Westwood Bund Ground Investigation

Ground Investigation Report

Biogen UK Ltd

Prepared by:

SLR Consulting Limited

3rd Floor, Brew House, Jacob Street, Tower Hill,
Bristol, BS2 0EQ

SLR Project No.: 403.065590.00001

Client Reference No: 083070

16 September 2024

Revision: 0

Document Revision Record

Revision	Date	Prepared By	Checked By	Authorised By
0	16 September 2024	APK	AK & TD	DG

Basis of Report

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1.0 Introduction

1.1 Background

SLR Consulting (SLR) was appointed by Biogen UK Ltd (Biogen) to undertake a Ground Investigation (GI) and prepare a factual Ground Investigation Report (GIR) for their Westwood Anaerobic Digestion (AD) plant site located on Bedford Road, Rushden, NN10 0SQ (the Site).

The AD plant was designed and constructed around 2009. The secondary containment is primarily provided by an unlined engineered clay bund, with minor sections of concrete walls.

This GIR is required to support ongoing permitting discussions, where Biogen have been asked to demonstrate that the existing secondary containment arrangements comply with C736[1]. In the absence of any construction records, a ground investigation has been undertaken to assess the composition of the existing bund and ensure the material meets the permeability requirements specified in C736[1], with a minimum permeability coefficient of $1x10^{-09}$ m/sec.

A permeability assessment[2] was previously completed for the bund during 2009 as part of the design and construction works. This assessment gave indication that the Site is underlain by a 20m thickness of glacial clay with a permeability significantly less than $1x10^{-09}$m/sec which was classed as acceptable in accordance with the guidance at time (since superseded by C736[1]).

This report has been prepared in general accordance with BS EN 1997-2:2007[3] section for ground investigation report and evaluation of geotechnical information.

1.2 Scope and Objectives of the Report

The scope of work comprised the following tasks:

- preparation of relevant health and safety documentation including a detailed Health & Safety Plan, Risk Assessments and Method Statements for the proposed works;
- procure and manage all site investigation works;
- clearance of all exploratory locations utilising a Cable Avoidance Tool (C.A.T) & Genny;
- 2No. dynamic sampling boreholes on to a maximum depth of 6.0m below ground level (bgl);
- supervision and logging of all locations in accordance with BS5930:2015+A1:2020[4] by a suitably qualified engineer;
- Backfill of all locations with arisings
- carry out permeability laboratory testing; and,
- produce an interpretative report detailing the findings of the investigation.

1 Watson, I.L.W. and Drake, C. (2014) Containment systems for the prevention of pollution. London: CIRIA.

2 07-0296 Westwood Biogen Permeability assessment, Rolton Group, 2009

3 Eurocode 7: Geotechnical Design: Part 2, ground investigation and testing (2007). London: BSI.

4 British Standards Institution (2020). BS 5930:2015+A1: 2020 BSI Standards Publication Code of Practice for Ground Investigations

2.0 Site Description

2.1 Summary Site Details

Table 2-1 summarises the site details. Information has been obtained from Ordnance Survey (OS), Environment Agency (EA) and British Geological Survey (BGS) mapping.

Table 2-1 Site Information

Site Information Review			
Site Location	Biogen Westwood, Bedford Road, Rushden NN10 0SQ.		
National Grid Reference	National Grid Reference SP 98893 63205.		
Current Site Use	The Site is an operational anaerobic digestion site.		
Access	The Site is accessed from Bedford by travelling northbound on the A6 (Bedford Road) toward Rushden for 13 miles, passing through Milton Ernest and Sharnbrook. The Site is then entered by turning right onto an unmarked (but signposted) road leading to Biogen Westwood, which will be on your left as you enter the area.		
Surrounding Land Use	North	The area immediately north of the Site is characterised by undeveloped arable farmland. A hard-standing farm access track extends northeast southwest parallel to the site. Several drainage ditches are observed along the field perimeter. Additionally, an isolated water body is identified approximately 25m north of the Site boundary, measuring 42m in width.	
	East	The area immediately east of the Site is characterised by undeveloped arable farmland.	
	South	The area immediately south of the Site consists of undeveloped woodland.	
	West	The area immediately west of the Site is undeveloped arable farmland. An overhead power cable runs north to south through the adjacent field. The unnamed access road to the site is located to the west, following the field boundaries. The A6 is approximately 550 meters west of the Site.	
Site History (OS mapping and Aerial Photographs)	Published Year/Map Scale	On-Site	Off-Site
	OS Six inch, 1830-1880's (county layers)	The Site is primarily undeveloped pastureland.	Surrounding land use is primarily undeveloped pastureland. West wood (woodland) identified to the west.
	OS One-Ince, 1885-1903-Hills	As above.	As above.
	OS Quarter inch, 3rd ed., 1919-1923	As above.	As above.
	OS 1:25,000 (Outline), 1945-65	As above.	As above.

Site Information Review		
Geography	Topography and Gradient	The Site is flat, with hardstanding surfaces across the Site surveyed at 97m above Ordnance Datum (AOD) (Appendix A). Containment bunds around the east, south and west perimeter range from 98.82-101.45m AOD in height.
	Elevation	97m AOD.
	Surface Water	Field drainage identified to the north of the Site. Isolated water body identified approx. 25 m north of the Site with a width of 42m.
	Superficial Geology	Review of the BGS Onshore GeoIndex 1:50,000 data (BGS, 2019) shows that the Site is underlain by the Oadby Member (Diamicton). Described as; Diamicton, grey, weathering brown, characterised by Cretaceous and Jurassic rock fragments; subordinate lenses of sand and gravel, clay and silt. Clay, brown to grey, and silty clay, with chalk and flint fragments.
	Bedrock Geology	Review of the BGS Onshore GeoIndex 1:50,000 data (BGS, 2019) shows that the Site is underlain by the Oxford Clay Formation – Mudstone. Described as: Silicate-mudstone, grey, generally smooth to slightly silty, with sporadic beds of argillaceous limestone nodules.
	British Geological Survey Borehole Data	No publicly available British Geological Survey borehole data within the Site boundary.
	Historic Ground Investigation Data	Previous reports indicate the Site is underlain by Glacial Till.
	Mining/Quarrying	There has been no historic mining or quarrying activities within the Site boundary.
Hydrological and Hydrogeological Setting	Aquifer	The superficial deposits (Oadby Member - Diamicton) is classified as a Secondary Aquifer. The bedrock (Oxford Clay Formation) is classified as unproductive.
	Flood map for planning	The Site is classified as Flood Zone 1, which has a low probability of flooding from rivers and the sea.
Ecological Setting	Protected Species	No protected species identified on Site.
Utilities	No overhead cables are present within the Site.	
Radon	All areas on the Site are in the lowest band of radon potential. Less than 1% of homes at or above the Action Level.	
Environmental Designations (e.g. SSSI's)	No designated environmental sites have been identified within or close proximity to the Site boundary.	

Site Information Review	
Unexploded Ordnance (UXO)	Based on the UXO risk map the risk of encountering UXO at the Site is considered to be low.

3.0 Ground Investigation

3.1 Rationale

A ground investigation scope was developed by SLR engineers to provide geotechnical information of the containment bund and to recover undisturbed samples for permeability testing of the bund material.

3.2 Summary of Fieldwork

SLR conducted an intrusive Ground Investigation at the Site on the 6th and 7th of August 2024. The scope of the investigation specified by SLR engineers included the following:

- Clearance of all exploratory locations with a CAT and Genny 4;
- 2 No. dynamic sampling boreholes to a maximum depth of 6.2m bgl (BH01 & BH02);
- Standard Penetration Tests (SPTs) at 1.0m centres to depths of 6.0m bgl;
- collection and submission of soil samples for permeability laboratory analysis;
- Supervision and logging of all exploratory holes were conducted in accordance with BS5930:2015 +A1:2020[5] by a suitability qualified engineer; and,
- backfill all investigation locations and reinstatement with arisings / bentonite (as appropriate).

Both boreholes were advanced from the crest of the containment bund. The locations of all exploratory locations are shown in Appendix A, which shows the Site in its current layout and exploratory hole locations in relation to the proposed development.

Geotechnical laboratory analysis was undertaken by Geolabs Ltd.

3.3 Boreholes

A total of two dynamic sampling boreholes were drilled using a P60 slope climbing rig to a maximum depth of 6.20m bgl between the 6th and 7th of August 2024. Boreholes were drilled to allow for logging, sampling and in situ testing of the underlying ground and groundwater conditions.

A summary of the boreholes is detailed in Table 3-1. A summary of site observations is provided within Table 3-2.

Detailed descriptions of the underlying geology are provided within the Borehole logs in Appendix B.

Table 3-1 Summary of Boreholes

Infrastructure Element	Borehole ID	Drilling Method	Depth completed (mbgl)
Containment Bund	BH01	Dynamic sampling	6.20
Containment Bund	BH02	Dynamic sampling	6.00

[5] British Standards Institution (2020). BS 5930:2015+A1: 2020 BSI Standards Publication Code of Practice for Ground Investigations

3.4 Ground Conditions

Site Geology

Table 3-2 below presents a summary of the encountered geology during the intrusive investigation.

Table 3-2 Summary of Strata Encountered

Ground Type	Strata	Description	Depth Range (m bgl)
Topsoil	Topsoil	Dark brown silty slightly sandy CLAY with frequent rootlets and occasional fine to medium rounded gravel of chalk and quartz. Sand is fine to medium.	0.00-0.15m
Made Ground	Made Ground	Brownish grey clayey silty fine to medium GRAVEL. Gravel is subangular to rounded of quartz and chalk.	0.15-1.10m
Reworked Clay	Reworked Clay	Firm light brown locally grey mottled slightly gravelly CLAY. Gravel is fine to medium subangular to rounded of quartz and chalk. Rare brick fragments.	0.15- 1.20m
Superficial	Oadby Member - Diamicton	Soft to firm yellowish brown locally grey mottled slightly gravelly CLAY. Gravel is fine to medium, subangular to angular of quartz and chalk.	1.10-6.20m

3.4.1 Topsoil

Topsoil was identified in both exploratory locations, recorded to a maximum depth of 0.15m bgl (at both BH01 and BH02). Topsoil was consistent across the Site comprising dark brown silty slightly sandy clay with frequent rootlets and occasional fine to medium rounded gravel.

3.4.2 Made Ground

Made Ground was identified in BH02, recorded to a depth of 1.10m bgl comprising brownish grey clayey silty fine to medium gravel of subangular to rounded quartz and chalk.

3.4.3 Reworked Clay

Reworked clay was identified in BH01 from 0.15- 1.20m. Reworked clay was recorded to comprise firm light brown locally grey mottled slightly gravelly clay. Gravel was subangular to rounded fine to medium of quartz and chalk with rare brick fragments. This was differentiated from the Oadby Member by the identification of the rare brick fragments.

3.4.4 Oadby Member – Diamicton

The Oadby Member was identified from 1.10m to 1.20m in BH02 and BH01 respectively. The Oadby Member was consistent across the Site comprising soft to firm yellowish brown locally mottled grey slightly gravelly clay. Gravel was subangular to angular fine to medium of quartz and chalk. Stiffness was observed to generally increase with depth becoming stiff in BH02 from 4.90m bgl.

3.4.5 Field / Visual Observations of Contamination

No visual/ olfactory contamination was encountered during the ground investigation.

3.4.6 Groundwater

Groundwater was not recorded in BH01 or BH02.

3.4.7 Standard Penetration Tests (SPT's)

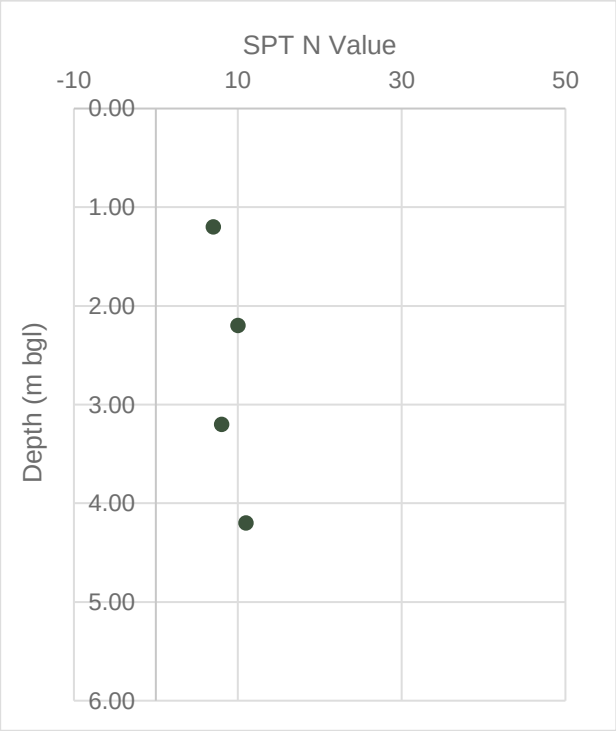
A total of 4No. in situ SPT's were undertaken in BH01 at 1.0m centres to a maximum depth of 4.20m bgl to obtain information on the relative density of strata encountered. Results are included on the borehole logs in Appendix B, summarised in Table 3-3 and presented graphically in Figure 3-1.

All 4No. SPT tests were conducted within the Oadby Member which were consistent with depth. A correlation between undrained strength in clay and SPT N-value is proposed by Stroud[6] (1989) which indicates the glacial till, as a low to medium strength material with undrained shear strengths of between 35kPa and 55kPa. However, the relationship is not considered to be as reliable as laboratory testing and alternative in-situ test methods.

Table 3-3 Summary of SPT tests.

Strata	N Value (Min)	N Value (Max)	N Value (Average)	Tests
Oadby Member	7	11	9	4

Figure 3-1 SPT N-Value with Depth.



[6] Stroud, M.A. (1989). *The Standard Penetration Test – its application and interpretation. Penetration testing in the UK,* Thomas Telford.

4.0 Laboratory Results

As part of the fieldwork, two UT100 samples were recovered from the bund which were submitted to an accredited Geotechnical Laboratory for triaxial permeability testing.

4.1 Geotechnical Laboratory Data

A summary of results can be found in Table 4-1, with the laboratory certificates included within Appendix D.

Table 4-1 Geotechnical Laboratory Test Results

Location ID	Depth (m)	Type	Water Content (%)		Bulk Density (Mg/m³)		Dry Density (Mg/m³)		Coefficient of Permeability (k_v at 20 °C)
			Initial	Final	Initial	Final	Initial	Final	
BH01	5.20-5.65	U	17.4	18.0	2.14	2.18	1.82	1.84	5.3×10^{-11} m/s
BH02	2.20-2.65	U	19.3	20.1	2.13	2.15	1.78	1.79	1.2×10^{-10} m/s

5.0 Conclusions

SLR conducted an intrusive Ground Investigation at the Site on the 6th and 7th of August 2024. Two dynamic sampling boreholes were drilled using a P60 slope climbing rig to a maximum depth of 6.20m bgl.

Topsoil was encountered to a maximum depth of 0.15m bgl at both locations. This was underlain by Reworked Clay to 1.20m at BH01 and Made Ground to 1.10m at BH02. Both exploratory locations then proved the Oadby Member to the termination depth. Detailed descriptions of the underlying geology are provided within the borehole logs in Appendix B. The boreholes are deemed representative of the secondary containment bund system (with exception to the minor sections of concrete walls). The two UT100 samples recovered from the ground investigation were taken from within the containment bund.

Upon receipt of the laboratory certificates, it was confirmed that the two UT100 samples recovered from the secondary containment bund at BH01 and BH02 exhibited Coefficients of Permeability values of 5.3×10^{-11} m/s and 1.2×10^{-10} m/s, respectively.

These Coefficient of Permeability values are significantly lower than the required threshold of 1×10^{-9} m/s, demonstrating that the material complies with the permeability requirements outlined in C736[1].

Appendix A Drawings

Westwood Bund Ground Investigation

Ground Investigation Report

Biogen UK Ltd

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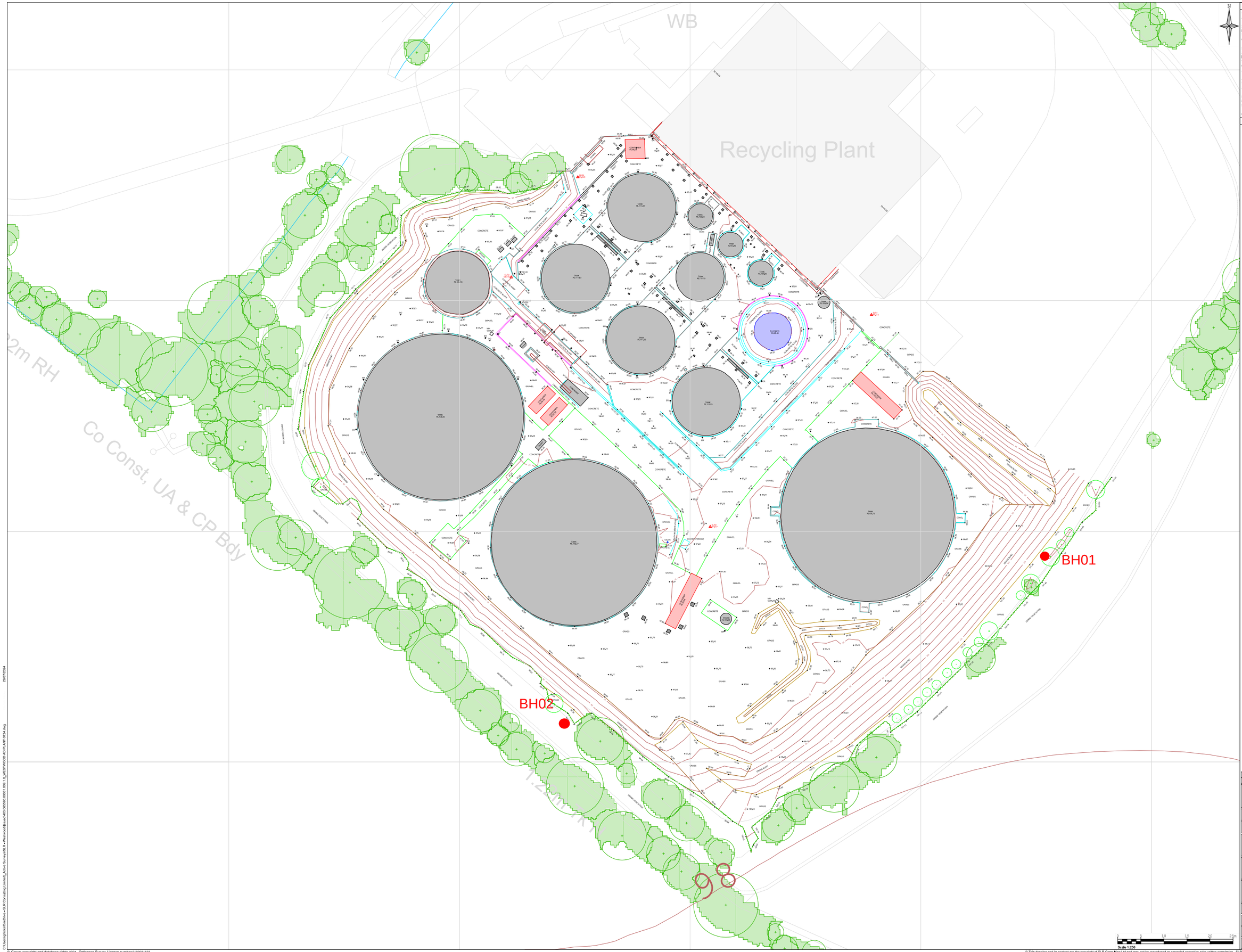
16 September 2024



Notes:

1. MONITORING SURVEY CARRIED OUT BY SLR CONSULTING JULY 22nd-23rd 2024.

2. THIS PLAN IS ORIENTATED TO ORDNANCE SURVEY NATIONAL GRID PLAN AND HEIGHT DATUM DERIVED FROM THE ORDNANCE SURVEY ACTIVE NETWORK; OSGB36(OSGM15/OSTN15).

3. WHILST EVERY EFFORT HAS BEEN MADE TO INCLUDE ALL ACCESSIBLE DETAIL, SOME FEATURES MAY NOT BE SHOWN IF OBSCURED AT THE TIME OF SURVEY (e.g. PARKED VEHICLES/BOATS/OVERGROWN AREAS). ONLY MAJOR TREES SURVEYED IN WOODED/OVERGROWN AREAS.

4. THE ACCURACY OF THIS SURVEY IS COMMENSURATE WITH THE DRAWING SCALE SPECIFIED WITHIN THE TITLE BLOCK. ALL CRUCIAL DIMENSIONS SHOULD BE CHECKED ON-SITE.

5. THE SCALE FACTOR HAS BEEN REMOVED FROM CONTROL STATION:
SLR2

6. OS DIGITAL DATA IS SHOWN IN GREY

Legend:

- SPOT LEVEL
- SURVEY CONTROL STATION WITH ID
- KERB BOTTOM
- KERB TOP
- CHANGE IN SURFACE
- WALL BOTTOM
- FENCE
- GATE
- WALL TOP
- BUILDING HATCH
- PLANT
- STEEL COLUMN
- WATER
- TREE - BLUESKY NATIONAL TREE MAP
- TREE

SURVEY ABBREVIATIONS

BB	Bellsha Beacon	LR	Life Ring
BC	Building Canopy	MH	Manhole
BH	Borehole	MKR	Marker
BM	Bench Mark	PO	Post
BOY	Boundary	PTH	Door Threshold Level
BOL	Bollard	IL	Pipe Invert
BT	British Telecom Manhole	RE	Rodding Eye
CCTV	Closed Circuit Television	RL	Ridge Level
CP	Chamber Pit	RNP	Road Name Plate
CTV	Cable Television Manhole	RS	Sign Post
CUL	Culvert	SL	Spot Light
DK	Drop Kerb	SO	Soffit Level
DP	Drain Pipe	ST	Stop Tap
DPC	Damp Proof Course	Stmp	Stump (Tree)
DWB	Dog Waste Bin	SV	Stop Valve
EB	Electricity Box	SVP	Soil Vent Pipe
EL	Eaves Level	SW	Storm Water
EP	Electricity Pole	SY	Stay (eg. Pylon, TP)
ER	Earthing Rod	TAP	Stand Pipe
IFL	Internal Floor Level	TCB	Telephone Call Box
INV	Invert	TCL	Tactile
FE	Fire Point	THL	Threshold Level
FA	Fire Alarm	TL	Traffic Light
GB	Grit Box	TW	Top of Wall
GV	Gas Valve	TP	Telegraph Pole
GP	Gate Post	TPT	Trial Pit
GRIT	Grit Bin	UIB	Under Beam
G	Gully	UTL	Unable To Lift
FH	Hydrant	VP	Vent Pipe
IC	Inspection Chamber	WSL	Window Sill Level
IT	Intercom	WHL	Window Head Level
KO	Kerb Outlet	WL	Water Level
LB	Life Buoy	WM	Water Meter
LP	Lamp Post	WO	Wash Out

FENCE TYPES

B/W	Barbed Wire
C/B	Closed Boarded
C/L	Chain Link
I/R	Iron Rail
G/P	Galvanised Palisade
P/W	Post & Wire

LEVEL PREFIX DESCRIPTIONS

CL	Cover Level
GL	Ground Level
IL	Invert Level
BL	Basal Level
SFL	Soffit Level
CP	Catch Pit

Rev	Amendments	Date	By	Chk	Auth
0	TOPOGRAPHIC SURVEY	07/24	GJH	NS	VSQ

SLR
www.slrconsulting.com

Drawing Status & Suitability Code:

Client: Biogen

Project: WESTWOOD AD PLANT
RUSHDEN

Drawing Title: TOPOGRAPHIC SURVEY

Scale		SLR Project No.
1:250	@ A0	403.065590.00001

Designed	Drawn	Checked	Authorised
	GJH	NS	VSQ
Date	Date	Date	Date
	07/24	07/24	07/24

Drawing Number: SHEET 1 OF 4
Rev: 0

Scale 1:250

Appendix B Borehole Logs

Westwood Bund Ground Investigation

Ground Investigation Report

Biogen UK Ltd

SLR Project No.: 403.065590.00001

16 September 2024

BOREHOLE LOG

BOREHOLE No **BH01**

Client: **Biogen UK Ltd**

Project No:	Date:	Ground Level:	Co-ordinates:
403.065590.00001	07/08/2024	101.56m	E498979 N263146

Project: **Westwood Ground Investigation**

Sheet 1 of 1

SAMPLES & TESTS				Water	STRATA				
Depth	Type No	Test Type	Test Result		Reduced Level	Legend	Depth (Thick-ness)	DESCRIPTION	Instrument Backfill
					101.41		0.15	Dark brown silty slightly sandy CLAY with frequent rootlets and occasional fine to medium rounded gravel of chalk and quartz. Sand is fine to medium. TOPSOIL	
0.70	B						(0.85)	Stiff light brown silty slightly gravelly CLAY. Gravel is fine to medium, subangular to rounded of quartz and chalk.	
0.70 - 0.85	D				100.56		1.00	REWORKED CLAY	
1.10	B	SPT	N=7		100.36		1.20	Firm light brown locally grey mottled slightly gravelly CLAY. Gravel is fine to medium subangular to rounded of quartz and chalk. Rare brick fragments. REWORKED CLAY	
1.10 - 1.20	D							Soft to firm yellowish brown locally grey and red mottled slightly gravelly CLAY. Gravel is fine to medium, subangular to rounded of chalk and quartz. OADBY MEMBER - DIAMICTON	
1.20 - 1.65	D								
2.20 - 2.65	D	SPT	N=10				(3.00)		
3.20 - 3.65	D	SPT	N=8						
4.20 - 4.65	D	SPT	N=11		97.36		4.20	Soft to firm yellowish brown locally grey mottled slightly gravelly CLAY. Gravel is fine to medium, subangular to angular of quartz and chalk. OADBY MEMBER - DIAMICTON	
5.20 - 5.65	UT						(2.00)		
5.65 - 5.75	D								
5.75 - 5.80	D				95.36		6.20	Borehole Complete at 6.20m	

Boring Progress and Water Observations					Chiselling			Water Added		General Remarks
Date	Depth	Casing Dpt	Casing Dia	Water Dpt	From	To	Hours	From	To	
07/08/2024			Start of shift							Location cleared with CAT & Genny 4 prior to breaking ground. Inspection pit hand dug to 1.20m.
07/08/2024	0.00		End of shift							

All dimensions in metres	Contractor: Geotechnical Engineering Ltd	Method: Cable percussion (shell and auger)	Logged By:	Approved By:
Scale 1:66	Plant: Hand tools/P60F	Hole Size: 128mm	APK	AK

LOGGING HAS BEEN CARRIED OUT IN ACCORDANCE WITH BS5930:2015+A2:2020

BOREHOLE LOG

BOREHOLE No **BH02**

Client: **Biogen UK Ltd**

Project No:	Date:	Ground Level:	Co-ordinates:
403.065590.00001	08/08/2024	99.29m	E498877 N263114

Project: **Westwood Ground Investigation**

Sheet 1 of 1

SAMPLES & TESTS				Water	STRATA				
Depth	Type No	Test Type	Test Result		Reduced Level	Legend	Depth (Thick-ness)	DESCRIPTION	Instrument Backfill
					99.14		0.15	Dark brown silty slightly sandy CLAY with frequent rootlets and occasional fine to medium rounded gravel of chalk and quartz. Sand is fine to medium.	
0.60	B						(0.95)	TOPSOIL	
0.60 - 0.80	D				98.19		1.10	Brownish grey clayey silty fine to medium GRAVEL. Gravel is subangular to rounded of quartz and chalk.	
1.10	B							MADE GROUND	
1.10 - 1.20	D							Firm orangish brown locally grey mottled slightly gravelly CLAY. Gravel is fine to medium subangular to rounded of quartz and chalk.	
1.75	D						(2.10)	OADBY MEMBER - DIAMICTON	
2.20 - 2.65	UT								
2.65 - 2.75	D								
2.75 - 2.80	D				96.09		3.20		
3.75	D						(1.70)	Firm to stiff brown locally grey and orange mottled CLAY with occasional fine to coarse angular to subrounded gravel of quartz and chalk. OADBY MEMBER - DIAMICTON	
4.50	D				94.39		4.90		
5.50	D						(1.10)	Stiff greyish brown locally orange mottled CLAY with occasional fine to medium angular to subrounded gravel of quartz and chalk. OADBY MEMBER - DIAMICTON	
					93.29		6.00		
								Borehole Complete at 6.00m	

Boring Progress and Water Observations					Chiselling			Water Added		General Remarks
Date	Depth	Casing Dpt	Casing Dia	Water Dpt	From	To	Hours	From	To	
08/08/2024			Start of shift							Location cleared with CAT & Genny 4 prior to breaking ground. Inspection pit hand dug to 1.20m.
08/08/2024	0.00		End of shift							

All dimensions in metres	Contractor: Geotechnical Engineering Ltd	Method: Cable percussion (shell and auger)	Logged By:	Approved By:
Scale 1:66	Plant: Hand tools/P60F	Hole Size: 98mm	APK	AK

LOGGING HAS BEEN CARRIED OUT IN ACCORDANCE WITH BS5930:2015+A2:2020

Appendix C Photo Log

Westwood Bund Ground Investigation

Ground Investigation Report

Biogen UK Ltd

SLR Project No.: 403.065590.00001

16 September 2024

Westwood Ground Investigation Photo Log

Photo 1: BH01 0.00-1.20m

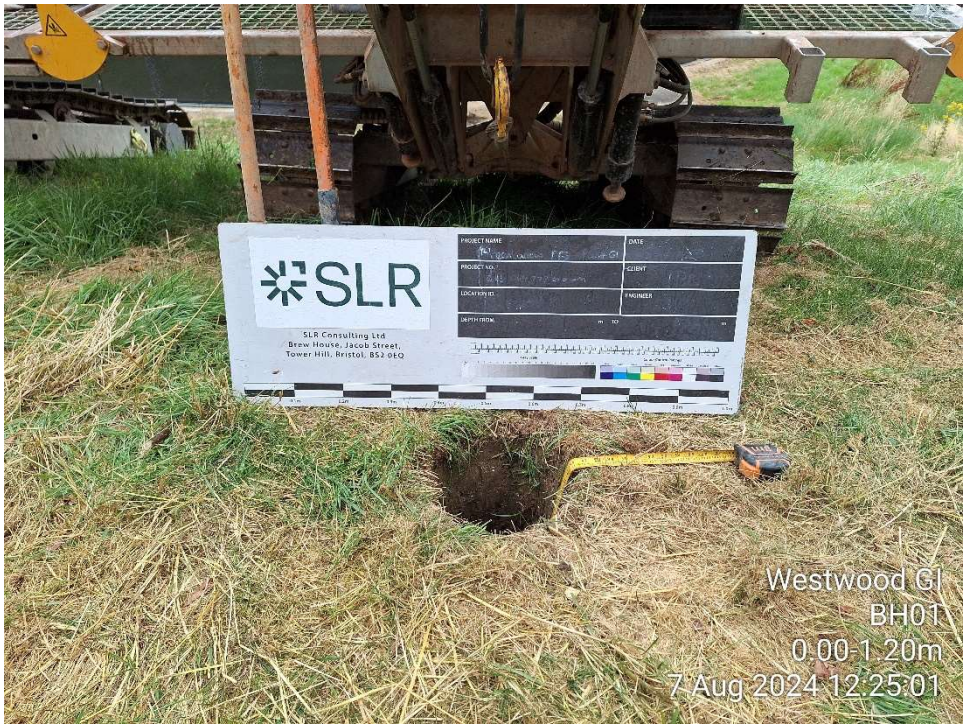


Photo 2: BH01 0.00-1.20m

Photo 3: BH01 1.20-4.20m

Photo 4: BH01 4.20- 6.20m

Photo 5: BH02 0.00-1.20m

Photo 6: BH02 0.00-1.20m

Photo 7: BH02 1.20- 4.20m

Photo 8: BH02 4.20- 6.00m

Appendix D Laboratory Certificates

Westwood Bund Ground Investigation

Ground Investigation Report

Biogen UK Ltd

SLR Project No.: 403.065590.00001

16 September 2024

GEOLABS Limited
Bucknalls Lane
Garston
Watford
Hertfordshire
WD25 9XX
Tel: +44(0) 1923 892 190
Fax: +44(0) 1923 892 191
email: admin@geolabs.co.uk
web: www.geolabs.co.uk

SLR Consulting Limited
3rd Floor
The Brew House
Jacob Street
Bristol
BS2 0EQ

16 September 2024
Report No : GEO/41072/01

For the attention of Ms A Kenshole

		Date samples received	19/08/2024
Our ref	**GEO / 41072**	Date written instructions received	15/08/2024
Your ref	**403.065590.00001**	Date testing commenced	20/08/2024
Order ref	**011390-416**	**Date of sample disposal**	**14/10/2024**

Project **WESTWOOD GROUND INVESTIGATION**

Further to your instructions we have pleasure in enclosing the results of the tests you requested in the attached figures.

LABORATORY TEST REPORT

Item No	Test Quantity	Description
1	2	Constant Head Permeability in a Triaxial Cell BH01 / 5.20-5.65 / U BH02 / 2.20-2.65 / U

Any opinions or interpretations expressed herein are outside the scope of UKAS accreditation. All results contained in this report are provisional unless signed by an approved signatory. The results contained in this report relate only to samples received in the laboratory and are tested 'as received' unless otherwise stated. This report should not be reproduced, except in full, without the written approval of the laboratory. The results reported are applicable only to the test items received by the laboratory.

All the necessary data required by the documented test procedures has been recorded and will be stored for a period of not less than 6 years. This data will be issued to yourselves at your request. All samples will be disposed of after the date shown above. Written confirmation will be required to retain the samples beyond this period and a storage charge may be applied.

We trust that the above meets your requirements and should you require any further information or assistance, please do not hesitate to contact us.

Yours faithfully
on behalf of **GEOLABS Limited**

P Heritage
Project Manager

BS EN ISO 17892-11 : 2019

PERMEABILITY IN A TRIAXIAL CELL

Location	BH01
Sample Depth	5.20-5.65 m
Sample Type	U

Description:
Stiff brown and yellowish brown mottled light grey gravelly CLAY. Gravel is fine to medium.

SPECIMEN DETAILS

Depth within original sample	25mm
Orientation within original	Vertical
Specimen preparation	Undisturbed

TEST DETAILS		**INITIAL**	**FINAL**
Diameter	*mm*	103.40	102.93
Height	*mm*	99.57	99.12
Water Content	*%*	17.4	18.0
Bulk Density	*Mg/m³*	2.14	2.18
Dry Density	*Mg/m³*	1.82	1.84
Average Laboratory Temperature	*°C*	20	
Source of Permeant Water		De-aired tap water	

SATURATION STAGE

Saturation initially by constant water content, followed by back-pressure assistance.

Pore pressure coefficient ('B' value)		0.52	0.95

CONSOLIDATION STAGE

Effective pressure	*kPa*	104
Volume change	*mL*	11.4

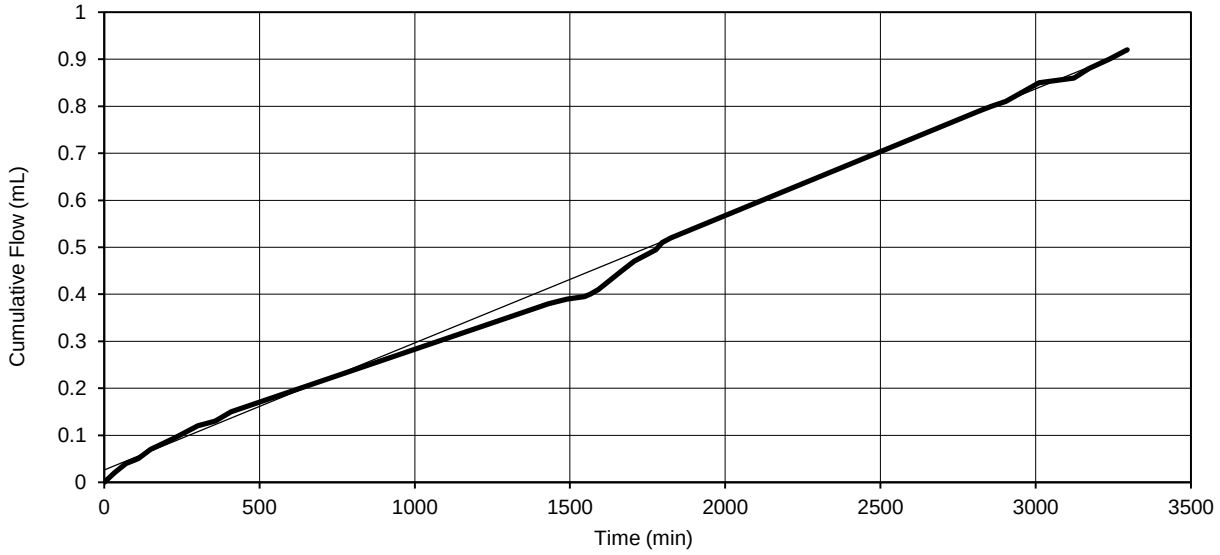
PERMEABILITY STAGE — Measured under constant head conditions in a triaxial cell

Pressure difference across specimen	*kPa*	10
Hydraulic gradient		10.3
Mean effective stress	*kPa*	104
Correction for head loss	*kPa*	0

TEST DURATIONS

Saturation	*days*	1
Consolidation	*days*	5
Flow	*days*	2

Coefficient of Permeability
k_v at 20 °C = 5.3×10^{-11} m/s



Tested by FL
Checked and Approved by

P Heritage

P Heritage - Project Manager
16/09/2024

Project Number:

GEO / 41072

Project Name:

WESTWOOD GROUND INVESTIGATION
403.065590.00001

GEOLABS®
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PERMEABILITY IN A TRIAXIAL CELL

Location	BH02
Sample Depth	2.20-2.65 m
Sample Type	U

Description:
Stiff yellowish brown mottled light grey slightly gravelly CLAY. Gravel is fine.

SPECIMEN DETAILS

Depth within original sample	30mm
Orientation within original	Vertical
Specimen preparation	Undisturbed

TEST DETAILS		**INITIAL**	**FINAL**
Diameter	*mm*	103.35	103.22
Height	*mm*	99.76	99.63
Water Content	*%*	19.3	20.1
Bulk Density	*Mg/m³*	2.13	2.15
Dry Density	*Mg/m³*	1.78	1.79
Average Laboratory Temperature	*°C*	20	
Source of Permeant Water		De-aired tap water	

SATURATION STAGE

Saturation initially by constant water content, followed by back-pressure assistance.

Pore pressure coefficient ('B' value)		0.80	0.95

CONSOLIDATION STAGE

Effective pressure	*kPa*	44
Volume change	*mL*	3.2

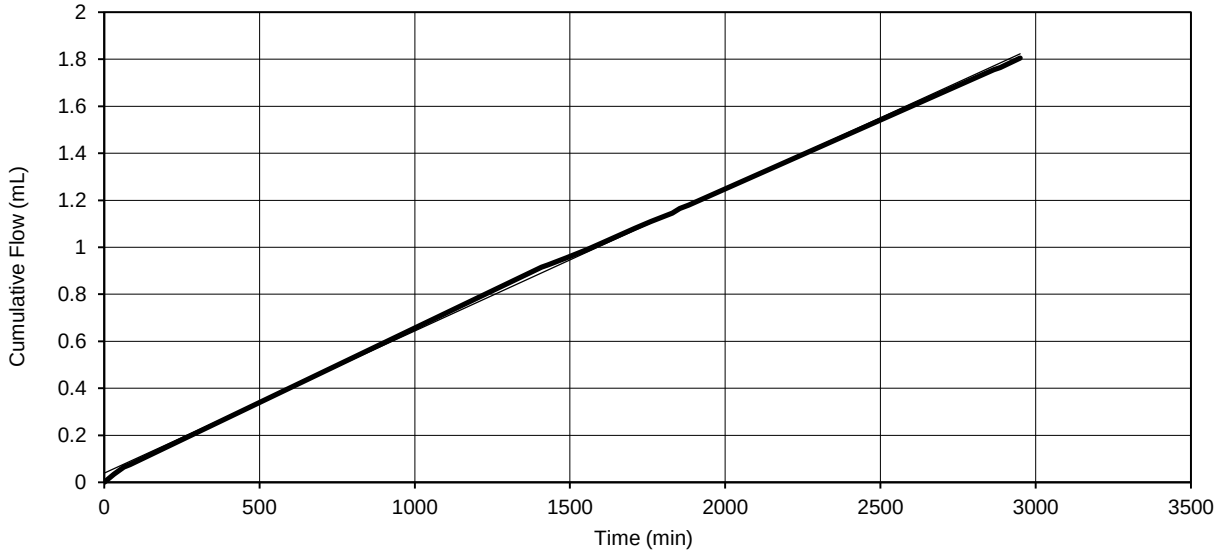
PERMEABILITY STAGE — Measured under constant head conditions in a triaxial cell

Pressure difference across specimen	*kPa*	10
Hydraulic gradient		10.2
Mean effective stress	*kPa*	44
Correction for head loss	*kPa*	0

TEST DURATIONS

Saturation	*days*	2
Consolidation	*days*	4
Flow	*days*	2

Coefficient of Permeability
k_v at 20 °C = 1.2×10^{-10} m/s



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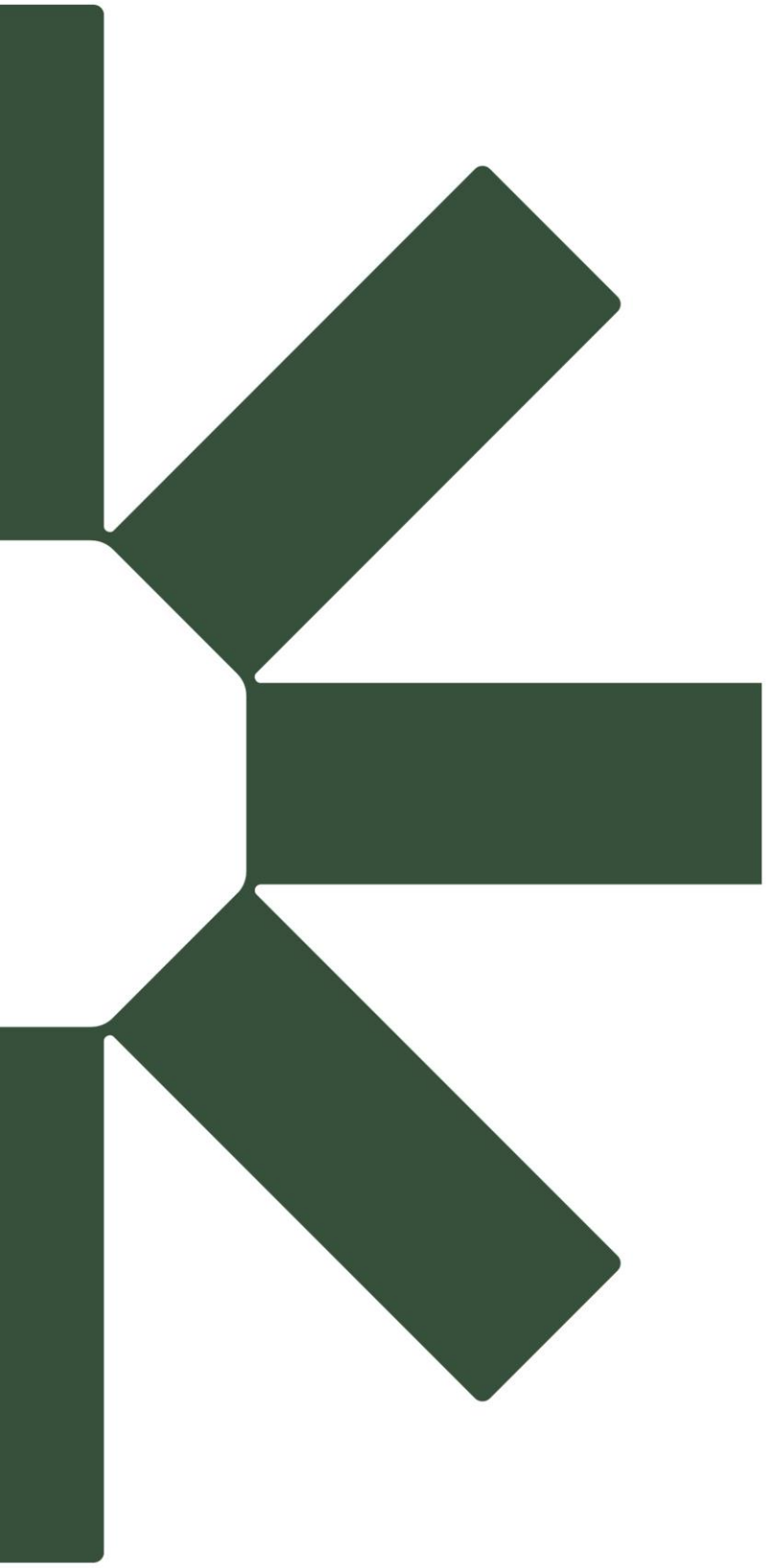

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