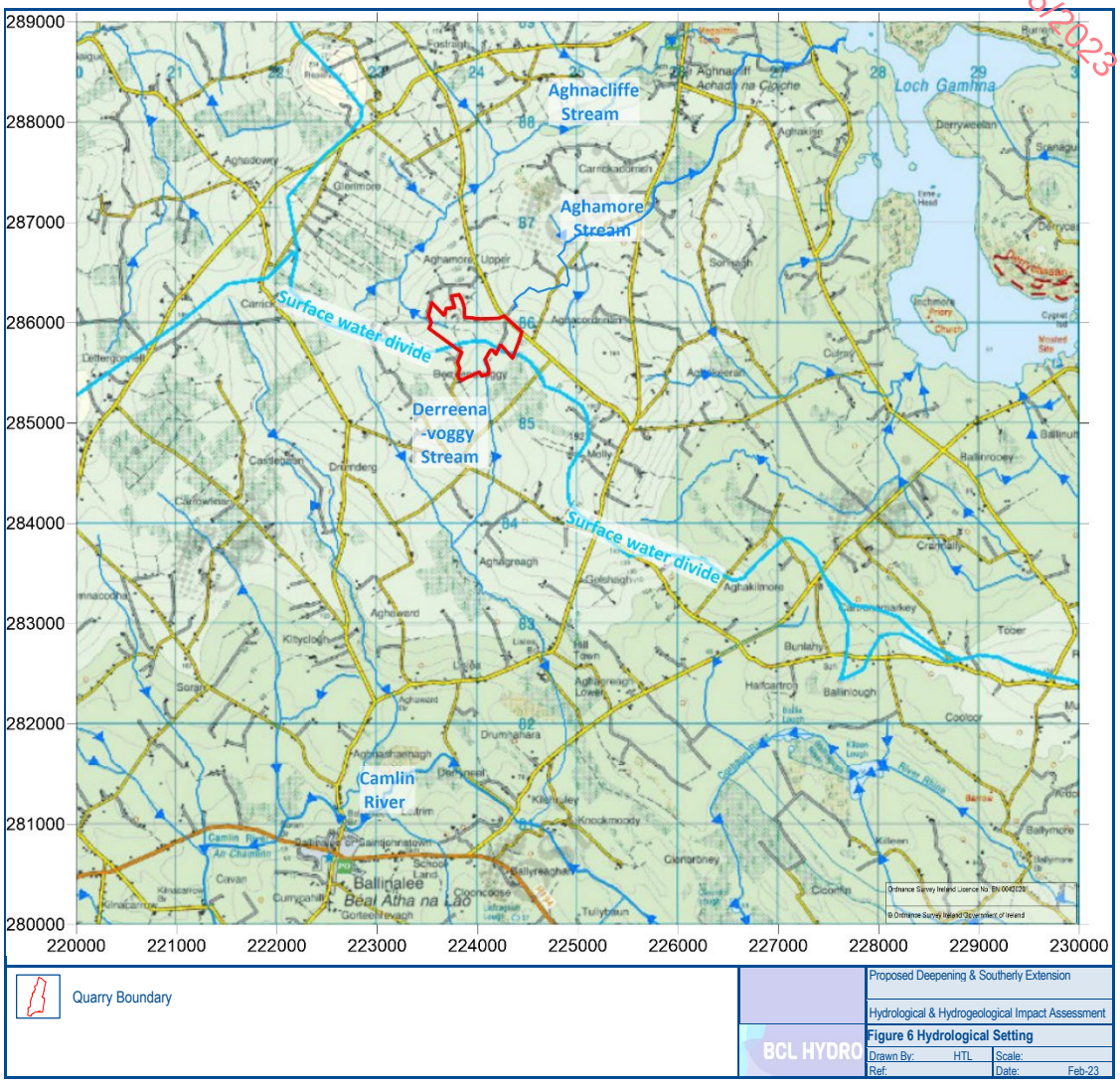
2.7.2.1 As outlined previously, the Application Area straddles a broad topographic ridge, which also forms a surface water divide.

2.7.2.2 To the north northeast of the Site, the Aghnacliffe Stream and its tributaries flow to Lough Gowna. The source of Aghnacliffe Stream is at the northwest boundary of the landholding. One of its tributaries, which arises close to the northeast corner of the quarry, is hereafter referred to as Aghamore Stream.

2.7.2.3 The larger part (c.90%) of the existing quarry void is on the north side of the watershed *i.e.* the pre-development footprint would have drained to Aghnacliffe Stream and Aghamore Stream.

2.7.2.4 To the south southwest, the slopes are drained in a southerly direction by un-named tributaries that join the Camlin River. The main river flows from east to west, passing to the north of Ballinalee. The stream that descends from the southern end of the Application Area is hereafter referred to as Derreenavoggy Stream.

2.7.2.5 The catchment boundaries and the drainage network of the district are illustrated upon Figure 6.



2.7.2.6 Lough Gowna pNHA is *circa* 3.25 km to the east northeast of the Site, at closest approach.

2.7.2.7 Under the Water Framework Directive (Directive 2000/60/EC), all surface water catchments have been characterised and assigned an overall status based principally on chemical and ecological status. The status of lake water bodies (LWB) and river water bodies (RWBs) can range from Unassigned-Bad-Poor-Moderate-Good-High.

2.7.2.8 The Lake Waterbody WFD Status (2016-2021) for Lough Gowna is “Moderate (At risk)” (this lough being assigned LWB European Code IE_NW_36_724). Full details are reproduced in Chart 1 below.

2.7.2.9 The status of Aghnacliffe Stream and Aghamore Stream (IE_NW_36A060400), taken together, is “Q4-5, High (Not at risk)”.

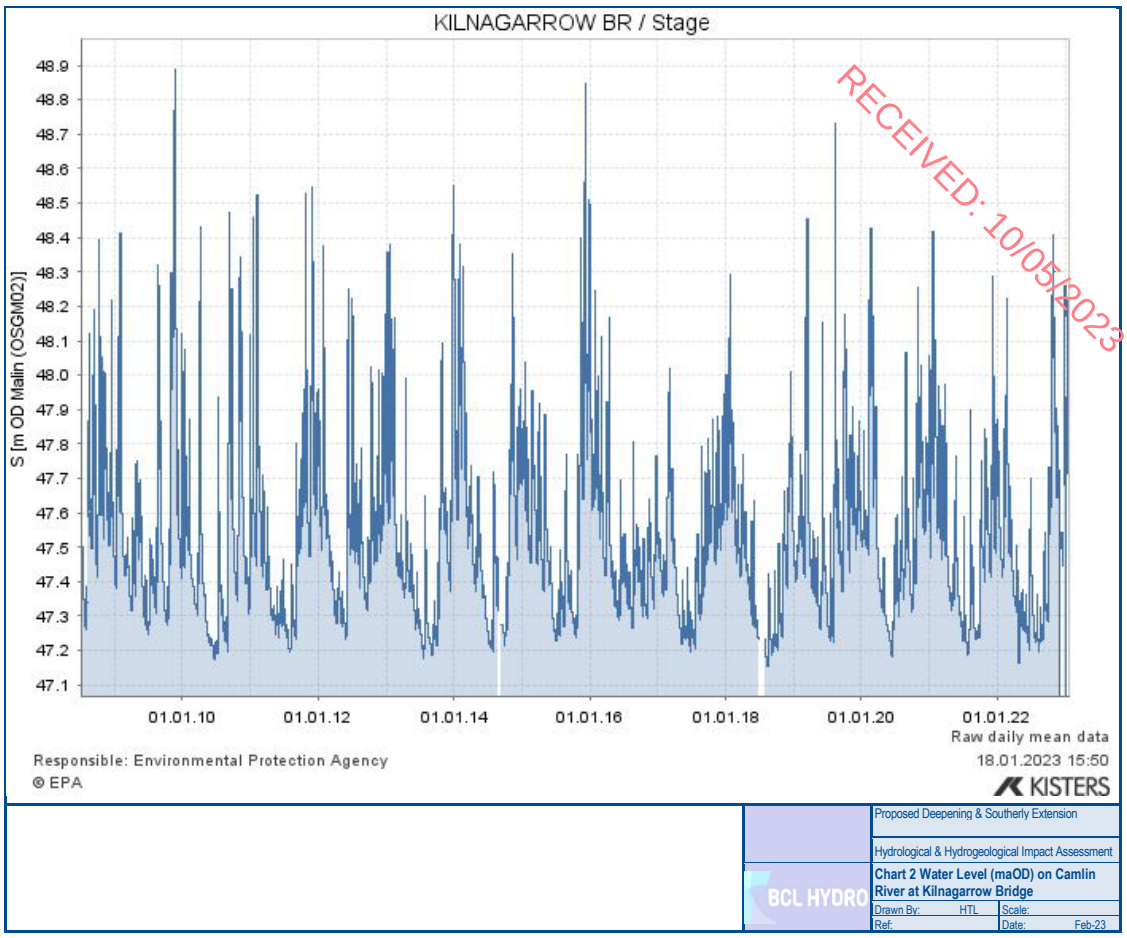
Status	Assessment Technique	Status Confidence	Value
▼ Ecological Status or Potential	Monitoring	medium confidence	Moderate
▼ Biological Status or Potential			Moderate
Phytoplankton Status or Potential			Moderate
▼ Other Aquatic Flora Status or Potential			Moderate
Macrophyte Status or Potential			Moderate
Phytobenthos Status or Potential			Not applicable
Invertebrate Status or Potential			Not applicable
Fish Status or Potential			Not applicable
Hydromorphological Conditions			Good
▼ Supporting Chemistry Conditions			Moderate
▼ General Conditions			Moderate
▼ Thermal Conditions			Pass
Water Temperature (C)			Pass
▼ Oxygenation Conditions			Pass
Dissolved Oxygen (% Sat)			Pass
▼ Acidification Conditions			High
pH			High
▼ Nutrient Conditions			Moderate
Other determinand for nutrient conditions			High
▼ Nitrogen Conditions			High
Ammonium			High
▼ Phosphorous Conditions			Moderate
Total phosphorous			Moderate
Specific Pollutant Conditions			Not applicable
Chemical Surface Water Status			Not applicable

Proposed Deepening & Southerly Extension
Hydrological & Hydrogeological Impact Assessment
BCL HYDRO
Chart 1 Water Quality Monitoring Data at Lough Gowna
Drawn By: HTL Scale:
Ref: Date: Feb-23

2.7.2.10 On the south side of the watershed, the locally east to west flowing Camlin River is situated c.3.75km to the south of the Application Area.

2.7.2.11 The EPA has a gauging station on the Camlin River at Kilnagarrow Bridge (Station number 26331; IGR ^{2}21328 ^{2}80176; c.6km to the southwest of the Site). The estimated 95%tile flow rate on this stretch of the Camlin River is 0.223 m^3/s; the catchment area being 93.30 km^2.

2.7.2.12 Stage data for the period June 2009 to 2022 ranges from 47.15 to 48.90 maOD.



2.7.2.13 34 rounds of spot gauging were undertaken on the main river in Ballinalee (4.5km south of the Site). The monitoring was completed between July 1989 and February 2008. The average gauged rate was 1 m^3/s; and the peak rate was 6.441 m^3/s.

2.7.2.14 The River Waterbody WFD Status (2016-2021) on the closest reach of the Camlin River is "Good (Not at risk)" (this stretch of river being assigned RWB European Code IE_SH_26C010600).

2.7.2.15 The status of Derreenavoggy Stream (IE_SH_26C010200) is "Moderate (Not at risk)".

2.7.3 Site Drainage

2.7.3.1 Ingress waters, principally comprising rainfall runoff, collect on the floor of the quarry and are currently managed through a series of natural channels and attenuation ponds leading into the quarry sump, where water level is suppressed by means of the dewatering pump.

2.7.3.2 The dewatering operation is conducted under Discharge Licence WP 02/20 (dated October 2020), issued by Longford County Council. The licence is reproduced at Appendix 4.

2.7.3.3 The licence specifies that the maximum volume of effluent discharged shall not exceed 1,350 m^3/day.

2.7.3.4 The discharge pipeline is fitted with a flow meter.

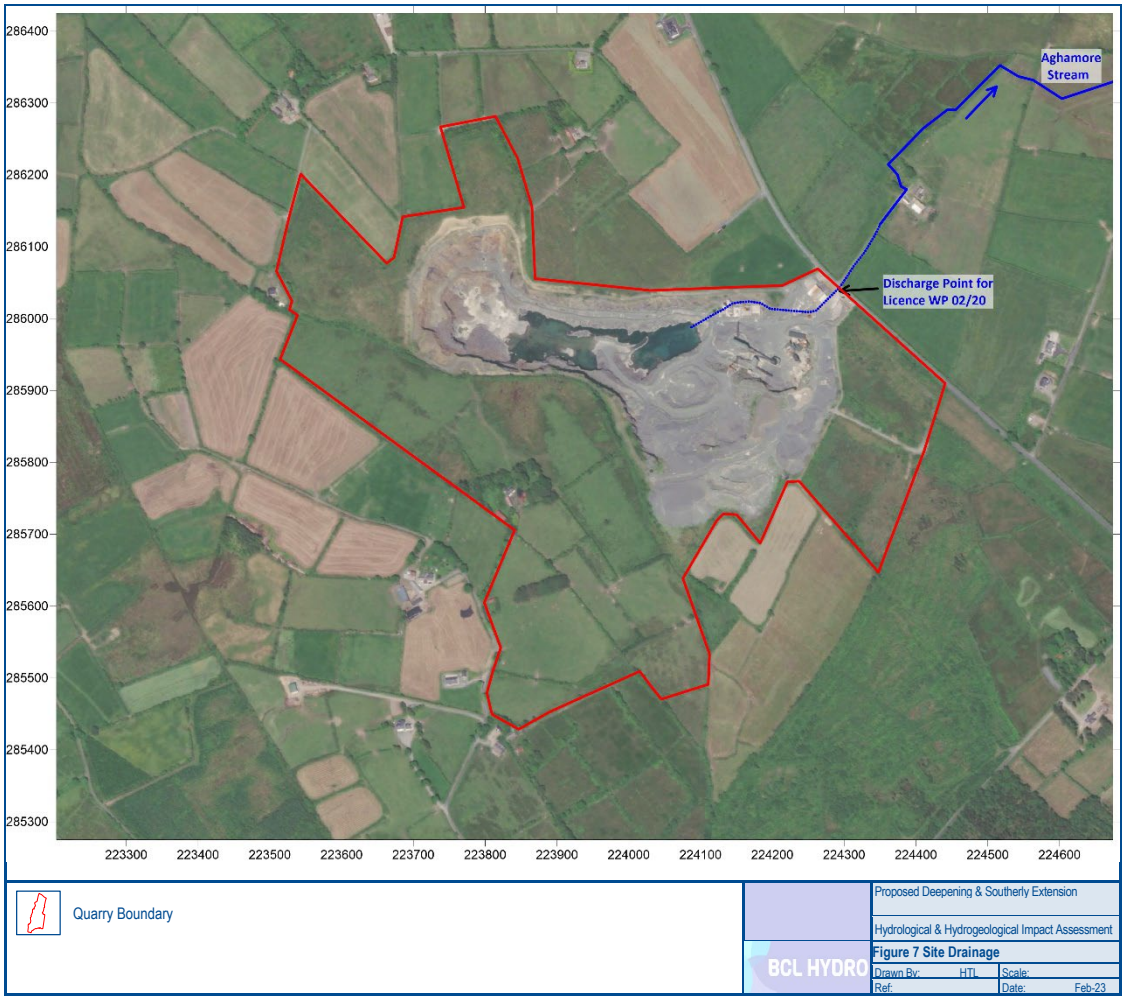
2.7.3.5 Flow rate data for the period June 2021 to date are presented at Appendix 5. The maximum permitted volume is discharged during periods of heavy rainfall, reducing to zero discharge during drier months and when the quarry is closed (*e.g.* weekends).

2.7.3.6 The total volume of water pumped from the void in the year from 19th January 2022 to 18th January 2023 (*i.e.* the most recent data) was 168,256 m^3/yr, averaging 461 m^3/d.

2.7.3.7 The quality of the effluent must comply with the following limits:

- Suspended solids shall not exceed 25 mg/l;
- pH shall be within the range 6-9 pH units;
- Temperature shall be consistent with ambient conditions; and,
- Hydrocarbons - no film shall be visible on the final effluent.

2.7.3.8 The Discharge Point is at the northeast corner of the landholding, adjacent to the Site entrance. The water is released into a field ditch, which flows in a northeasterly direction to join Aghamore Stream (Figure 7).



2.7.3.9 As outlined earlier, Derreenavoggy Stream arises close to the southern end of the Application Area. The expanse of Blanket Peat (Figure 5) supports a minor drainage ditch, which was inspected during site reconnaissance and water features surveying on 11th October 2022. The flow rate was estimated at 0.02 l/s; the channel was 0.4m in width and 0.1m in depth, with 5-10cm depth of water with sluggish movement.

2.7.3.10 The source of Aghnacliffe Stream, which is at the northwest boundary of the landholding, was seen to be dry on 11th October 2022. The channel was 0.8m in width and 0.6m in depth.

2.7.4 Flood Risk

2.7.4.1 Reference has been made to the published mapping showing River Flood Extents at Present Day and Past Flood Events (https://www.floodinfo.ie/map/floodmaps/).

2.7.4.2 The mapping data shows that no part of the proposed development footprint lies within lands designated to be at risk of flooding.

2.7.4.3 The closest sections of floodplain are on the lower reach of Aghnacliffe Stream (1.4km north of the quarry) and the final stretch of Derreenavoggy Stream (2.75km south of the Site); in both cases, the at-risk section of stream is below the 100-maOD contour, which is c.60m below ground level at the Site boundary.

2.8 Hydrogeology

2.8.1 Background

2.8.1.1 The hydrogeological regime of the Site and its surrounding areas has been elucidated on the basis of:

- Review of published and site specific geological data including mineral evaluation borehole and piezometer borehole logs;
- The occurrence and elevation of local water features such as drainage ditches;
- Manual measurement of groundwater levels at 8 No. piezometer boreholes undertaken at a regular interval (initially weekly, reducing to fortnightly), commencing 3rd June 2022;
- Automated recording of groundwater levels at 4 No. piezometer boreholes, with data loggers installed on 14th July 2022, and;
- Experience of similar hydrogeological terrains within Ireland and the UK.

2.8.2 Regional Setting

2.8.2.1 Bedrock aquifer maps, published on the GSI website, provide a detailed classification of bedrock aquifer types; and indicate that the Ordovician strata (Red Island, Glen Lodge, Carrickateane, Corn Hill and Coronea Formations grouped together) are classed as a "*Poor Aquifer - Bedrock which is Generally Unproductive except for Local Zones*" (Pl).

2.8.2.2 The nearest superficial aquifer is the gravel resource near Castletown, c.20km to the southeast of the Site.

2.8.2.3 Groundwater vulnerability maps (GSI website) indicate that the natural groundwater vulnerability beneath the Site would be classified as ranging from "low" to "extreme"; the latter would be expected at a quarry development (due to removal of overburden and reduction in the thickness of the unsaturated zone).

2.8.2.4 The hydrological watershed described in section 2.7 also delineates the boundary between the Cavan GWB (IE_NW_G_061), which is on the north side of the divide, and the Longford Ballinalee GWB (IE_SH_G_149), which is on the south side.

2.8.2.5 Under the Water Framework Directive (Directive 2000/60/EC), both GWBs are assessed by the EPA as being 'Not at risk' and having 'Good' quantitative status; and 'Good' chemical status for the monitoring period 2016-2021.

2.8.2.6 The Cavan GWB is conceptualised by the GSI as follows:

- Of the c.320 available groundwater levels, 60% are 0-3 m below ground level (bgl) and just over 12% are greater than 10 m bgl, indicating that flow is predominantly shallow. Groundwater gradients have not been calculated but are expected to be relatively steep;
- Most groundwater flux will be in the uppermost part of the aquifer comprising a broken and weathered zone typically less than 3 m thick, as indicated by the predominantly shallow water levels, a zone of interconnected fissuring around 10 m thick, and a zone of isolated poorly connected fissuring typically less than 150 m;
- Only one transmissivity value is available for this GWB: 0.23 m^2/d for a low yielding well. The national transmissivity data for these rocks are also low (<20 m^2/d in most rocks). However, higher values may be achieved in faulted zones, especially in the coarser-grained rocks. The available specific dry weather flows are low, ranging from 0.01-0.55 $l/s/km^2$ (6 stations), suggesting that these aquifers do not make a significant baseflow contribution to streamflow. Storativity is also expected to be low, and;
- Diffuse recharge occurs via rainfall percolating through the thinner/more permeable subsoil and via outcrops. Due to the low permeability of some of the subsoil (thicker till and peat) and the aquifers in the GWB, a high proportion of the available recharge will discharge to the streams in the GWB. In addition, the steep drumlin slopes will promote surface runoff. The high stream density is likely to be influenced by the lower permeability rocks as well as the subsoil.

2.8.2.7 The GSI conceptual model for the Longford Ballinalee GWB is very similar to the Cavan GWB:

- No data on hydrogeological properties specific to this groundwater body are available. The Ordovician Metasediments in the north of the body are considered to be a poor aquifer. Transmissivity is presumed to be low (<6 m^2/d). Well yields from this aquifer are rarely good. Storativity in these rocks will be low, and;
- In the low permeability rocks, which make up this GWB, most groundwater flow is expected to occur within 15 m of the top of the rock, comprising a weathered zone of a few metres and a zone of interconnected fissures below this of about 10 m thick. In the Ordovician Metasediments, in particular, most flow will be concentrated near the top of the rock.

2.8.3 Groundwater Levels

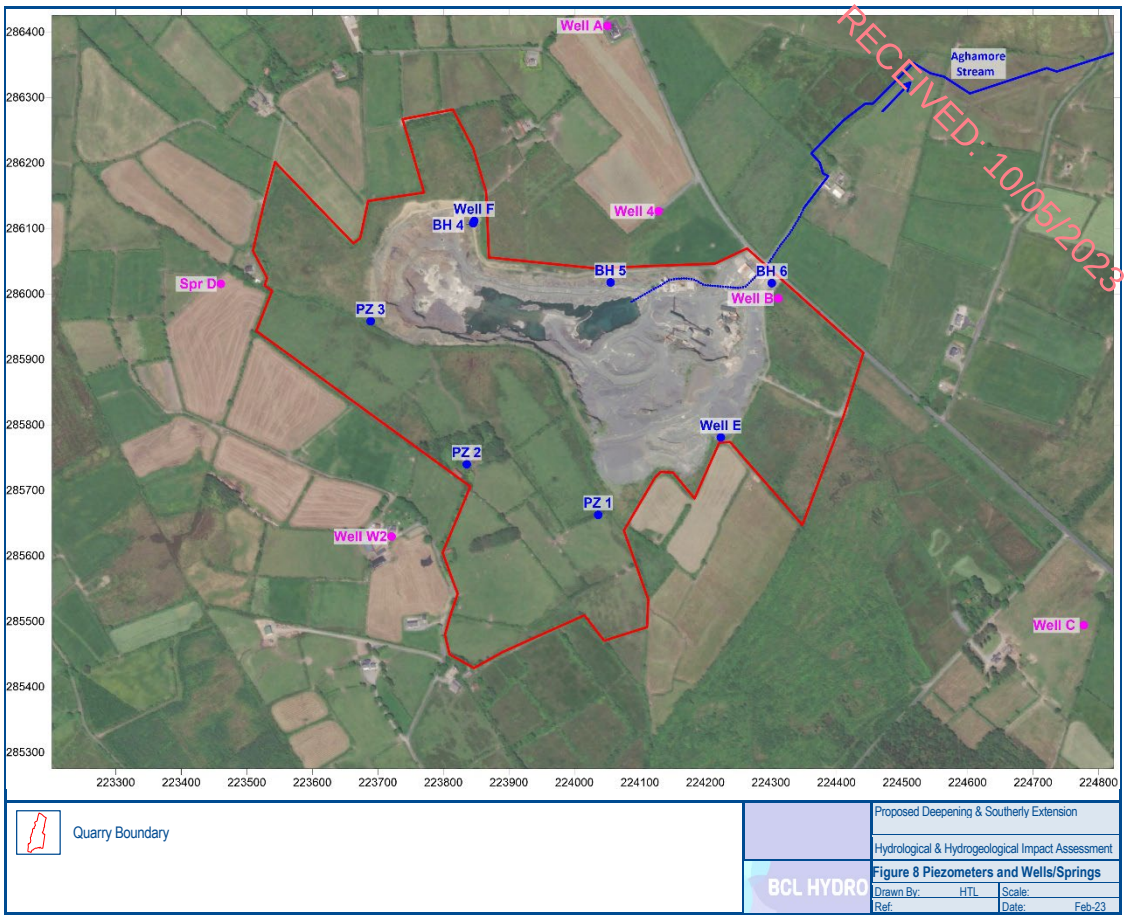
2.8.3.1 The locations of the active Site piezometers are shown as blue dots at Figure 8. The piezometers are installed within the economic mineral (Ordovician strata) and extend down to 65-75 maOD, which is 40-50 m below the proposed quarry floor. The groundwater level data (manual measurements and logger data) are presented in Appendix 6.

2.8.3.2 The magenta dots (Figure 8) are abstraction points identified in Reference 1 (Wells A, B and C; Spring D) and following door-to-door survey in January 2023 (Well W2) and having consulted GSI mapping of Groundwater Wells and Springs (Well 4).

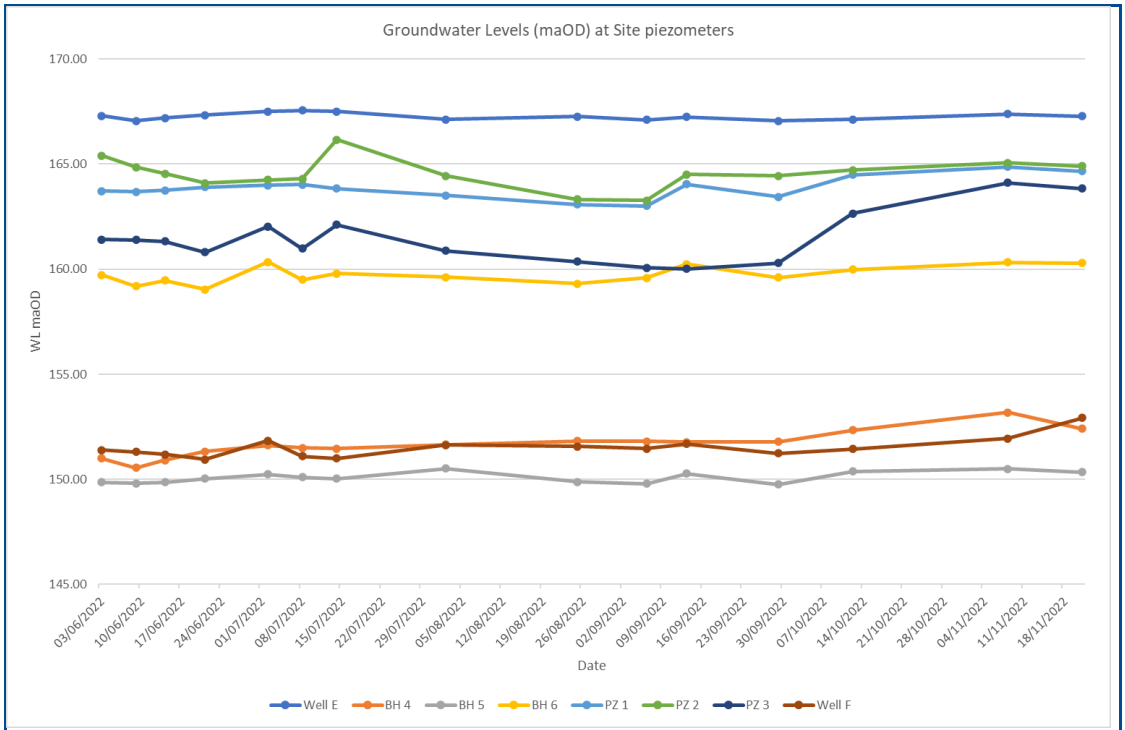
2.8.3.3 In October 2006 (Reference 1), groundwater level at Well A was 3.9 m below ground level (mbgl); Well B was 2.8 mbgl; Well C was 7.8 mbgl; and Spring D was at ground level.

2.8.3.4 Well W2 was inspected on 30th January 2023; depth to water was 4.13 mbgl.

2.8.3.5 There was no access to the building at Well 4.

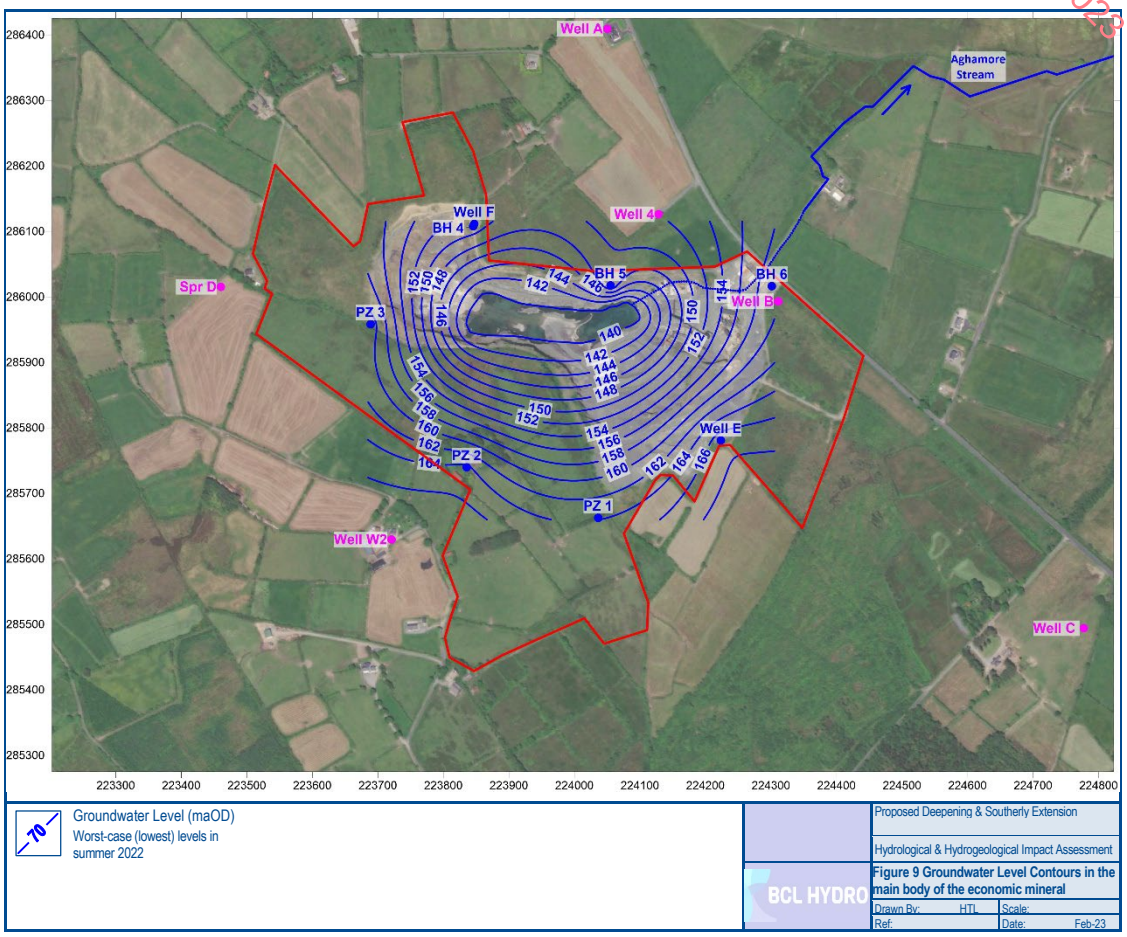


2.8.3.6 Summary hydrographs for the Site piezometers are presented below.



2.8.3.7 Prior to the quarry development (and the associated dewatering operation), it is postulated that the groundwater flow direction would have been from south southwest (peaking at 164-167 maOD in the vicinity of PZ1, PZ2, PZ3 & Well E); and declining towards the north northeast (equating to 158-160 maOD at BH6).

2.8.3.8 At present day, the water level in the quarry sump is suppressed at 140 maOD by means of pumped dewatering and a very steep-sided cone of depression has been imposed upon groundwater levels, as illustrated in Figure 9.



2.8.3.9 Piezometers PZ1, BH6 and Well E are situated some 200-250 m from the deepest sinking and have been installed at original ground level. Groundwater level at these locations is 2-5 m bgl, demonstrating that they have not been impacted by the dewatering operation.

2.8.3.10 The logger data indicates that there is some 2.5 m seasonal variation at PZ1 and BH6.

2.8.3.11 Piezometer PZ2 is on undisturbed land and groundwater level resides at 10-12 m bgl. This converts to 164-165 maOD, which is consistent with the other piezometers in the south southwest half of the landholding (*i.e.* PZ1 and Well E). The latter two locations are unaffected by the dewatering operation; and therefore the same conclusion can be drawn for PZ2.

2.8.3.12 Piezometer PZ3 is some 40 m standoff from the quarry face and is located within an area that has been stripped of overburden/soils. Groundwater level is at 5-9 m bgl, being lowest in the summer-autumn, when it equates to 160-161 maOD. The water level recovers to 164 maOD in the winter.

2.8.3.13 Comparing its hydrograph with the other piezometers, the seasonal trend diverges by 2-3 m, which could be attributed to drawdown.

2.8.3.14 Piezometer BH5 is on the quarry bench overlooking (and only 5-10 m standoff from) the dewatering sump, where water is held at 140 maOD. The groundwater level at BH5 is at 150 maOD, thus demonstrating that the cone of depression is very steep-sided.

2.8.3.15 Comparing the data at BH5 with that recorded at BH6, it is apparent that groundwater drawdown at BH5 equates to c.10 m.

2.8.3.16 The seasonal range in groundwater level at BH5 is minimal (0.75 m); any variations are stifled by its proximity to the dewatering sump.

2.8.3.17 Piezometers BH4 and Well F are within 5 m of each other; and register groundwater level at 19-21 m bgl, which equates to 150-152 maOD. These piezometers are only 10-15 m from the nearest quarry face.

2.8.3.18 Comparing the data at BH4 and Well F with that recorded at BH6, it is apparent that groundwater levels at BH4 / Well F have been lowered by 7-8 m as a result of the quarry development.

2.8.3.19 The logger data indicates that there is some 2 m seasonal variation at BH4.

2.8.4 Hydraulic Conductivity

2.8.4.1 The hydraulic conductivity of the bedrock has been estimated using falling-head test data collected by BCL from 5-no. piezometers (PZ1, PZ2, PZ3, BH4 and BH6).

2.8.4.2 The falling head test comprises the introduction of a slug (25 litres) of water to the piezometer and the measurement of the ensuing change in groundwater level. The rate of change in water level is used to determine the hydraulic conductivity of the strata.

2.8.4.3 For each test, a Cambertronics CTL2-2 data-logger, allied to a Druck PCDR830 pressure transducer, were utilised to facilitate efficient and accurate recording and recovery of test data.

2.8.4.4 The data was analysed using the Bouwer & Rice method, which is detailed in “Analysis and evaluation of pumping test data”, Kruseman and de Ridder, 1990.

2.8.4.5 The raw data and calculations are presented in Appendix 7.

2.8.4.6 The results range from 0.002 m/day to 0.125 m/day. This is consistent with published literature (“Physical and Chemical Hydrogeology”, Domenico and Schwartz, 1990): the hydraulic conductivity for weathered to poorly-fractured bedrock would be in the region of $8x10^{-9}$ m/s (0.001 m/d) to $3.3x10^{-6}$ m/s (0.285 m/d), based on upper end (worst-case) values.

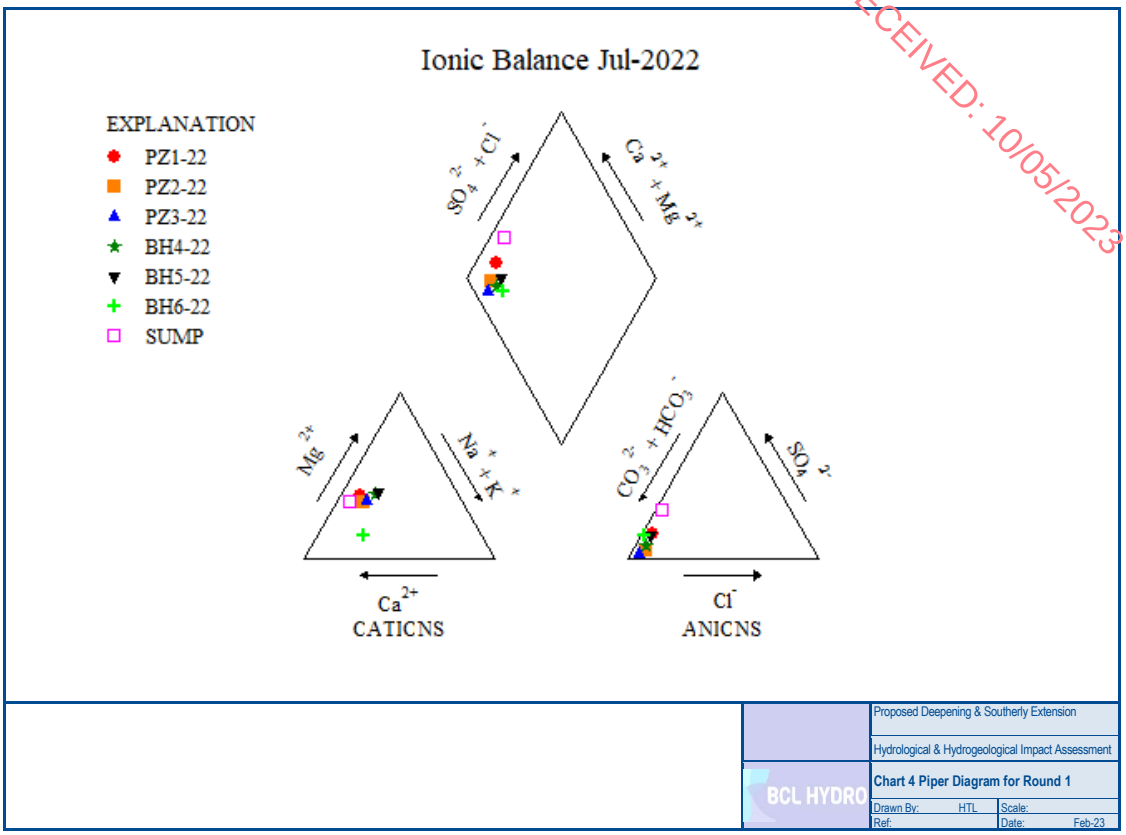
2.8.4.7 Reference 1 states that the transmissivity of Well 4 (Figure 8) is reported by the GSI to equate to 0.23 m^2/d; and the hydraulic conductivity is estimated at $6.6x10^{-8}$ m/s (equivalent to 0.006 m/d).

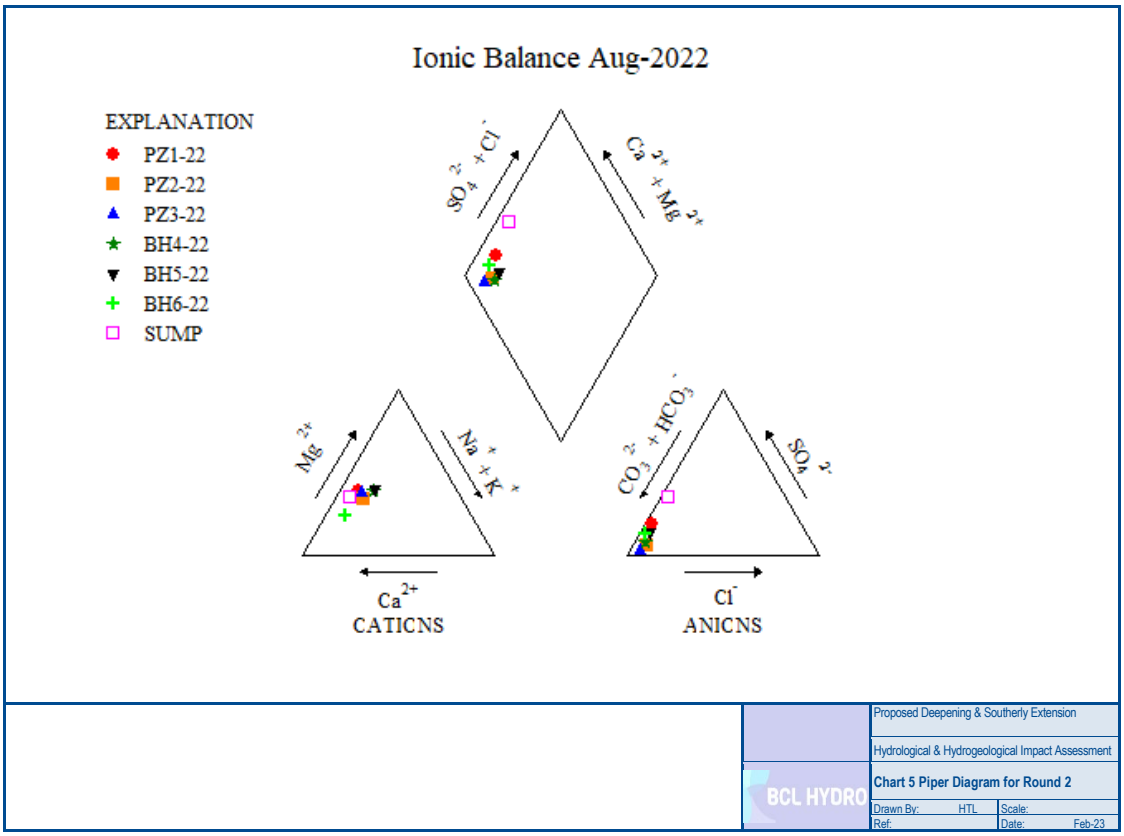
2.8.5 Groundwater Quality

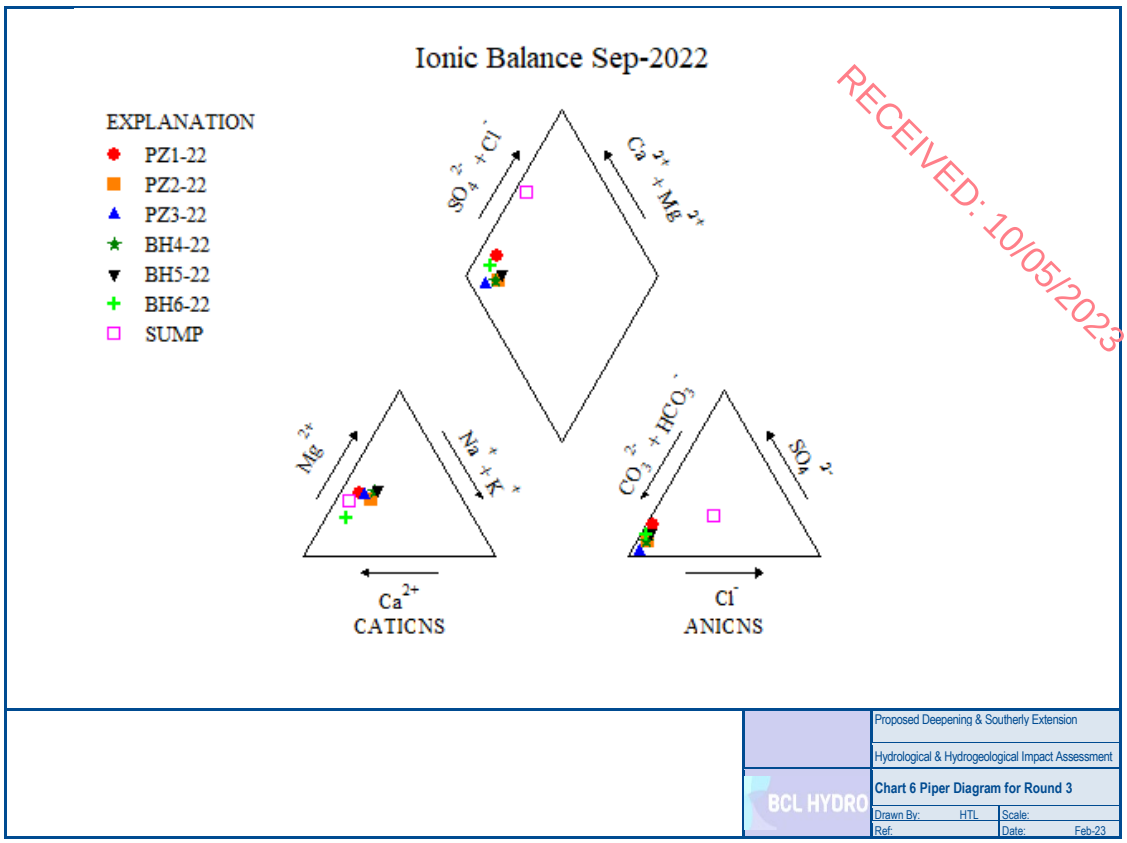
2.8.5.1 4 rounds of sampling have been conducted at the Site piezometers (PZ1, PZ2, PZ3, BH4, BH5 and BH6) as well as the Quarry Sump in order to provide a record of current groundwater quality.

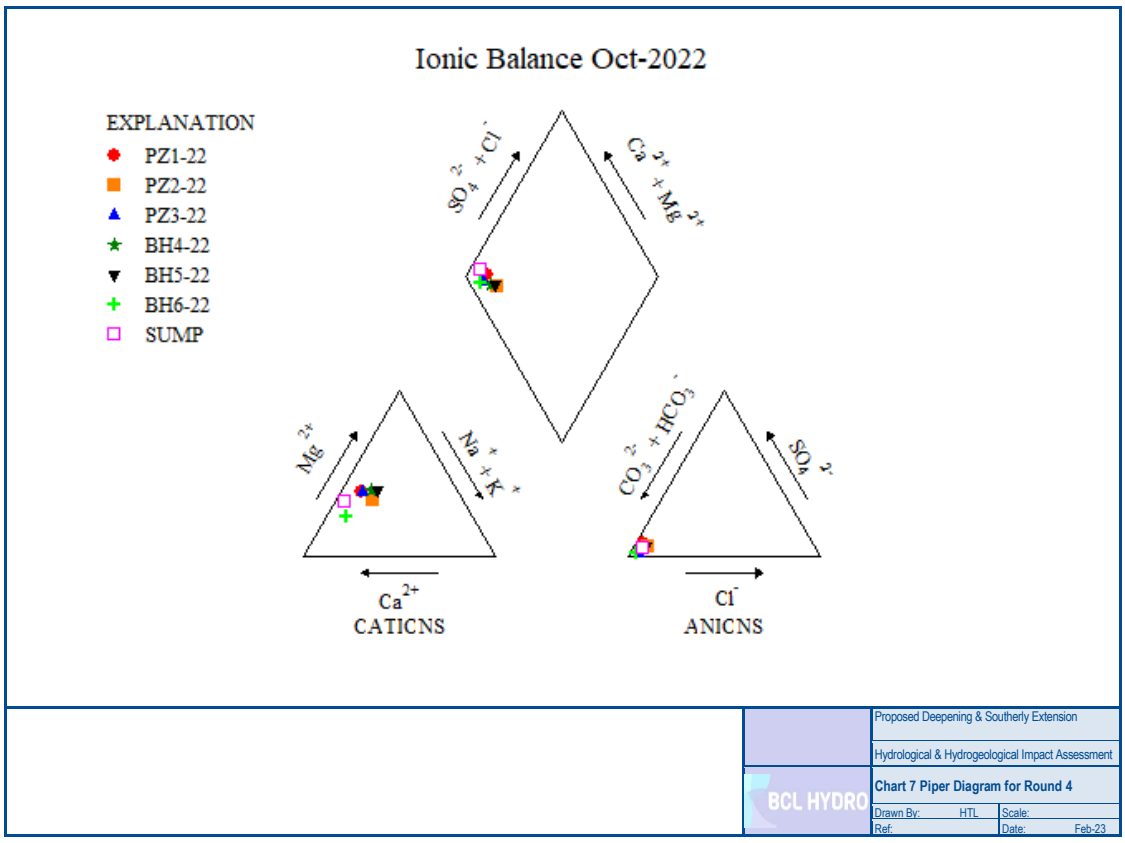
2.8.5.2 The sampling was completed on 19th July; 8th August; 5th September; and 5th October 2022. The laboratory certificates are reproduced in Appendix 8.

2.8.5.3 The major cations and anions have been plotted on a series of Piper diagrams to identify any major changes in ionic balance.









2.8.5.4 The ionic balance is relatively stable throughout the 4 rounds of sampling, with all the piezometer borehole results being tightly clustered.

2.8.5.5 The sump data generally sits outside the cluster; and moves furthest from the other data points during periods of high rainfall, when the groundwater seeping into the sump is more diluted by rainfall runoff.

2.8.5.6 Groundwater quality is generally good.

2.8.5.7 As would be expected in a rural setting, Orthophosphate is detected sporadically (peaking at 0.08 mg/l P) but generally below the limit of detection (<0.02 mg/l P). It should be noted that the various forms of Phosphorus (orthophosphate, polyphosphate, organic phosphate) occur widely in nature in plants, in micro-organisms and in animal wastes. It is widely used as an agricultural fertiliser and as a major constituent of detergents, particularly those for domestic use. Run-off and sewage discharges are thus important contributors of phosphorus to the water environment.

2.8.5.8 Similarly, occasional spikes in Ammonia (up to 0.59 mg/l) could be attributed to agricultural practices.

2.8.5.9 E. Coli and Faecal Streptococci are commonly detected in the water samples and would be caused by livestock and landspreading.

2.8.5.10 Antimony is elevated at BH4 (c.20 µg/l) and BH5 (c.50 µg/l), both of which are located within the cone of depression associated with the dewatering sump; therefore, they are drawing groundwater from the fields to the north of the quarry. The EPA report that Antimony is a "*naturally occurring trace element used in metal industry and in flame retardant materials. Antimony can occur naturally in water from weathering of rocks but is more likely to arise from effluents*."

2.8.5.11 During Round 2, the sample at the Quarry Sump shows a reading of 13 µg/l in Aliphatic Hydrocarbons at the carbon band range C16-C35.

2.8.5.12 This reading is marginally above the limit of detection (10 µg/l) and would relate to lubricating oils and grease, which could be sourced from quarry vehicles, but equally could be drawn into the sump from 3rd-party land (e.g. from agricultural machinery).

2.8.5.13 Aqueous solubility and relative mobility in groundwater are very low for the C16-35 Hydrocarbons. No hydrocarbons are detected in the Quarry Sump in subsequent rounds of sampling (Rounds 3 and 4).

2.8.5.14 During Round 1, the sample at BH6 shows a reading of 88.8 µg/l in Aliphatic Hydrocarbons at the carbon band range C5-C10; but this is not repeated in subsequent rounds. Aliphatic C5–C6 and C7–C8 fractions have relatively high volatility and low solubility in water.

2.8.5.15 During Round 2, the sample at BH4 shows a reading of 23 µg/l in Aliphatic Hydrocarbons at the carbon band range C16-C35. As outlined above, this piezometer is within the cone of depression associated with the dewatering sump; therefore, it is drawing groundwater from the fields to the north of the quarry. The readings diminish during subsequent rounds, approaching close to the limit of detection.

2.8.5.16 A very minor occurrence of Aromatic Hydrocarbons at the carbon band range C21-C35 is recorded at PZ2 in Round 2, equating to 12 µg/l. This in area that has been stripped of overburden and soils. The samples in Rounds 3 and 4 are below the limit of detection.

2.8.5.17 In Round 4, the sample at BH6 shows a reading of 30 µg/l in Aliphatic Hydrocarbons at the carbon band range C16-C35. This location is close to the public highway. It is anticipated that the reading for C16-C35 will diminish in future rounds of sampling, given what has been seen at the other piezometers.

2.9 Abstractions

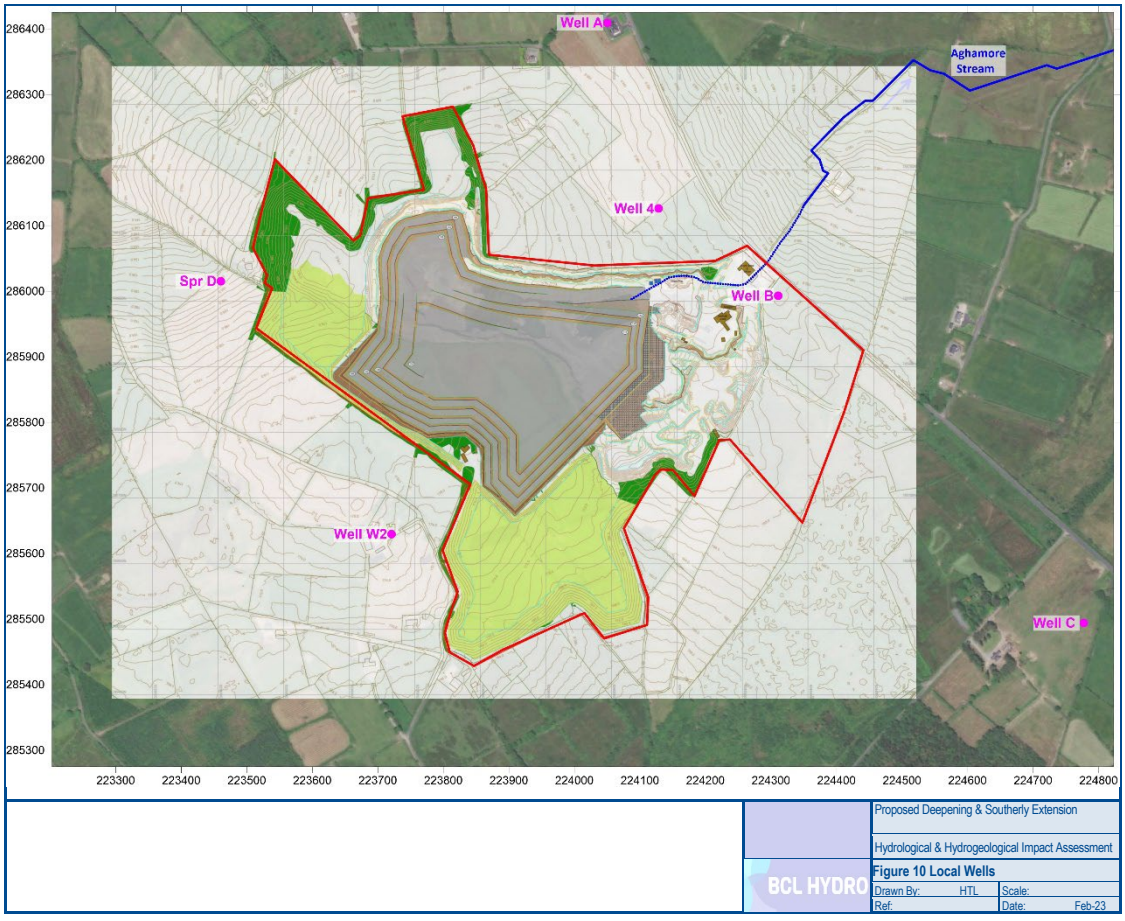
2.9.1 Source Protection Areas

2.9.1.1 The Site is not located within any EPA/GSI-delineated Source Protection Areas for Public Water Supplies or for Group Schemes.

2.9.1.2 The closest mapped Group Scheme Preliminary Source Protection Area is at Fostragh, which is some 2.3 km to the north of the Site; and is referred to as the Fosta GWS. The abstraction borehole (GSI ref: 2027NEW004) was drilled in May 1964 to a depth of 56.4 m bgl; the yield is classed as moderate, providing 41.4 m^3/d. The bedrock geology is the Coronea Formation, underlain by the Corn Hill Formation.

2.9.2 Private Supplies

2.9.2.1 The magenta dots (Figure 10) are abstraction points identified in Reference 1 (Wells A, B and C; Spring D) and following door-to-door survey in January 2023 (Well W2) and having consulted GSI mapping of Groundwater Wells and Springs (Well 4). The final development plan has been superimposed on the drawing to illustrate the full extent of proposed mineral extraction.



2.9.2.2 The closest mapped supply (Well 4) is some 185m to the north of the deepest proposed sinking at the Application Site. This is situated next to a football pitch; there is no residential property at this location. At the time of the water features survey, there was no access to the small building adjacent to the pitch, which is likely to be the well housing. The base of the well is reportedly c.40 m bgl (125 maOD).

2.9.2.3 Well B belongs to the Applicant and is redundant, with no access for monitoring.

2.9.2.4 Well W2 is a private well (6-inch diameter) used for domestic water supply. It is some 205m to the southwest of the deepest proposed sinking at the Application Site. The owner estimates that the well is "85 feet" in depth. On 30th January 2023, the depth to water was 4.13 mbgl. It is noteworthy that there is mains water supply coming to other properties in Derreenavoggy *e.g.* the neighbouring house (130m to the south).

2.9.2.5 Spring D is about 310m to the west of the deepest proposed sinking. Groundwater elevation coincides with ground level, estimated at 159.5 maOD by the author of Reference 1. The adjacent property is an abandoned cottage.

2.9.2.6 Well A is 450m to the north of the deepest sinking. The dip reading in October 2006 was 3.9 m bgl, equating to c.156 maOD.

2.9.2.7 Well C is at a private house lying some 730m to the southeast of the final sinking. The dip reading in October 2006 was 7.8 m bgl, equating to a groundwater level of c.167 maOD. The plumbed depth to the base of the well was c.70 m bgl (105 maOD).

3 THE PROPOSED DEVELOPMENT

3.1 Existing Development

3.1.1 As detailed on Drawing Ref 220912Dwg01, mineral extraction at the quarry to date has extended to a depth c.141 maOD and the quarry sump in the eastern part of the quarry void has a water level of c.140 maOD.

3.1.2 Mineral extraction is ongoing in the western part of the void in accordance with the extant planning permission for the Site.

3.1.3 Workings to date have resulted in 2 faces, split by a bench at c.155 maOD. The quarry floor is accessed via a ramp located to the south of the quarry sump.

3.1.4 Water at the Site will continue to be managed via the established water management practices as currently employed at the quarry. This process involves the accumulation of surface water in the quarry sump. The water is then pumped to a settlement pond prior to being discharged off-site into the local drainage network. As outlined earlier, this process is licenced by Longford County Council under Effluent Discharge Licence Ref WP 02/20.

3.1.5 The location and dimensions of the sump will depend on the configuration of specific working at each phase; however it is anticipated that it will be c. 2-3m below the depth of the quarry floor at any time.

3.2 Phase 1

3.2.1 Rather than stripping overburden from the entirety of the lateral extension area at the outset, the extension area will be stripped in phases, on a campaign basis, in advance of extraction as it progresses from north to south.

3.2.2 Overburden from the 'initial strip' of the proposed lateral extension area will be utilised in the construction of an earthen screening bund along the southern boundary of the Site. The bund has been designed to a maximum height of c.3-4m above current ground levels.

3.2.3 The first phase of extraction (Drawing Ref 220912Dwg02) will see the north-western part of the existing void deepened by an additional bench, to a depth of c.128 maOD. The quarry benches will be accessed via ramps excavated from the bedrock along the northern faces of the quarry void.

3.2.4 Mineral extraction will then progress southwards, with the eastern part of the extension area extended southwards to approximately align with the current extent of permitted workings in the western part of the quarry void. This lateral extension of works will see the void extended southwards to a depth matching that of the current quarry floor (c.141 maOD).

3.2.5 Non-commercially viable and out of specification material resultant from the processing of the mineral will be placed in lands to the west and south of the quarry void. The material will be graded to create a shallow outer slope. The material will then be topped with stripped topsoils and overburden; and planted with the prescribed woodland mix.

3.3 Phase 2

3.3.1 Phase 2 will see the gradual extension of the quarry void southwards (Drawing Ref 220912Dwg03). As the quarry gradually extends laterally, the disturbed footprint will be periodically deepened so as to make best use of the mineral resource within the disturbed quarry footprint.

3.3.2 The various quarry benches will continue to be accessed via the ramps along the northern faces and additional ramping along the western faces.

3.3.3 The overburden and topsoils will be extracted with the use of a 12m-reach 360° excavator, loaded into dump trucks, and deposited to create the overburden landforms to the north and south of the lateral extension area.

3.3.4 Following construction, the overburden landforms will be capped with topsoils and planted with an appropriate mix.

3.3.5 The topsoils and overburden will be removed on a campaign basis, across areas sufficient in size to facilitate 1-2 years' worth of extraction of the underlying bedrock at any one time. As such, the change in the surface will be gradual with overburden and underlying bedrock removed in increments. This process of incremental overburden removal followed by bedrock extraction will continue until the quarry has reached its maximum lateral extents, following which the void will be deepened.

3.3.6 The underlying bedrock will be extracted via drill and blast methodology as is the current, approved practice at the quarry. Blasting will occur on average once per month and will be undertaken under strict regulations. The mineral won will be processed at the quarry face using mobile resizing plant and machinery to produce a range of single size aggregates. The aggregate products will be stockpiled on the quarry floor, prior to being sold and transported off-site via HGV or used in the asphalt and concrete plants on site.

3.4 Phase 3

3.4.1 The third phase of the quarry development (Drawing Ref 220912Dwg04) will see the quarry extend laterally to the south and the quarry floor deepened to result in a maximum quarry floor depth of 114 maOD in the southwestern part of the quarry void.

3.4.2 The various quarry benches will continue to be accessed via the ramps along the northern faces and additional ramping along the western faces.

3.5 Phase 4

3.5.1 Phase 4 will see the quarry extension area extend to its maximum eastern lateral extents (Drawing Ref 220912Dwg05).

3.5.2 The faces developed in Phases 2 and 3 will be extended eastwards and the deepest sinking at 114 maOD created in Phase 3 will also be extended eastwards.

3.5.3 Overburden stripping in this phase will be limited to only a small remaining area, with this material used to finalise the landform to the southeast of the void.

3.5.4 By the end of this phase the quarry extension will have reached its full proposed lateral extents and the surrounding landform will be completely 'greened up' and planting well established.

3.6 Phase 5

3.6.1 Phase 5 will see the deepest sinking of the quarry floor extended eastwards (Drawing Ref 220912Dwg06).

3.6.2 All development within this phase of the development will be within the disturbed footprint and no overburden removal is required. The development will result in a quarry floor at 114 maOD, which will be accessed via the ramping system established in the previous phases of the development.

3.7 Restoration

3.7.1 Following the completion of extraction, the Site will be restored in accordance with the submitted restoration concept to create a waterbody and a range of biodiverse habitats.

3.7.2 Details of the proposed planting ratios are detailed on the restoration scheme, with the aim of allowing the site to assimilate back into the local landscape as well as delivering biodiversity improvements.

3.7.3 Over the lifetime of the development, the overburden landforms will have been planted and will have become well-established prior to the completion of extraction.

3.7.4 Following the completion of mineral extraction at the Site and the associated cessation of de-watering, groundwater levels will rebound, and a waterbody (lake) will be formed within the quarry void.

3.7.5 The void will fill to the lowest point on the brim (northeast corner) and therefore the maximum water level will be fixed at c.160 maOD by allowing controlled overflow down the existing discharge ditch.

4 IMPACT ASSESSMENT & MITIGATION MEASURES

4.1 Background

4.1.1 Baseline characterisation has provided a conceptual model of the extant groundwater and surface water regimes operating within and around the Site. This has been utilised to inform assessment of the potential impacts to the water environment that may be posed by the Proposed Development.

4.1.2 Operation of the Proposed Development in the planned manner has the potential to impact upon the water environment in the following ways:

- Interception of groundwater causing a modification of groundwater levels and flow rates within the quarry void, both during and following workings;
- Derogation of existing groundwater quality;
- Derogation of surface water quantity and quality, and;
- Risk to local water supplies and floral/faunal habitats.

4.2 Ingress Rates and Radius of Influence of Dewatering Drawdown

4.2.1 Current Ingress Rates

4.2.1.1 As discussed previously, the total volume of water pumped from the quarry void in the year from 19th January 2022 to 18th January 2023 (*i.e.* the most recent data) was 168,256 m^3/yr, averaging 461 m^3/d.

4.2.1.2 Using Met Éireann data, the effective rainfall rate is estimated at 725 mm/yr within the catchment area of the active void (141,500 m^2); therefore, the input from effective rainfall is estimated at 102,600 m^3/yr, equivalent to 281 m^3/d.

4.2.1.3 Subtracting rainfall input from the overall pumped volume, it is calculated that the groundwater ingress rate within the quarry void in its current configuration equates to 65,670 m^3/yr, equivalent to 180 m^3/d.

4.2.2 Current Radius of Influence of Dewatering Drawdown

4.2.2.1 To aid quantification of the degree of risk posed to potential receptors as a result of the lowering of groundwater levels, calculations have been undertaken to estimate the radius of influence of dewatering drawdown.

4.2.2.2 The methodology has been tested using input data that is representative of the quarry in its current configuration *i.e.* based upon the dimensions of the extraction void; the groundwater ingress rate recorded above; and the distance-drawdown relationship being observed at Site piezometers. The hydraulic conductivity for this model is set at 0.088 m/day; this is the best-fit value whereby the model output is consistent with Site experience and falls within the range demonstrated by falling head test.

4.2.2.3 The radius of influence of dewatering drawdown (R_0) at the current void is estimated to equate to some 60 m. This means that quarry-related lowering of groundwater levels is unlikely to extend greater than 60 m from the toe of the quarry face in the deepest sinking. The drawdown profile tabulated below is consistent with what is observed at the Site piezometers *e.g.* Piezometer PZ3 is some 40 m standoff from the quarry face; comparing its hydrograph with the other piezometers, the drawdown is c.2-3 m.

4.2.2.4 The modelled groundwater ingress rate (Q) is 180 m^3/d, matching what is given in section 4.2.1 (based on current pumping rates measured by calibrated flow meter).

4.2.2.5 This lends confidence to the accuracy of the calculations when going forward to quantify likely impacts in the future.

Aughnacliffe, Current Dewatering to 140 maOD

Radius of Influence	CIRIA Ro= C x S x sqrt(K)
Discharge	Modified Todd - Impermeable base
Distance Drawdown	CIRIA "Percentage" method
Input Variables	Red text

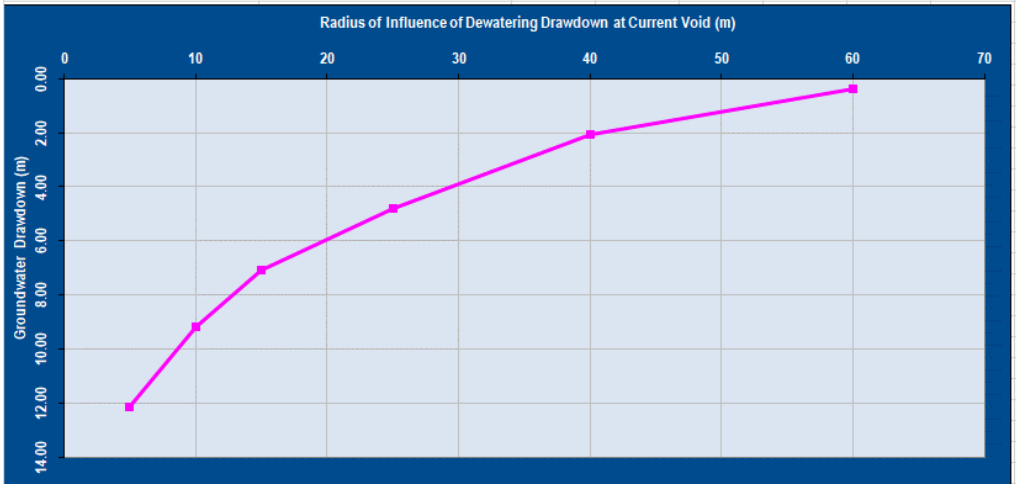
Representing extraction area by well
Ro & Q

Required drawdown in void, S (m)	20
length of deepest sinking	320
width of deepest sinking	50
C	3000

	K (m/s)	K (m/d)	Ro	r	R	Q(m3/d)	Q(l/s)
Site pumping rate and FHT	1.019E-06	0.088	61	71	132	180	2.1

Distance Drawdown

			metres from face					
		Ro	5	10	15	25	40	60
Percentage distance from face	Site pumping rate and FHT	60.553	8.26%	16.51%	24.77%	41.29%	66.06%	99.09%
%age drawdown (from lookup)	Site pumping rate and FHT		60.64%	45.90%	35.50%	24.02%	10.36%	1.91%
Absolute drawdown (m)	Site pumping rate and FHT		12.13	9.18	7.10	4.80	2.07	0.38



BCL HYDRO	Proposed Deepening & Southerly Extension
	Hydrological & Hydrogeological Impact Assessment
	Chart 8 Radius of Influence of Dewatering Drawdown in Current Void
	Drawn By: HTL / Scale:
	Ref: / Date: Feb-23

4.2.3 Final Radius of Influence of Dewatering Drawdown & Ingress Rates

4.2.3.1 The above modelling process has been repeated to provide an estimate of the potential radius of influence of dewatering drawdown (R_0) and likely groundwater ingress rate (Q) associated with the final development (extended and deepened void, with depth of dewatering set at 114 maOD).

Aughnacliffe, Final Dewatering to 114 maOD

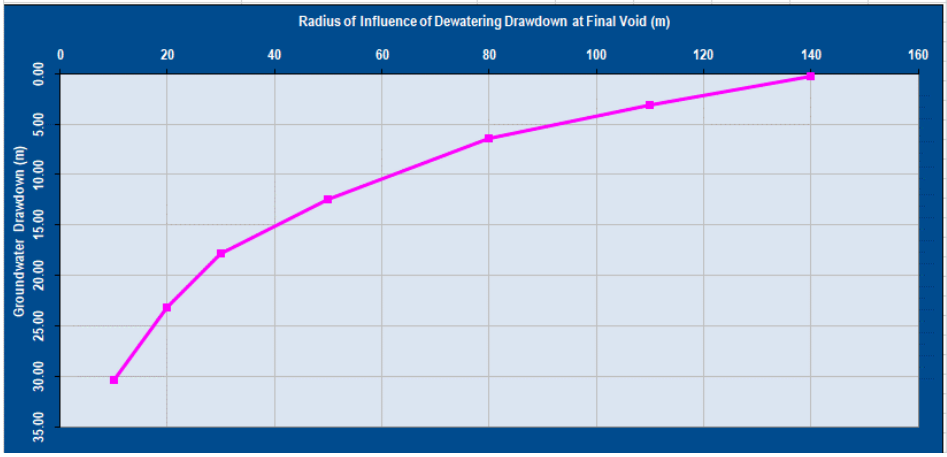
Radius of Influence	CIRIA Ro= C x S x sqrt(K)
Discharge	Modified Todd - Impermeable base
Distance Drawdown	CIRIA "Percentage" method
Input Variables	Red text

Representing extraction area by well
Ro & Q

Required drawdown in void, S (m)	46						
length of deepest sinking	270						
width of deepest sinking	195						
C	3000						
	K (m/s)	K (m/d)	Ro	r	R	Q(m3/d)	Q(l/s)
Site pumping rate and FHT	1.019E-06	0.088	139	129	269	801	9.3

Distance Drawdown

			metres from face						
		Ro	10	20	30	50	80	110	140
Percentage distance from face	Site pumping rate and FHT	139.272	7.18%	14.36%	21.54%	35.90%	57.44%	78.98%	100.52%
%age drawdown (from lookup)	Site pumping rate and FHT		65.95%	50.34%	38.75%	27.05%	14.05%	6.68%	0.61%
Absolute drawdown (m)	Site pumping rate and FHT		30.34	23.16	17.82	12.44	6.46	3.07	0.28



Proposed Deepening & Southerly Extension
Hydrological & Hydrogeological Impact Assessment
BCL HYDRO
Chart 9 Radius of Influence of Dewatering Drawdown in Final Void
Drawn By: HTL | Scale:
Ref: | Date: Feb-23

4.2.3.2 Full details of the above estimation method are described by CIRIA report no. 113 ("Control of Groundwater for Temporary Works", Somerville, 1986).

4.2.3.3 The final radius of influence is likely to be in the region of 140 m.

4.2.3.4 The estimated groundwater ingress rate at the final development (114 maOD) is in the region of 800 m^3/d (equivalent to 292,365 m^3/yr).

4.2.3.5 Applying the effective rainfall rate (725 mm/yr) within the catchment area of the final void (212,800 m^2); the input from effective rainfall is estimated at 154,280 m^3/yr, equivalent to 423 m^3/d.

4.2.3.6 The overall dewatering requirement in the final phase of the proposed development (to deal with the combined input from rainfall and groundwater ingress) equates to an estimated 446,645 m^3/yr, equivalent to 1,223 m^3/d.

4.2.3.7 On this evidence, even when the proposed development reaches its maximum extent, the average discharge rate at the licensed outfall is not anticipated to exceed the limit specified under Discharge Licence WP 02/20, which specifies that the maximum volume of effluent discharged shall not exceed 1,350 m^3/day.

4.2.3.8 As explained in section 2.7.3, the maximum permitted volume is already being discharged during periods of heavy rainfall, but this reduces to zero discharge during drier months and when the quarry is closed (e.g. weekends).

4.2.3.9 Even though the average predicted rate would comply with the licensed rate, it is recommended that the Applicant should lodge an application to vary the consented limit, making allowance for seasonal variations in rainfall.

4.2.3.10 Monthly rainfall data for the period January 2019 to December 2022 peaks at 225 mm/month in February 2020. Within the catchment area of the final void (212,800 m^2), the input from peak rainfall would be c. 47,880 m^3/month, equivalent to 1,650 m^3/d.

4.2.3.11 Added to groundwater ingress (800 m^3/d), the peak seasonal dewatering requirement at the final development is estimated at 2,450 m^3/d. This would not cause any flood risk in the receiving watercourse because the system has already been tested at 3,500 m^3/d under the terms of Discharge Licence WP 02/20 (Condition 2.1), effective from 20th October 2020. This was the permitted dewatering rate when the quarry void was being brought back into operation.

4.2.3.12 It should be noted that the adopted analysis method was devised for use in intergranular flow systems. Thus, its application here is reliant upon the generalising assumption that the joint and fracture system of the greywacke strata may, en-masse, be thought to operate analogously to an intergranular system.

4.2.3.13 The assessment methodology takes no account of hydraulic head loss due to turbulent flow that will inevitably occur within the first few metres of rock immediately behind the seepage faces of the quarry. As postulated for other quarries within the same type of aquifer ("*Poor Aquifer - Bedrock which is Generally Unproductive except for Local Zones*"), which have for many years extracted from depths below the pre-development groundwater level, these head losses are thought to represent a significant component in the amelioration of distance-drawdown and groundwater ingress rates.

4.2.3.14 Further to the above, experience of both quarries and well drilling operations strongly suggests that the hydraulic conductivity of the rock mass will reduce with increased depth. This will have a proportionate decelerating effect upon the increase of both the rates of groundwater ingress and propagation of groundwater drawdown outwith the Site (thus lending a greater safety margin to the findings of this assessment).

4.2.3.15 Evidence gained from surface mapping, and inspection of exposed sections of bedrock within the existing quarry void, have not elucidated the presence of significant active fracture flow within or surrounding the Site. The likelihood of intercepting such fracture flow is considered low.

4.2.3.16 The necessary adoption of simplifying assumptions dictates that the analysis results should be taken only as indicative of the likely general hydraulic response to the dewatering operation.

4.2.3.17 Given the hydrogeological characteristics of the bedrock, the collection of further monitoring data (rainfall depths, groundwater levels in the piezometer network and pumping rates at the dewatering sump) will give the opportunity for these calculations (radius of influence) to be reviewed and refined as the development progresses.

4.3 Storm Balancing

4.3.1 Mineral Extraction Phases

4.3.1.1 Total rainfall occurring on Site during the design storm (6-hour duration and 100-year return period) is 64.1 mm. Given the catchment area of the final extraction area (*circa* 22 hectares), this equates to some 14,100 m^3 input of rainfall.

4.3.1.2 All ingress water will drain under gravity into the dewatering sump, which will be maintained with a minimum surface area of approximately 2,450 m^2 (section 4.5.1) and operational freeboard of 1 m, thus providing 2,450 m^3 storage capacity.

4.3.1.3 The operational solution (when rainfall exceeds the capacity of the sump) is to allow temporary and shallow ponding across the across the final sinking (114 maOD), which has a surface area of approximately 5.2 hectares. Given that the quarry floor is relatively flat, the water would spread across a large part of the floor without exceeding 25 cm depth, although there would be local deepening at the sump.

4.3.1.4 Following abatement of the storm, water would be pumped from the quarry to the consented discharge point at the permitted rate (currently limited to 1,350 m^3/day), based upon the capacity of the pump and the requirement to maintain dry workings under average conditions.

4.3.1.5 There is no risk of runoff from the quarry void to neighbouring land. The lowest point on the Site boundary is at *circa* 160 maOD, which is 45 m higher than the level of ponded water (temporary flooding) on the quarry floor.

4.3.2 Restoration Phase

4.3.2.1 Upon the completion of extraction, the dewatering pumps will be turned off and the process of the water rebounding will commence.

4.3.2.2 The proposed restoration will see the water balance out at a level of approximately 160 maOD in the final development.

4.3.2.3 The Site will top out and drain naturally to the existing low point at the northeast corner of the landholding, adjacent to the Site entrance, where the water will be released at the consented discharge point and follow the same route as currently employed *i.e.* into a field ditch, which flows in a northeasterly direction to join Aghamore Stream.

4.4 Groundwater Quality

4.4.1 Accidental Spillages / Long-term Leakage

4.4.1.1 Potential exists for derogation of groundwater quality as a result of accidental spillages or long-term leakages of potential contaminants (oils, lubricants and solvents) at the Application Site.

4.4.1.2 It is important to recognise that the likelihood or consequences of such an occurrence during the working of the Proposed Development will be no greater than currently prevail at Aughnacliffe Quarry and numerous similar operations sited throughout the region.

4.4.1.3 The company has an accredited ISO 14001:2015 EMS covering all of its quarry sites.

4.4.2 Refuelling & Maintenance of Plant

4.4.2.1 This is addressed in the Quarry Operator's EMS. Plant operated wholly on-site will be refueled on-site within a designated area. Less mobile plant will be refueled using a fuel bowser mounted on an all-terrain vehicle. Fuel will be delivered via a delivery meter, 'full tank' sensor stop valve and a pistol grip filler nozzle in order to prevent over-filling and accidental spillage.

4.4.2.2 Maintenance of all plant will be carried out in the dedicated plant workshop. Emergency repairs of immobilized plant will, in exceptional circumstances, be carried out in the operational quarry area, however staff will be required to use appropriate drip trays and oil catcher tanks to drain hydraulic, or oil lubrication, systems.

4.4.3 Fuels Handling & Storage

4.4.3.1 This is addressed in the Quarry Operator's EMS. All surface water from vehicular refueling, waiting and parking areas will be directed through adequately sized and located petrol/oil bypass interceptors. All fuel, lubricants or other chemical storage tanks will be adequately bunded to protect against spillage. Bunding will be capable of retaining a volume equal to 1.5 times the capacity of the largest tank. All waste oil will be removed from the site and disposed of through the use of a licensed contractor.

4.4.3.2 The EMS includes procedures and protocol for dealing with any spillage of fuel / oil.

4.4.3.3 Application of the preventative and reactive management measures will provide appropriate mitigation against the risks posed to groundwater by the on-site storage and use of hydrocarbons and operation of plant and machinery.

4.5 Potential for Impact upon Surface Water Regime

4.5.1 Review of Water Management Practices

4.5.1.1 Practical experience indicates that the application of Stokes Law provides a reasonable basis for sizing settlement lagoons. Stokes Law defines the critical settling velocity with which suspended solids in a fluid fall under gravity.

4.5.1.2 For practical values of water temperature and particle specific gravity (density), and a settlement lagoon depth of 1 m, the following theoretical retention times are calculated:

- 11 hours to settle out particles of 0.006 mm (medium silt) or greater;
- 24 hours to settle out particles of 0.004 mm (fine silt) or greater.

4.5.1.3 The depth of water in the settlement lagoons is not a variable in the equation relating capacity flow rate to minimum settling velocity (*i.e.* making lagoons deeper does not improve their efficiency or performance). In practice, it has been shown that settlement lagoons are efficient if the water depth in the lagoon is not less than 1 m.

4.5.1.4 The overall depth of the lagoons should also consider the maximum depth of sediment that will be allowed to collect before removal (typically 0.5–1.0 m) and provision of freeboard (typically 0.5 m between maximum water level in the lagoon and the crest of the lagoon).

4.5.1.5 Within quarry developments, settlement lagoons are generally excavated with overburden material or created by a combination of impounding embankments and excavation. The size, shape and layout can be limited by the areas available on site. The dimensions of the system are dictated by the requirement to allow digging out by long reach excavator.

4.5.1.6 The primary consideration is the maintenance of uniform horizontal flow. For this, the lagoons should be rectangular in shape with parallel sides in the directions of flow. The floor and sides of the lagoon should be as smooth as practicable to minimise turbulent flow. Where turbulence is created, currents can create scour conditions and negate the settlement process.

4.5.1.7 As outlined above, each settlement stage will be maintained with a minimum operational depth of 1 m.

4.5.1.8 The total predicted pumping requirement (groundwater and rainfall) at the final development equates to 2,450 m^3/d (section 4.2.3).

4.5.1.9 Therefore, the sizing of the settlement area (including quarry sump) will need to be maintained with a minimum surface area of approximately 2,450 m^2. This is a precautionary approach – it allows 24 hours to settle out particles of 0.004 mm (fine silt) or greater.

4.5.1.10 It is noteworthy that the enlargement of the settlement area is not an instantaneous figure and is progressive as the quarry develops and increases in size, therefore it is a sliding scale requirement; and the full area will only be required when the void is at maximum proposed extent.

4.5.2 Surface Water Levels and Flows

4.5.2.1 As explained in section 2.7.2, the southern slopes of the landholding are drained by the Derreenavoggy Stream, which descends in a southerly direction to join the Camlin River. The main river flows from east to west, passing to the north of Ballinalee.

4.5.2.2 The catchment area of the Derreenavoggy Stream is 31.60 km^2 (WFD River Sub Basin "CAMLIN_020"; RWB European Code IE_SH_26C010200).

4.5.2.3 The Proposed Development will remove the uppermost section (0.017 km^2) of this catchment area, which is less than 0.1% reduction and therefore considered to be of negligible impact.

4.5.2.4 To the north northeast of the Site, the Aghnacliffe Stream and Aghamore Stream join together and flow to Lough Gowna. The catchment area of these two streams is 14.14 km^2 (WFD River Sub Basin "AGHNACLIFFE STREAM_010"; RWB European Code IE_NW_36A060400).

4.5.2.5 As explained previously, the Applicant already has a licence to allow for dewatering of the existing quarry and discharging into the Aghamore Stream.

4.5.2.6 Any rainfall runoff intercepted by the quarry and temporarily lost from the northern Sub Basin (Aghnacliffe – Aghamore) will be collected in the quarry sump; and, after settlement, it will be directed to the consented discharge point and returned to the same sub basin (immediately downstream of the quarry). Quarry dewatering is a non-consumptive abstraction and there will be no reduction in flow rates in the sub basin.

4.6 Surface Water Quality

4.6.1 The dewatering operation is conducted under Discharge Licence WP 02/20 (dated October 2020), issued by Longford County Council.

4.6.2 Water quality in the receiving watercourse is protected under the terms and conditions set by the licence. The quality of the effluent must comply with the following limits:

- Suspended solids shall not exceed 25 mg/l;
- pH shall be within the range 6-9 pH units;
- Temperature shall be consistent with ambient conditions; and,
- Hydrocarbons - no film shall be visible on the final effluent.

4.6.3 It is considered that the continued implementation of the measures advanced in section 4.4 (for the protection of groundwater quality) will also serve to prevent the derogation of surface water quality by ensuring the maintenance of good quality discharge of groundwater baseflow and downstream linkage to surface water.

4.6.4 Silt fencing will be erected at the toe of the outer slope of any screening bund when it is under construction. On each new section of screening bund, this silt fencing will be left in place until the slope is seeded and fully-vegetated.

4.7 Water Supplies

4.7.1 The closest mapped supply (Well 4) is some 185m to the north of the deepest proposed sinking at the Application Site. This is situated next to a football pitch; there is no residential property at this location. At the time of the water features survey, there was no access to the small building adjacent to the pitch, which is likely to be the well housing.

4.7.2 The development will not encroach upon the existing standoff between the quarry and Well 4.

4.7.3 Well W2 is a private well (6-inch diameter) used for domestic water supply. It is some 205m to the southwest of the deepest proposed sinking at the Application Site. The owner estimates that the well is “85 feet” in depth. On 30th January 2023, the depth to water was 4.13 mbgl. It is noteworthy that there is mains water supply coming to other properties in Derreenavoggy *e.g.* the neighbouring house (130m to the south).

4.7.4 The final radius of influence of dewatering drawdown is estimated at c.140 m.

4.7.5 All water supplies sit outside this radius. Therefore, it is considered that the proposed development will cause no derogation in the yield of local water supplies.

4.7.6 Water quality at local abstractions will be safeguarded against quarry-related impact by the same measures adopted to protect groundwater quality (section 4.4) and to control the discharge of trade effluent (section 4.6).

4.7.7 The piezometer network provides sufficient coverage for groundwater level and quality monitoring to check that there is no risk of impact at local water supplies.

4.8 Residual Impacts

4.8.1 In this instance, the proposed restoration will see the cessation of dewatering and the water will recover to a level of approximately 160 maOD in the final development.

4.8.2 The Site will top out and drain naturally to the existing low point at the northeast corner of the landholding, adjacent to the Site entrance, where the water will be released at the consented discharge point and follow the same route as currently employed, i.e. into a field ditch, which flows in a northeasterly direction to join Aghamore Stream.

4.8.3 The management of residual risk will, for the most part, be the responsibility of the landowner, who will need to be aware that, during storm events, there will be water level variations within the freeboard zone at the margins of the waterbody in the restored workings. Land use should be tailored to allow for these variations.

5 SUMMARY & CONCLUSIONS

5.1 Published guidance[1], which details the criteria for ranking the importance of hydrological and hydrogeological features (low / medium / high / very high / extreme) and assessing the magnitude of impact (negligible / small / moderate / large adverse), has allowed for judging the significance of impact (imperceptible / slight / moderate / significant / profound).

5.2 The pre-existing quarry operates below the watertable; however, the bedrock at the quarry has very low hydraulic conductivity, which restricts the groundwater inflow rate within the quarry excavation. Pumping is principally of rainwater and surface water runoff.

5.3 The bedrock strata (Red Island, Glen Lodge, Carrickateane, Corn Hill and Coronea Formations grouped together) are classed as a "*Poor Aquifer - Bedrock which is Generally Unproductive except for Local Zones*" (Pl). Criteria for Rating Site Importance of Hydrogeological Features (IGI 2013) indicates that this type of aquifer is of '**low**' importance.

5.4 The quarry straddles the boundary between the Cavan GWB (IE_NW_G_061), which is on the north side of the divide and has an area of 1,410 km^2, and the Longford Ballinalee GWB (IE_SH_G_149), which is on the south side and has an area of 340 km^2.

5.5 Given the overall area of the GWBs, the magnitude of impact of the proposed operation at the Applicant's quarry (0.22 km^2) on the regional water balance is '**negligible**', therefore the significance of impact on the regional water balance is rated as '**imperceptible**'.

5.6 The final radius of influence of dewatering drawdown is estimated at c.140 m. All water supplies sit outside this radius. Therefore, it is considered that the proposed development will cause no derogation in the yield of local water supplies.

5.7 The dewatering operation is conducted under Discharge Licence WP 02/20 (dated October 2020), issued by Longford County Council. Water is discharged into a field ditch, which flows in a northeasterly direction to join Aghamore Stream, which then joins the Aghnacliffe Stream and flows into Lough Gowna.

5.8 Any rainfall runoff intercepted by the quarry and temporarily lost from the Aghamore – Aghnacliffe Sub Basin will be collected in the quarry sump; and, after settlement, it will be directed to the consented discharge point and returned to the same sub basin (immediately downstream of the quarry). Quarry dewatering is a non-consumptive abstraction and there will be no reduction in flow rates in the sub basin.

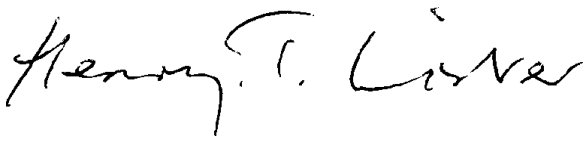
5.9 Water quality in the receiving watercourse is protected under the terms and conditions set by the Discharge Licence.

5.10 Lough Gowna is a proposed Natural Heritage Area (pNHA), which is of '**high**' importance (rising to '**very high**' if NHA status is confirmed). As outlined above, the quarry will not have an adverse impact upon flow rate or water quality in Aghamore – Aghnacliffe Stream, which feeds into Lough Gowna.

1 Institute of Geologists of Ireland (IGI 2013) 'Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements'.

5.11 The magnitude of impact on the hydrology of the Lough is '**negligible**', therefore the significance of impact of activities within the Application Area on the hydrology of the Lough is rated as '**imperceptible**'.

5.12 In view of the findings of assessment and the planned approach to the Proposed Development, which includes specific measures for the protection of the water environment, it is concluded that there are no over-riding hydrogeologically or hydrologically based reasons why development should not proceed in the manner described in the Application. This conclusion assumes that planning permission, if granted, will condition the implementation and adherence to any relevant recommendations advanced within this report and other such conditions that may be reasonably imposed by the Planning Authority.



Henry Lister B.Sc. (Hons), M.Sc.
Principal Hydrogeologist & Company Director

BCL Consultant Hydrogeologists Limited
April 2023

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Lagan Materials Limited, trading as Breedon Ireland

Proposed Deepening & Southerly Extension at Aughnacliffe Quarry

Townlands of Aghamore Upper and Derreenavoggy, County Longford

Planning Application for Mineral Extraction

Hydrological & Hydrogeological Impact Assessment

April 2023

Appendix 1 Citations for Protected Sites

BCL HYDRO
Consultant Hydrogeologists Limited

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West Midlands, WV10 9RU. Tel: 01902 824111, Fax: 01902 824112
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SITE SYNOPSIS

SITE NAME: LOUGH GOWNA

SITE CODE: 000992

Lough Gowna is located 10km north-west of Granard on the River Erne. It is a medium sized lake divided into two main sections by a narrow channel at Dernaferst Bridge. The substrate is Silurian grits and slates and it is situated in a drumlin filled basin with many bays and inlets. Nearby Sean Lough is of similar habitat and included in the site. The site was not visited recently.

In 1975 An Foras Forbartha described the lake as having a relatively low base status with a pH of 7.5 and this is indicated by the presence of two plants, Water Lobelia (*Lobelia dartmanna*) and Quillwort (*Isoetes lacustris*), which have an oligotrophic habit. A stonewort of limited distribution, *Nitella flexilis*, is also present. Common plankton organisms present include diatoms (*Asterionella* spp.), blue-green algae (*Anabaena* spp., *Coelosphaerium* spp.) and crustaceans (*Daphnia* spp., *Diaptomus* spp.).

Peat bog occurs along the shore in the north and east where the unusual Lesser Bulrush (*Typha angustifolia*) occurs along with the unusual upland Lemon-scented Fern (*Oreopteris limbosperma*). Elsewhere the shores are stony being either flat or sloping. A woodland fringe is present in places with willow (*Salix* spp.), alder (*Alnus* spp.), Ash (*Fraxinus excelsior*), Hazel (*Corylus avellana*) and Holly (*Ilex aquilifolium*). Some scattered oak (*Quercus* spp.) occurs and the ground flora includes Common Cow-wheat (*Melampryum pratense*), Hand Fern (*Blechnum spicant*) and Hay-scented Buckler-fern (*Dryopteris aemula*).

This is an important site for wintering waterfowl with nationally important populations of Great Grebe (51) along with Whooper Swan (29) and Golden Plover (65), species listed in Annex I of the EU Birds Directive (Counts 1988). Several other species are also present.

Nutrient inflow is leading to eutrophication and is a threat to the oligotrophic communities. Algal blooms are quite common resulting in fish kills – in this important coarse fishing area this is a serious threat.

With its importance for wintering waterfowl and the presence of interesting oligotrophic plant communities which are scarce in the midlands, this site has high scientific interest.

16.11.2009

Lagan Materials Limited, trading as Breedon Ireland

Proposed Deepening & Southerly Extension at Aughnacliffe Quarry

Townlands of Aghamore Upper and Derreenavoggy, County Longford

Planning Application for Mineral Extraction

Hydrological & Hydrogeological Impact Assessment

April 2023

Appendix 2 Borehole Logs

BCL HYDRO
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Registered in England & Wales. Company Registration Number: 4043373

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Pat and Mark Dempsey Ltd
Sheane, Rathangan Co. Kildare R51EA39

Daily Drilling Borehole Log.

Lagan Aghamore Upper Aughnacliffe Co Longford

Client **Lagan**

Borehole No BH5 Depth 85 Meters Date 23/5/22

Drill Diameter 155 MM Pipe Installed 125mm UPVC

Estimated Well Yeild 125 Liters per hour

Borehole Details

Depth From	To	Drill Conditions	Depth From	To	Drill Conditions	Water Strike
0	.65	Fill				
.65	57	Blue Limestone				61 m
57	68.2	Red Mudstone				
68.2	79.4	Blue Limestone				
79.4	85	Black Limestone				80 m

Pat and Mark Dempsey Ltd
Sheane, Rathangan Co. Kildare R51EA39

Daily Drilling Borehole Log.

Lagan Aghamore Upper Aughnacliffe Co Longford

Client **Lagan**

Borehole No PZ3-22E Depth 100 Meters Date 24/5/22

Drill Diameter 155 MM Pipe Installed 125mm UPVC
Estimated Well Yeild 780 Liters per hour

Borehole Details

Depth From	To	Drill Conditions	Dept From	To	Drill Conditions	Water Strike
0	15.6	Brown Shale				
15.6	94.5	Blue Limestone				90
94.5	100	BlackLimestone				96.8

Pat and Mark Dempsey Ltd
Sheane, Rathangan Co. Kildare R51EA39

Daily Drilling Borehole Log.

Lagan Aghamore Upper Aughnacliffe Co Longford

Client **Lagan**

Borehole No 4-22 Depth 106 Meters Date 24/5/22

Drill Diameter 155 MM Pipe Installed 125mm UPVC
Estimated Well Yeild 160 Liters Per Hour

Borehole Details

Depth From	To	Drill Conditions	Depth From	To	Drill Conditions	Water Strike
0	.5	Soil				
.5	6	Brown Shale				
6	59	Blue Limestone				
59	66	Black Limestone				
66	106	Blue Limestone				88

Pat and Mark Dempsey Ltd
Sheane, Rathangan Co. Kildare R51EA39

Daily Drilling Borehole Log.

Lagan Aghamore Upper Aughnacliffe Co Longford

Client **Lagan**

Borehole No 6-22 Depth 95 Meters Date 25/5/22

Drill Diameter 155 MM Pipe Installed 125mm UPVC Casing
Estimated Well Yeild 215 Liters Per Hour

Borehole Details

Depth From	To	Drill Conditions	Depth From	To	Drill Conditions	Water Strike
0	.3	Concrete				
.3	1.2	Fill				
1.2	35	Black Limestone				
35	42.4	Red Mudstone				
42.4	57.7	Black Limestone				
57.7	63.3	Red Mudstone				63.4
63.3	95	Black Limestone				83.5

Pat and Mark Dempsey Ltd
Sheane, Rathangan Co. Kildare R51EA39

Daily Drilling Borehole Log.

Lagan Aghamore Upper Aughnacliffe Co Longford

Client **Lagan**

Borehole No PZ2-22 Depth 100 Meters Date 26/5/22

Drill Diameter 155MM Pipe Installed 125mm UPVC Casing
Estimated Well Yeild 350 Liters Per Hour

Borehole Details

Depth From	To	Drill Conditions	Depth From	To	Drill Conditions	Water Strike
0	13.2	Shale				
13.2	76	Blue Limestone				
76	84.5	Red Mudstone				77
84.5	100	Black Limestone				93.8

Pat and Mark Dempsey Ltd
Sheane, Rathangan Co. Kildare R51EA39

Daily Drilling Borehole Log.

Lagan Aghamore Upper Aughnacliffe Co Longford

Client **Lagan**

Borehole No PZ1-22 Depth 95 Meters Date 30/5/22

Drill Diameter 155MM Pipe Installed 125mm UPVC Well Casing
Estimated Well Yeild 2,500 per hour

Borehole Details

Depth From	To	Drill Conditions	Depth From	To	Drill Conditions	Water Strike
0	.8	Soil				
.8	4	Brown Shale				
4	22	Weather Rock				9.8
22	77	Blue Limestone				22.5
77	90	Black Limestone				
90	95	Blue Limestone				

Lagan Materials Limited, trading as Breedon Ireland

Proposed Deepening & Southerly Extension at Aughnacliffe Quarry

Townlands of Aghamore Upper and Derreenavoggy, County Longford

Planning Application for Mineral Extraction

Hydrological & Hydrogeological Impact Assessment

April 2023

Appendix 3 Met Éireann's Rainfall Return Period Table

BCL HYDRO
Consultant Hydrogeologists Limited

Technology Centre, Wolverhampton Science Park, Glashier Drive, Wolverhampton
West Midlands, WV10 9RU. Tel: 01902 824111, Fax: 01902 824112
email: info@bclhydro.co.uk, web: http://www.bclhydro.co.uk
Registered Office: 33, Wolverhampton Road, Cannock, West Midlands, WV11 1AP
Registered in England & Wales. Company Registration Number: 4043373

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Met Eireann
Return Period Rainfall Depths for sliding Durations
Irish Grid: Easting: 224020, Northing: 285951,

	Interval		Years											
DURATION	6months,	1year,	2,	3,	4,	5,	10,	20,	30,	50,	75,	100,	150,	200,	250,	500,
5 mins	2.7,	3.8,	4.4,	5.2,	5.8,	6.3,	7.8,	9.5,	10.7,	12.3,	13.7,	14.8,	16.5,	17.8,	18.9,	N/A ,
10 mins	3.7,	5.3,	6.1,	7.3,	8.1,	8.8,	10.9,	13.3,	14.9,	17.1,	19.1,	20.6,	23.0,	24.8,	26.3,	N/A ,
15 mins	4.4,	6.2,	7.2,	8.6,	9.6,	10.3,	12.8,	15.6,	17.5,	20.1,	22.4,	24.2,	27.0,	29.2,	31.0,	N/A ,
30 mins	5.8,	8.1,	9.3,	11.1,	12.3,	13.2,	16.3,	19.7,	21.9,	25.0,	27.8,	30.0,	33.3,	35.8,	37.9,	N/A ,
1 hours	7.7,	10.5,	12.0,	14.3,	15.7,	16.9,	20.6,	24.7,	27.4,	31.2,	34.5,	37.0,	40.9,	43.9,	46.4,	N/A ,
2 hours	10.2,	13.7,	15.6,	18.4,	20.2,	21.6,	26.1,	31.1,	34.3,	38.8,	42.8,	45.8,	50.4,	53.9,	56.8,	N/A ,
3 hours	12.0,	16.0,	18.2,	21.3,	23.3,	24.9,	30.0,	35.6,	39.2,	44.2,	48.5,	51.8,	56.9,	60.8,	64.0,	N/A ,
4 hours	13.4,	17.9,	20.2,	23.6,	25.9,	27.6,	33.1,	39.1,	43.0,	48.4,	53.0,	56.6,	62.0,	66.2,	69.6,	N/A ,
6 hours	15.8,	20.9,	23.6,	27.4,	29.9,	31.9,	38.0,	44.7,	49.1,	55.0,	60.2,	64.1,	70.1,	74.6,	78.4,	N/A ,
9 hours	18.6,	24.4,	27.4,	31.8,	34.6,	36.8,	43.7,	51.2,	56.0,	62.5,	68.2,	72.6,	79.1,	84.1,	88.2,	N/A ,
12 hours	20.9,	27.3,	30.6,	35.3,	38.4,	40.7,	48.2,	56.3,	61.4,	68.5,	74.6,	79.2,	86.3,	91.6,	96.0,	N/A ,
18 hours	24.6,	31.9,	35.6,	40.9,	44.4,	47.0,	55.4,	64.4,	70.1,	77.9,	84.6,	89.7,	97.4,	103.3,	108.0,	N/A ,
24 hours	27.6,	35.6,	39.6,	45.4,	49.2,	52.1,	61.1,	70.8,	76.9,	85.3,	92.5,	98.0,	106.2,	112.4,	117.5,	134.7,
2 days	34.2,	43.1,	47.5,	53.8,	57.8,	60.9,	70.4,	80.5,	86.8,	95.3,	102.6,	108.1,	116.3,	122.5,	127.5,	144.4,
3 days	40.0,	49.6,	54.4,	61.1,	65.5,	68.7,	78.8,	89.3,	95.9,	104.8,	112.3,	118.0,	126.4,	132.7,	137.8,	154.9,
4 days	45.2,	55.6,	60.7,	67.9,	72.4,	75.9,	86.4,	97.5,	104.4,	113.5,	121.3,	127.2,	135.8,	142.3,	147.5,	165.0,
6 days	54.7,	66.5,	72.1,	80.1,	85.1,	88.8,	100.4,	112.3,	119.7,	129.5,	137.8,	144.0,	153.1,	159.9,	165.4,	183.6,
8 days	63.6,	76.4,	82.6,	91.2,	96.6,	100.7,	113.1,	125.8,	133.7,	144.1,	152.8,	159.3,	168.9,	176.0,	181.8,	200.7,
10 days	71.9,	85.8,	92.5,	101.7,	107.5,	111.8,	125.0,	138.5,	146.7,	157.7,	166.8,	173.6,	183.6,	191.1,	197.0,	216.8,
12 days	79.9,	94.8,	101.9,	111.7,	117.8,	122.4,	136.3,	150.4,	159.1,	170.6,	180.1,	187.2,	197.6,	205.3,	211.5,	231.9,
16 days	95.3,	111.9,	119.8,	130.6,	137.4,	142.4,	157.6,	173.0,	182.4,	194.8,	205.1,	212.7,	223.8,	232.0,	238.6,	260.3,
20 days	110.0,	128.3,	136.9,	148.6,	156.0,	161.4,	177.8,	194.3,	204.4,	217.6,	228.5,	236.6,	248.4,	257.1,	264.0,	286.8,
25 days	127.9,	148.0,	157.4,	170.2,	178.2,	184.1,	201.9,	219.7,	230.5,	244.6,	256.3,	264.9,	277.4,	286.7,	294.1,	318.2,

NOTES:
N/A Data not available
These values are derived from a Depth Duration Frequency (DDF) Model
For details refer to:
'Fitzgerald D. L. (2007), Estimates of Point Rainfall Frequencies, Technical Note No. 61, Met Eireann, Dublin',
Available for download at www.met.ie/climate/dataproducts/Estimation-of-Point-Rainfall-Frequencies_TN61.pdf

Lagan Materials Limited, trading as Breedon Ireland

Proposed Deepening & Southerly Extension at Aughnacliffe Quarry

Townlands of Aghamore Upper and Derreenavoggy, County Longford

Planning Application for Mineral Extraction

Hydrological & Hydrogeological Impact Assessment

April 2023

Appendix 4 Discharge Licence WP 02/20

BCL HYDRO
Consultant Hydrogeologists Limited

Technology Centre, Wolverhampton Science Park, Glashier Drive, Wolverhampton
West Midlands, WV10 9RU. Tel: 01902 824111, Fax: 01902 824112
email: info@bclhydro.co.uk, web: http://www.bclhydro.co.uk
Registered Office: 33, Wolverhampton Road, Cannock, West Midlands, WV11 1AP
Registered in England & Wales. Company Registration Number: 4043373

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AN LONGFORT CONNECTED
Comhairle Chontae An Longfoirt
Longford County Council
People · Place · Opportunity

Áras an Chontae, Sráid Mhór Na hAbhann, Longford, N39 NH56
County Buildings, Great Water Street, Longford, N39 NH56
(043) 33 43300 www.longfordcoco.ie

20th October, 2020

Mr. Peter Glanville,
SLR Consulting,
7, Dundrum Business Park,
Windy Arbour,
Dublin 14

Re: Effluent Discharge Licence – Lagan Materials Ltd., Aghamore Upper, Aughnacliff, Co. Longford. WP 02/20

Dear Peter,

I enclose Effluent Discharge License for Lagan Materials Ltd. quarry at Aghamore Upper, Aughnacliff, Co. Longford granted by Longford County Council for your attention.

The license is effective from 23rd October , 2020.

Angela Brady

Scientific Officer,
Longford County Council.

AN LONGFORT CONNECTED
People · Place · Opportunity
Comhairle Chontae An Longfoirt
Longford County Council

- 1 DEC 2020

Local Government (Water Pollution) Acts, 1977 and 1990

Local Government (Water Pollution) Regulations 1978 & 1992

APPLICATION BY:

Lagan Materials Ltd.,
Rosemount Business Park,
Ballycoolin Road,
Dublin 11

BY REGISTERED POST
GRANT OF LICENCE

FOR: Discharge of effluent
AT: Lagan Quarry, Aghamore Upper, Aughnacliffe, Co. Longford

Longford County Council, in exercise of the Powers conferred on it by Section 4 of the Local Government (Water Pollution) Act 1977, as amended by the Local Government (Water Pollution) (Amendment) Act 1990, hereby grant a licence to discharge effluent at **Lagan Quarry, Aghamore Upper, Aughnacliffe, Co. Longford,** in accordance with the plans and particulars submitted by the applicant and subject to the conditions set out in the schedule hereto.

Signed on behalf of the said Council _____
Mr. John Brannigan,
Director of Services

Dated this day of October, 2020

NOTE
An appeal under Section 8 of the Principal Act against the granting, refusal to grant or revocation of a licence under section 4 of the said Act, or against any conditions attached to such a licence, may be made within one month beginning on the date of the grant of licence. Any such appeal must be accompanied by a fee of €126 and all appeals should be addressed to:-

An Board Pleanala,
64 Marlborough Street,
Dublin 1.

LONGFORD COUNTY COUNCIL

LOCAL GOVERNMENT (WATER POLLUTION) ACTS 1977 AND 1990

LOCAL GOVERNMENT (WATER POLLUTION) REGULATIONS 1978 & 1992

LICENCE TO DISCHARGE

TRADE EFFLUENT TO WATERS

WP 02/20

Longford County Council, in exercise of the powers conferred on it by the Local Government (Water Pollution) Acts 1977 & 1990 and the Local Government (Water Pollution) Regulations, 1978 and 1992, hereby grants a Licence to:

Lagan Materials Ltd.,
Rosemount Business Park,
Ballycoolin Rd,
Dublin 11

In respect of discharge of effluent at Lagan Quarry, Aghamore, Aughnacliffe, Co Longford.

Subject to the following conditions:

CONDITIONS

1. General Layout and Operation

1.1 This licence shall be in respect of the discharge of effluent generated at Lagan Quarry, Aghamore Upper, Aughnacliffe, Co Longford.

1.2 Drainage within the quarry shall be laid out, operated and maintained in such a manner as to prevent the discharge of any effluent other than in accordance with quality standards as set out in conditions 2.3.

1.3 All chemicals, fuels and oils need to be stored in a secure and adequately bunded area. All fuel storage tanks should have an adequately designed reinforced concrete bund system complete with impervious base. Chemical absorbent material should be on site at all times and a contingency plan prepared in the event of a spill.

1.4 Authorised Officers of the Licensing Authority or it's agents, or any other person authorised under Section 28 of the Local Government (Water Pollution) Act, 1977, shall have access to the site at all reasonable times for the purpose of carrying out such monitoring as may be deemed necessary by them, including if necessary, times other than normal working hours in the event of an emergency.

1.5 The licensee shall ensure that an emergency response procedure is in place, that shall address any emergency situations, which may originate on site. This procedure will include provision for minimising the effect of any emergency on the environment.

2. Effluent Volume and Characteristics

2.1 Before quarry is brought back into operation the quarry void may be de-watered as per plans and particulars submitted at a rate not exceeding 3,500 m3/day.

2.2 When quarry is operational the maximum volume of effluent discharged shall not exceed 1350 m^3 per day

2.3 Effluent as discharged from the pump chamber shall comply with the quality standards set out hereunder in respect of the following determinants.

Determinant	Maximum Limit
Suspended Solids	25 mg/l
pH	6 – 9 pH Units
Temperature	Ambient
Hydrocarbons	No film shall be visible on the final effluent

3. Monitoring

3.1 The Licensee shall arrange for the quarterly analysis of grab samples of the effluent from the pump chamber for the parameters set out in Condition 2.3. Analysis shall be carried out at an accredited laboratory

3.2 A non-compliance with any of the limits set in Condition 2.3, together with reasons for the non-compliance and details of measures being taken to correct the non-compliance should be submitted to Longford County Council.

3.3 The licensee shall ensure that there is safe and free access for sampling by authorised personnel at all times.

3.4 The Licensee shall keep records of all monitoring carried out. These records shall be available for inspection by authorised personnel of the Licensing Authority or its authorised agents or any statutory body having responsibility for water pollution control, at any time.

3.5 Copies of the analysis results shall be submitted to the Licensing Authority on a quarterly basis. The results will include details of date and time of sampling, and the name of the laboratory carrying out the sample analysis.

3.6 Longford County Council may arrange to have samples of effluent taken and analysed periodically. One sample per quarter will be the normal level of monitoring carried out unless Longford County Council believes that license levels are being exceeded and in such cases monitoring may be increased.

4. Contribution to Licensing Authority

4.1 The Licensee shall pay the Licensing Authority the sum of €150 (index linked) per sample or such other amount as the Licensing Authority from time to time determines. This shall be paid annually in full before 31st December of the year to which the monitoring relates.

5. Change of use of premises

5.1 This licence is for the discharge of effluent generated by the extraction and processing of aggregate. The licensee shall notify the licensing authority of any proposed changes in operation of the premises, such as washing of aggregate, manufacture of concrete or concrete products which would cause, or be likely to cause an alteration in the volume or composition of the treated effluent discharged.

6. Review of Licence

6.1 This licence may be reviewed when the licensing authority has reasonable grounds to do so, on request of the licensee, or otherwise every three years.

7. Date Effective From; 23rd October, 2020

Signed: _____

Director of Services

Lagan Materials Limited, trading as Breedon Ireland

Proposed Deepening & Southerly Extension at Aughnacliffe Quarry

Townlands of Aghamore Upper and Derreenavoggy, County Longford

Planning Application for Mineral Extraction

Hydrological & Hydrogeological Impact Assessment

April 2023

Appendix 5 Flow Rate Data for Dewatering Operation

BCL HYDRO
Consultant Hydrogeologists Limited

Technology Centre, Wolverhampton Science Park, Glashier Drive, Wolverhampton
West Midlands, WV10 9RU. Tel: 01902 824111, Fax: 01902 824112
email: info@bclhydro.co.uk, web: http://www.bclhydro.co.uk
Registered Office: 33, Wolverhampton Road, Cannock, West Midlands, WV11 1AP
Registered in England & Wales. Company Registration Number: 4043373

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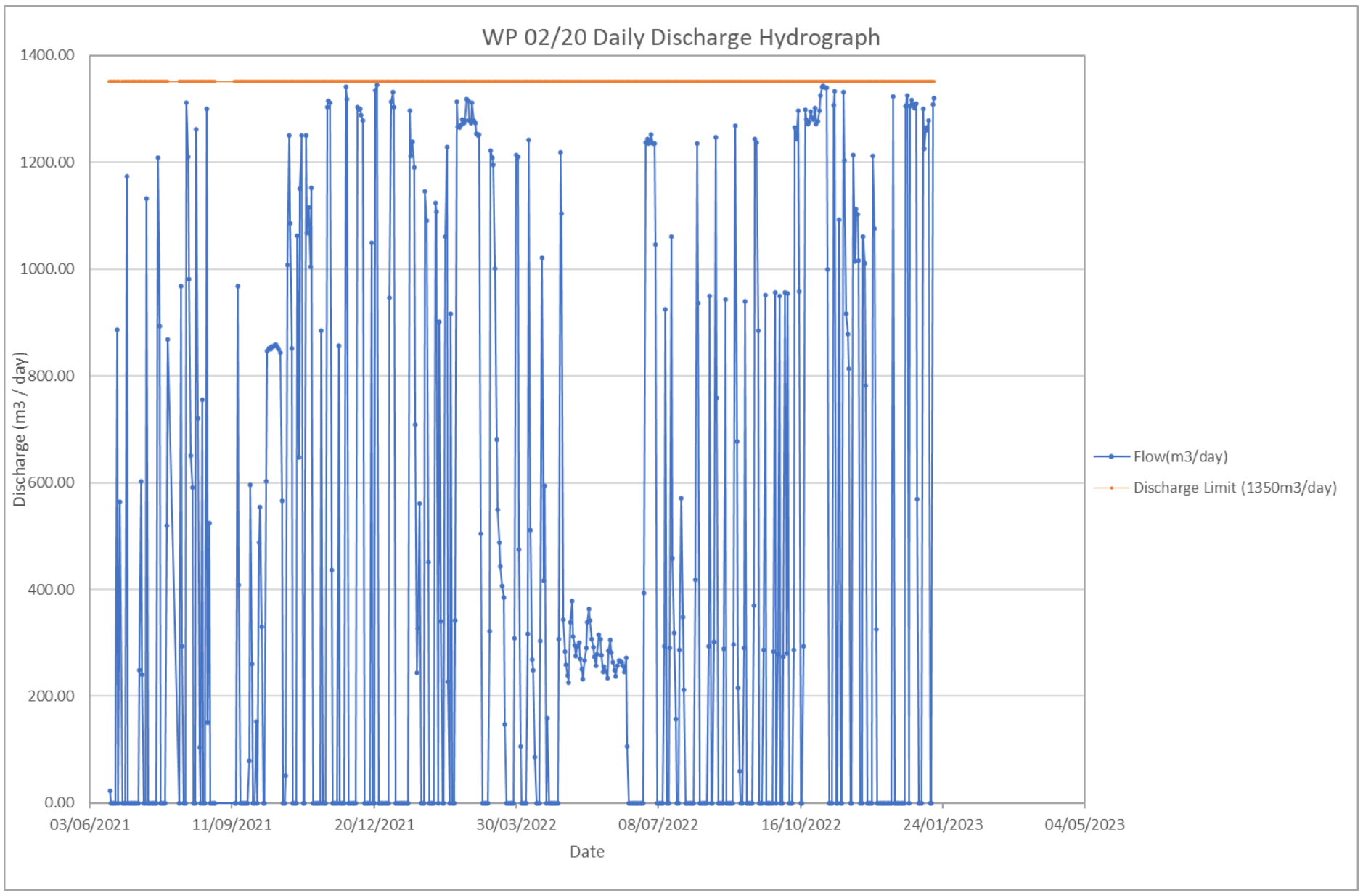
Flow(m^3/day)	Jun-21	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21	Jan-22	Feb-22	Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22	Nov-22	Dec-22	Jan-23
Day 1		0.00	0.00	0.00	555.07	0.00	1317.83	1313.03	1124.52	1273.69	475.18	1103.65	246.41	1235.84	0.00	678.01	949.27	1342.81	781.77	1304.69
Day 2		0.00	0.00	0.00	330.53	1250.84	0.00	1330.70	1107.08	1253.37	105.90	342.96	233.48	1236.49	0.00	215.81	0.00	1340.25	0.00	1315.78
Day 3		0.00	0.00	0.00	0.00	1067.86	0.00	1302.83	0.00	1250.75	0.00	282.90	284.86	1251.98	418.51	59.11	0.00	1339.01	0.00	1307.91
Day 4		0.00	0.00	0.00	0.00	1116.23	0.00	0.00	901.02	1251.39	0.00	258.46	306.01	1234.87	1235.34	0.00	273.94	998.59	0.00	1301.38
Day 5		0.00	0.00	0.00	602.17	1004.23	0.00	0.00	339.58	505.30	0.00	239.47	282.83	1235.23	936.06	0.00	956.85	0.00	0.00	1309.44
Day 6		0.00	968.21	0.00	846.13	1151.53	0.00	0.00	0.00	0.00	0.00	225.22	263.08	1045.89	0.00	289.57	60.57	0.00	1212.23	569.30
Day 7		0.00	293.47	0.00	851.05	0.00	0.00	0.00	0.00	0.00	316.11	339.15	249.62	0.00	0.00	938.83	954.89	0.00	1075.44	0.00
Day 8		249.45	0.00	0.00	849.85	0.00	1302.98	0.00	1060.59	0.00	1241.95	378.75	237.99	0.00	0.00	0.00	0.00	1306.57	325.42	0.00
Day 9		601.84	0.00	0.00	854.16	0.00	1298.67	0.00	1229.02	0.00	511.30	311.83	256.57	0.00	0.00	0.00	0.00	1332.41	0.00	0.00
Day 10		240.02	1311.87	0.00	855.31	0.00	1299.40	0.00	227.53	0.00	269.45	295.31	266.74	0.00	0.00	0.00	0.00	0.00	0.00	1299.96
Day 11		0.00	1209.78	0.00	857.55	0.00	1287.64	0.00	0.00	322.03	249.20	274.57	264.67	0.00	0.00	0.00	287.52	0.00	0.00	1225.39
Day 12		0.00	980.39	0.00	858.62	0.00	1277.88	0.00	916.45	1221.19	86.21	292.95	264.09	292.92	294.16	0.00	1265.09	1091.73	0.00	1265.38
Day 13		1132.36	649.99	0.00	852.83	885.09	0.00	0.00	0.00	1208.93	0.00	299.62	257.07	924.92	949.75	369.54	1243	0.00	0.00	1260.55
Day 14		0.00	591.17	0.00	849.20	0.00	0.00	1296.44	0.00	1195.19	0.00	269.71	246.24	0.00	0.00	1242.76	1297.3	0.00	0.00	1278.34
Day 15		0.00	0.00	967.52	843.76	0.00	0.00	1212.20	341.22	1000.49	0.00	250.29	271.56	0.00	0.00	1237.34	958.08	1332.07	0.00	0.00
Day 16		0.00	0.00	408.51	565.30	0.00	0.00	1237.70	1312.37	680.51	303.70	232.49	106.23	289.79	301.63	885.19	0.00	1204.35	0.00	0.00
Day 17	23.32	0.00	1261.17	0.00	0.00	1303.16	0.00	1189.83	1266.25	549.31	1020.57	267.40	0.00	1060.77	1246.56	0.00	0.00	916.22	0.00	1308.34
Day 18	0.00	0.00	719.79	0.00	0.00	1314.12	1048.85	709.42	1265.75	487.89	417.08	290.52	0.00	458.34	758.46	0.00	293.28	877.46	0.00	1319.30
Day 19	0.00	0.00	104.93	0.00	51.59	1311.12	0.00	244.08	1269.55	442.63	594.48	338.94	0.00	318.26	0.00	0.00	1297.64	813.48	0.00	
Day 20	0.00	0.00	0.00	0.00	1007.46	437.24	0.00	326.98	1280.20	406.20	0.00	363.61	0.00	156.94	0.00	286.44	1279.59	0.00	1322.54	
Day 21	0.00	1208.58	755.90	0.00	1250.15	0.00	1334.03	561.52	1272.93	385.24	158.44	341.28	0.00	0.00	0.00	950.43	1271.07	0.00	0.00	
Day 22	886.06	893.88	0.00	0.00	1086.48	0.00	1344.18	0.00	1278.07	147.64	0.00	307.04	0.00	0.00	0.00	0.00	1275.64	1213.67	0.00	
Day 23	0.00	0.00	0.00	79.13	852.38	0.00	0.00	0.00	1318.88	0.00	0.00	291.26	0.00	287.60	288.56	0.00	1294.86	1013.68	0.00	
Day 24	564.07	0.00	1300.00	596.50	0.00	0.00	0.00	0.00	1315.60	0.00	0.00	273.73	0.00	571.51	942.68	0.00	1282.44	1111.97	0.00	
Day 25	0.00	0.00	150.12	259.89	0.00	857.21	0.00	1145.23	1277.49	0.00	0.00	256.87	0.00	349.00	0.00	0.00	1280.19	1101.95	0.00	
Day 26	0.00	0.00	524.98	0.00	0.00	0.00	0.00	1090.48	1274.01	0.00	0.00	278.14	0.00	212.80	0.00	0.00	1300.78	1015.66	0.00	
Day 27	0.00	518.83	0.00	0.00	1061.82	0.00	0.00	451.58	1312.02	0.00	0.00	314.72	0.00	0.00	0.00	283.31	1271.82	0.00	0.00	
Day 28	0.00	868.54	0.00	152.59	647.50	0.00	0.00	0.00	1278.42	0.00	0.00	307.33	392.94	0.00	0.00	956.65	1276.34	0.00	0.00	
Day 29	1173.23	0.00	0.00	0.00	1150.22	0.00	0.00	0.00		307.98	306.88	276.94	1237.33	0.00	0.00	0.00	1296.82	1061.06	1304.34	
Day 30	0.00	0.00	0.00	487.97	1250.26	1340.93	0.00	0.00		1214.04	1217.92	245.89	1244.08	0.00	297.37	278.23	1325.56	1010.25	1324.00	
Day 31		0.00			0.00		946.11	0.00		1210.85		256.20		0.00	1267.72		1341.01		0.00	



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Hydrological & Hydrogeological Impact Assessment

April 2023

Appendix 6 Groundwater Level Data

BCL HYDRO
Consultant Hydrogeologists Limited

Technology Centre, Wolverhampton Science Park, Glashier Drive, Wolverhampton
West Midlands, WV10 9RU. Tel: 01902 824111, Fax: 01902 824112
email: info@bclhydro.co.uk, web: http://www.bclhydro.co.uk
Registered Office: 33, Wolverhampton Road, Cannock, West Midlands, WV11 1AP
Registered in England & Wales. Company Registration Number: 4043373

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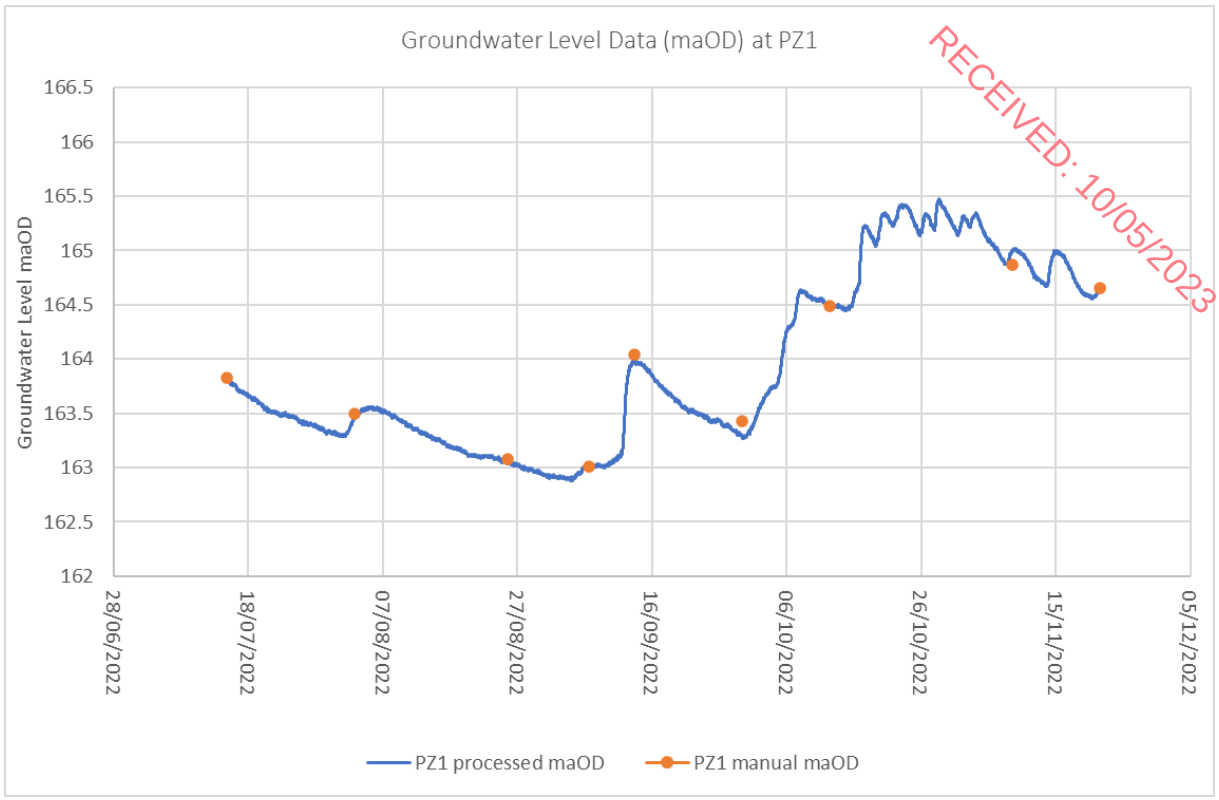
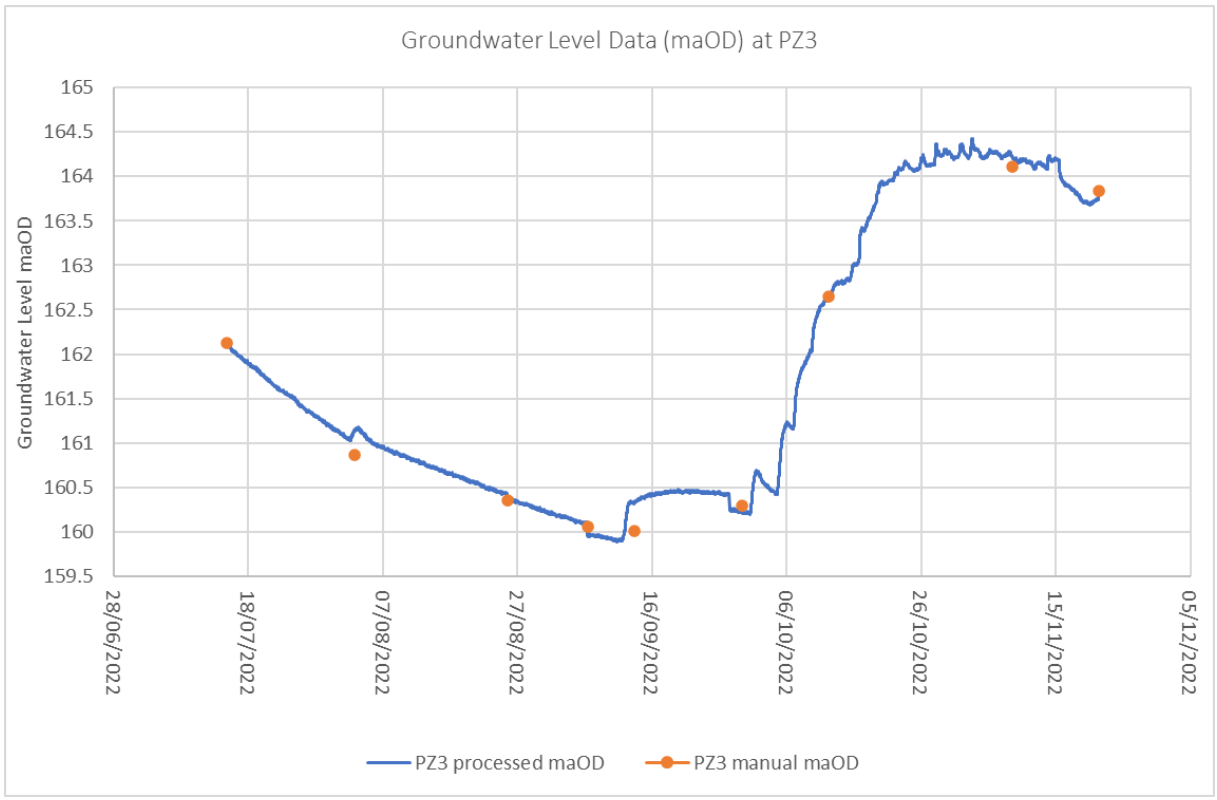
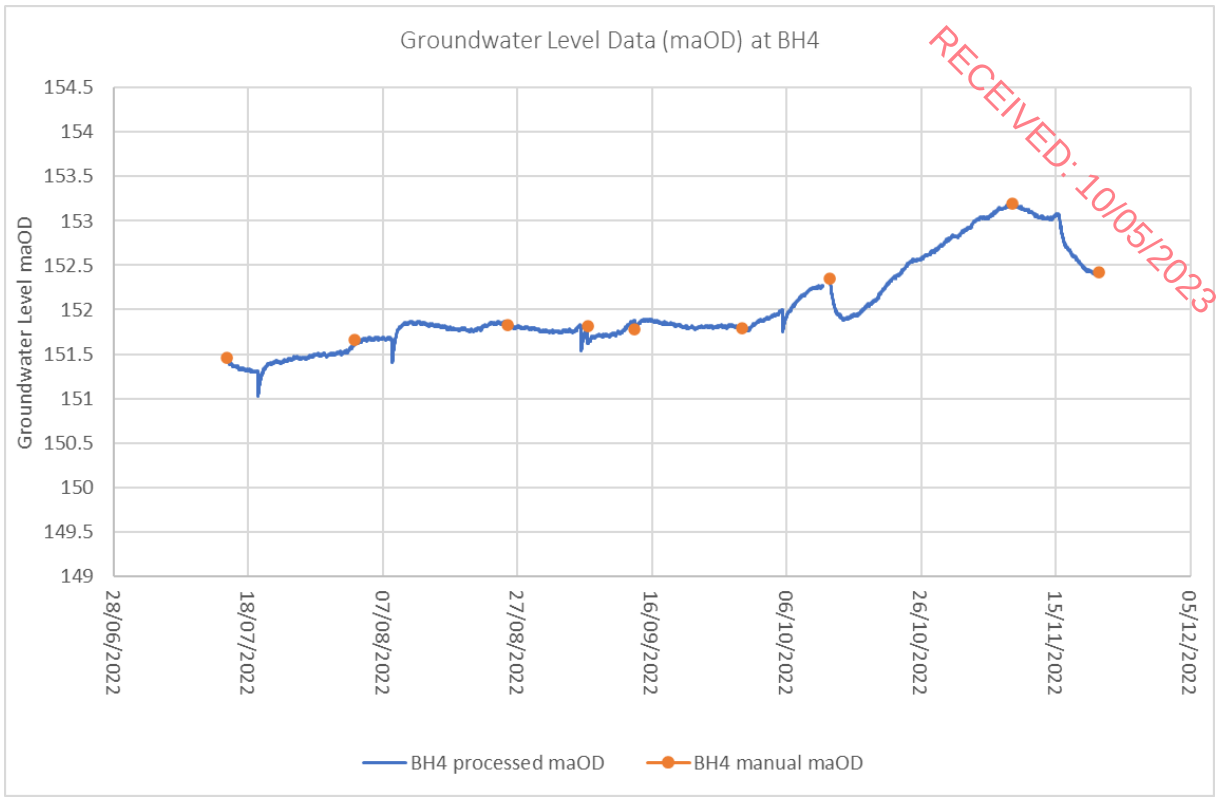
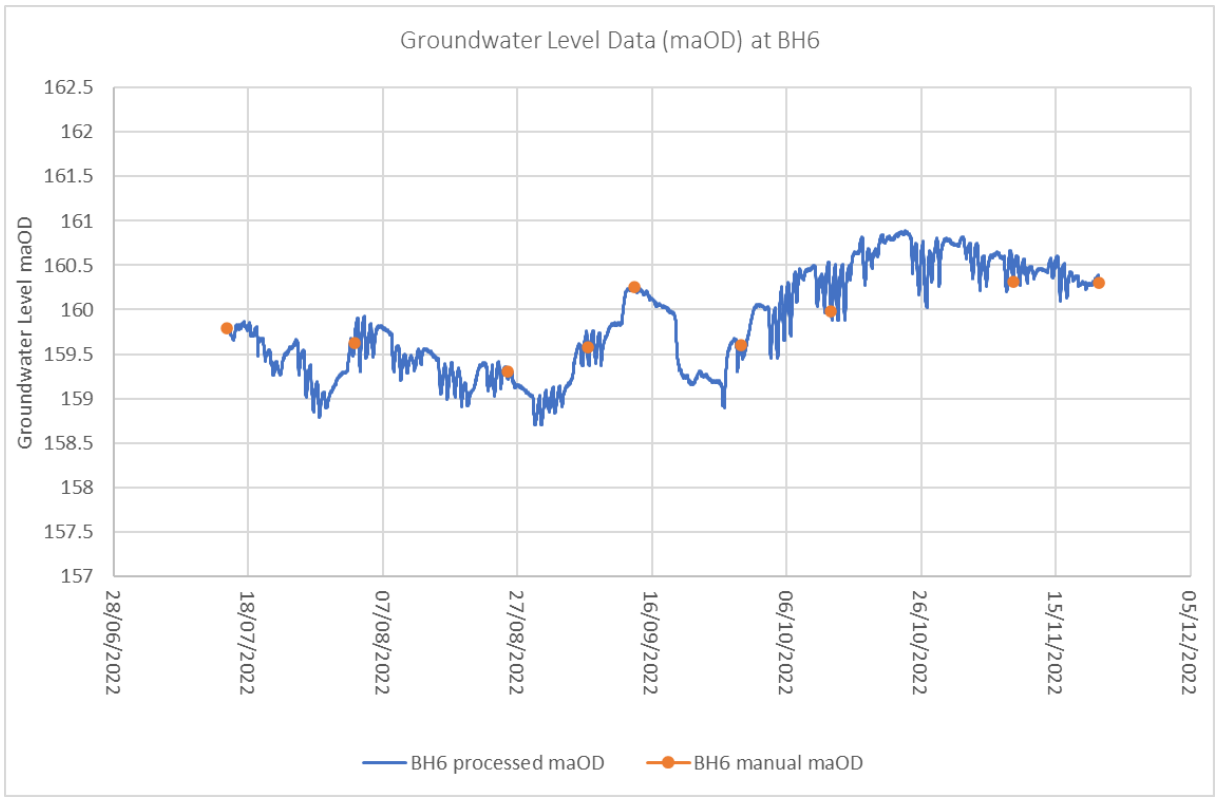
Date	Well E	BH 4	BH 5	BH 6	PZ 1	PZ 2	PZ 3	Well F
Easting	624167.48	623789.7	623999.2	624245.2	623980.4	623779.7	623633.22	623791.24
Northing	785795.49	786122.4	786032.1	786031.0	785677.2	785754.2	785972.69	786125.78
Elevation mOD	172.52	172.07	154.59	162.53	166.66	175.49	169.38	172.33
Date	SWL (mbtoc)							
03/06/2022	5.22	21.07	4.72	2.81	2.95	10.08	7.97	20.94
09/06/2022	5.46	21.52	4.78	3.33	2.98	10.64	7.99	21.02
14/06/2022	5.32	21.15	4.73	3.07	2.92	10.94	8.06	21.14
21/06/2022	5.18	20.74	4.56	3.50	2.76	11.39	8.57	21.38
02/07/2022	5.02	20.44	4.34	2.19	2.68	11.23	7.36	20.48
08/07/2022	4.97	20.56	4.49	3.02	2.64	11.19	8.40	21.22
14/07/2022	5.01	20.61	4.56	2.74	2.83	9.32	7.26	21.33
02/08/2022	5.39	20.41	4.08	2.91	3.16	11.05	8.51	20.69
25/08/2022	5.26	20.24	4.71	3.22	3.58	12.17	9.03	20.76
06/09/2022	5.41	20.26	4.79	2.95	3.65	12.22	9.32	20.87
13/09/2022	5.28	20.29	4.32	2.28	2.62	10.98	9.37	20.65
29/09/2022	5.47	20.28	4.83	2.93	3.23	11.04	9.09	21.09
12/10/2022	5.39	19.72	4.21	2.55	2.17	10.78	6.73	20.89
08/11/2022	5.13	18.88	4.09	2.21	1.79	10.42	5.27	20.38
21/11/2022	5.24	19.65	4.24	2.23	2.01	10.59	5.54	19.4

Date	Well E	BH 4	BH 5	BH 6	PZ 1	PZ 2	PZ 3	Well F
Easting	624167.48	623789.7	623999.2	624245.2	623980.4	623779.7	623633.22	623791.24
Northing	785795.49	786122.4	786032.1	786031.0	785677.2	785754.2	785972.69	786125.78
Elevation mOD	172.52	172.07	154.59	162.53	166.66	175.49	169.38	172.33
WL mOD								
03/06/2022	167.30	151.00	149.87	159.72	163.71	165.41	161.41	151.39
09/06/2022	167.06	150.55	149.81	159.20	163.68	164.85	161.39	151.31
14/06/2022	167.20	150.92	149.86	159.46	163.74	164.55	161.32	151.19
21/06/2022	167.34	151.33	150.03	159.03	163.90	164.10	160.81	150.95
02/07/2022	167.50	151.63	150.25	160.34	163.98	164.26	162.02	151.85
08/07/2022	167.55	151.51	150.10	159.51	164.02	164.30	160.98	151.11
14/07/2022	167.51	151.46	150.03	159.79	163.83	166.17	162.12	151.00
02/08/2022	167.13	151.66	150.51	159.62	163.50	164.44	160.87	151.64
25/08/2022	167.26	151.83	149.88	159.31	163.08	163.32	160.35	151.57
06/09/2022	167.11	151.81	149.80	159.58	163.01	163.27	160.06	151.46
13/09/2022	167.24	151.78	150.27	160.25	164.04	164.51	160.01	151.68
29/09/2022	167.05	151.79	149.76	159.60	163.43	164.45	160.29	151.24
12/10/2022	167.13	152.35	150.38	159.98	164.49	164.71	162.65	151.44
08/11/2022	167.39	153.19	150.50	160.32	164.87	165.07	164.11	151.95
21/11/2022	167.28	152.42	150.35	160.30	164.65	164.90	163.84	152.93









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April 2023

Appendix 7 Falling Head Test Data and Analysis

BCL HYDRO
Consultant Hydrogeologists Limited

Technology Centre, Wolverhampton Science Park, Glashier Drive, Wolverhampton
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email: info@bclhydro.co.uk, web: http://www.bclhydro.co.uk
Registered Office: 33, Wolverhampton Road, Cannock, West Midlands, WV11 1AP
Registered in England & Wales. Company Registration Number: 4043373

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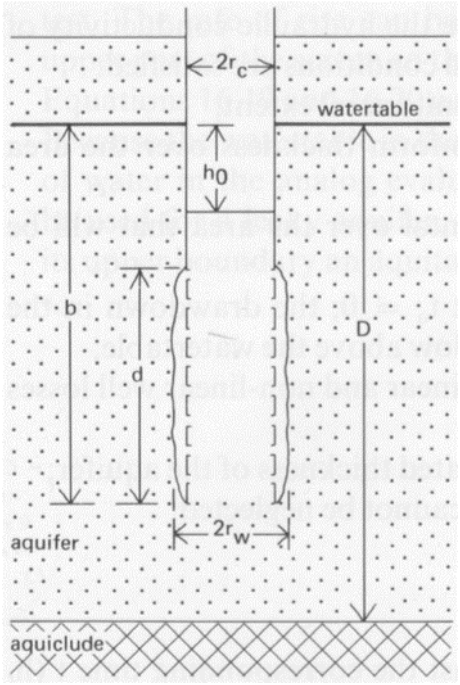


Pz1-22

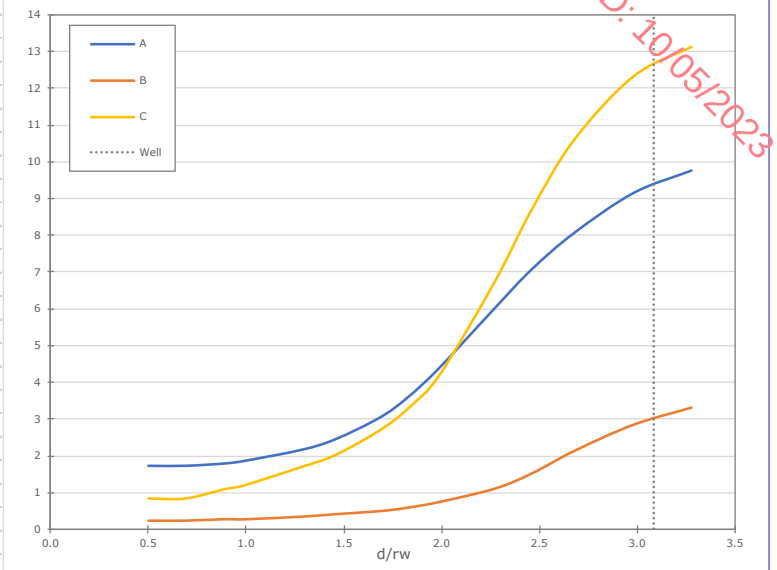
BOUWER-RICE ANALYSIS (PARTIALLY PENTRATING BOREHOLE)

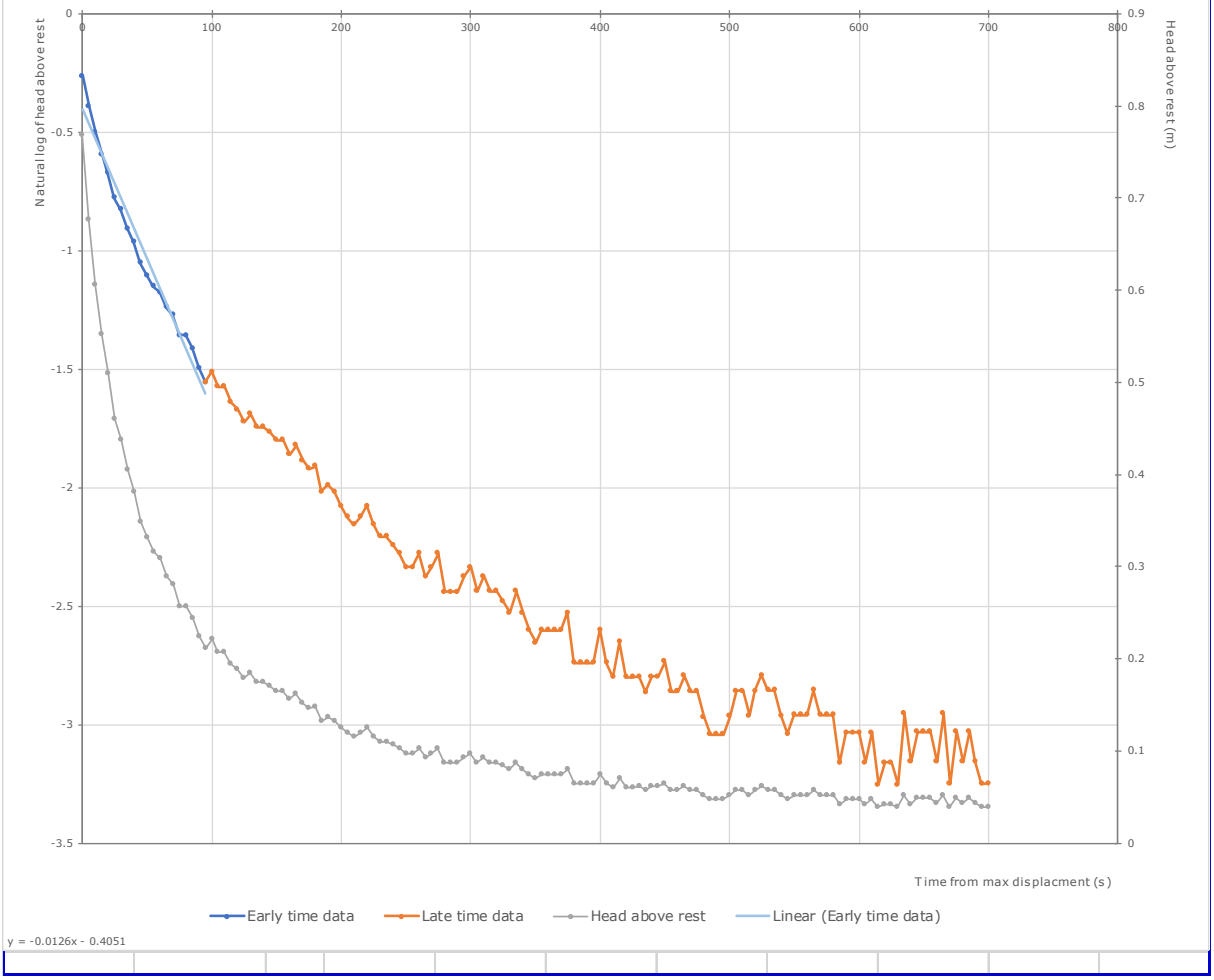
CALCULATION FOR HYDRAULIC CONDUCTIVITY (K) FROM SLUG TEST

Assumes aquifer is unconfined, homogeneous etc.

INPUTS

Screen length (m); d	=	94.00
Drilled radius (m); r_w	=	0.08
Casing radius (m); r_c	=	0.06
Base of deposit (mb collar)	=	202.00
Base of piezometer (mb collar)	=	95.00
Dip to water level (m)	=	2.14
Graph gradient (s^{-1}); $(1/t)\ln(h_0/h_t)$	=	0.0126
(linear approx. to early time data)		
A	=	9.368623368
B	=	3.011708444
(Published graph from d/r_w)		
Calculations		
D (m)	=	199.86
b (m)	=	92.86
d/r_w	=	1212.903226
$\ln(Re/r_w)$	=	5.529236873
K (ms^{-1})	=	1.44756E-06
K (md^{-1})	=	0.125069573





Pz2-22

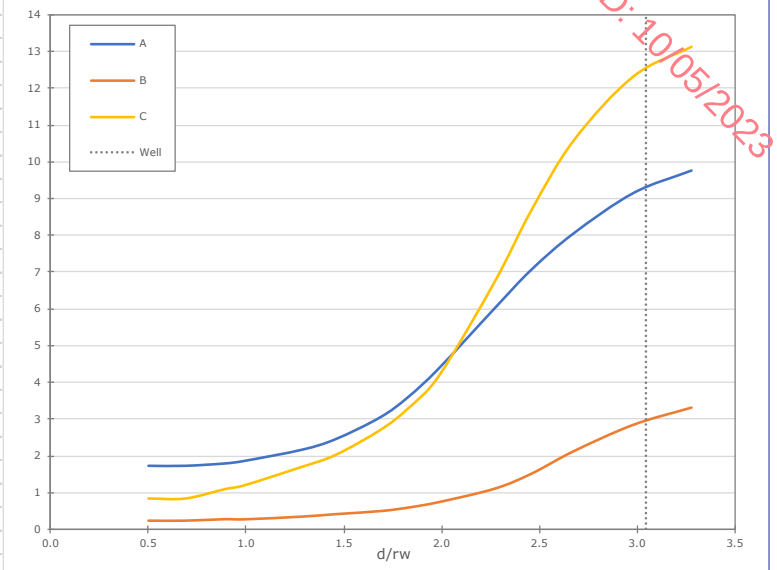
BOUWER-RICE ANALYSIS (PARTIALLY PENTRATING BOREHOLE)

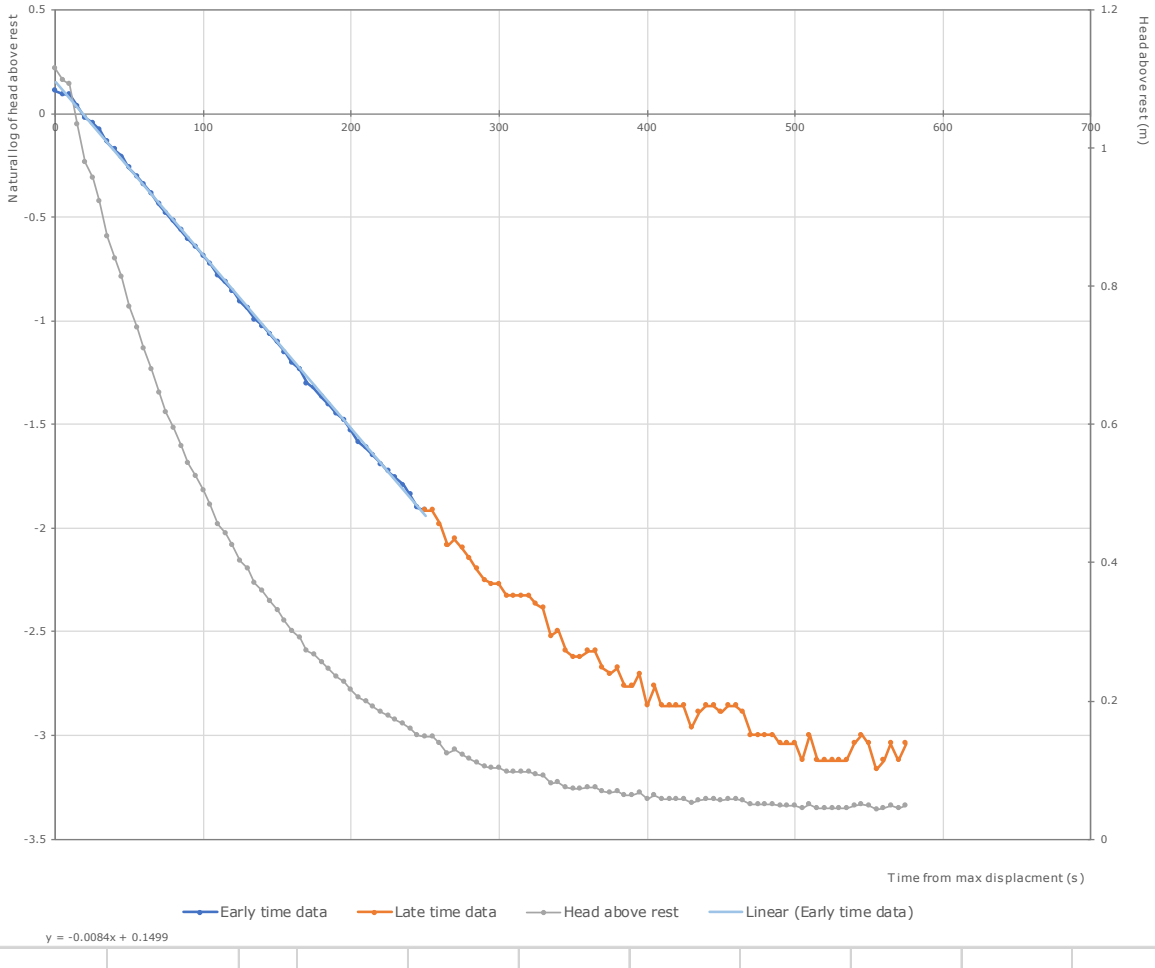
CALCULATION FOR HYDRAULIC CONDUCTIVITY (K) FROM SLUG TEST

Assumes aquifer is unconfined, homogeneous etc.

INPUTS

Screen length (m); d	=	86.00
Drilled radius (m); r_w	=	0.08
Casing radius (m); r_c	=	0.06
Base of deposit (mb collar)	=	202.00
Base of piezometer (mb collar)	=	87.60
Dip to water level (m)	=	7.16
Graph gradient (s^{-1}); $(1/t)\ln(h_0/h_t)$	=	0.0084
(linear approx. to early time data)		
A	=	9.28905522
B	=	2.950632403
(Published graph from d/r_w)		
Calculations		
D (m)	=	194.84
b (m)	=	80.44
d/r_w	=	1109.677419
$\ln(Re/r_w)$	=	5.371673292
K (ms^{-1})	=	1.02476E-06
K (md^{-1})	=	0.088538917





Pz3-22

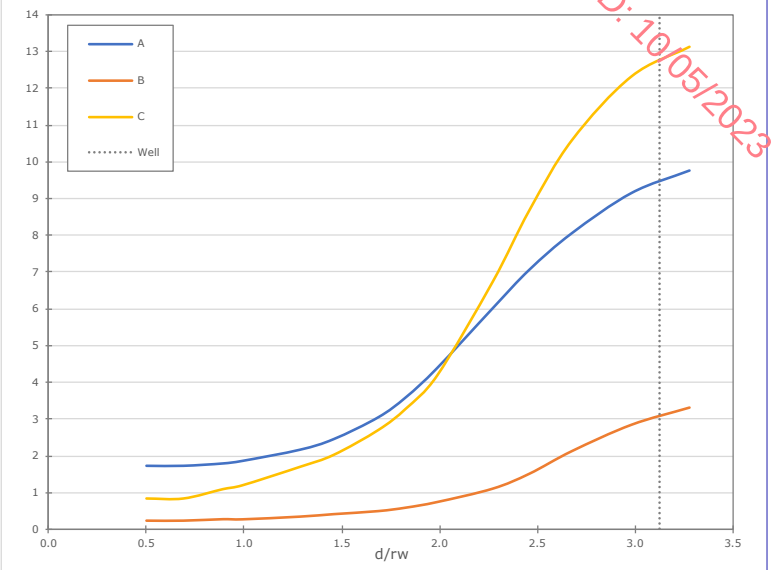
BOUWER-RICE ANALYSIS (PARTIALLY PENTRATING BOREHOLE)

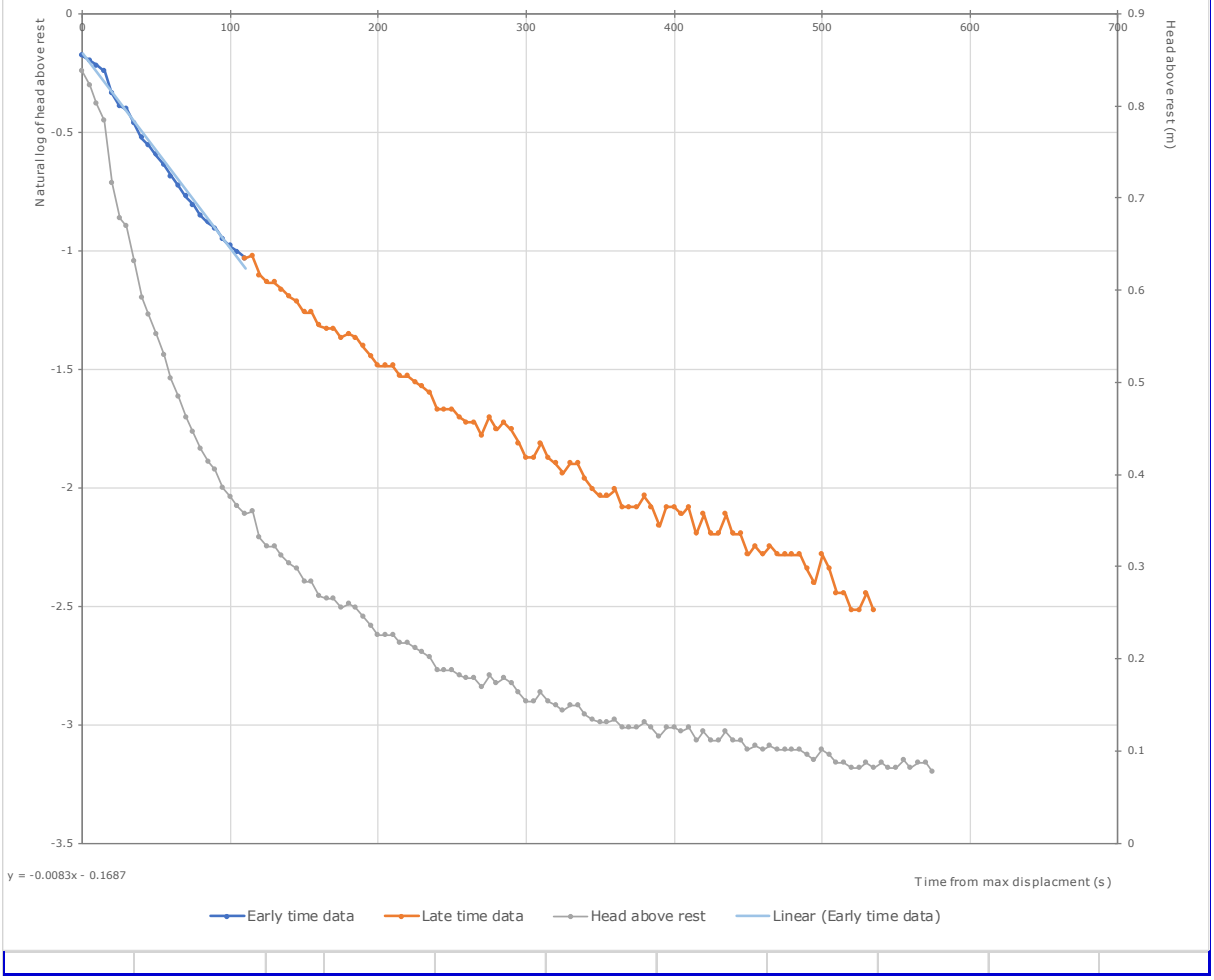
CALCULATION FOR HYDRAULIC CONDUCTIVITY (K) FROM SLUG TEST

Assumes aquifer is unconfined, homogeneous etc.

INPUTS

Screen length (m); d	=	103.60
Drilled radius (m); r_w	=	0.08
Casing radius (m); r_c	=	0.06
Base of deposit (mb collar)	=	202.00
Base of piezometer (mb collar)	=	104.60
Dip to water level (m)	=	6.82
Graph gradient (s^{-1}); (1/t)ln(h_0/h_t)	=	0.0083
(linear approx. to early time data)		
A	=	9.455611879
B	=	3.078480313
(Published graph from d/r_w)		
Calculations		
D (m)	=	195.18
b (m)	=	97.78
d/r_w	=	1336.774194
ln(Re/r_w)	=	5.631736157
K (ms^{-1})	=	8.81233E-07
K (md^{-1})	=	0.076138518





BH4-22

BOUWER-RICE ANALYSIS (PARTIALLY PENTRATING BOREHOLE)

CALCULATION FOR HYDRAULIC CONDUCTIVITY (K) FROM SLUG TEST

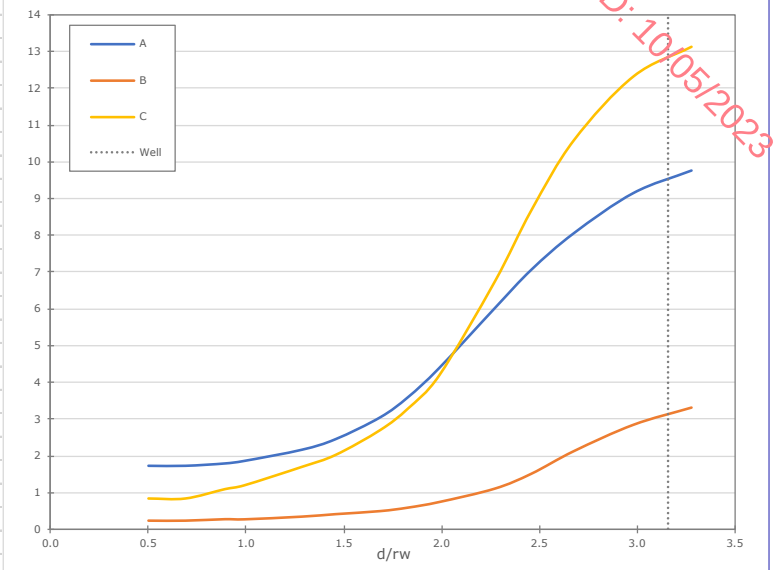
Assumes aquifer is unconfined, homogeneous etc.

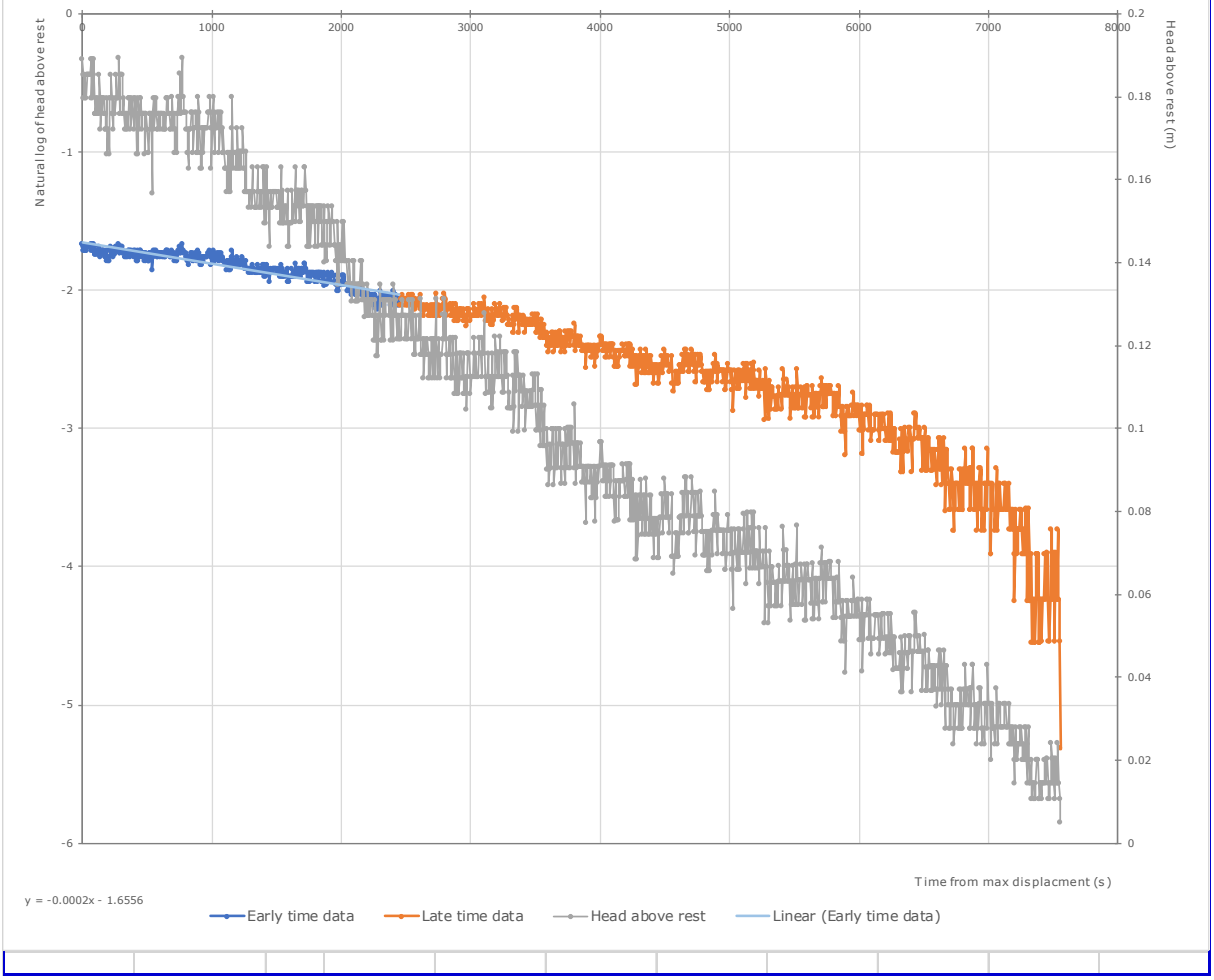
INPUTS

Screen length (m); d	=	111.00
Drilled radius (m); r_w	=	0.08
Casing radius (m); r_c	=	0.06
Base of deposit (mb collar)	=	202.00
Base of piezometer (mb collar)	=	112.00
Dip to water level (m)	=	19.80
Graph gradient (s^{-1}); (1/t)ln(h_0/h_t)	=	0.0002
(linear approx. to early time data)		
A	=	9.517329587
B	=	3.125854462
(Published graph from d/r_w)		

Calculations

D (m)	=	182.2
b (m)	=	92.2
d/r_w	=	1432.258065
$\ln(Re/r_w)$	=	5.637519947
K (ms^{-1})	=	1.98392E-08
K (md^{-1})	=	0.001714111





BH6-22

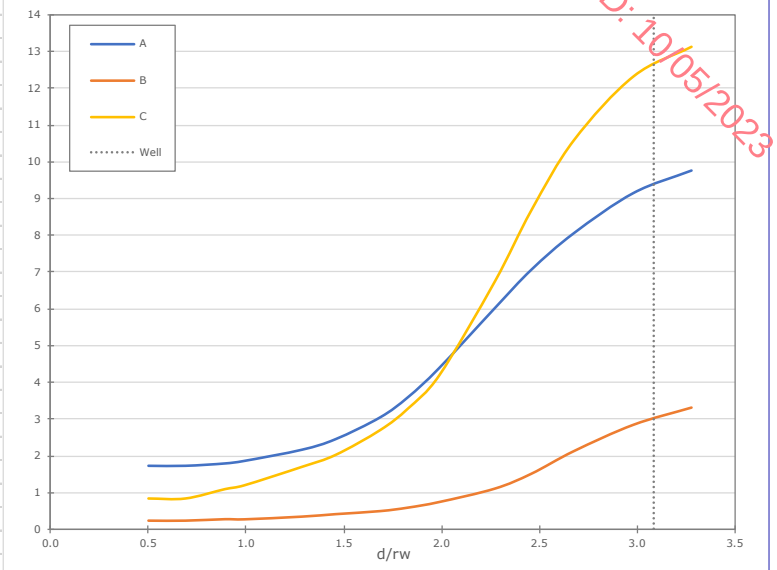
BOUWER-RICE ANALYSIS (PARTIALLY PENTRATING BOREHOLE)

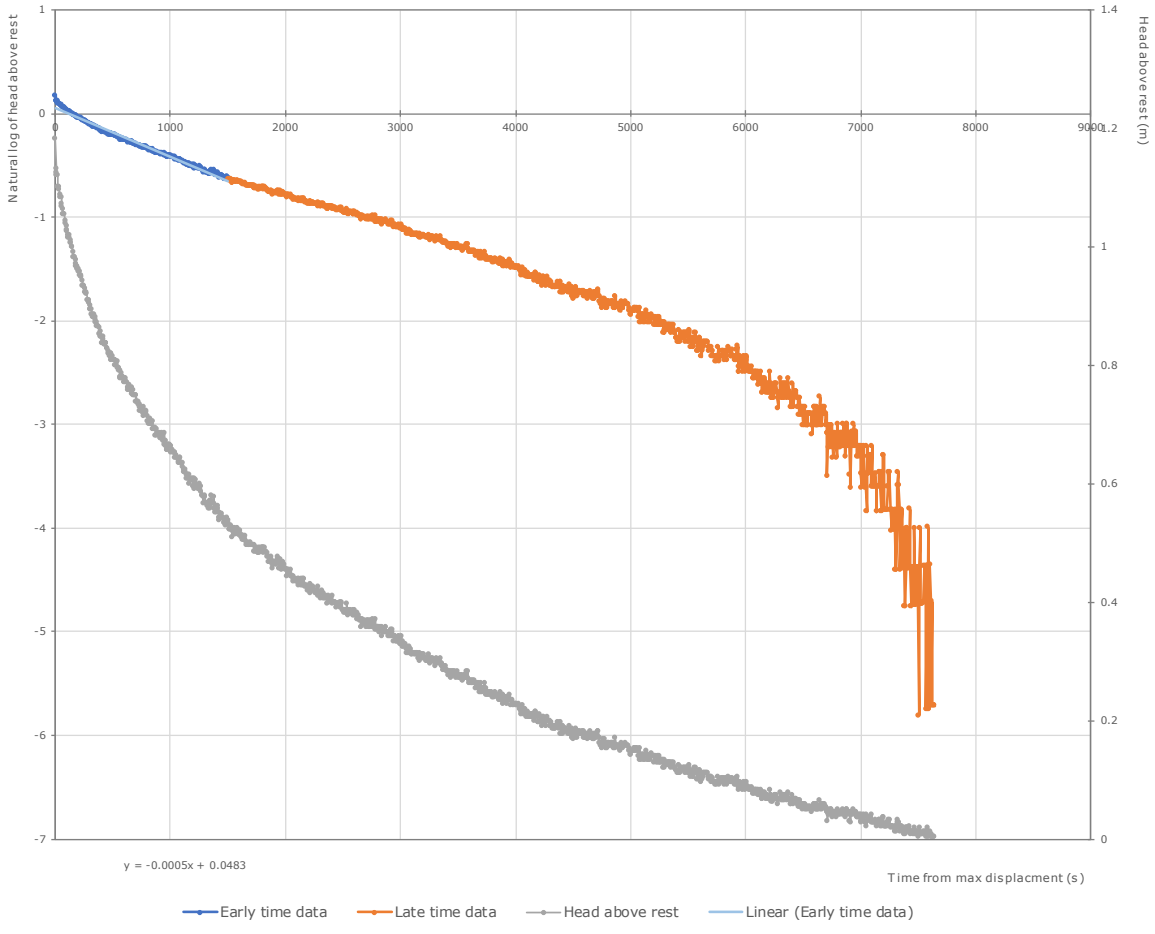
CALCULATION FOR HYDRAULIC CONDUCTIVITY (K) FROM SLUG TEST

Assumes aquifer is unconfined, homogeneous etc.

INPUTS

Screen length (m); d	=	94.00
Drilled radius (m); r_w	=	0.08
Casing radius (m); r_c	=	0.06
Base of deposit (mb collar)	=	202.00
Base of piezometer (mb collar)	=	95.00
Dip to water level (m)	=	2.34
Graph gradient (s^{-1}); $(1/t)\ln(h_0/h_t)$	=	0.0005
(linear approx. to early time data)		
A	=	9.368623368
B	=	3.011708444
(Published graph from d/r_w)		
Calculations		
D (m)	=	199.66
b (m)	=	92.66
d/r_w	=	1212.903226
$\ln(Re/r_w)$	=	5.527793781
K (ms^{-1})	=	5.7428E-08
K (md^{-1})	=	0.004961783





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Appendix 8 Laboratory Certificates for Water Samples

BCL HYDRO
Consultant Hydrogeologists Limited

Technology Centre, Wolverhampton Science Park, Glashier Drive, Wolverhampton
West Midlands, WV10 9RU. Tel: 01902 824111, Fax: 01902 824112
email: info@bclhydro.co.uk, web: http://www.bclhydro.co.uk
Registered Office: 33, Wolverhampton Road, Cannock, West Midlands, WV11 1AP
Registered in England & Wales. Company Registration Number: 4043373

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tms environment ltd

TMS Environment Ltd
53 Broomhill Drive
Tallaght
Dublin 24

Phone: +353-1-4626710
Fax: +353-1-4626714
Web: www.tmsenv.ie

Confidential Laboratory Test Report

Client: Lagan
Aughnacliffe
Co. Longford

F.T.A.O: John Fennell
Commencement Date: 19 July 2022
Completion Date: 11 August 2022
Report Date: 29 September 2022
Page: 1 of 9

TMS Environment Ref: 30370

Sample Type: Ground Water

TEST RESULTS

Parameter	30370-1 PZ1-22	30370-2 PZ2-22	30370-3 PZ3-22	30370-4 BH4-22	Units	Methodology	Test Procedure Ref.
Temperature**	18.7	17.4	16.9	17.0	°C	DO Meter	QP-MEAS-2011
DO**	51.7	85.5	84.6	67.5	% Sat	DO Meter	QP-MEAS-2019
DO**	4.95	8.27	8.22	6.56	mg/l O_2	DO Meter	QP-MEAS-2019
pH**	7.3	7.7	7.7	7.9	pH Units	pH Probe	QP-MEAS-2011
Conductivity**	581	413	368	462	µS/cm @ 25°C	Conductivity Meter	QP-MEAS-2009
BOD*	2.9	3.5	4.1	3.4	mg/l cBOD5	5 Day incubation/DO probe	QP-CHEM-2016
COD*	6	6	5	5	mg/l O_2	Digestion spectrophotometry	QP-CHEM-2065
Suspended Solids*	11	36	8	5	mg/l SS	Gravimetry	QP-CHEM-2002
Total Dissolved Solids	338	224	184	247	mg/l TDS	Gravimetry	QP-CHEM-2059
TOC	6.3	2.5	2.5	4.0	mg/l C	Spectrophotometry	QP-CHEM-2071
DOC	2.2	1.7	1.2	5.7	mg/l C	Spectrophotometry	QP-CHEM-2071
Colour	9	19	21	14	mg/l PtCo	Spectroscopy	QP-CHEM-2064
Turbidity	2.57	11.9	3.51	1.05	NTU	Turbidimetry	QP-CHEM-2014
Ammonia	0.03	< 0.02	0.03	< 0.02	mg/l	Auto Analyser	QP-CHEM-2037
Orthophosphate	< 0.02	< 0.02	< 0.02	< 0.02	mg/l P	Auto Analyser	QP-CHEM-2040
TON	< 0.50	3.93	3.37	< 0.50	mg/l N	Auto Analyser	QP-CHEM-2042
Nitrate (NO_3-N)	< 0.50	3.92	3.38	< 0.50	mg/l N	Auto Analyser	QP-CHEM-2043
Nitrite (NO_2-N)	< 0.002	0.02	< 0.002	< 0.002	mg/l N	Auto Analyser	QP-CHEM-2087
Alkalinity	223	164	155	192	mg/l $CaCO_3$	Titration	QP-CHEM-2012

Parameter	30370-1 PZ1-22	30370-2 PZ2-22	30370-3 PZ3-22	30370-4 BH4-22	Units	Methodology	Test Procedure Ref.
Chloride	16.5	15.5	10.0	13.5	mg/l Cl	Titration	QP-CHEM-2035
Sulphate	68.5	14.8	6.9	29.8	mg/l SO_4	Auto Analyser	QP-CHEM-2013
Fluoride	0.06	0.07	0.10	0.18	mg/l F	Auto Analyser	QP-CHEM-2013

* In-house Accredited Test
**On-site Accredited Test

Parameter	30370-1 PZ1-22	30370-2 PZ2-22	30370-3 PZ3-22	30370-4 BH4-22	Units	Methodology	Test Procedure Ref.
Ethylbenzene	< 1	< 1	< 1	< 1	ug/l	Note 1	Note 1
Benzene	< 1	< 1	< 1	< 1	ug/l	Note 1	Note 1
Toluene	< 1	< 1	< 1	< 1	ug/l	Note 1	Note 1
m&p Xylene	< 1	< 1	< 1	< 1	ug/l	Note 1	Note 1
o-Xylene	< 1	< 1	< 1	< 1	ug/l	Note 1	Note 1
Enterococci	0	2	> 200	0	cfu/l00 ml	Note 1	Note 1
E Coli (Colilert)	0	0	0	0	mpn/100 ml	Note 1	Note 1
Aluminium, Filtered as Al***	< 0.1	< 0.1	< 0.1	< 0.1	mg/l	Note 1	Note 1
Barium, Filtered as Ba***	0.032	0.026	0.066	0.059	mg/l	Note 1	Note 1
Boron, Filtered as B***	< 0.23	< 0.23	< 0.23	< 0.23	mg/l	Note 1	Note 1
Cadmium, Filtered as Cd***	< 0.0006	< 0.0006	< 0.0006	< 0.0006	mg/l	Note 1	Note 1
Calcium, Filtered as Ca***	61.1	42.7	38.7	44.4	mg/l	Note 1	Note 1
Chromium, Filtered as Cr***	< 0.002	0.003	< 0.002	< 0.002	mg/l	Note 1	Note 1
Chromium-Hexavalent***	< 0.003	< 0.003	< 0.003	< 0.003	mg/l	Note 1	Note 1
Copper, Filtered as Cu***	< 0.009	< 0.009	< 0.009	< 0.009	mg/l	Note 1	Note 1
Iron, Filtered as Fe***	< 0.23	< 0.23	< 0.23	< 0.23	mg/l	Note 1	Note 1
Lead, Filtered as Pb***	< 0.006	< 0.006	< 0.006	< 0.006	mg/l	Note 1	Note 1
Magnesium, Filtered as Mg***	27.7	16.9	16.9	24.8	mg/l	Note 1	Note 1
Manganese, Filtered as Mn***	3.13	< 0.007	0.010	< 0.007	mg/l	Note 1	Note 1
Mercury, Filtered as Hg***	< 0.00001	< 0.00001	< 0.00001	< 0.00001	mg/l	Note 1	Note 1
Molybdenum, Filtered as Mo***	0.036	< 0.003	< 0.003	0.006	mg/l	Note 1	Note 1
Nickel, Filtered as Ni***	0.004	0.003	< 0.003	< 0.003	mg/l	Note 1	Note 1

Parameter	30370-1 PZ1-22	30370-2 PZ2-22	30370-2 PZ2-22	30370-4 BH4-22	Units	Methodology	Test Procedure Ref.
Potassium, Filtered as K***	1.40	2.17	1.99	2.30	mg/l	Note 1	Note 1
Sodium, Filtered as Na***	13.5	11.9	13.4	19.9	mg/l	Note 1	Note 1
Zinc, Filtered as Zn***	0.035	< 0.018	< 0.018	< 0.018	mg/l	Note 1	Note 1
Total Hardness as CaCO3***	267	186	166	213	mg/l	Note 1	Note 1
Cyanide, Total as CN***	< 0.009	< 0.009	< 0.009	< 0.009	mg/l	Note 1	Note 1
Aliphatic VPH >C5-C6***	< 10	< 10	< 10	< 10	ug/l	Note 1	Note 1
Aliphatic VPH >C6-C8***	< 10	< 10	< 10	< 10	ug/l	Note 1	Note 1
Aliphatic VPH >C8-C10***	< 10	< 10	< 10	< 10	ug/l	Note 1	Note 1
Aliphatic VPH >C5-C10***	< 10	< 10	< 10	< 10	ug/l	Note 1	Note 1
Aromatic VPH > C5-C7***	< 10	< 10	< 10	< 10	ug/l	Note 1	Note 1
Aromatic VPH > C7-C8***	< 10	< 10	< 10	< 10	ug/l	Note 1	Note 1
Aromatic VPH > C8-C10***	< 10	< 10	< 10	< 10	ug/l	Note 1	Note 1
Aromatic VPH >C5-C10***	< 10	< 10	< 10	< 10	ug/l	Note 1	Note 1
VPH >C5-C10***	< 10	< 10	< 10	< 10	ug/l	Note 1	Note 1
Aliphatic EPH > C10-C12	< 10	< 10	< 10	< 10	ug/l	Note 1	Note 1
Aliphatic EPH >C12-C16	< 10	< 10	< 10	< 10	ug/l	Note 1	Note 1
Aliphatic EPH >C16-C35	< 10	< 10	< 10	< 10	ug/l	Note 1	Note 1
Aliphatic EPH >C35-C44	< 10	< 10	< 10	< 10	ug/l	Note 1	Note 1
Aliphatic EPH >C10-C44	< 10	< 10	< 10	< 10	ug/l	Note 1	Note 1
Aromatic EPH > C10-C12	< 10	< 10	< 10	< 10	ug/l	Note 1	Note 1
Aromatic EPH >C12-C16	< 10	< 10	< 10	< 10	ug/l	Note 1	Note 1
Aromatic EPH > C16-C21	< 10	< 10	< 10	< 10	ug/l	Note 1	Note 1
Aromatic EPH >C21-C35	< 10	< 10	< 10	< 10	ug/l	Note 1	Note 1
Aromatic EPH >C35-C44	< 10	< 10	< 10	< 10	ug/l	Note 1	Note 1
Aromatic EPH >C10-C44	< 10	< 10	< 10	< 10	ug/l	Note 1	Note 1
EPH >C10-C44	< 10	< 10	< 10	< 10	ug/l	Note 1	Note 1
Aliphatic VPH/EPH >C5-C44	< 10	< 10	< 10	< 10	ug/l	Note 1	Note 1
Aromatic VPH/EPH >C5-C44	< 10	< 10	< 10	< 10	ug/l	Note 1	Note 1

Parameter	30370-1 PZ1-22	30370-2 PZ2-22	30370-2 PZ2-22	30370-4 BH4-22	Units	Methodology	Test Procedure Ref.
VPH/EPH >C5-C44	< 10	< 10	< 10	< 10	ug/l	Note 1	Note 1
Arsenic, filter as AS***	1.4	3.9	1.4	20	ug/l	Note 1	Note 1
Selenium, filter as Se***	< 1.2	< 1.2	< 1.2	< 1.2	ug/l	Note 1	Note 1
Antimony, filter as Sb***	5.1	6.1	5.6	21	ug/l	Note 1	Note 1
Naphthalene***	< 0.010	< 0.010	< 0.010	< 0.010	ug/l	Note 1	Note 1
Acenaphthylene***	< 0.010	0.037	< 0.010	< 0.010	ug/l	Note 1	Note 1
Acenaphthene***	< 0.010	< 0.010	< 0.010	< 0.010	ug/l	Note 1	Note 1
Fluorene***	< 0.010	< 0.010	< 0.010	< 0.010	ug/l	Note 1	Note 1
Phenanthrene***	< 0.010	< 0.010	< 0.010	< 0.010	ug/l	Note 1	Note 1
Anthracene***	< 0.010	< 0.010	< 0.010	< 0.010	ug/l	Note 1	Note 1
Fluoranthene***	< 0.010	< 0.010	< 0.010	< 0.010	ug/l	Note 1	Note 1
Pyrene***	< 0.010	< 0.010	< 0.010	< 0.010	ug/l	Note 1	Note 1
Benzo(a)anthracene***	< 0.010	< 0.010	< 0.010	< 0.010	ug/l	Note 1	Note 1
Chrysene***	< 0.010	< 0.010	< 0.010	< 0.010	ug/l	Note 1	Note 1
Benzo(b)fluoranthene***	< 0.010	0.018	< 0.010	< 0.010	ug/l	Note 1	Note 1
Benzo(k)fluoranthene***	< 0.010	0.016	< 0.010	< 0.010	ug/l	Note 1	Note 1
Benzo(a)pyrene***	< 0.010	< 0.010	< 0.010	< 0.010	ug/l	Note 1	Note 1
Indeno(123cd)pyrene***	< 0.010	< 0.010	< 0.010	< 0.010	ug/l	Note 1	Note 1
Dibenzo(ah)anthracene***	< 0.010	< 0.010	< 0.010	< 0.010	ug/l	Note 1	Note 1
Benzo(ghi)perylene***	< 0.010	< 0.010	< 0.010	< 0.010	ug/l	Note 1	Note 1
PAH,Total of 16	< 0.010	0.072	< 0.010	< 0.010	ug/l	Note 1	Note 1

*** Subcontracted Accredited test
Note 1: Analysis subcontracted to ALS

Parameter	30370-5 BH5-22	30370-6 BH6-22	30370-7 SUMP	Units	Methodology	Test Procedure Ref.
Temperature**	18.3	17.6	19.8	°C	DO Meter	QP-MEAS-2011
DO**	65.4	71.5	60.0	% Sat	DO Meter	QP-MEAS-2019
DO**	6.99	6.83	5.47	mg/l O_2	DO Meter	QP-MEAS-2019
pH**	8.1	7.2	7.7	pH Units	pH Probe	QP-MEAS-2011
Conductivity**	430	661	605	µS/cm @ 25°C	Conductivity Meter	QP-MEAS-2009
BOD*	2.9	3.3	2.7	mg/l cBOD5	5 Day incubation/DO probe	QP-CHEM-2016
COD*	5	12	5	mg/l O_2	Digestion spectrophotometry	QP-CHEM-2065
Suspended Solids*	7.0	< 3	7.0	mg/l SS	Gravimetry	QP-CHEM-2002
Total Dissolved Solids	226	407	379	mg/l TDS	Gravimetry	QP-CHEM-2059
TOC	1.2	3.7	1.8	mg/l C	Spectrophotometry	QP-CHEM-2071
DOC	0.5	6.9	1.5	mg/l C	Spectrophotometry	QP-CHEM-2071
Colour	16	19	26	mg/l PtCo	Spectroscopy	QP-CHEM-2064
Turbidity	1.55	0.85	3.78	NTU	Turbidimetry	QP-CHEM-2014
Ammonia	< 0.02	0.51	< 0.02	mg/l	Auto Analyser	QP-CHEM-2037
Orthophosphate	< 0.02	< 0.02	< 0.02	mg/l P	Auto Analyser	QP-CHEM-2040
TON	< 0.50	< 0.50	2.48	mg/l N	Auto Analyser	QP-CHEM-2042
Nitrate (NO_3-N)	< 0.50	< 0.50	2.48	mg/l N	Auto Analyser	QP-CHEM-2043
Nitrite (NO_2-N)	< 0.002	< 0.002	< 0.002	mg/l N	Auto Analyser	QP-CHEM-2087
Alkalinity	163	275	175	mg/l $CaCO_3$	Titration	QP-CHEM-2012
Chloride	12.0	8.5	11.5	mg/l Cl	Titration	QP-CHEM-2035
Sulphate	46.4	73.5	118	mg/l SO_4	Auto Analyser	QP-CHEM-2013
Fluoride	0.13	0.12	0.08	mg/l F	Auto Analyser	QP-CHEM-2013

* In-house Accredited Test
**On-site Accredited Test

Parameter	30370-5 BH5-22	30370-6 BH6-22	30370-7 SUMP	Units	Method ology	Test Procedure Ref.
Ethylbenzene	<1	<1	<1	ug/l	Note 1	Note 1
Benzene	<1	<1	<1	ug/l	Note 1	Note 1
Toluene	<1	<1	<1	ug/l	Note 1	Note 1
m&p Xylene	<1	<1	<1	ug/l	Note 1	Note 1
o-Xylene	<1	<1	<1	ug/l	Note 1	Note 1
Enterococci	1	0	40	cfu/l00 ml	Note 1	Note 1
E Coli (Colilert)	0	0	1	mpn/100 ml	Note 1	Note 1
Aluminium, Filtered as Al***	<0.1	<0.1	<0.1	mg/l	Note 1	Note 1
Barium, Filtered as Ba***	0.051	0.047	0.041	mg/l	Note 1	Note 1
Boron, Filtered as B***	<0.23	1.0	<0.23	mg/l	Note 1	Note 1
Cadmium, Filtered as Cd***	<0.0006	<0.0006	<0.0006	mg/l	Note 1	Note 1
Calcium, Filtered as Ca***	36.8	221	76.2	mg/l	Note 1	Note 1
Chromium, Filtered as Cr***	<0.002	<0.002	<0.002	mg/l	Note 1	Note 1
Chromium-Hexavalent***	<0.003	<0.003	<0.003	mg/l	Note 1	Note 1
Copper, Filtered as Cu***	<0.009	<0.009	<0.009	mg/l	Note 1	Note 1
Iron, Filtered as Fe***	<0.23	<0.23	<0.23	mg/l	Note 1	Note 1
Lead, Filtered as Pb***	<0.006	<0.006	<0.006	mg/l	Note 1	Note 1
Magnesium, Filtered as Mg***	21.6	30.1	26.6	mg/l	Note 1	Note 1
Manganese, Filtered as Mn***	<0.007	0.124	<0.007	mg/l	Note 1	Note 1
Mercury, Filtered as Hg***	<0.00001	<0.00001	<0.00001	mg/l	Note 1	Note 1
Molybdenum, Filtered as Mo***	0.013	<0.003	0.014	mg/l	Note 1	Note 1
Nickel, Filtered as Ni***	<0.003	0.021	0.007	mg/l	Note 1	Note 1

*** Subcontracted Accredited Test
Note 1: Analysis subcontracted to ALS

Parameter	30370-5 BH5-22	30370-6 BH6-22	30370-7 SUMP	Units	Methodology	Test Procedure Ref.
Potassium, Filtered as K***	3.35	17.2	1.82	mg/l	Note 1	Note 1
Sodium, Filtered as Na***	17.2	86.8	10.3	mg/l	Note 1	Note 1
Zinc, Filtered as Zn***	<0.018	7.76	<0.018	mg/l	Note 1	Note 1
Total Hardness as CaCO3***	183	318	300	mg/l	Note 1	Note 1
Cyanide, Total as CN***	<0.009	<0.009	<0.009	mg/l	Note 1	Note 1
Aliphatic VPH >C5-C6***	<10	<10	<10	ug/l	Note 1	Note 1
Aliphatic VPH >C6-C8***	<10	19.1	<10	ug/l	Note 1	Note 1
Aliphatic VPH >C8-C10***	<10	69.7	<10	ug/l	Note 1	Note 1
Aliphatic VPH >C5-C10***	<10	88.8	<10	ug/l	Note 1	Note 1
Aromatic VPH > C5-C7***	<10	<10	<10	ug/l	Note 1	Note 1
Aromatic VPH > C7-C8***	<10	<10	<10	ug/l	Note 1	Note 1
Aromatic VPH > C8-C10***	<10	<10	<10	ug/l	Note 1	Note 1
Aromatic VPH >C5-C10***	<10	<10	<10	ug/l	Note 1	Note 1
VPH >C5-C10***	<10	88.8	<10	ug/l	Note 1	Note 1
Aliphatic EPH > C10-C12	<10	<10	<10	ug/l	Note 1	Note 1
Aliphatic EPH >C12-C16	<10	<10	<10	ug/l	Note 1	Note 1
Aliphatic EPH >C16-C35	<10	<10	<10	ug/l	Note 1	Note 1
Aliphatic EPH >C35-C44	<10	<10	<10	ug/l	Note 1	Note 1
Aliphatic EPH >C10-C44	<10	<10	<10	ug/l	Note 1	Note 1
Aromatic EPH > C10-C12	<10	<10	<10	ug/l	Note 1	Note 1
Aromatic EPH >C12-C16	<10	<10	<10	ug/l	Note 1	Note 1
Aromatic EPH > C16-C21	<10	<10	<10	ug/l	Note 1	Note 1
Aromatic EPH >C21-C35	<10	<10	<10	ug/l	Note 1	Note 1
Aromatic EPH >C35-C44	<10	<10	<10	ug/l	Note 1	Note 1
Aromatic EPH >C10-C44	<10	<10	<10	ug/l	Note 1	Note 1
EPH >C10-C44	<10	<10	<10	ug/l	Note 1	Note 1
Aliphatic VPH/EPH >C5-C44	<10	88.8	<10	ug/l	Note 1	Note 1
Aromatic VPH/EPH >C5-C44	<10	<10	<10	ug/l	Note 1	Note 1

Parameter	30370-5 BH5-22	30370-6 BH6-22	30370-7 SUMP	Units	Methodology	Test Procedure Ref.
VPH/EPH >C5-C44	<10	<10	<10	ug/l	Note 1	Note 1
Arsenic, filter as AS***	23	1.8	3.2	ug/l	Note 1	Note 1
Selenium, filter as Se***	<1.2	<1.2	<1.2	ug/l	Note 1	Note 1
Antimony, filter as Sb***	48	12	11	ug/l	Note 1	Note 1
Naphthalene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Acenaphthylene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Acenaphthene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Fluorene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Phenanthrene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Anthracene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Fluoranthene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Pyrene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Benzo(a)anthracene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Chrysene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Benzo(b)fluoranthene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Benzo(k)fluoranthene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Benzo(a)pyrene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Indeno(123cd)pyrene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Dibenzo(ah)anthracene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Benzo(ghi)perylene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
PAH,Total of 16	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1

*** Subcontracted Accredited Test
Note 1: Analysis subcontracted to ALS

Prepared By: _____ **Date:** 29 SEP 2022

Svetlana Krivelo
Senior Laboratory Analyst

Approved By: Imelda Shanahan **Date:** 29 Sep 2022

Dr. Imelda Shanahan
Technical Manager

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Confidential Laboratory Test Report

Client: Lagan
Aughnacliffe
Co. Longford

F.T.A.O: John Fennell
Commencement Date: 08 August 2022
Completion Date: 06 September 2022
Report Date: 29 September 2022

TMS Environment Ref: 30486

Sample Type: Ground Water

TEST RESULTS

Parameter	30486-1 PZ1-22	30486-2 PZ2-22	30486-3 PZ3-22	30486-4 BH4-22	Units	Methodology	Test Procedure Ref.
Temperature**	13.8	11.5	10.6	11.0	°C	DO Meter	QP-MEAS-2011
DO**	50.8	71.8	66.9	44.0	% Sat	DO Meter	QP-MEAS-2019
DO**	5.25	7.11	7.2	4.72	mg/l O_2	DO Meter	QP-MEAS-2019
pH**	7.1	7.7	7.8	7.86	pH Units	pH Probe	QP-MEAS-2011
Conductivity**	276	388	345	255	µS/cm @ 25°C	Conductivity Meter	QP-MEAS-2009
BOD*	3.2	3.1	3.9	5.0	mg/l cBOD5	5 Day incubation/DO probe	QP-CHEM-2016
COD*	<5	<5	<5	5	mg/l O_2	Digestion spectrophotometry	QP-CHEM-2065
Suspended Solids*	8.0	39	4.5	5.5	mg/l SS	Gravimetry	QP-CHEM-2002
Total Dissolved Solids	335	23	214	271	mg/l TDS	Gravimetry	QP-CHEM-2059
TOC	3.5	3.0	1.0	3.0	mg/l C	Spectrophotometry	QP-CHEM-2071
DOC	1.0	2.0	<0.3	1.0	mg/l C	Spectrophotometry	QP-CHEM-2071
Colour	10	37	3	5	mg/l PtCo	Spectroscopy	QP-CHEM-2064
Turbidity	2.67	6.96	1.14	1.26	NTU	Turbidimetry	QP-CHEM-2014
Ammonia	0.05	<0.02	0.06	0.04	mg/l	Auto Analyser	QP-CHEM-2037
Orthophosphate	<0.02	<0.02	0.06	<0.02	mg/l P	Auto Analyser	QP-CHEM-2040
TON	<0.5	3.73	2.84	<0.5	mg/l N	Auto Analyser	QP-CHEM-2042
Nitrate (NO_3-N)	<0.5	3.74	2.90	<0.5	mg/l N	Auto Analyser	QP-CHEM-2043
Nitrite (NO_2-N)	<0.002	<0.002	<0.002	<0.002	mg/l N	Auto Analyser	QP-CHEM-2087
Alkalinity	208	167	161	211	mg/l $CaCO_3$	Titration	QP-CHEM-2012

Parameter	30486-1 PZ1-22	30486-2 PZ2-22	30486-3 PZ3-22	30486-4 BH4-22	Units	Methodology	Test Procedure Ref.
Chloride	11.0	16.5	11.5	16.5	mg/l Cl	Titration	QP-CHEM-2035
Sulphate	79.1	18.6	7.66	33.0	mg/l SO_4	Auto Analyser	QP-CHEM-2013
Fluoride	0.08	0.11	0.13	0.19	mg/l F	Auto Analyser	QP-CHEM-2013

* In-house Accredited Test
**On-site Accredited Test

Parameter	30486-1 PZ1-22	30486-2 PZ2-22	30486-3 PZ3-22	30486-4 BH4-22	Units	Methodology	Test Procedure Ref.
Ethylbenzene	<1	<1	<1	<1	ug/l	Note 1	Note 1
Benzene	<1	<1	<1	<1	ug/l	Note 1	Note 1
Toluene	<1	<1	<1	<1	ug/l	Note 1	Note 1
m&p Xylene	<1	<1	<1	<1	ug/l	Note 1	Note 1
o-Xylene	<1	<1	<1	<1	ug/l	Note 1	Note 1
Enterococci	0	0	66	0	cfu/l00 ml	Note 1	Note 1
E Coli (Colilert)	0	0	0	0	mpn/100 ml	Note 1	Note 1
Aluminium, Filtered as Al***	<0.1	<0.1	<0.1	<0.1	mg/l	Note 1	Note 1
Barium, Filtered as Ba***	0.025	0.027	0.063	0.053	mg/l	Note 1	Note 1
Boron, Filtered as B***	<0.23	<0.23	<0.23	<0.23	mg/l	Note 1	Note 1
Cadmium, Filtered as Cd***	<0.0006	<0.0006	<0.0006	<0.0006	mg/l	Note 1	Note 1
Calcium, Filtered as Ca***	55.4	41.5	35.7	41.9	mg/l	Note 1	Note 1
Chromium, Filtered as Cr***	<0.002	<0.002	<0.002	<0.002	mg/l	Note 1	Note 1
Chromium-Hexavalent***	<0.003	<0.003	<0.003	<0.003	mg/l	Note 1	Note 1
Copper, Filtered as Cu***	<0.009	<0.009	<0.009	<0.009	mg/l	Note 1	Note 1
Iron, Filtered as Fe***	<0.23	<0.23	<0.23	<0.23	mg/l	Note 1	Note 1
Lead, Filtered as Pb***	<0.0006	<0.0006	<0.0006	<0.0006	mg/l	Note 1	Note 1
Magnesium, Filtered as Mg***	25.6	16.6	16.5	22.9	mg/l	Note 1	Note 1
Manganese, Filtered as Mn***	3.50	<0.007	<0.007	<0.007	mg/l	Note 1	Note 1
Mercury, Filtered as Hg***	<0.00001	<0.00001	<0.00001	<0.00001	mg/l	Note 1	Note 1
Molybdenum, Filtered as Mo***	0.005	0.004	0.006	0.009	mg/l	Note 1	Note 1
Nickel, Filtered as Ni***	<0.003	<0.003	<0.003	<0.003	mg/l	Note 1	Note 1

Parameter	30486-1 PZ1-22	30486-2 PZ2-22	30486-2 PZ2-22	30486-4 BH4-22	Units	Methodology	Test Procedure Ref.
Potassium, Filtered as K***	1.24	3.56	2.19	2.56	mg/l	Note 1	Note 1
Sodium, Filtered as Na***	12.2	11.8	9.20	17.5	mg/l	Note 1	Note 1
Zinc, Filtered as Zn***	0.019	<0.018	<0.018	<0.018	mg/l	Note 1	Note 1
Total Hardness as CaCO3***	257	179	166	202	mg/l	Note 1	Note 1
Cyanide, Total as CN***	<0.009	<0.009	<0.009	<0.009	mg/l	Note 1	Note 1
Aliphatic VPH >C5-C6***	<10	<10	<10	<10	ug/l	Note 1	Note 1
Aliphatic VPH >C6-C8***	<10	<10	<10	<10	ug/l	Note 1	Note 1
Aliphatic VPH >C8-C10***	<10	<10	<10	<10	ug/l	Note 1	Note 1
Aliphatic VPH >C5-C10***	<10	<10	<10	<10	ug/l	Note 1	Note 1
Aromatic VPH > C5-C7***	<10	<10	<10	<10	ug/l	Note 1	Note 1
Aromatic VPH > C7-C8***	<10	<10	<10	<10	ug/l	Note 1	Note 1
Aromatic VPH > C8-C10***	<10	<10	<10	<10	ug/l	Note 1	Note 1
Aromatic VPH >C5-C10***	<10	<10	<10	<10	ug/l	Note 1	Note 1
VPH >C5-C10***	<10	<10	<10	<10	ug/l	Note 1	Note 1
Aliphatic EPH > C10-C12	<10	<10	<10	<10	ug/l	Note 1	Note 1
Aliphatic EPH >C12-C16	<10	<10	<10	<10	ug/l	Note 1	Note 1
Aliphatic EPH >C16-C35	<10	<10	<10	23	ug/l	Note 1	Note 1
Aliphatic EPH >C35-C44	<10	<10	<10	<10	ug/l	Note 1	Note 1
Aliphatic EPH >C10-C44	<10	<10	<10	23	ug/l	Note 1	Note 1
Aromatic EPH > C10-C12	<10	<10	<10	<10	ug/l	Note 1	Note 1
Aromatic EPH >C12-C16	<10	<10	<10	<10	ug/l	Note 1	Note 1
Aromatic EPH > C16-C21	<10	<10	<10	<10	ug/l	Note 1	Note 1
Aromatic EPH >C21-C35	<10	<10	12	<10	ug/l	Note 1	Note 1
Aromatic EPH >C35-C44	<10	<10	<10	<10	ug/l	Note 1	Note 1
Aromatic EPH >C10-C44	<10	<10	12	<10	ug/l	Note 1	Note 1
EPH >C10-C44	<10	<10	12	23	ug/l	Note 1	Note 1
Aliphatic VPH/EPH >C5-C44	<10	<10	<10	23	ug/l	Note 1	Note 1
Aromatic VPH/EPH >C5-C44	<10	<10	12	<10	ug/l	Note 1	Note 1

Parameter	30486-1 PZ1-22	30486-2 PZ2-22	30486-2 PZ2-22	30486-4 BH4-22	Units	Methodology	Test Procedure Ref.
VPH/EPH >C5-C44	<10	<10	12	23	ug/l	Note 1	Note 1
Arsenic, filter as AS***	1.1	3.5	1.9	19	ug/l	Note 1	Note 1
Selenium, filter as Se***	<1.2	<1.2	<1.2	<1.2	ug/l	Note 1	Note 1
Antimony, filter as Sb***	3.4	6.1	6.7	20	ug/l	Note 1	Note 1
Naphthalene***	<0.01	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Acenaphthylene***	<0.01	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Acenaphthene***	<0.01	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Fluorene***	<0.01	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Phenanthrene***	<0.01	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Anthracene***	<0.01	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Fluoranthene***	<0.01	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Pyrene***	<0.01	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Benzo(a)anthracene***	<0.01	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Chrysene***	<0.01	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Benzo(b)fluoranthene***	<0.01	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Benzo(k)fluoranthene***	<0.01	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Benzo(a)pyrene***	<0.01	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Indeno(123cd)pyrene***	<0.01	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Dibenzo(ah)anthracene***	<0.01	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Benzo(ghi)perylene***	<0.01	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
PAH,Total of 16	<0.01	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1

*** Subcontracted Accredited test

Note 1: Note 1: Analysis subcontracted to ALS

Parameter	30486-5 BH5-22	30486-6 BH6-22	30486-7 SUMP	Units	Methodology	Test Procedure Ref.
Temperature**	11.9	13.0	17.3	°C	DO Meter	QP-MEAS-2011
DO**	55.9	66.7	109.9	% Sat	DO Meter	QP-MEAS-2019
DO**	5.88	6.93	10.6	mg/l O_2	DO Meter	QP-MEAS-2019
pH**	7.8	7.25	7.7	pH Units	pH Probe	QP-MEAS-2011
Conductivity**	389	628	555	µS/cm @ 25°C	Conductivity Meter	QP-MEAS-2009
BOD*	3.1	3.8	4.2	mg/l cBOD5	5 Day incubation/DO probe	QP-CHEM-2016
COD*	7	8	8	mg/l O_2	Digestion spectrophotometry	QP-CHEM-2065
Suspended Solids*	11	4.0	<3	mg/l SS	Gravimetry	QP-CHEM-2002
Total Dissolved Solids	251	387	423	mg/l TDS	Gravimetry	QP-CHEM-2059
TOC	3	4	2	mg/l C	Spectrophotometry	QP-CHEM-2071
DOC	1	2	<0.3	mg/l C	Spectrophotometry	QP-CHEM-2071
Colour	3	9	5	mg/l PtCo	Spectroscopy	QP-CHEM-2064
Turbidity	0.77	0.87	0.52	NTU	Turbidimetry	QP-CHEM-2014
Ammonia	<0.02	0.52	<0.02	mg/l	Auto Analyser	QP-CHEM-2037
Orthophosphate	<0.02	<0.02	0.06	mg/l P	Auto Analyser	QP-CHEM-2040
TON	<0.5	<0.5	3.87	mg/l N	Auto Analyser	QP-CHEM-2042
Nitrate (NO_3-N)	<0.5	<0.5	3.86	mg/l N	Auto Analyser	QP-CHEM-2043
Nitrite (NO_2-N)	0.02	<0.002	0.01	mg/l N	Auto Analyser	QP-CHEM-2087
Alkalinity	164	276	149	mg/l $CaCO_3$	Titration	QP-CHEM-2012
Chloride	14.0	11.0	12.0	mg/l Cl	Titration	QP-CHEM-2035
Sulphate	45.9	69.2	136	mg/l SO_4	Auto Analyser	QP-CHEM-2013
Fluoride	0.15	0.14	0.09	mg/l F	Auto Analyser	QP-CHEM-2013

* In-house Accredited Test
**On-site Accredited Test

Parameter	30486-5 BH5-22	30486-6 BH6-22	30486-7 SUMP	Units	Method ology	Test Procedure Ref.
Ethylbenzene	<1	<1	<1	ug/l	Note 1	Note 1
Benzene	<1	<1	<1	ug/l	Note 1	Note 1
Toluene	<1	<1	<1	ug/l	Note 1	Note 1
m&p Xylene	<1	<1	<1	ug/l	Note 1	Note 1
o-Xylene	<1	<1	<1	ug/l	Note 1	Note 1
Enterococci	0	0	0	cfu/l00 ml	Note 1	Note 1
E Coli (Colilert)	0	0	2	mpn/100 ml	Note 1	Note 1
Aluminium, Filtered as Al***	<0.1	<0.1	<0.1	mg/l	Note 1	Note 1
Barium, Filtered as Ba***	0.051	0.125	0.08	mg/l	Note 1	Note 1
Boron, Filtered as B***	<0.23	<0.23	<0.23	mg/l	Note 1	Note 1
Cadmium, Filtered as Cd***	<0.0006	<0.0006	<0.0006	mg/l	Note 1	Note 1
Calcium, Filtered as Ca***	36.7	86.5	72.5	mg/l	Note 1	Note 1
Chromium, Filtered as Cr***	<0.002	<0.002	<0.002	mg/l	Note 1	Note 1
Chromium-Hexavalent***	<0.003	<0.003	<0.003	mg/l	Note 1	Note 1
Copper, Filtered as Cu***	<0.009	<0.009	<0.009	mg/l	Note 1	Note 1
Iron, Filtered as Fe***	<0.23	<0.23	<0.23	mg/l	Note 1	Note 1
Lead, Filtered as Pb***	<0.0006	<0.0006	<0.0006	mg/l	Note 1	Note 1
Magnesium, Filtered as Mg***	21.5	18.9	27.3	mg/l	Note 1	Note 1
Manganese, Filtered as Mn***	<0.007	2.42	<0.07	mg/l	Note 1	Note 1
Mercury, Filtered as Hg***	<0.00001	<0.00001	<0.00001	mg/l	Note 1	Note 1
Molybdenum, Filtered as Mo***	0.016	0.005	0.009	mg/l	Note 1	Note 1
Nickel, Filtered as Ni***	<0.003	0.005	<0.003	mg/l	Note 1	Note 1

*** Subcontracted Accredited Test
Note 1: Analysis subcontracted to ALS

Parameter	30486-5 BH5-22	30486-6 BH6-22	30486-7 SUMP	Units	Methodology	Test Procedure Ref.
Potassium, Filtered as K***	3.75	2.79	1.52	mg/l	Note 1	Note 1
Sodium, Filtered as Na***	15.9	14.0	10.2	mg/l	Note 1	Note 1
Zinc, Filtered as Zn***	<0.018	0.019	<0.018	mg/l	Note 1	Note 1
Total Hardness as CaCO3***	180	310	286	mg/l	Note 1	Note 1
Cyanide, Total as CN***	<0.009	<0.009	<0.009	mg/l	Note 1	Note 1
Aliphatic VPH >C5-C6***	<10	<10	<10	ug/l	Note 1	Note 1
Aliphatic VPH >C6-C8***	<10	<10	<10	ug/l	Note 1	Note 1
Aliphatic VPH >C8-C10***	<10	<10	<10	ug/l	Note 1	Note 1
Aliphatic VPH >C5-C10***	<10	<10	<10	ug/l	Note 1	Note 1
Aromatic VPH > C5-C7***	<10	<10	<10	ug/l	Note 1	Note 1
Aromatic VPH > C7-C8***	<10	<10	<10	ug/l	Note 1	Note 1
Aromatic VPH > C8-C10***	<10	<10	<10	ug/l	Note 1	Note 1
Aromatic VPH >C5-C10***	<10	<10	<10	ug/l	Note 1	Note 1
VPH >C5-C10***	<10	<10	<10	ug/l	Note 1	Note 1
Aliphatic EPH > C10-C12	<10	<10	<10	ug/l	Note 1	Note 1
Aliphatic EPH >C12-C16	<10	<10	<10	ug/l	Note 1	Note 1
Aliphatic EPH >C16-C35	<10	<10	13	ug/l	Note 1	Note 1
Aliphatic EPH >C35-C44	<10	<10	<10	ug/l	Note 1	Note 1
Aliphatic EPH >C10-C44	<10	<10	13	ug/l	Note 1	Note 1
Aromatic EPH > C10-C12	<10	<10	<10	ug/l	Note 1	Note 1
Aromatic EPH >C12-C16	<10	<10	<10	ug/l	Note 1	Note 1
Aromatic EPH > C16-C21	<10	<10	<10	ug/l	Note 1	Note 1
Aromatic EPH >C21-C35	<10	<10	<10	ug/l	Note 1	Note 1
Aromatic EPH >C35-C44	<10	<10	<10	ug/l	Note 1	Note 1
Aromatic EPH >C10-C44	<10	<10	<10	ug/l	Note 1	Note 1
EPH >C10-C44	<10	<10	13	ug/l	Note 1	Note 1
Aliphatic VPH/EPH >C5-C44	<10	<10	13	ug/l	Note 1	Note 1
Aromatic VPH/EPH >C5-C44	<10	<10	<10	ug/l	Note 1	Note 1

Parameter	30486-5 BH5-22	30486-6 BH6-22	30486-7 SUMP	Units	Methodology	Test Procedure Ref.
VPH/EPH >C5-C44	<10	<10	13	ug/l	Note 1	Note 1
Arsenic, filter as AS***	23	1.8	3.1	ug/l	Note 1	Note 1
Selenium, filter as Se***	<1.2	<1.2	<1.2	ug/l	Note 1	Note 1
Antimony, filter as Sb***	47	11	3.9	ug/l	Note 1	Note 1
Naphthalene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Acenaphthylene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Acenaphthene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Fluorene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Phenanthrene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Anthracene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Fluoranthene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Pyrene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Benzo(a)anthracene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Chrysene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Benzo(b)fluoranthene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Benzo(k)fluoranthene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Benzo(a)pyrene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Indeno(123cd)pyrene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Dibenzo(ah)anthracene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Benzo(ghi)perylene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
PAH,Total of 16	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1

*** Subcontracted Accredited Test
Note 1: Analysis subcontracted to ALS

Prepared By: _____ **Date:** 29 SEP 2022

Svetlana Krivelo
Senior Laboratory Analyst

Approved By: Imelda Shanahan **Date:** 29 Sep 2022

Dr. Imelda Shanahan
Technical Manager

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Confidential Laboratory Test Report

Client: Lagan
Aughnacliffe
Co. Longford

F.T.A.O: John Fennell
Commencement Date: 05 September 2022
Completion Date: 26 September 2022
Report Date: 29 September 2022
Page: 1 of 9

TMS Environment Ref: 30612

Sample Type: Ground Water

TEST RESULTS

Parameter	30612-1 PZ1-22	30612-2 PZ2-22	30612-3 PZ3-22	30612-4 BH4-22	Units	Methodology	Test Procedure Ref.
Temperature**	13.9	13.9	11.1	11.6	°C	DO Meter	QP-MEAS-2011
DO**	30.6	72.9	55.9	38.0	% Sat	DO Meter	QP-MEAS-2019
DO**	3.14	7.73	6.17	4.13	mg/l O_2	DO Meter	QP-MEAS-2019
pH**	7.6	7.7	7.8	7.6	pH Units	pH Probe	QP-MEAS-2011
Conductivity**	502	389	236	265	µS/cm @ 25°C	Conductivity Meter	QP-MEAS-2009
BOD*	9.0	3.1	3.3	3.0	mg/l cBOD5	5 Day incubation/DO probe	QP-CHEM-2016
COD*	5	<5	<5	9	mg/l O_2	Digestion spectrophotometry	QP-CHEM-2065
Suspended Solids*	23	20	4.6	17	mg/l SS	Gravimetry	QP-CHEM-2002
Total Dissolved Solids	330	231	178	207	mg/l TDS	Gravimetry	QP-CHEM-2059
TOC	<0.3	1.1	0.5	3.1	mg/l C	Spectrophotometry	QP-CHEM-2071
DOC	<0.3	0.8	1.6	1.8	mg/l C	Spectrophotometry	QP-CHEM-2071
Colour	4	46	17	15	mg/l PtCo	Spectroscopy	QP-CHEM-2064
Turbidity	2.76	11.1	2.90	3.83	NTU	Turbidimetry	QP-CHEM-2014
Ammonia	<0.02	<0.02	0.10	0.13	mg/l	Auto Analyser	QP-CHEM-2037
Orthophosphate	0.04	0.02	<0.02	0.07	mg/l P	Auto Analyser	QP-CHEM-2040
TON	0.17	2.74	2.73	<0.5	mg/l N	Auto Analyser	QP-CHEM-2042
Nitrate (NO_3-N)	<0.5	2.74	2.73	<0.5	mg/l N	Auto Analyser	QP-CHEM-2043
Nitrite (NO_2-N)	<0.002	<0.002	<0.002	<0.002	mg/l N	Auto Analyser	QP-CHEM-2087
Alkalinity	198	162	160	204	mg/l $CaCO_3$	Titration	QP-CHEM-2012

Parameter	30612-1 PZ1-22	30612-2 PZ2-22	30612-3 PZ3-22	30612-4 BH4-22	Units	Methodology	Test Procedure Ref.
Chloride	8.00	13.5	10.0	15.0	mg/l Cl	Titration	QP-CHEM-2035
Sulphate	79.3	28.5	7.49	32.5	mg/l SO_4	Auto Analyser	QP-CHEM-2013
Fluoride	0.11	0.13	0.14	0.17	mg/l F	Auto Analyser	QP-CHEM-2013

* In-house Accredited Test
**On-site Accredited Test

Parameter	30612-1 PZ1-22	30612-2 PZ2-22	30612-3 PZ3-22	30612-4 BH4-22	Units	Methodology	Test Procedure Ref.
Ethylbenzene	<1	<1	<1	<1	ug/l	Note 1	Note 1
Benzene	<1	<1	<1	<1	ug/l	Note 1	Note 1
Toluene	<1	<1	<1	<1	ug/l	Note 1	Note 1
m&p Xylene	<1	<1	<1	<1	ug/l	Note 1	Note 1
o-Xylene	<1	<1	<1	<1	ug/l	Note 1	Note 1
Enterococci	1	1	0	0	cfu/l00 ml	Note 1	Note 1
E Coli (Colilert)	0	0	0	0	mpn/100 ml	Note 1	Note 1
Aluminium, Filtered as Al***	<0.1	<0.1	<0.1	<0.1	mg/l	Note 1	Note 1
Barium, Filtered as Ba***	0.012	0.027	0.068	0.059	mg/l	Note 1	Note 1
Boron, Filtered as B***	<0.23	<0.23	<0.23	<0.23	mg/l	Note 1	Note 1
Cadmium, Filtered as Cd***	<0.0006	<0.0006	<0.0006	<0.0006	mg/l	Note 1	Note 1
Calcium, Filtered as Ca***	59.1	40.0	37.3	44.8	mg/l	Note 1	Note 1
Chromium, Filtered as Cr***	<0.002	<0.002	<0.002	<0.002	mg/l	Note 1	Note 1
Chromium-Hexavalent***	<0.003	<0.003	<0.003	<0.003	mg/l	Note 1	Note 1
Copper, Filtered as Cu***	<0.009	<0.009	<0.009	<0.009	mg/l	Note 1	Note 1
Iron, Filtered as Fe***	<0.23	<0.23	<0.23	<0.23	mg/l	Note 1	Note 1
Lead, Filtered as Pb***	<0.0006	<0.0006	<0.0006	<0.0006	mg/l	Note 1	Note 1
Magnesium, Filtered as Mg***	26.1	17.0	17.1	24.2	mg/l	Note 1	Note 1
Manganese, Filtered as Mn***	0.019	<0.007	<0.007	<0.007	mg/l	Note 1	Note 1
Mercury, Filtered as Hg***	<0.00001	<0.00001	<0.00001	<0.00001	mg/l	Note 1	Note 1
Molybdenum, Filtered as Mo***	0.006	0.008	0.007	0.012	mg/l	Note 1	Note 1
Nickel, Filtered as Ni***	<0.003	<0.003	<0.003	<0.003	mg/l	Note 1	Note 1

Parameter	30612-1 PZ1-22	30612-2 PZ2-22	30612-2 PZ2-22	30612-4 BH4-22	Units	Methodology	Test Procedure Ref.
Potassium, Filtered as K***	1.24	5.96	2.38	2.69	mg/l	Note 1	Note 1
Sodium, Filtered as Na***	12.2	14.1	10.2	18.2	mg/l	Note 1	Note 1
Zinc, Filtered as Zn***	<0.018	<0.018	<0.018	<0.018	mg/l	Note 1	Note 1
Total Hardness as CaCO3***	249	175	164	209	mg/l	Note 1	Note 1
Cyanide, Total as CN***	<0.009	<0.009	<0.009	<0.009	mg/l	Note 1	Note 1
Aliphatic VPH >C5-C6***	<10	<10	<10	<10	ug/l	Note 1	Note 1
Aliphatic VPH >C6-C8***	<10	<10	<10	<10	ug/l	Note 1	Note 1
Aliphatic VPH >C8-C10***	<10	<10	<10	<10	ug/l	Note 1	Note 1
Aliphatic VPH >C5-C10***	<10	<10	<10	<10	ug/l	Note 1	Note 1
Aromatic VPH > C5-C7***	<10	<10	<10	<10	ug/l	Note 1	Note 1
Aromatic VPH > C7-C8***	<10	<10	<10	<10	ug/l	Note 1	Note 1
Aromatic VPH > C8-C10***	<10	<10	<10	<10	ug/l	Note 1	Note 1
Aromatic VPH >C5-C10***	<10	<10	<10	<10	ug/l	Note 1	Note 1
VPH >C5-C10***	<10	<10	<10	<10	ug/l	Note 1	Note 1
Aliphatic EPH > C10-C12	<10	<10	<10	<10	ug/l	Note 1	Note 1
Aliphatic EPH >C12-C16	<10	<10	<10	<10	ug/l	Note 1	Note 1
Aliphatic EPH >C16-C35	<10	<10	<10	11	ug/l	Note 1	Note 1
Aliphatic EPH >C35-C44	<10	<10	<10	<10	ug/l	Note 1	Note 1
Aliphatic EPH >C10-C44	<10	<10	<10	11	ug/l	Note 1	Note 1
Aromatic EPH > C10-C12	<10	<10	<10	<10	ug/l	Note 1	Note 1
Aromatic EPH >C12-C16	<10	<10	<10	<10	ug/l	Note 1	Note 1
Aromatic EPH > C16-C21	<10	<10	<10	<10	ug/l	Note 1	Note 1
Aromatic EPH >C21-C35	<10	<10	<10	<10	ug/l	Note 1	Note 1
Aromatic EPH >C35-C44	<10	<10	<10	<10	ug/l	Note 1	Note 1
Aromatic EPH >C10-C44	<10	<10	<10	<10	ug/l	Note 1	Note 1
EPH >C10-C44	<10	<10	<10	11	ug/l	Note 1	Note 1
Aliphatic VPH/EPH >C5-C44	<10	<10	<10	11	ug/l	Note 1	Note 1
Aromatic VPH/EPH >C5-C44	<10	<10	<10	<10	ug/l	Note 1	Note 1

Parameter	30612-1 PZ1-22	30612-2 PZ2-22	30612-2 PZ2-22	30612-4 BH4-22	Units	Methodology	Test Procedure Ref.
VPH/EPH >C5-C44	<10	<10	<10	11	ug/l	Note 1	Note 1
Arsenic, filter as AS***	0.33	3.0	1.9	18	ug/l	Note 1	Note 1
Selenium, filter as Se***	<1.2	<1.2	<1.2	<1.2	ug/l	Note 1	Note 1
Antimony, filter as Sb***	<1.3	5.0	7.5	20	ug/l	Note 1	Note 1
Naphthalene***	0.014	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Acenaphthylene***	<0.01	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Acenaphthene***	<0.01	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Fluorene***	<0.01	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Phenanthrene***	<0.01	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Anthracene***	<0.01	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Fluoranthene***	<0.01	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Pyrene***	<0.01	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Benzo(a)anthracene***	<0.01	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Chrysene***	<0.01	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Benzo(b)fluoranthene***	<0.01	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Benzo(k)fluoranthene***	<0.01	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Benzo(a)pyrene***	<0.01	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Indeno(123cd)pyrene***	<0.01	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Dibenzo(ah)anthracene***	<0.01	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Benzo(ghi)perylene***	<0.01	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
PAH,Total of 16	0.014	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1

*** Subcontracted Accredited test

Note 1: Note 1: Analysis subcontracted to ALS

Parameter	30612-5 BH5-22	30612-6 BH6-22	30612-7 SUMP	Units	Methodology	Test Procedure Ref.
Temperature**	13.0	14.7	15.9	°C	DO Meter	QP-MEAS-2011
DO**	55.3	67.9	92.9	% Sat	DO Meter	QP-MEAS-2019
DO**	5.83	6.90	9.19	mg/l O_2	DO Meter	QP-MEAS-2019
pH**	7.8	7.1	7.9	pH Units	pH Probe	QP-MEAS-2011
Conductivity**	339	686	493	µS/cm @ 25°C	Conductivity Meter	QP-MEAS-2009
BOD*	2.8	3.0	3.5	mg/l cBOD5	5 Day incubation/DO probe	QP-CHEM-2016
COD*	<5	<5	7	mg/l O_2	Digestion spectrophotometry	QP-CHEM-2065
Suspended Solids*	<3.0	<3.0	5.9	mg/l SS	Gravimetry	QP-CHEM-2002
Total Dissolved Solids	237	341	571	mg/l TDS	Gravimetry	QP-CHEM-2059
TOC	0.9	15.2	<0.3	mg/l C	Spectrophotometry	QP-CHEM-2071
DOC	2.7	4.9	0.3	mg/l C	Spectrophotometry	QP-CHEM-2071
Colour	47	19	56	mg/l PtCo	Spectroscopy	QP-CHEM-2064
Turbidity	0.37	0.72	1.66	NTU	Turbidimetry	QP-CHEM-2014
Ammonia	<0.02	0.56	0.15	mg/l	Auto Analyser	QP-CHEM-2037
Orthophosphate	0.08	0.08	<0.02	mg/l P	Auto Analyser	QP-CHEM-2040
TON	<0.5	<0.5	2.63	mg/l N	Auto Analyser	QP-CHEM-2042
Nitrate (NO_3-N)	<0.5	<0.5	2.62	mg/l N	Auto Analyser	QP-CHEM-2043
Nitrite (NO_2-N)	<0.002	<0.002	<0.002	mg/l N	Auto Analyser	QP-CHEM-2087
Alkalinity	170	270	138	mg/l $CaCO_3$	Titration	QP-CHEM-2012
Chloride	12.0	10.5	125	mg/l Cl	Titration	QP-CHEM-2035
Sulphate	45.6	69.1	121	mg/l SO_4	Auto Analyser	QP-CHEM-2013
Fluoride	0.17	0.15	0.10	mg/l F	Auto Analyser	QP-CHEM-2013

* In-house Accredited Test
**On-site Accredited Test

Parameter	30612-5 BH5-22	30612-6 BH6-22	30612-7 SUMP	Units	Method ology	Test Procedure Ref.
Ethylbenzene	<1	<1	<1	ug/l	Note 1	Note 1
Benzene	<1	<1	<1	ug/l	Note 1	Note 1
Toluene	<1	<1	<1	ug/l	Note 1	Note 1
m&p Xylene	<1	<1	<1	ug/l	Note 1	Note 1
o-Xylene	<1	<1	<1	ug/l	Note 1	Note 1
Enterococci	1	0	2	cfu/l00 ml	Note 1	Note 1
E Coli (Colilert)	0	0	2	mpn/100 ml	Note 1	Note 1
Aluminium, Filtered as Al***	<0.1	<0.1	<0.1	mg/l	Note 1	Note 1
Barium, Filtered as Ba***	0.052	0.137	0.095	mg/l	Note 1	Note 1
Boron, Filtered as B***	<0.23	<0.23	<0.23	mg/l	Note 1	Note 1
Cadmium, Filtered as Cd***	<0.0006	<0.0006	<0.0006	mg/l	Note 1	Note 1
Calcium, Filtered as Ca***	36.2	92.7	70.8	mg/l	Note 1	Note 1
Chromium, Filtered as Cr***	<0.002	<0.002	<0.002	mg/l	Note 1	Note 1
Chromium-Hexavalent***	<0.003	<0.003	<0.003	mg/l	Note 1	Note 1
Copper, Filtered as Cu***	<0.009	<0.009	<0.009	mg/l	Note 1	Note 1
Iron, Filtered as Fe***	<0.23	<0.23	<0.23	mg/l	Note 1	Note 1
Lead, Filtered as Pb***	<0.006	<0.006	<0.006	mg/l	Note 1	Note 1
Magnesium, Filtered as Mg***	21.1	20.0	24.3	mg/l	Note 1	Note 1
Manganese, Filtered as Mn***	<0.007	2.60	<0.007	mg/l	Note 1	Note 1
Mercury, Filtered as Hg***	<0.00001	<0.00001	<0.00001	mg/l	Note 1	Note 1
Molybdenum, Filtered as Mo***	0.018	0.007	0.011	mg/l	Note 1	Note 1
Nickel, Filtered as Ni***	<0.003	0.005	<0.003	mg/l	Note 1	Note 1

*** Subcontracted Accredited Test
Note 1: Analysis subcontracted to ALS

Parameter	30612-5 BH5-22	30612-6 BH6-22	30612-7 SUMP	Units	Methodology	Test Procedure Ref.
Potassium, Filtered as K***	3.83	3.12	1.55	mg/l	Note 1	Note 1
Sodium, Filtered as Na***	15.9	15.0	9.16	mg/l	Note 1	Note 1
Zinc, Filtered as Zn***	<0.018	0.019	<0.018	mg/l	Note 1	Note 1
Total Hardness as CaCO3***	174	324	284	mg/l	Note 1	Note 1
Cyanide, Total as CN***	<0.009	<0.009	<0.009	mg/l	Note 1	Note 1
Aliphatic VPH >C5-C6***	<10	<10	<10	ug/l	Note 1	Note 1
Aliphatic VPH >C6-C8***	<10	<10	<10	ug/l	Note 1	Note 1
Aliphatic VPH >C8-C10***	<10	<10	<10	ug/l	Note 1	Note 1
Aliphatic VPH >C5-C10***	<10	<10	<10	ug/l	Note 1	Note 1
Aromatic VPH > C5-C7***	<10	<10	<10	ug/l	Note 1	Note 1
Aromatic VPH > C7-C8***	<10	<10	<10	ug/l	Note 1	Note 1
Aromatic VPH > C8-C10***	<10	<10	<10	ug/l	Note 1	Note 1
Aromatic VPH >C5-C10***	<10	<10	<10	ug/l	Note 1	Note 1
VPH >C5-C10***	<10	<10	<10	ug/l	Note 1	Note 1
Aliphatic EPH > C10-C12	<10	<10	<10	ug/l	Note 1	Note 1
Aliphatic EPH >C12-C16	<10	<10	<10	ug/l	Note 1	Note 1
Aliphatic EPH >C16-C35	<10	<10	<10	ug/l	Note 1	Note 1
Aliphatic EPH >C35-C44	<10	<10	<10	ug/l	Note 1	Note 1
Aliphatic EPH >C10-C44	<10	<10	<10	ug/l	Note 1	Note 1
Aromatic EPH > C10-C12	<10	<10	<10	ug/l	Note 1	Note 1
Aromatic EPH >C12-C16	<10	<10	<10	ug/l	Note 1	Note 1
Aromatic EPH > C16-C21	<10	<10	<10	ug/l	Note 1	Note 1
Aromatic EPH >C21-C35	<10	<10	<10	ug/l	Note 1	Note 1
Aromatic EPH >C35-C44	<10	<10	<10	ug/l	Note 1	Note 1
Aromatic EPH >C10-C44	<10	<10	<10	ug/l	Note 1	Note 1
EPH >C10-C44	<10	<10	<10	ug/l	Note 1	Note 1
Aliphatic VPH/EPH >C5-C44	<10	<10	<10	ug/l	Note 1	Note 1
Aromatic VPH/EPH >C5-C44	<10	<10	<10	ug/l	Note 1	Note 1

Parameter	30612-5 BH5-22	30612-6 BH6-22	30612-7 SUMP	Units	Methodology	Test Procedure Ref.
VPH/EPH >C5-C44	<10	<10	<10	ug/l	Note 1	Note 1
Arsenic, filter as AS***	23	1.2	2.9	ug/l	Note 1	Note 1
Selenium, filter as Se***	<1.2	<1.2	<1.2	ug/l	Note 1	Note 1
Antimony, filter as Sb***	51	12	4.4	ug/l	Note 1	Note 1
Naphthalene***	<0.01	<0.01	0.022	ug/l	Note 1	Note 1
Acenaphthylene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Acenaphthene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Fluorene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Phenanthrene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Anthracene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Fluoranthene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Pyrene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Benzo(a)anthracene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Chrysene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Benzo(b)fluoranthene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Benzo(k)fluoranthene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Benzo(a)pyrene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Indeno(123cd)pyrene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Dibenzo(ah)anthracene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Benzo(ghi)perylene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
PAH,Total of 16	<0.01	<0.01	0.022	ug/l	Note 1	Note 1

*** Subcontracted Accredited Test
Note 1: Analysis subcontracted to ALS

Prepared By: _____ **Date:** 29 Sep 2022

Svetlana Krivelo
Senior Laboratory Analyst

Approved By: Imelda Shanahan **Date:** 29 Sep 2022

Dr. Imelda Shanahan
Technical Manager

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Confidential Laboratory Test Report

Client: Lagan
Aughnacliffe
Co. Longford

F.T.A.O: John Fennell
Commencement Date: 05 September 2022
Completion Date: 02 November 2022
Report Date: 14 November 2022

TMS Environment Ref: 30773

Sample Type: Ground Water

TEST RESULTS

Parameter	30773-1 PZ1-22	30773-2 PZ2-22	30773-3 PZ3-22	30773-4 BH4-22	Units	Methodology	Test Procedure Ref.
Temperature**	11.8	12.1	10.2	10.2	°C	DO Meter	QP-MEAS-2011
DO**	30.6	72.3	55.8	33.3	% Sat	DO Meter	QP-MEAS-2019
DO**	3.13	7.73	6.24	3.74	mg/l O_2	DO Meter	QP-MEAS-2019
pH**	7.6	7.8	8.0	7.9	pH Units	pH Probe	QP-MEAS-2011
Conductivity**	543	420	203	305	µS/cm @ 25°C	Conductivity Meter	QP-MEAS-2009
BOD*	8.7	5.9	6.3	6.6	mg/l cBOD5	5 Day incubation/DO probe	QP-CHEM-2016
COD*	<5	19	8	13	mg/l O_2	Digestion spectrophotometry	QP-CHEM-2065
Suspended Solids*	<3	11	9.4	5.6	mg/l SS	Gravimetry	QP-CHEM-2002
Total Dissolved Solids	335	276	215	277	mg/l TDS	Gravimetry	QP-CHEM-2059
TOC	1.0	7.8	3.4	5.4	mg/l C	Spectrophotometry	QP-CHEM-2071
DOC	1.4	5.2	1.0	1.8	mg/l C	Spectrophotometry	QP-CHEM-2071
Colour	6	54	8	11	mg/l PtCo	Spectroscopy	QP-CHEM-2064
Turbidity	0.76	7.88	1.89	1.69	NTU	Turbidimetry	QP-CHEM-2014
Ammonia	<0.02	<0.02	0.12	0.23	mg/l	Auto Analyser	QP-CHEM-2037
Orthophosphate	<0.02	<0.02	<0.02	<0.02	mg/l P	Auto Analyser	QP-CHEM-2040
TON	<0.5	2.72	2.91	<0.5	mg/l N	Auto Analyser	QP-CHEM-2042
Nitrate (NO_3-N)	<0.5	2.73	2.90	<0.5	mg/l N	Auto Analyser	QP-CHEM-2043
Nitrite (NO_2-N)	<0.002	<0.002	0.01	<0.002	mg/l N	Auto Analyser	QP-CHEM-2087
Alkalinity	199	158	163	211	mg/l $CaCO_3$	Titration	QP-CHEM-2012

Parameter	30773-1 PZ1-22	30773-2 PZ2-22	30773-3 PZ3-22	30773-4 BH4-22	Units	Methodology	Test Procedure Ref.
Chloride	8.50	15.0	12.0	16.0	mg/l Cl	Titration	QP-CHEM-2035
Sulphate	29.6	18.1	5.59	17.7	mg/l SO_4	Auto Analyser	QP-CHEM-2013
Fluoride	0.09	0.14	0.10	0.10	mg/l F	Auto Analyser	QP-CHEM-2013

* In-house Accredited Test
**On-site Accredited Test

Parameter	30773-1 PZ1-22	30773-2 PZ2-22	30773-3 PZ3-22	30773-4 BH4-22	Units	Methodology	Test Procedure Ref.
Ethylbenzene	<1	<1	<1	<1	ug/l	Note 1	Note 1
Benzene	<1	<1	<1	<1	ug/l	Note 1	Note 1
Toluene	<1	<1	<1	<1	ug/l	Note 1	Note 1
m&p Xylene	<1	<1	<1	<1	ug/l	Note 1	Note 1
o-Xylene	<1	<1	<1	<1	ug/l	Note 1	Note 1
Enterococci	17	42	33	13	cfu/l00 ml	Note 1	Note 1
E Coli (Colilert)	0	6	0	0	mpn/100 ml	Note 1	Note 1
Aluminium, Filtered as Al***	<1	<1	<1	<1	mg/l	Note 1	Note 1
Barium, Filtered as Ba***	<0.07	<0.07	<0.07	<0.07	mg/l	Note 1	Note 1
Boron, Filtered as B***	<2.30	<2.30	<2.30	<2.30	mg/l	Note 1	Note 1
Cadmium, Filtered as Cd***	<0.006	<0.006	<0.006	<0.006	mg/l	Note 1	Note 1
Calcium, Filtered as Ca***	58.3	40.1	36.2	44.2	mg/l	Note 1	Note 1
Chromium, Filtered as Cr***	<0.02	<0.02	<0.02	<0.02	mg/l	Note 1	Note 1
Chromium-Hexavalent***	<0.003	<0.003	<0.003	<0.003	mg/l	Note 1	Note 1
Copper, Filtered as Cu***	<0.09	<0.09	<0.09	<0.09	mg/l	Note 1	Note 1
Iron, Filtered as Fe***	<2.30	<2.30	<2.30	<2.30	mg/l	Note 1	Note 1
Lead, Filtered as Pb***	<0.06	<0.06	<0.06	<0.06	mg/l	Note 1	Note 1
Magnesium, Filtered as Mg***	27.0	17.4	17.0	24.5	mg/l	Note 1	Note 1
Manganese, Filtered as Mn***	0.326	<0.07	<0.07	<0.07	mg/l	Note 1	Note 1
Mercury, Filtered as Hg***	<0.00001	<0.00001	<0.00001	<0.00001	mg/l	Note 1	Note 1
Molybdenum, Filtered as Mo***	0.006	<0.03	0.03	<0.03	mg/l	Note 1	Note 1
Nickel, Filtered as Ni***	<0.03	<0.03	<0.03	<0.03	mg/l	Note 1	Note 1

Parameter	30773-1 PZ1-22	30773-2 PZ2-22	30773-2 PZ2-22	30773-4 BH4-22	Units	Methodology	Test Procedure Ref.
Potassium, Filtered as K***	<1.80	6.56	<1.80	<1.80	mg/l	Note 1	Note 1
Sodium, Filtered as Na***	12.6	14.7	8.72	16.9	mg/l	Note 1	Note 1
Zinc, Filtered as Zn***	<0.18	<0.18	<0.08	<0.18	mg/l	Note 1	Note 1
Total Hardness as CaCO3***	271	178	169	216	mg/l	Note 1	Note 1
Cyanide, Total as CN***	<0.009	<0.009	<0.009	<0.009	mg/l	Note 1	Note 1
Aliphatic VPH >C5-C6***	<10	<10	<10	<10	ug/l	Note 1	Note 1
Aliphatic VPH >C6-C8***	<10	<10	<10	<10	ug/l	Note 1	Note 1
Aliphatic VPH >C8-C10***	<10	<10	<10	<10	ug/l	Note 1	Note 1
Aliphatic VPH >C5-C10***	<10	<10	<10	<10	ug/l	Note 1	Note 1
Aromatic VPH > C5-C7***	<10	<10	<10	<10	ug/l	Note 1	Note 1
Aromatic VPH > C7-C8***	<10	<10	<10	<10	ug/l	Note 1	Note 1
Aromatic VPH > C8-C10***	<10	<10	<10	<10	ug/l	Note 1	Note 1
Aromatic VPH >C5-C10***	<10	<10	<10	<10	ug/l	Note 1	Note 1
VPH >C5-C10***	<10	<10	<10	<10	ug/l	Note 1	Note 1
Aliphatic EPH > C10-C12	<10	<20	<10	<10	ug/l	Note 1	Note 1
Aliphatic EPH >C12-C16	<10	<20	<10	<10	ug/l	Note 1	Note 1
Aliphatic EPH >C16-C35	<10	<20	<10	14	ug/l	Note 1	Note 1
Aliphatic EPH >C35-C44	<10	<20	<10	<10	ug/l	Note 1	Note 1
Aliphatic EPH >C10-C44	<10	<20	<10	14	ug/l	Note 1	Note 1
Aromatic EPH > C10-C12	<10	<20	<10	<10	ug/l	Note 1	Note 1
Aromatic EPH >C12-C16	<10	<20	<10	<10	ug/l	Note 1	Note 1
Aromatic EPH > C16-C21	<10	<20	<10	<10	ug/l	Note 1	Note 1
Aromatic EPH >C21-C35	<10	<20	<10	<10	ug/l	Note 1	Note 1
Aromatic EPH >C35-C44	<10	<20	<10	<10	ug/l	Note 1	Note 1
Aromatic EPH >C10-C44	<10	<20	<10	<10	ug/l	Note 1	Note 1
EPH >C10-C44	<10	<20	<10	14	ug/l	Note 1	Note 1
Aliphatic VPH/EPH >C5-C44	<10	<20	<10	14	ug/l	Note 1	Note 1
Aromatic VPH/EPH >C5-C44	<10	<20	<10	<10	ug/l	Note 1	Note 1

Parameter	30773-1 PZ1-22	30773-2 PZ2-22	30773-2 PZ2-22	30773-4 BH4-22	Units	Methodology	Test Procedure Ref.
VPH/EPH >C5-C44	<10	<20	<10	14	ug/l	Note 1	Note 1
Arsenic, filter as AS***	0.35	2.3	1.8	17	ug/l	Note 1	Note 1
Selenium, filter as Se***	<1.2	<1.2	<1.2	<1.2	ug/l	Note 1	Note 1
Antimony, filter as Sb***	<1.3	4.4	7.3	16	ug/l	Note 1	Note 1
Naphthalene***	<0.01	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Acenaphthylene***	<0.01	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Acenaphthene***	<0.01	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Fluorene***	<0.01	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Phenanthrene***	<0.01	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Anthracene***	<0.01	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Fluoranthene***	<0.01	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Pyrene***	<0.01	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Benzo(a)anthracene***	<0.01	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Chrysene***	<0.01	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Benzo(b)fluoranthene***	<0.01	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Benzo(k)fluoranthene***	<0.01	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Benzo(a)pyrene***	<0.01	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Indeno(123cd)pyrene***	<0.01	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Dibenzo(ah)anthracene***	<0.01	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Benzo(ghi)perylene***	<0.01	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
PAH,Total of 16	<0.01	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1

*** Subcontracted Accredited test

Note 1: Note 1: Analysis subcontracted to ALS

Parameter	30773-5 BH5-22	30773-6 BH6-22	30773-7 SUMP	Units	Methodology	Test Procedure Ref.
Temperature**	12.3	13.2	12.1	°C	DO Meter	QP-MEAS-2011
DO**	59.0	55.2	104.9	% Sat	DO Meter	QP-MEAS-2019
DO**	6.31	5.78	11.3	mg/l O_2	DO Meter	QP-MEAS-2019
pH**	8.0	7.3	7.8	pH Units	pH Probe	QP-MEAS-2011
Conductivity**	232	423	606	µS/cm @ 25°C	Conductivity Meter	QP-MEAS-2009
BOD*	5.9	6.3	6.6	mg/l cBOD5	5 Day incubation/DO probe	QP-CHEM-2016
COD*	23	12	7	mg/l O_2	Digestion spectrophotometry	QP-CHEM-2065
Suspended Solids*	3.9	5.9	<3	mg/l SS	Gravimetry	QP-CHEM-2002
Total Dissolved Solids	257	407	489	mg/l TDS	Gravimetry	QP-CHEM-2059
TOC	3.2	11.9	3.3	mg/l C	Spectrophotometry	QP-CHEM-2071
DOC	0.6	4.1	0.8	mg/l C	Spectrophotometry	QP-CHEM-2071
Colour	5	17	200	mg/l PtCo	Spectroscopy	QP-CHEM-2064
Turbidity	1.20	1.72	1.61	NTU	Turbidimetry	QP-CHEM-2014
Ammonia	<0.02	0.59	0.04	mg/l	Auto Analyser	QP-CHEM-2037
Orthophosphate	<0.02	<0.02	<0.02	mg/l P	Auto Analyser	QP-CHEM-2040
TON	<0.5	<0.5	2.59	mg/l N	Auto Analyser	QP-CHEM-2042
Nitrate (NO_3-N)	<0.5	<0.5	2.56	mg/l N	Auto Analyser	QP-CHEM-2043
Nitrite (NO_2-N)	<0.002	<0.002	0.01	mg/l N	Auto Analyser	QP-CHEM-2087
Alkalinity	163	265	140	mg/l $CaCO_3$	Titration	QP-CHEM-2012
Chloride	14.0	10.5	9.00	mg/l Cl	Titration	QP-CHEM-2035
Sulphate	18.9	10.4	11.7	mg/l SO_4	Auto Analyser	QP-CHEM-2013
Fluoride	0.16	0.10	0.15	mg/l F	Auto Analyser	QP-CHEM-2013

* In-house Accredited Test
**On-site Accredited Test

Parameter	30773-5 BH5-22	30773-6 BH6-22	30773-7 SUMP	Units	Method ology	Test Procedure Ref.
Ethylbenzene	<1	<1	<1	ug/l	Note 1	Note 1
Benzene	<1	<1	<1	ug/l	Note 1	Note 1
Toluene	<1	<1	<1	ug/l	Note 1	Note 1
m&p Xylene	<1	<1	<1	ug/l	Note 1	Note 1
o-Xylene	<1	<1	<1	ug/l	Note 1	Note 1
Enterococci	0	4	2	cfu/l00 ml	Note 1	Note 1
E Coli (Colilert)	0	0	2	mpn/100 ml	Note 1	Note 1
Aluminium, Filtered as Al***	<0.1	<0.1	<0.1	mg/l	Note 1	Note 1
Barium, Filtered as Ba***	0.051	0.134	0.069	mg/l	Note 1	Note 1
Boron, Filtered as B***	<0.23	<0.23	<0.23	mg/l	Note 1	Note 1
Cadmium, Filtered as Cd***	<0.0006	<0.0006	<0.0006	mg/l	Note 1	Note 1
Calcium, Filtered as Ca***	35.8	90.3	88.8	mg/l	Note 1	Note 1
Chromium, Filtered as Cr***	<0.002	<0.002	<0.002	mg/l	Note 1	Note 1
Chromium-Hexavalent***	<0.003	<0.003	<0.003	mg/l	Note 1	Note 1
Copper, Filtered as Cu***	<0.009	<0.009	<0.009	mg/l	Note 1	Note 1
Iron, Filtered as Fe***	<0.23	<0.23	<0.23	mg/l	Note 1	Note 1
Lead, Filtered as Pb***	<0.006	<0.006	<0.006	mg/l	Note 1	Note 1
Magnesium, Filtered as Mg***	21.0	19.7	28.5	mg/l	Note 1	Note 1
Manganese, Filtered as Mn***	<0.007	2.79	<0.007	mg/l	Note 1	Note 1
Mercury, Filtered as Hg***	<0.00001	<0.00001	<0.00001	mg/l	Note 1	Note 1
Molybdenum, Filtered as Mo***	0.008	<0.003	0.004	mg/l	Note 1	Note 1
Nickel, Filtered as Ni***	<0.003	0.005	<0.003	mg/l	Note 1	Note 1

*** Subcontracted Accredited Test
Note 1: Analysis subcontracted to ALS

Parameter	30773-5 BH5-22	30773-6 BH6-22	30773-7 SUMP	Units	Methodology	Test Procedure Ref.
Potassium, Filtered as K***	3.60	2.69	1.68	mg/l	Note 1	Note 1
Sodium, Filtered as Na***	16.0	14.9	8.85	mg/l	Note 1	Note 1
Zinc, Filtered as Zn***	<0.018	<0.018	<0.018	mg/l	Note 1	Note 1
Total Hardness as CaCO3***	182	302	352	mg/l	Note 1	Note 1
Cyanide, Total as CN***	<0.009	<0.009	<0.009	mg/l	Note 1	Note 1
Aliphatic VPH >C5-C6***	<10	<10	<10	ug/l	Note 1	Note 1
Aliphatic VPH >C6-C8***	<10	<10	<10	ug/l	Note 1	Note 1
Aliphatic VPH >C8-C10***	<10	<10	<10	ug/l	Note 1	Note 1
Aliphatic VPH >C5-C10***	<10	<10	<10	ug/l	Note 1	Note 1
Aromatic VPH > C5-C7***	<10	<10	<10	ug/l	Note 1	Note 1
Aromatic VPH > C7-C8***	<10	<10	<10	ug/l	Note 1	Note 1
Aromatic VPH > C8-C10***	<10	<10	<10	ug/l	Note 1	Note 1
Aromatic VPH >C5-C10***	<10	<10	<10	ug/l	Note 1	Note 1
VPH >C5-C10***	<10	<10	<10	ug/l	Note 1	Note 1
Aliphatic EPH > C10-C12	<10	<10	<10	ug/l	Note 1	Note 1
Aliphatic EPH >C12-C16	<10	<10	<10	ug/l	Note 1	Note 1
Aliphatic EPH >C16-C35	<10	30	<10	ug/l	Note 1	Note 1
Aliphatic EPH >C35-C44	<10	<10	<10	ug/l	Note 1	Note 1
Aliphatic EPH >C10-C44	<10	30	<10	ug/l	Note 1	Note 1
Aromatic EPH > C10-C12	<10	<10	<10	ug/l	Note 1	Note 1
Aromatic EPH >C12-C16	<10	<10	<10	ug/l	Note 1	Note 1
Aromatic EPH > C16-C21	<10	<10	<10	ug/l	Note 1	Note 1
Aromatic EPH >C21-C35	<10	12	<10	ug/l	Note 1	Note 1
Aromatic EPH >C35-C44	<10	<10	<10	ug/l	Note 1	Note 1
Aromatic EPH >C10-C44	<10	12	<10	ug/l	Note 1	Note 1
EPH >C10-C44	<10	43	<10	ug/l	Note 1	Note 1
Aliphatic VPH/EPH >C5-C44	<10	30	<10	ug/l	Note 1	Note 1
Aromatic VPH/EPH >C5-C44	<10	12	<10	ug/l	Note 1	Note 1

Parameter	30773-5 BH5-22	30773-6 BH6-22	30773-7 SUMP	Units	Methodology	Test Procedure Ref.
VPH/EPH >C5-C44	<10	42	<10	ug/l	Note 1	Note 1
Arsenic, filter as AS***	23	0.37	2.5	ug/l	Note 1	Note 1
Selenium, filter as Se***	<1.2	<1.2	<1.2	ug/l	Note 1	Note 1
Antimony, filter as Sb***	51	9.2	4.2	ug/l	Note 1	Note 1
Naphthalene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Acenaphthylene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Acenaphthene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Fluorene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Phenanthrene***	<0.01	0.013	<0.01	ug/l	Note 1	Note 1
Anthracene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Fluoranthene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Pyrene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Benzo(a)anthracene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Chrysene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Benzo(b)fluoranthene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Benzo(k)fluoranthene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Benzo(a)pyrene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Indeno(123cd)pyrene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Dibenzo(ah)anthracene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
Benzo(ghi)perylene***	<0.01	<0.01	<0.01	ug/l	Note 1	Note 1
PAH,Total of 16	<0.01	0.013	<0.01	ug/l	Note 1	Note 1

*** Subcontracted Accredited Test
Note 1: Analysis subcontracted to ALS

Prepared By: _____ **Date:** 14 Nov 2022

Svetlana Krivelo
Senior Laboratory Analyst

Approved By: Imelda Shanahan **Date:** 14 Nov 2022

Dr. Imelda Shanahan
Technical Manager

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