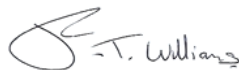


Ground Investigation Report and Basement Impact Assessment

42 Shepherds Hill, London, N6 5RR

On behalf of Harry Travers

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EXECUTIVE SUMMARY	
PROPOSED DEVELOPMENT	At the time of reporting, February 2024, the proposed development comprised the new single storey basement extension to be formed to the rear of the existing house, connecting into the existing basement. The development would also contain a new single storey extension at the ground floor over the new proposed basement. The proposed development fell within Geotechnical Design Category 2 in accordance with Eurocode 7. A plan view of the proposed development can be viewed within Figure 5.
GEOLOGY	The BGS Solid and Drift Geological Map for the North London Area (Sheet Number 256) revealed that the site was underlain by the underlain London Clay Formation bedrock. No superficial deposits, outcrops of other bedrock deposits or areas of Made/Worked Ground were noted within a 250m radius of the site.
HYDROGEOLOGY	The DEFRA online maps indicated that the site was located on unproductive strata associated with the London Clay Formation. No designation was given to superficial deposits due to their likely absence. From analysis of hydrogeological and topographical maps the groundwater table was anticipated to be encountered at depth within the geological formations below the London Clay Formation. Perched water was also likely to be found within localised cappings of Topsoil or Made Ground, and sandy/silty bands of the London Clay Formation especially after periods of intense or prolonged rainfall. It was considered that the groundwater was flowing southwards, towards the Thames. With reference to the Strategic Flood Risk Assessment for the London Borough of Haringey, the site was located between the two branches of the culverted Moselle Brook as shown in Figure 6.
VOLUME CHANGE POTENTIAL	Foundations should be designed in accordance with soils of medium volume change potential.
FOUNDATION DESIGN	Foundations constructed on the cohesive bedrock soils of the London Clay Formation at depths of between 1.50m – 3.50m bgl can be designed based on an allowable bearing capacity of 80kN/m² – 10kN/m². This is based on the ground conditions encountered and the in-situ strength data recorded.
SUB-SURFACE CONCRETE	Made Ground The water soluble sulphate concentration was 8.40mg/l, with a pH of 8.7. According to BRE Special Digest 1, 2005, 'Concrete in Aggressive Ground' a Sulphate Design Class of DS-1 could be used for sub-surface concrete in contact with the Made Ground. Table C1 of the Digest indicated an ACEC (Aggressive Chemical Environment for Concrete) classification of AC-1. London Clay Formation According to Box C6 of BRE Special Digest 1, 2005, 'Concrete in Aggressive Ground' the London Clay Formation fell within a list of UK geological formations known to contain pyrite. It was therefore required to consider the levels of total potential sulphate in the classification process. The water soluble sulphate concentration ranged between 36mg/l – 2,150mg/l, with a pH range of 5.1 – 8.23. The total potential sulphates were noted to be between 0.0618% - 1.329% from laboratory chemical testing. According to BRE Special Digest 1, 2005, 'Concrete in Aggressive Ground' a Sulphate Design Class of DS-1 could be used for sub-surface concrete in contact with the London Clay Formation at a shallow depth <6.00m bgl. Table C1 of the Digest indicated an ACEC (Aggressive Chemical Environment for Concrete) classification of AC-4. Should foundations extend >6.00m bgl then a higher design class of DS-4 and ACEC class of AC-4 should be used given the results of the sample tested at 10.00m bgl.

EXECUTIVE SUMMARY

CONTAMINATION

Based on the proposed development, the results of the chemical laboratory testing were compared to the Generic Assessment Criteria (GAC) for a 'Residential with homegrown produce' land-use scenario, as this was considered the most appropriate land-use scenario. The soil assessment criteria is displayed within Appendix F.

Elevated levels of Lead were found within the sample collected (406mg/kg), therefore, a Full Contamination Assessment is recommended, which was not within the scope of this report.

1.0 INTRODUCTION

1.1 General

Ground and Water Limited were instructed by Advantage Basements on the 22nd January 2024 to conduct a Ground Investigation Report and Basement Impact Assessment on the site referred to as 42 Shepherds Hill, London, N6 5RR. The scope of the investigation was detailed within the Ground and Water Limited fee proposal (reference: GW-2692).

1.2 Aims of the Investigation

The aim of the investigation was understood to be to supply the client and their designers with information regarding the ground conditions underlying the site to assist them in preparing an appropriate scheme for development.

The investigation was to be undertaken to provide parameters for the design of foundations by means of in-situ and laboratory geotechnical testing undertaken on soil samples recovered from trial holes.

The proposed development includes a basement. A Basement Impact Assessment, including screening and detailed comment on surface water flooding/management or combined flooding (sourced from SFRA or similar sources) was part of the remit of the report.

The requirements of the following reports were reviewed with respect to this project:

- The Strategic Flood Risk Assessment for the London Borough of Haringey, produced by JBA Consulting in February 2015;
- The Surface Water Management Plan for the London Borough of Haringey, produced by the Greater London Authority and Drain London in August 2011 (reference: CS/046913);
- The Basement Development Supplementary Planning Document, produced by Haringey Borough Council in June 2012.

In addition, a Ground Movement Assessment for the impact of the proposed development on surrounding properties and assets was not in the remit of the report.

A full scale Environmental Desk Study and Contamination Assessment including a gas risk assessment were not part of the remit of this report; however Included within the fee proposal was an allowance to undertake chemical laboratory testing on soil samples recovered from the site to enable recommendations for the safe redevelopment of the site and the protection of site workers, end-users and the public from any potential contamination identified.

The techniques adopted for the investigation were chosen considering the requirements of the client, anticipated ground conditions, and bearing in mind the nature of the site, limitations to site access and other logistical limitations.

1.3 Conditions and Limitations

This report has been prepared based on the terms, conditions and limitations outlined within Appendix A.

This report relies on information provided within the Preliminary Arboricultural Report conducted by

ACS (Trees) Consulting Limited (Ref: ha/an1/42 Shepherds Hill/July 2019). Ground and Water Limited cannot be held liable for any shortcomings of this report.

1.4 Technical Glossary

Generic technical terms can be viewed within the glossary provided within Appendix B.

2.0 SITE SETTING

2.1 Site Location

The site comprised a 1,442m² rectangular shaped plot of land, with a north-west to south-east orientation, located along the southern side of Shepherds Hill Road. The site was located within Highgate, a mainly residential suburb in north London. A Site Location Plan is provided within Figure 1 and a plan showing the site development area is given within Figure 2.

2.2 Site Description

At the time of site works, January 2024, the existing development comprised a detached three storey private residential dwelling with existing partial basement level. A gravel driveway was located to the front of the site with further areas of patio hardstanding to the rear of the main structure. Areas of soft landscaping were then noted in the rear garden area extending to the very south of the site.

2.3 Site Topography

The site was noted to be sloping downwards in a north-west to south-east direction. The north (front) of the site was noted to be located at an approximate elevation of ~83.40m AOD decreasing to an approximate elevation of 79.60m AOD. A topographical survey is displayed within Figure 3 and a topographical contour map is displayed within Figure 4.

2.4 Nearby Assets and Subterranean Developments

No railway cuttings were noted within a 250m radius of the site. No London Underground tunnels were noted within a 250m radius of the site. The site is not in close proximity to any National Rail lines. The site was considered to be not sufficiently close to underground transport services, in order for these to affect the property and there are no approved proposals for any TfL services in the vicinity that would affect the development.

The properties along Shepherds Hill Road were mainly noted to comprise a mixture of semi-detached three storey private residential dwellings and four to six storey multi-occupancy dwellings. No evidence of existing lower ground floor and/or basement levels were noted to be associated with the nearby properties.

2.5 Proposed Development

At the time of reporting, February 2024, the proposed development comprised the new single storey basement extension to be formed to the rear of the existing house, connecting into the existing basement. The development would also contain a new single storey extension at the ground floor over the new proposed basement.

The proposed development fell within Geotechnical Design Category 2 in accordance with Eurocode 7. A plan view of the proposed development can be viewed within Figure 5.

2.6 Geology

The BGS Solid and Drift Geological Map for the North London Area (Sheet Number 256) revealed that the site was underlain by the underlain London Clay Formation bedrock. No superficial deposits, outcrops of other bedrock deposits or areas of Made/Worked Ground were noted within a 250m radius of the site.

2.7 Hydrogeology and Hydrology

The DEFRA online maps indicated that the site was located on unproductive strata associated with the London Clay Formation. No designation was given to superficial deposits due to their likely absence.

From analysis of hydrogeological and topographical maps the groundwater table was anticipated to be encountered at depth within the geological formations below the London Clay Formation. Perched water was also likely to be found within localised capping of Topsoil or Made Ground, and sandy/silty bands of the London Clay Formation especially after periods of intense or prolonged rainfall. It was considered that the groundwater was flowing southwards, towards the Thames.

With reference to the Strategic Flood Risk Assessment for the London Borough of Haringey, the site was located between the two branches of the culverted Moselle Brook as shown in Figure 6.

No surface water features were noted within a 250m radius of the site.

2.8 BGS Borehole Records

A BGS borehole record in similar geology located ~206m west (ref: TQ28NE305) noted ~0.30m of Made Ground overlying ~1.10m bgl of Topsoil. Bedrock deposits of the London Clay Formation comprising brownish grey sandy clay were noted for the remainder of the borehole, a depth of 12.19m bgl. No groundwater strikes were recorded.

Another BGS borehole record in similar geology ~1.40km north-west of the site (ref: TQ28NE200), noted the London Clay Formation extending to a depth of 100m bgl overlying the Lambeth Group that extending to 119m bgl. The Upper Chalk Group were then noted to a depth of 176m bgl, the Middle Chalk Group were then noted for the remainder of the borehole, a depth of 178m bgl. A groundwater strike was noted at 17.13m bgl.

2.9 Flooding

A summary of the risk of various flooding types has been summarised in the following table.

Summary of Flood Risk			
Type of Flooding	Figure Reference	On-site Flood Risk	Maximum Nearby Flood Risk
Rivers and Seas	Figure 7	Flood Zone 1	
Flood Defences	Figure 7	No	
Reservoir	Figure 8	No	
Surface Water Flooding	Figure 9	Very Low	Low
Groundwater Flooding	N/A	The site was located in an area where there was an aquifer underlain by unproductive strata	
Sewer Flooding	N/A	6 internal and 2 external record of sewer flooding within post code district N6 5	
Critical Drainage Areas	Figure 10	Group4_055: North of Hornsey High Street and west of mainline railway, Hornsey.	

2.10 Radon

A review of the freely available UK Health Security Agency radon database, UK Radon, indicated that the site was located within a 1km grid square, where the maximum radon potential of <1% was recorded. The neighbouring 1km grid square was noted to have a maximum radon potential of <1%.

Basic radon protection measures are required in areas where more than 3% of houses are at or above the Action Level. The site was in an area where a risk assessment was not required.

It is proposed that the development includes radon resistant waterproofing within the basement which will sever any pathway between the soils and receptor, thus mitigation against any negligible radon ingress. As the pathway is broken, no further investigation (monitoring) is required. If further results show that a vapor resistant membrane is required, then that would be sufficient for radon protection as well.

2.11 Unexploded Ordnance Review

A review of the data available on www.zeticauxo.com/ revealed the site was located within the London high-risk area associated with unexploded ordnance (UXO). The London area is further separated into 25No. categories based on bombing densities, where green is indicated for areas having <10 bombs dropped per km² and red is indicated for areas having >150 bombs dropped per km². The site is situated within the light orange area, ~halfway through the spectrum.

A review of the data available on <http://bombsight.org/> revealed 6No. bombs within a 250m radius of the site associated with the London Blitz (07/10/1940 – 06/06/1941). The bomb records were noted to be located to the north-east and south-west of the site.

3.0 BASEMENT IMPACT ASSESSMENT

3.1 Scoping

A screening and scoping assessment was undertaken for the proposed development based on the supplementary planning document (SPD) for the London Borough of Haringey. This stage should identify any areas of concern and therefore focus efforts on further investigation. There are areas of concerns that the Screening process have highlighted.

- **Perched Water and Groundwater:** It was anticipated that groundwater was perched on top of the London Clay Formation. Given the proposed basement depth, it was likely that the basement may encounter perched water/groundwater during construction. **This is to be taken forward for further assessment through a ground investigation and the installation of a monitoring well.**
- **Seasonal Soil Moisture and Volume Change Potential:** Anticipated geology considered the presence of mainly cohesive soils of the London Clay Formation which are likely to be subject to subsidence due to shrinkage-swelling. **The depth and volume change potential of the underlying soils should be investigated.**
- **Pressure Induced Settlement and Heave:** Given the overburden pressure release following excavation of soil, as well as the loading of retaining wall foundations, the pressure across the basement is likely to cause differential settlement and heave. **Regarding the bulk basement construction, care will need to be taken to ensure that the slab is protected through accommodating heave (primarily) and any seasonal if applicable.**
- **Retaining Wall Design:** Given the design of basements, retaining walls should be appropriately designed to withstand the horizontal pressure of adjacent strata. **Retaining walls should be appropriately designed.**
- **Instability During Excavation:** Stability issues may arise during the excavation through natural soils and Made Ground. **Specific measures to be undertaken throughout excavation and construction will be discussed within this report, and more specifically the construction method statement.**
- **Ground Movement and Nearby Assets:** Various buildings and structures were noted in close proximity to the site; therefore, differential foundation depths would cause potential damage to the walls of nearby buildings, due to soil displacement following the excavation/installation of the basement. This may also cause damage to nearby roads, pavements and utilities. **A Ground Movement Assessment (GMA) is recommended to fully assess the soil displacement and damage to nearby buildings, roads, pavements and utilities.**
- **Sub-Surface Concrete in Aggressive Ground Conditions:** Concrete may corrode if unsuitable concrete is used. A suitable concrete class should be used for all sub-surface concrete used for all foundations, based on the levels of sulphates and the pH within the ground it is being constructed on/through. **Testing in accordance with BRE Special Digest is required to be**

undertaken and a concrete specification is to be provided.

- **Surface Water Flooding and Site Drainage:** Data from the Environment Agency website indicated that the site, and the majority of the surrounding area, was at very low risk of surface water flooding. The amount of hardstanding is likely to increase following the construction of the proposed development, leading to less areas for surface water to infiltrate into the ground. **The effect the proposed development will have on surface water flooding and the requirements to prevent surface water flooding and site drainage is to be discussed further within this report.**
- **Groundwater Flooding and Flow:** As the site was located in an area where there was an aquifer underlain by unproductive strata, there was considered to be a risk of groundwater flooding; however, this is considered to be low as a result of the anticipated cohesive nature of the soils. **A groundwater monitoring well should be installed as part of the site investigation, as well as groundwater dip measurements following the site works, to investigate groundwater levels.**
- **Sewer Flooding:** Given their subterranean position, basements can be susceptible to flooding from sewers. 6 internal and 2 external records of sewer flooding within post code district N6 5. **The effect the basement will have on the risk of sewer flooding and the requirements to prevent sewer flooding is to be discussed further within this report.**

A site-specific ground investigation has been undertaken to inform design, including provision of information on the existing foundations. The results of this investigation and subsequent engineering considerations are provided within this report.

The submission of a drainage scheme will likely be required. It is understood this will form part of the overall Structural Scheme and will be included in the Structural Engineers report.

A qualified arboriculturist should be consulted for advice on the impact of nearby trees to the construction of the basement.

4.0 SITE WORKS

4.1 Scope of Works

Initial site works were undertaken on the 25th of January 2024 and comprised the drilling of 1No. windowless sampler trial hole (WS01) to a depth of 10.45m bgl. Standard penetration testing was conducted at 1.00m intervals within WS01. A combined ground-gas/groundwater monitoring standpipe, with an internal diameter of 50mm, was installed to 5.00m bgl within WS01, with a response zone between 1.00 – 5.00m bgl. The installation details can be viewed within the table below.

Combined Ground-gas and Groundwater Monitoring Well Construction						
Trial Hole	Type of Installation	Depth of Installation (m bgl)	Thickness of slotted piping with gravel filter pack (m)	Depth of plain piping with bentonite seal (m bgl)	Response Zone (m bgl)	Piping internal diameter (mm)
WS01	Standpipe	5.00	4.00	1.00	1.00 – 5.00	50

Further site works also included the hand excavation of 3No. trial pits foundation exposures (TP/FE01 – TP/FE02 and TP/FE05) to depths of between 0.50m – 1.30m bgl.

The approximate location of the trial hole locations can be seen within Figure 11.

Prior to commencing the ground investigation, a walkover survey was carried out to identify the presence of underground services and drainage. Where underground services/drainage were suspected and/or positively identified, the exploratory position was relocated away from these areas.

As a further precautionary measure, the borehole was hand excavated to 1.00m below the local ground level (bgl) and scanned with a Cable Avoidance Tool (CAT scanner) to minimise the risk to services.

Upon completion of the drilling works, the trial holes were backfilled and made good, in relation to the surrounding area.

4.2 Sampling Procedures

Small disturbed samples were recovered from the trial holes at the depths shown on the trial hole records. Soil samples were generally retrieved from each change of strata and/or at specific areas of concern. Samples were also taken at approximately 0.5m intervals during broad homogenous soil horizons.

A selection of samples were despatched for geotechnical testing purposes. A programme of chemical laboratory testing, scheduled by Ground and Water Limited and carried out by an accredited chemical testing laboratory, was undertaken on soils samples recovered from the trial holes.

5.0 ENCOUNTERED GROUND CONDITIONS

5.1 Soil Conditions

The trial holes were logged by a Ground and Water Limited representative, generally in accordance with BS EN 14688 'Geotechnical Investigation and Testing – Identification and Classification of Soil'.

The ground conditions encountered within the trial holes constructed on the site did generally conform to that anticipated from examination of the geology map. A capping of Made Ground was noted to overlie the bedrock deposits of the London Clay Formation.

The succession of conditions and description of soils encountered in the trial holes in descending order is tabulated below.

Summary of Strata Encountered (WS01; TP/FE01 – TP/FE02 and TP/FE05)			
Strata	Top Depth (m bgl)	Base Depth (m bgl)	Thickness (m)
MADE GROUND: Dark orangish brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is fine to coarse sub-angular to sub-rounded flint (50% - 60%), brick (20% - 40%), plastic (10%), concrete (10%) and carbonaceous material (10%).	GL	0.40 – 1.20	0.40 – 1.20
MADE GROUND: Dark reddish brown gravelly clayey fine to coarse SAND. Gravel is fine to coarse sub-angular to sub-rounded brick (70%) and flint (30%).	GL	1.10	1.10
LONDON CLAY FORMATION: Dark orangish brown mottled with dark brownish grey slightly sandy silty CLAY. Sand is fine.	GL – 1.20	>0.50 - 5.70	>0.10 - 5.30
LONDON CLAY FORMATION: Dark brownish grey slightly sandy silty CLAY. Sand is fine.	5.70	>10.45	>4.75

For details of the composition of the soils encountered at particular points, reference must be made to the individual trial hole logs within Appendix C of this report. A trial hole location plan can also be viewed within Figure 11.

5.2 Foundation Exposures

The hand excavation of 3No. Foundation Exposures (TP/FE01 – TP/FE02 and TP/FE05) was undertaken across the site. A tabulated summary showing the depth and width of each foundation can be viewed below, as well as the bearing stratum. Diagrams of each foundation exposure can be viewed within Figure 12 – Figure 15.

Summary of Foundations Encountered			
Trial Hole	Depth of Foundation (m bgl)	Width at the Base of Foundation (mm)	Bearing Stratum
TP/FE01	1.35	160	London Clay Formation
TP/FE02 (East Wall)	0.26*	Does not step out	London Clay Formation
TP/FE02 (South Wall)	0.26*	Does not step out	London Clay Formation
TP/FE05	1.39	180	London Clay Formation

*No foundations were noted, it was understood a ground bearing slab was present.

5.3 Roots Encountered

Fresh roots were noted to a depth of 1.00m bgl within WS01. No fresh roots were noted within TP/FE01 - TP/FE02 and TP/FE05.

A summary of the depth of root penetration can be viewed below.

Root Depth	
Trial Hole	Fresh Root Penetration (m bgl)
WS01	1.00
TP/FE02 (East Wall)	-
TP/FE02 (South Wall)	-
TP/FE05	-

It must be noted that the chance of determining actual depth of root penetration through a narrow diameter borehole is low. Roots may be found to greater depths at other locations on the site, particularly close to trees and/or trees that have been removed both within the site and its close environs.

5.4 Groundwater Conditions

No groundwater strikes were observed during the investigation.

Changes in groundwater level occur for a number of reasons including seasonal effects and variations in drainage. The investigation was undertaken in January –February 2024 when groundwater levels are likely to be approaching their annual maximum (highest elevation). Exact groundwater levels may only be determined through long term measurements from monitoring wells installed on-site.

Groundwater monitoring was undertaken on one occasion to date. The results can be seen tabulated below.

Groundwater Observations			
Date	Trial Hole	Water Level (m bgl)	Final Well Depth (m bgl)
01/02/2024	WS01	3.10	5.00

Given the underlying unproductive strata, the groundwater level recorded at 3.10m bgl was anticipated to be accumulation of perched water and not representative of the on-site groundwater conditions (eg aquifer). Conversely the record of perched water should be taken through to design.

5.5 Obstructions

Due to on-site restrictions TP/FE03 could not be undertaken due to concrete in excess of 300mm and TP/FE04 was not required.

No other artificial or natural sub-surface obstructions were noted during construction of the trial holes.

6.0 IN-SITU AND LABORATORY TESTING

6.1 In-Situ Strength Testing

Standard Penetration Tests (SPTs) were undertaken as part of the site investigation. The results of the SPT's have not been amended to consider hammer efficiency, rod lengths and overburden pressure in accordance with Eurocode 7. The test results are presented on the borehole logs within Appendix E. An interpretation of the in-situ geotechnical testing results is given in the table below.

Interpretation of In-situ Geotechnical Testing Results					
Strata	SPT "N" Blow Counts/Equivalent SPT "N Value from DP	Equivalent Undrained Shear Strength (Cu) (kPa)	Soil Type		Trial Hole/s
			Granular (Density)	Cohesive (Cu)	
London Clay Formation	8 - 22	40 - 110	-	Medium – High	WS01/1.00m – 10.45m bgl

It must be noted that field measurements of undrained shear strength (Cu) are dependent on a number of variables including disturbance of sample, method of investigation and also the size of specimen or test zone.

6.2 Geotechnical Laboratory Testing

A programme of geotechnical laboratory testing, scheduled by Ground and Water Limited and carried out by an accredited geotechnical testing laboratory was undertaken on samples recovered. Details of the specific tests used in each case are given below.

Standard Methodology for Laboratory Geotechnical Testing		
Test	Standard	Number of Tests
Atterberg Limit Tests	BS1377:2016:Part 2:Clauses 3.2, 4.3 & 5	4
Water Soluble Sulphate and pH Test	BS1377:2018:Part 3:Clause 5	1
BRE Special Digest 1 Tests	BRE Special Digest 1 "Concrete in Aggressive Ground (BRE, 2005).	2

6.2.1 Atterberg Limit Testing

A précis of Atterberg limit testing undertaken can be seen tabulated below. The test results are presented within Appendix D.

Atterberg Limit Tests Results Summary							
Stratum	Moisture Content (%)	Passing 425 µm sieve (%)	Modified PI (%)	Soil Class	Consistency Index (Ic)	Volume Change Potential	
						BRE	NHBC
London Clay Formation	25 - 28	100	30 - 43	CH	Stiff	Medium – High	Medium – High
- NP – Non-plastic - BRE Volume Change Potential refers to BRE Digest 240 (based on Atterberg results) - Soil Classification based on British Soil Classification System. - Consistency Index (Ic) based on BS EN ISO 14688-2:2018.							

6.2.2 Moisture Deficit Assessment

The results of the Atterberg Limit tests were analysed to determine the Liquidity Index of the samples, to give an indication as to whether the samples recovered showed a moisture deficit as well as assessing their degree of consolidation. Liquid Limit analyses were undertaken to assess whether there were any potentially significant moisture deficits within the samples tested.

A potential moisture deficit, caused by lithology (overconsolidated cohesive soils), was noted within the sample collected at WS01/7.00m bgl.

6.3 Chemical Laboratory Testing

An un-targeted sample of Made Ground (WS01/0.30m bgl) was submitted to the accredited chemical laboratory for analysis. The results can be viewed in Appendix E.

Based on the proposed development, the results of the chemical laboratory testing were compared to the Generic Assessment Criteria (GAC) for a 'Residential with homegrown produce' land-use scenario, as this was considered the most appropriate land-use scenario. The soil assessment criteria is displayed within Appendix F.

Elevated levels of Lead were found within the sample collected (406mg/kg), therefore, a Full Contamination Assessment is recommended, which was not within the scope of this report.

7.0 ENGINEERING CONSIDERATIONS

7.1 Soil Characteristics and Foundation Considerations

A summary of the soil characteristics following the intrusive site investigation and laboratory testing and the relevant foundation considerations has been provided below. The following information from the ground investigation was considered pertinent to the design of foundations.

- Foundations should be taken through any Made Ground/Topsoil and either into, or onto a suitable underlying natural stratum of adequate bearing characteristics.
- Foundations should be designed in accordance with soils of medium volume change potential.
- The design and construction of the basement and associated structural elements would need to take into account the volume change potential of the respective soils.
- The loads of proposed foundations should not exceed the allowable bearing capacity of the soils they are founding upon.
- Foundations must not be placed within fresh root penetrated and/or desiccated soils with volume change potential. It is recommended that foundations are taken at least 300mm into non-fresh root penetrated strata if the soils have volume change potential, or into soils of no volume change potential.
- The influence of trees on or surrounding the site will need to be taken into account in final design (NHBC Standards Chapter 4. 2) (tree rings).
- Any water ingress must be prevented from entering foundation trenches and excavations must be kept dry and either concreted or blinded as soon after excavation as possible. If water were allowed to accumulate within the excavation for even a short period of time, an increase in heave occur. The shear strength will also be reduced, resulting in lower bearing capacities, resulting in increased settlements. Instability issues may arise within the foundation trenches, in case of perched water being present.
- Final designs for the foundations should be carried out by a suitably qualified Engineer based on the findings of this investigation and with reference to the anticipated loadings, serviceability requirements for the structure and the developments proximity to former, present, and proposed trees.

7.2 Geotechnical Analysis

This section of the report states suitable geotechnical parameters for the soils encountered as well as analysis for the bearing capacity of the soils. A settlement/heave analysis was also undertaken following the construction of the proposed development using Pdisp from Oasys.

7.2.1 Geotechnical Parameters for Modelling

Following a literature review from well documents publications, the short-term and long-term Young's Modulus (E short term and E') has been produced. The parameters, shown below, were used when undertaking the settlement/heave analysis within Pdisp.

Summary of Geotechnical Parameters							
Geological Strata	Depth (m bgl)		Short-term Young's Modulus (Eu short term) (kPa)		Long-term, Young's Modulus (E' long term) (kPa)		Poisson's Ratio
	Top	Base	Top	Base	Top	Base	
Made Ground	0.00	0.40	10,000	10,000	10,000	10,000	0.45
London Clay Formation	0.40	1.45	10,000	10,000	10,000	10,000	0.45
	1.45	2.45	33,750	33,750	25,312.5	25,312.5	0.45
	2.45	3.45	33,750	30,000	25,312.5	22,500	0.45
	3.45	4.45	30,000	45,000	22,500	33,750	0.45
	4.45	5.00	45,000	30,000	33,750	22,500	0.45
	5.00	5.45	30,000	48,750	22,500	36,562.5	0.45
	5.45	6.45	48,750	45,000	36,562.5	33,750	0.45
	6.45	7.45	45,000	60,000	33,750	45,000	0.45
	7.45	8.45	60,000	67,500	45,000	50,625	0.45
	8.45	9.45	67,500	75,000	50,625	56,250	0.45
	9.45	10.45	75,000	82,500	56,250	61,875	0.45
	10.45	50.00	82,500	335,100	61,875	251,325	0.45

Made Ground

Made Ground was modelled between ground level and 0.40m bgl. A short-term and long-term Young Modulus (Eu and E') of 10MPa was suitable and on the conservative side, regarding Made Ground encountered on site. A Poisson's Ratio of 0.45 was considered suitable for these soils, given their variable nature.

London Clay Formation

Cohesive soils of the London Clay Formation were encountered from 0.40m to the base of the borehole, 10.45m bgl. Based on nearby BGS boreholes, the London Clay Formation was understood to reach a depth of ~100m bgl however a rigid boundary of 50.00m bgl has been applied.

Where SPT "N" Values were undertaken, the Cu could be calculated by multiplying by 5, as stated by Stroud (1974). Where the London Clay Formation was inferred, a design line was taken from "*Burland JB, Standing, JR, and Jardine, FM (2001) Building response to tunnelling, case studies from construction of the Jubilee Line Extension CIRIA Special Publication 200*". The equation was undrained shear strength = (depth into the LCF x 8) + 50.

The relationship between Eu and Cu is generally dependent on strain levels. For small strains, a ratio of 750 can be adopted based on well documented publications. This is also reflected for the London Clay Formation, after extensive research, within graphs depicting strains and Eu/Cu ratios included in "*Burland JB, Standing, JR, and Jardine, FM (2001) Building response to tunnelling, case studies from construction of the Jubilee Line Extension CIRIA Special Publication 200*". A Poisson's Ratio of 0.45 was considered suitable for these soils, given their cohesive nature.

Long-Term Conditions

A ratio of E' to Eu of ~0.75 was considered a sensible approach for this stage in the design, for cohesive soils. For Made Ground, it was considered suitable for E' and Eu to be equal, given that these soils are more permeable and to limit the level of anticipated Young Modulus at a representative value.

7.2.2 Bearing Capacity Analysis

The following allowable bearing capacities were anticipated for foundations at 1.50m and 3.50m bgl, based on the soil profiles within WS01.

Allowable Bearing Capacities Calculated		
Foundation Depth (m bgl)	Foundation Type	Limit State
		Allowable Bearing Capacity (kN/m ²)
1.50	5.00m long by 0.75m wide strip foundation	86.68
	5.00m long by 1.00m wide strip foundation	86.55
	1.50m square pad foundation	90.72
3.50	5.00m long by 0.75m wide strip foundation	119.80
	5.00m long by 1.00m wide strip foundation	117.24
	1.50m square pad foundation	119.09

7.2.3 Impact of Nearby Trees Upon Foundations

With reference to the Preliminary Arboricultural Report conducted by ACS (Trees) Consulting Limited (Ref: ha/an1/42 Shepherds Hill/July 2019) three retained trees G3, T16 and T17 were located within close proximity to the proposed development.

Nearby Trees Data						
Tree Ref	Tree Type	Tree Height (m)	Distance from Footings (m)	Tree Elevation (m below Decking Level)	NHBC Foundation Depth Required (m bgl)	Minimum Required Footing Depth (m below decking level)
G3	Sycamore	10	5.50	0.98	1.63	2.61
T16	Norway Maple	10	10.00	2.70	1.19	3.89
T17	Sycamore	9	2.70	2.36	1.83	4.19

7.2.4 Settlement/Heave Analysis

Analyses of vertical ground movements, using the Mindlin analysis method within Pdisp software, was undertaken to assess the potential movements resulting from changes of net vertical pressure changes. Geotechnical parameters noted in the previous section of this report were used for the model. A rigid boundary at depth was considered at 50.00m bgl, for calculation purposes. The inputs and outputs of this analysis can be viewed within Appendix G.

Five representative stages of construction, in terms of the net change in vertical pressure, have been modelled. These were considered to adequately approximate the movements rising from the basement construction.

- **Stage 1:** Excavation of the retaining wall voids, with short-term conditions;
- **Stage 2:** Representative net loads associated with the construction of the retaining walls, with short-term conditions;
- **Stage 3:** Stage 2 loads as well as loads associated with the mass excavation of the basement footprint, with short-term conditions;
- **Stage 4:** Mass excavation load, as well as loads associated with the construction of the basement slab, with short term conditions and full net pressure at retaining wall locations. The basement is fully constructed from this stage onwards;

- **Stage 5:** Stage 4 arrangement but for long-term conditions.

As the proposed development did not comprise the demolition of the existing building, the existing loads of the property were not anticipated to change throughout the development. The final loads were based on calculations by the structural engineers and they were selected to be representative of the site.

Given the overall square shape of the basement, the excavation was based on a square using the maximum length and width of the basement. This was considered conservative and will ensure accurate results.

The overburden pressure release following the excavation and removal of soils was based on a specific weight of soil of 19kN/m^3 . Due to the nearby trees, the foundation depths would vary across the structure.

The proposed excavation depths were understood to be 3.50m bgl to the front of the basement and then 1.50m bgl to the rear, therefore an average excavation depth of 2.50m bgl was utilised for the modelling. Using the averaged basement depth of 2.50m bgl, an overburden pressure release of 47.50kN/m^2 was calculated. The overburden pressure release was modelled at 3.50m bgl.

Retaining wall loads were modelled as extending 1.00m towards the centre of the basement. These were assumed to have a net representative pressure difference of 30.00kN/m^2 during construction, increasing to 60.00kN/m^2 once the basement slab was cast. This was selected in order not to underestimate the heave and overestimate any settlement. The load of the basement slab was unknown at the time of reporting and was assumed to be 10kN/m^2 . All loads were modelled at 3.50m bgl.

A tabulated summary of all applied loads, at each stage/model, can be viewed below.

Summary of Net Bearing Pressure Changes for PDisp Analysis				
Description	Applied Load (+ive)/ Load Removal (-ive) (kN/m^2)			
	Stage 1	Stage 2	Stage 3	Stage 4 and 5
Excavation of Retaining Wall Voids	-47.50			
Construction of Retaining Walls		30.00	30.00	60.00
Mass Excavation Void			-47.50	-47.50
Construction of Basement Slabs				10.00

The method stated above was considered to comprise a comprehensive and reasonably conservative approach, in order to estimate the maximum potential heave and settlements.

A tabulated summary concluding the amount of soil displacement shown at the basement depth within the contour plots can be viewed below. It should be noted that the soil displacement between models are not cumulative values; therefore, the amount of soil displacement between models should not be added together as each model shows each construction stage individually.

Settlement/Heave Analysis	
Model	Soil Displacement
Model 1	0.596mm – 3.97mm heave. No settlement

Settlement/Heave Analysis	
Model	Soil Displacement
Model 2	0.0824mm – 1.15mm settlement. No heave
Model 3	0.0552mm – 4.82mm heave. No settlement
Model 4	3.65mm of heave and 1.24mm of Settlement.
Model 5	4.87mm of heave and 1.65mm of Settlement.
Diagrammatic representation can be viewed within Appendix G. Please note that the above figures should not be added together (or be superimposed) and that they represent anticipated movements at different accumulated stages of construction, in order to approach and test all expected combinations of loading regimes (models).	

A maximum amount of heave of 4.82mm was noted following the mass excavation of the basement void (Model 3) and was noted to be the maximum amount of heave during the construction phases. Once constructed, the maximum amount of heave increased from 1.24mm for short term conditions (Model 4), to 1.65mm for long term conditions (Model 5); therefore, the highest risk of movement will likely occur during the construction of the basement and later through long-term heave of the constructed basement.

7.2.5 Additional Comments

Regarding the bulk basement construction, care will need to be taken to ensure that the slab is protected through accommodating heave. Heave protection measures will need to be incorporated.

Final designs for the foundations should be carried out by a suitably qualified Engineer based on the findings of this investigation and with reference to the anticipated loadings, serviceability requirements for the foundations. A Structural Engineer will also need to review the anticipated ground movements and assess their potential impact on the existing structure and neighbouring properties. It must be noted that finalised construction will aid the structural stability of the neighbouring party walls, reducing the risk of the seasonal movements noted during the structural works.

7.3 Retaining Walls, Excavations and Stability

Shallow excavations in the Made Ground are likely to be marginally stable at best. Long, deep excavations, through these strata and into the underlying London Clay Formation are likely to become unstable.

Appropriate propping and support should be incorporated during construction of the basement.

The excavation of the basement must not affect the integrity of the adjacent structures beyond the boundaries. The excavation must be supported by suitably designed retaining walls. It is considered unlikely that battering the sides of the excavation, casting the retaining walls and then backfilling to the rear of the walls would be suitable given the close proximity of the party walls.

The retaining walls for the basement will need to be constructed based on the soils encountered with an appropriate angle of shear resistance (Φ') and effective cohesion (C') for the ground conditions encountered, regarding long-term considerations, as well using an appropriate undrained shear strength C_u for short-term considerations.

The overlying Made Ground needs to be considered in the design of the basement. A conservative

value of C_u will need to be considered.

Based on the ground conditions encountered within the boreholes the following parameters tabulated below could be used in the design of retaining walls, for a long-term consideration. These have been designed based on the in-situ strength testing profile recorded, results of geotechnical classification tests and reference to literature.

Retaining Wall/Basement Design Parameters					
Strata	Unit Volume Weight (kN/m ³)	Cohesion Intercept (c') (kPa)	Angle of Shearing Resistance (°)	K_a (Rankine)	K_p (Rankine)
Made Ground	~19	0	12	0.66	1.52
London Clay Formation	~20 – 22	0	24	0.42	2.37

It should be noted that the K_a and K_p values presented in the table, are shown for guidance and they are derived from the Rankine theory for soil pressures. The values for angles of internal friction provided are considered to be characteristic values of the soils encountered.

According to C760, a design method (e.g. EC7) should be adopted and followed through the whole design process. In addition, the following considerations should be considered during the design process:

- Appropriate consideration of groundwater levels.
- Surcharge pressure equivalent to the pressures of any adjacent buildings.
- Surcharge pressures from potential piling work platforms and heavy plant traffic.

Unsupported earth faces formed during excavation may be liable to collapse without warning and suitable safety precautions should therefore be taken to ensure that such earth faces are adequately supported before excavations are entered by personnel.

Ground Instability Recommendations

No significant instability issues related with soils are expected and no instability issues were observed during the ground investigation. Specific measures should be included in a competent Construction Method Statement for the works on this site by the structural engineer and the contractor. If instability is noted, the following could be applied for good workmanship and mitigation of any risk. It should be noted that these are indicative.

- Where soft/loose spots are encountered, trench sheets should be left in. Alternatively, a back prop with precast lintels or sacrificial boards should be installed. If the soil support to the ends of the lintels is insufficient, brace the ends of the PC lintels with 150x150 C24 timbers and prop with Acrows diagonally back to the ground.
- Where voids are present, trench sheeting with 75mm diameter holes should be installed, to allow the concrete to flow behind the trench sheeting thereby filling any voids encountered in soils behind.
- Prior to casting, a layer of DPM should be installed between trench sheeting (or PC lintels) and new concrete. The lintels should be cut into the soil by 150mm either side of the pin. A site stock of a minimum of 10 lintels should be present to prevent delays due to ordering.

7.4 Sub-Surface Concrete Design

Concrete to be placed in contact with soil or groundwater must be designed in accordance with the recommendations of Building Research Establishment Special Digest 1, 2005, '*Concrete in Aggressive Ground*' considering the pH of the soils. For the classification given below, the "mobile" and "natural" case was adopted given the geology encountered and the residential use of the site.

Made Ground

The water soluble sulphate concentration was 8.40mg/l, with a pH of 8.7. According to BRE Special Digest 1, 2005, '*Concrete in Aggressive Ground*' a Sulphate Design Class of DS-1 could be used for sub-surface concrete in contact with the Made Ground. Table C1 of the Digest indicated an ACEC (Aggressive Chemical Environment for Concrete) classification of AC-1.

London Clay Formation

According to Box C6 of BRE Special Digest 1, 2005, '*Concrete in Aggressive Ground*' the London Clay Formation fell within a list of UK geological formations known to contain pyrite. It was therefore required to consider the levels of total potential sulphate in the classification process.

The water soluble sulphate concentration ranged between 36mg/l – 2,150mg/l, with a pH range of 5.1 – 8.23. The total potential sulphates were noted to be between 0.0618% - 1.329% from laboratory chemical testing.

According to BRE Special Digest 1, 2005, '*Concrete in Aggressive Ground*' a Sulphate Design Class of DS-1 could be used for sub-surface concrete in contact with the London Clay Formation at a shallow depth <6.00m bgl. Table C1 of the Digest indicated an ACEC (Aggressive Chemical Environment for Concrete) classification of AC-4.

Should foundations extend >6.00m bgl then a higher design class of DS-4 and ACEC class of AC-4 should be used given the results of the sample tested at 10.00m bgl.

It is prudent to note that pyrite nodules may be present within the London Clay Formation. Pyrite can oxidise to gypsum and this normally only occurs in the upper weathered layer, but excavation allows faster oxidation and water-soluble sulphate values can rapidly increase during construction. Therefore, rising sulphate values should be considered should ferruginous staining/pyrite nodules be encountered within the London Clay Formation.

7.5 Hydrogeological Effects, Flooding and Surface Water Disposal

Basements have potential to greatly impact hydrological and hydrogeological regimes. Numerous comments and considerations reflecting on the relationship between the basement and groundwater/surface water have been discussed below.

7.5.1 Basement Construction

If the construction works take place during the winter months, when the groundwater level is expected to be at its higher elevation, water could accumulate thus dewatering could be required to facilitate the construction and prevent the base of the excavation blowing before the slab was cast. The lower ground floors must be suitably tanked to prevent ingress of groundwater and also surface water run-off. A dewatering or permitting grout contingency plan should be included within the Construction Method Statement and considered in the final design. As there will be potential for

groundwater to collect behind the retaining walls, the basement should be waterproofed and designed to withstand hydrostatic pressures in accordance with BS8102:2009: Code of Practice for the Protection of Below Ground Structures against Water from the Ground.

It was anticipated the perched groundwater would be encountered on-site during the development therefore, dewatering from sumps introduced into the floor of the excavation may be required. Consideration could be given to creating a coffer dam using secant piled or sheet piled walls to aid construction below the perched water table if groundwater becomes a significant issue. The advice of a reputable dewatering company should be sought.

7.5.2 Site Drainage

The majority of new developments are encouraged to use Sustainable Urban Drainage Systems (SUDS) to manage surface water drainage. This ensures that any volumes and peak flow rates of surface water leaving a developed site are no greater than the rates prior to the proposed development unless specific off-site arrangements are made and result in the same effect.

The principles of SUDS and the requirements of the London Plan Policy 5.13 Sustainable Drainage should be applied to reduce the risk of flooding from surface water ponding and collection associated with the construction of the basement.

In accordance with the London Plan Policy 5.13 Sustainable Drainage the surface water run-off should be managed as close to its source as possible in line with the following drainage hierarchy.

- Rainwater use as a resource (for example rainwater harvesting, blue roofs for irrigation)
- Rainwater infiltration to ground at or close to source
- Rainwater attenuation in green infrastructure features for gradual release (for example green roofs, rain gardens)
- Rainwater discharge direct to a watercourse (unless not appropriate)
- Controlled rainwater discharge to a surface water sewer or drain
- Controlled rainwater discharge to a combined sewer.

Drainage should be designed and implemented in ways that deliver other policy objectives of this Plan, including water use efficiency and quality, biodiversity, amenity and recreation.

7.5.3 Additional Comments

The site was noted to be located within the bedrock soils of the London Clay Formation which was classified as a unproductive aquifer and therefore was not considered to be at risk of groundwater flooding. Groundwater monitoring has indicated that perched water would be encountered on-site and was likely to be present during the construction. **This should be considered in final design.**

Given their subterranean position, lower ground floors can be susceptible to flooding from sewers. In order to minimise the risk of sewer flooding to the development, all subterranean development must be connected to the sewerage network, installed with a positively pumped non-return valve device.

Consultation with the Environment Agency must be sought regarding any use that may have an impact on groundwater resources, abstractions and surface water features/watercourses.

7.6 Discovery Strategy

A full contamination assessment was beyond the scope of this investigation, where targeted sampling was not undertaken. There may be areas of contamination that have not been identified during the course of the intrusive investigation (e.g. underground storage tanks). Such occurrences may be discovered during the construction phases for the redevelopment of the site.

Groundworkers should be instructed to report to the Site Manager any evidence for such contamination; this may comprise visual indicators, such as fibrous materials within the soil, discolouration, or odours and emission. Upon discovery advice must be taken from a suitably qualified person and then the Local Authority will need to be informed.

7.7 Waste Disposal

The excavation of foundations and soils is likely to produce waste which will require classification and then recycling or removal from site.

Under the Landfill (England and Wales) Regulations 2002 (as amended), prior to disposal all waste must be classified as;

- Inert;
- Non-hazardous, or;
- Hazardous.

The Environment Agency's Hazardous Waste Technical Guidance (WM3) document outlines the methodology for classifying wastes. Once classified the waste can be removed to the appropriately licensed facilities, with some waste requiring pre-treatments prior to disposal.

Following the investigation, 1No. sample of Made Ground (WS01/0.30m bgl) was submitted to the analytical laboratory to undergo a suite of testing for contamination testing, as discussed in the previous sections.

Based on a risk phase analysis of the chemical laboratory test results, in accordance with EC Hazardous Waste Directive and undertaken by Ground and Water Limited, the Made Ground encountered on-site was NON-HAZARDOUS. The results of the assessment are given within Appendix H.

It is important to note that whilst we consider our in-house assessment tool to be an accurate interpretation of the requirements of WM3, therefore producing an initial classification in accordance with the guidance, this method classifies soils as either non-hazardous or hazardous and landfill operators have their own assessment tools and can often come to different conclusions. As a result, some landfill operators could refuse to take apparently suitable waste. It is recommended that the receiving landfill views the results of this assessment and the chemical laboratory results to determine their own classification.

The sample of Made Ground was scheduled to undergo Waste Acceptance Criteria (WAC) testing with single batch leachate from samples with a range of depths. The results indicate that the sample of Made Ground conformed to the Inert Waste Classification, the results can be seen in Appendix E. The locations of these samples can be seen on Figure 11.

Where contaminated soils are to be removed, they should be placed on an impermeable membrane (visqueen or similar) to ensure that no cross-contamination of soils occurs.

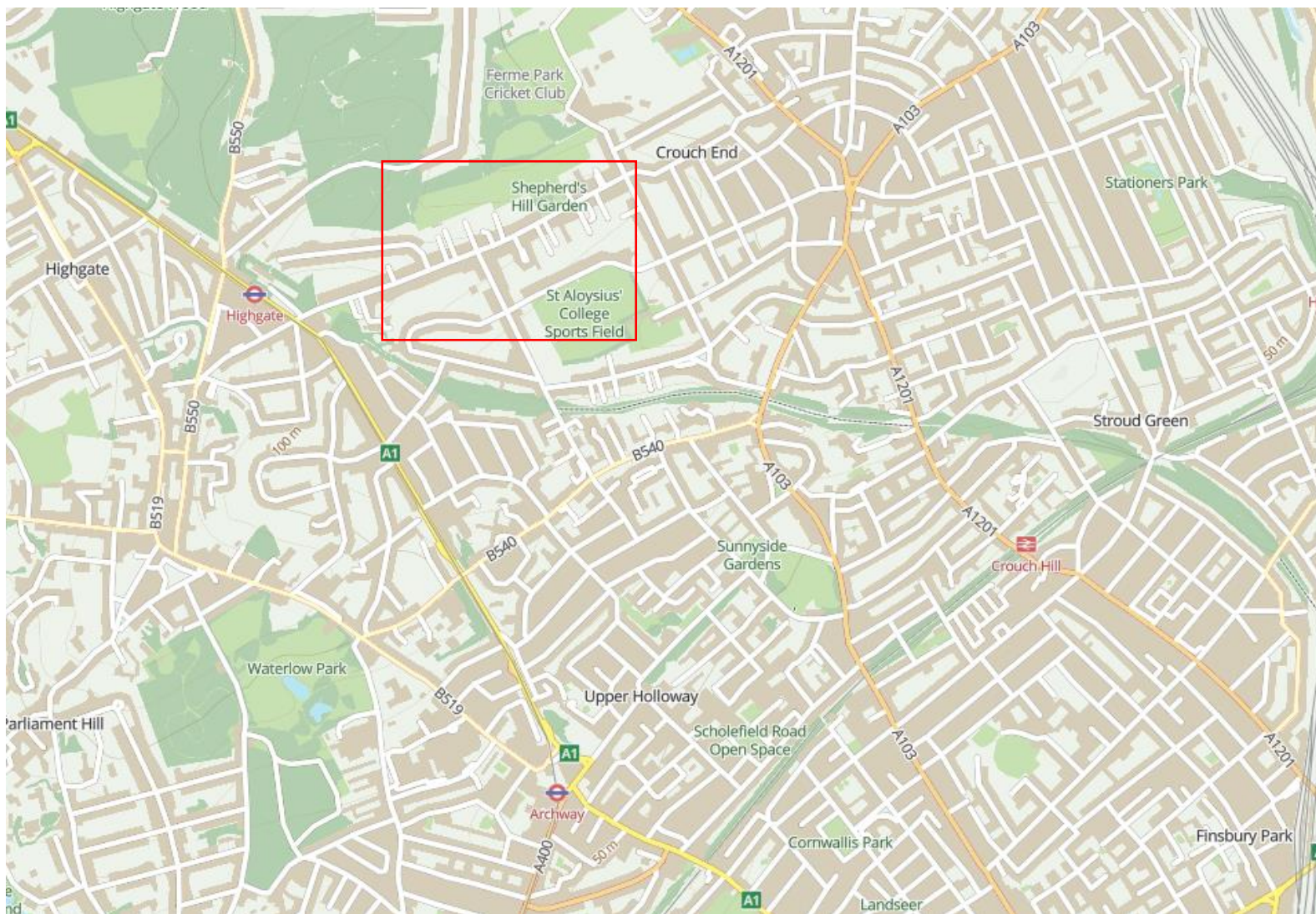
7.8 Duty of Care

Groundworkers must maintain a good standard of personal hygiene including the wearing of overalls, boots, gloves and eye protectors and the use of dust masks during periods of dry weather.

To prevent exposure to airborne dust by both the general public and construction personnel the site should be kept damp during dry weather and at other times when dust would be generated as a result of construction activities.

The site should be securely fenced at all times to prevent unauthorised access. Washing facilities should be provided and eating restricted to mess huts.

FIGURES



Site Location: See Figure 2

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Figure 1 – Site Location Plan

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Site Boundary

NTS

42 Shepherds Hill, London, N6 5RR

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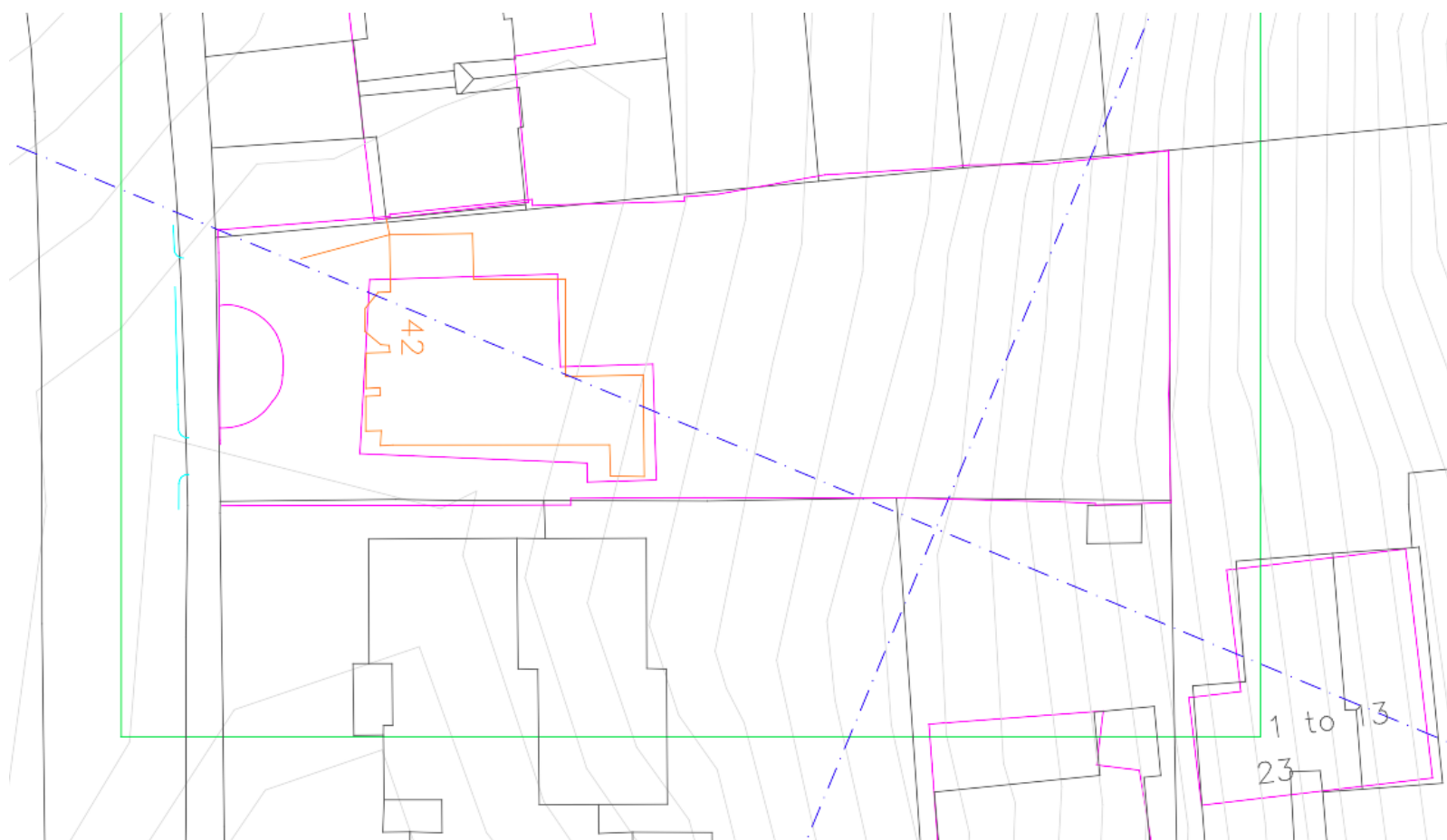
Figure 2 – Site Development Area

GWPR5810





Site Boundary



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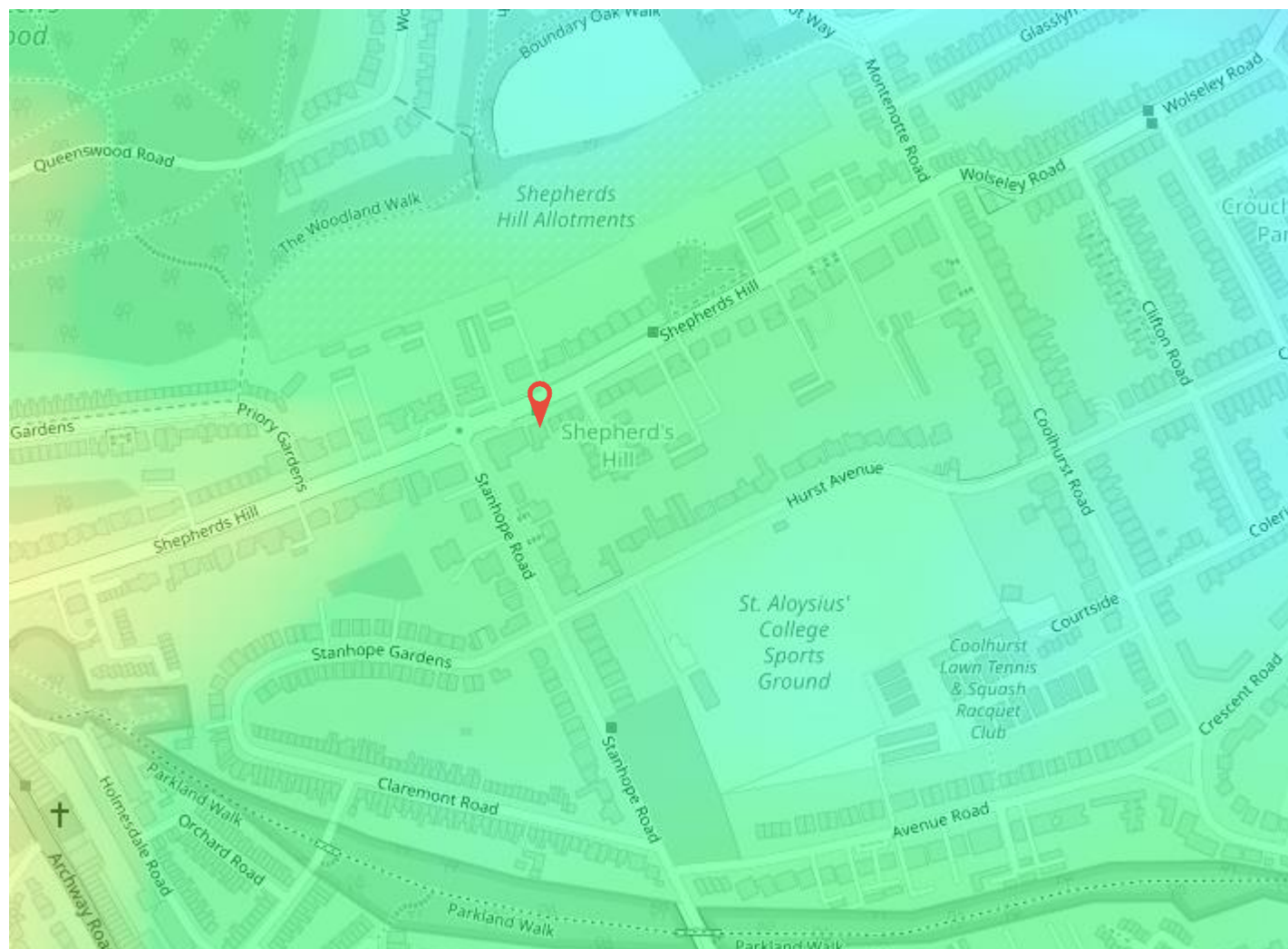
Figure 3 – Topographical Survey

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 Site Location



42 Shepherd's Hill, London, N6 5RR

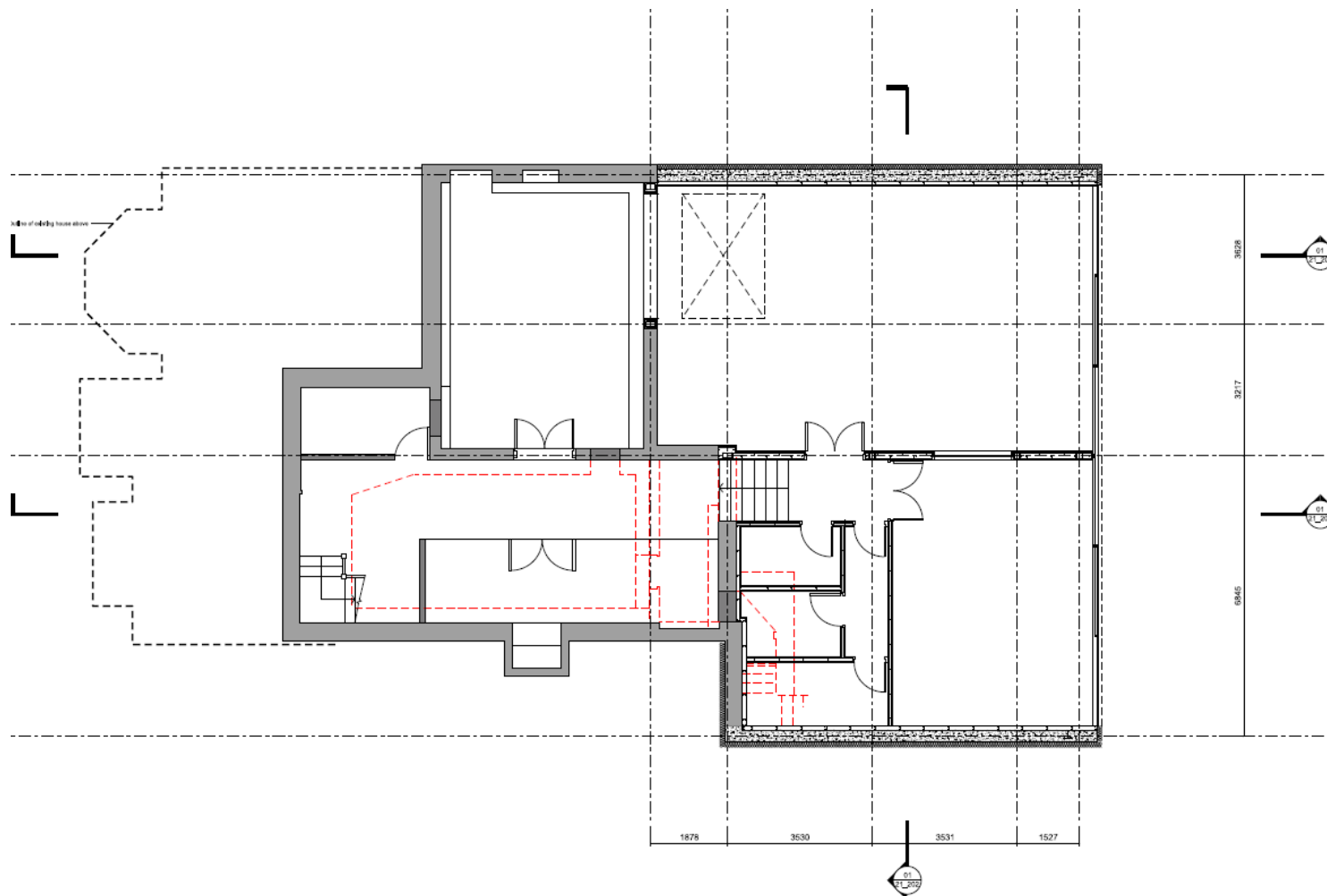
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Figure 4 – Topographical Contour Map

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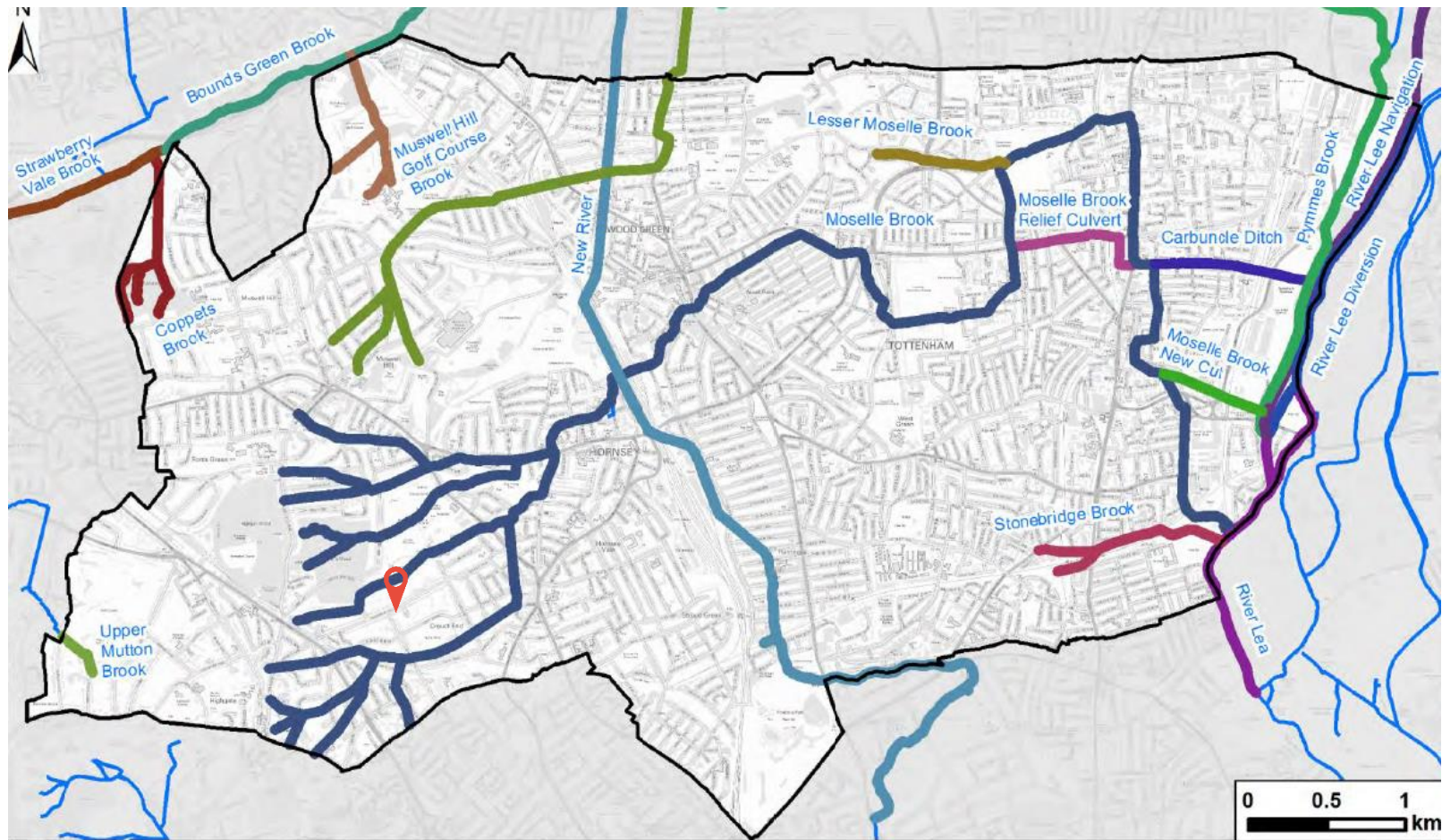
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Figure 5 – Proposed Development Plan

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Legend

'Watercourses'	Coppets Brook	Moselle Brook	Muswell Stream	Pymmes Brook	River Lee Navigation
Bounds Green Brook	Lesser Moselle	Moselle Relief Culvert	Mutton Brook	River Lea	Stonebridge Brook
Carbuncle Ditch	Moselle Brook (New Cut)	Muswell Hill Golf Course Brook	New River	River Lee Diversion	Strawberry Vale Brook
					Other Watercourses



Site Location

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Figure 6 – LB of Haringey Watercourses

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 Site Boundary



Your site boundary



Flood zone 3



Flood zone 2



Flood zone 1



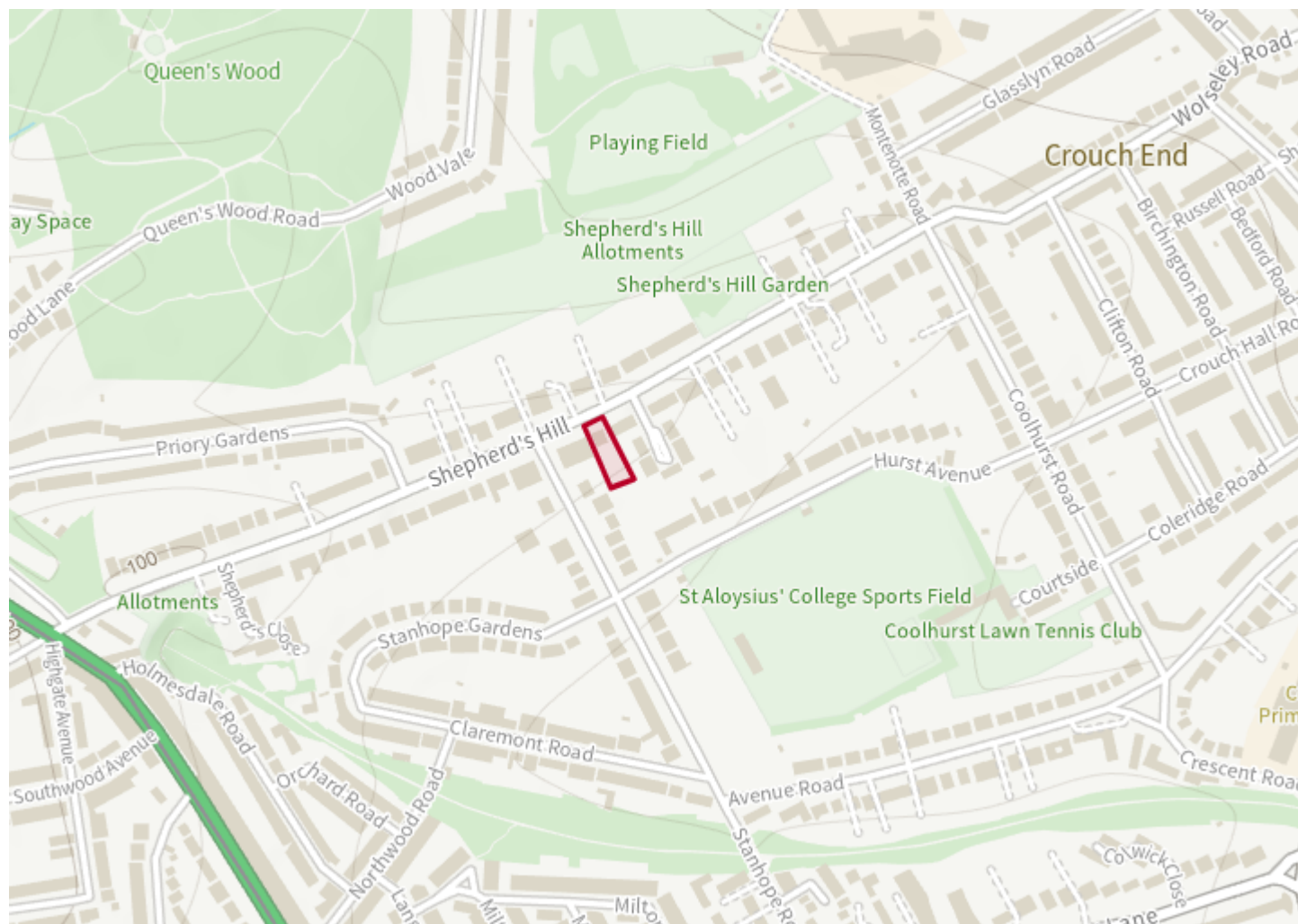
Flood defence



Main river



Water storage area



42 Shepherds Hill, London, N6 5RR

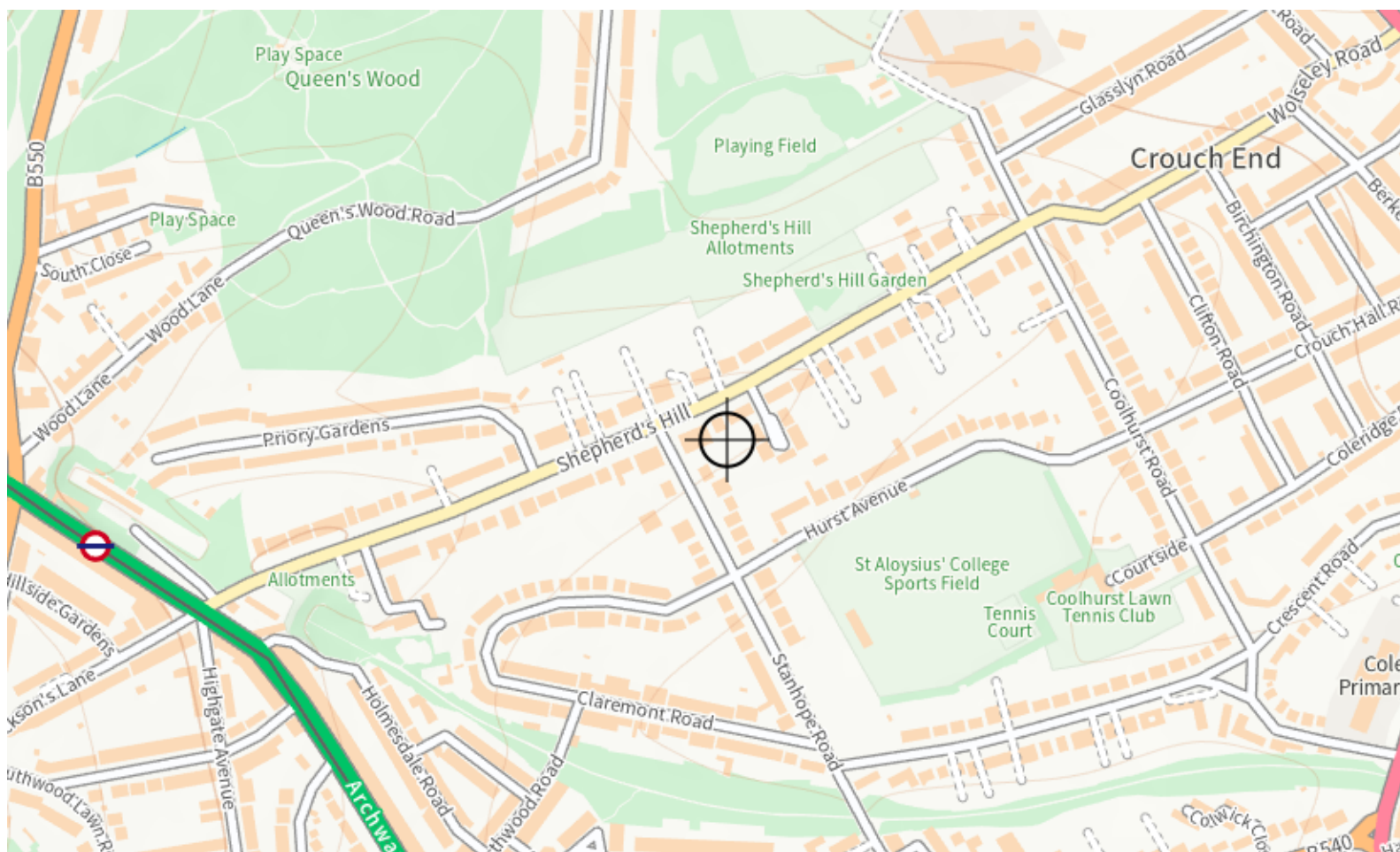
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Figure 7 – EA Flooding From Rivers and Seas

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Location you selected

when there is also flooding from rivers

when river levels are normal

42 Shepherds Hill, London, N6 5RR

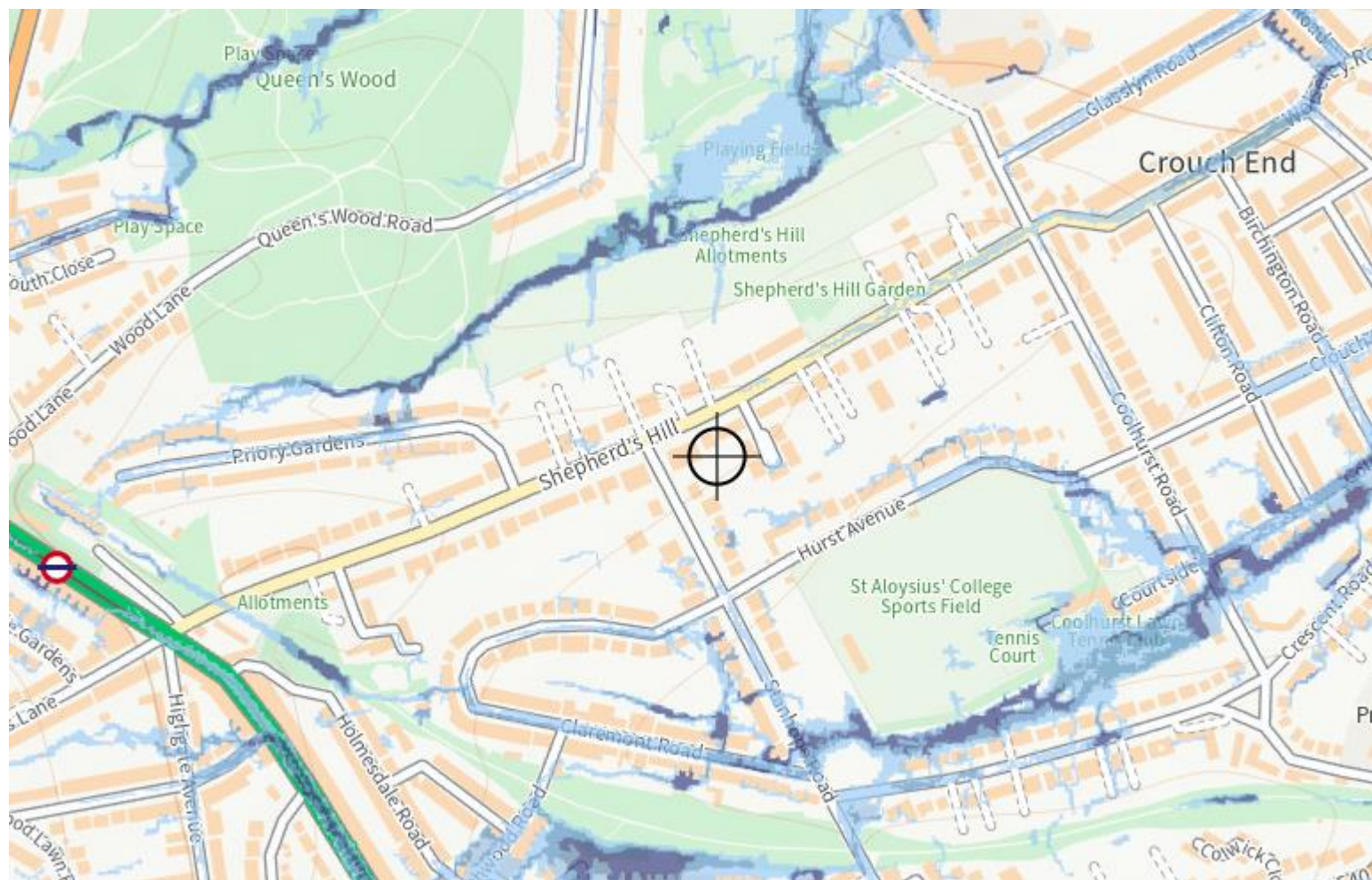
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Figure 8 – Reservoir Flooding

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⊕ Location you selected

● High ● Medium

● Low ○ Very low

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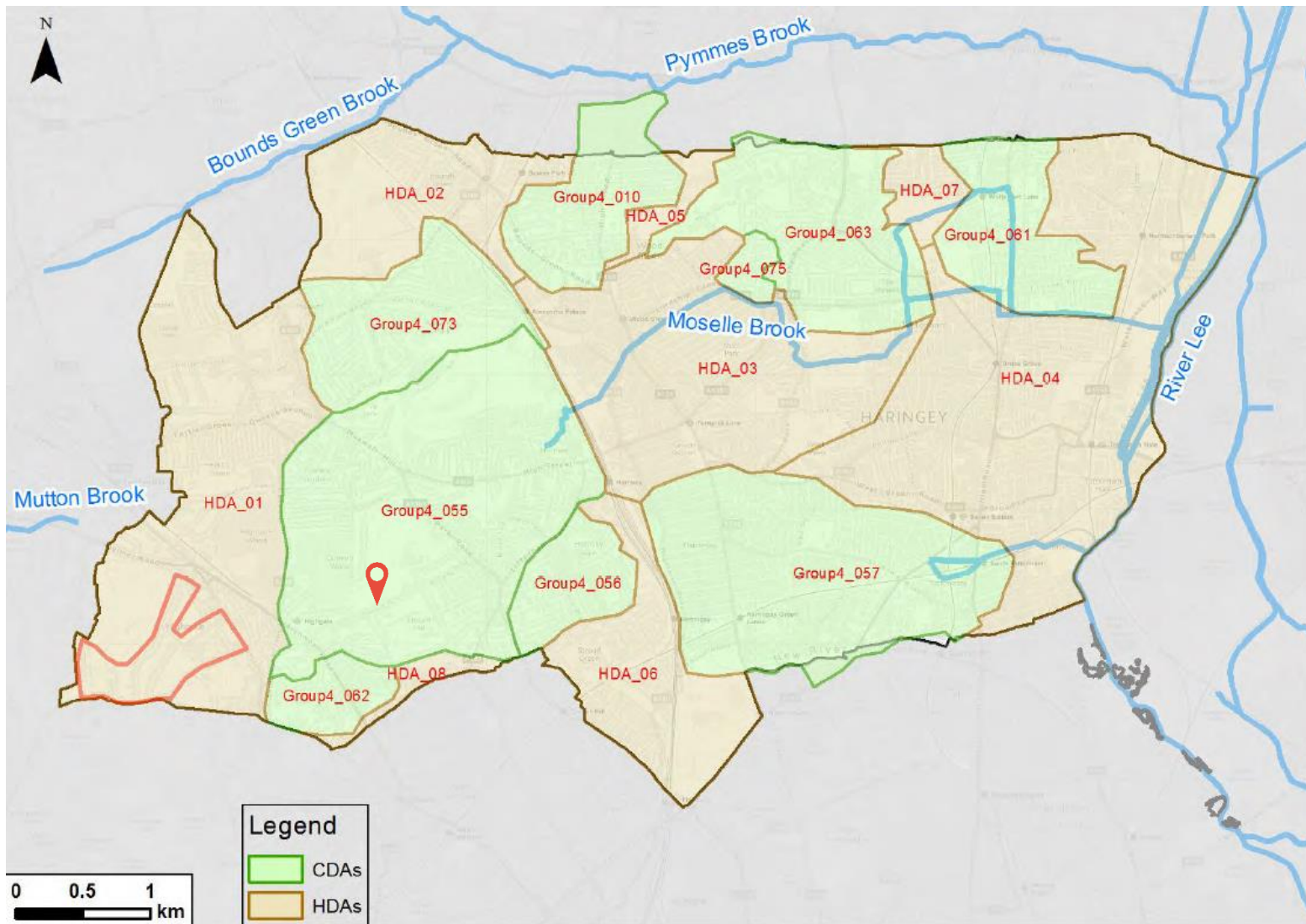
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Figure 9 – EA Surface Water Flooding Extent

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Site Location

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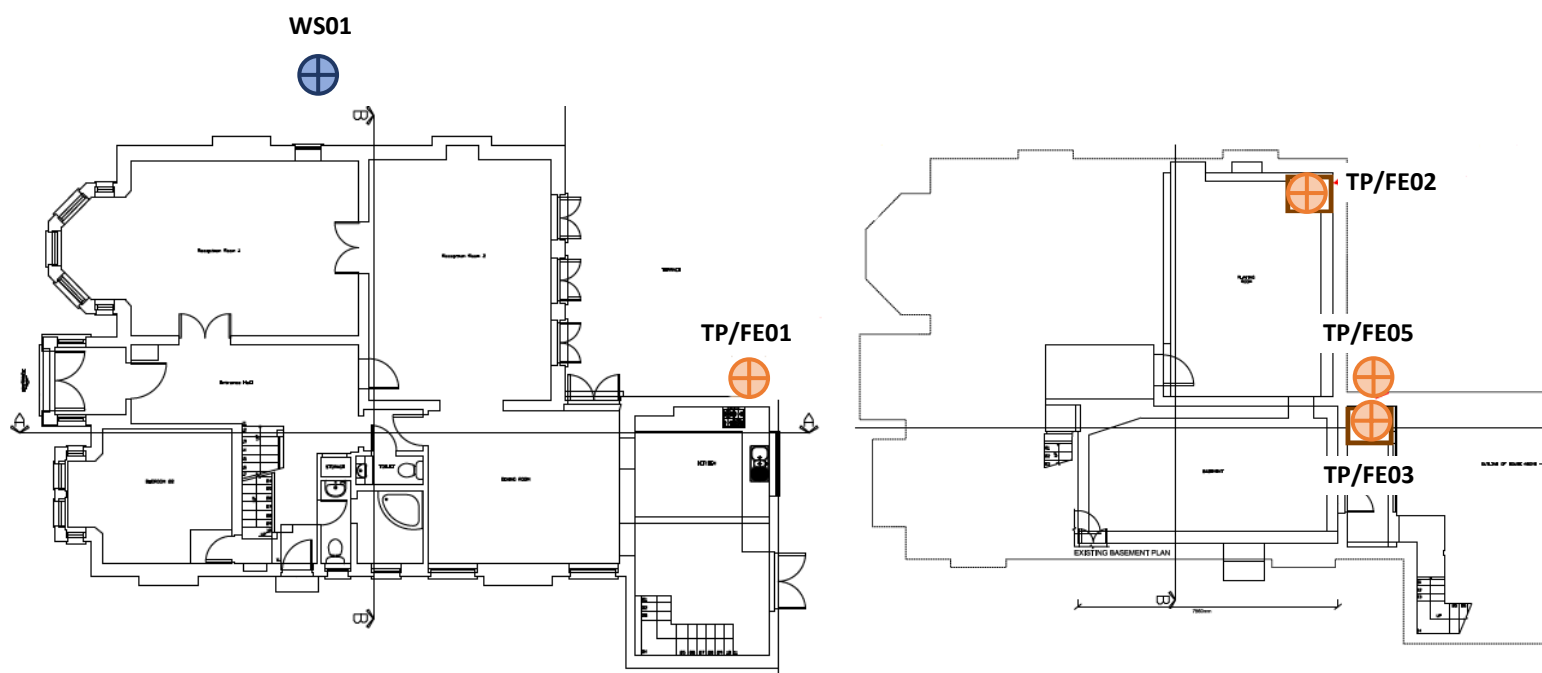
Figure 10 – SFRA Surface Water Flooding

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-  Site boundary
-  Windowless Sampler Borehole
-  Trial Pit Foundation Exposure



42 Shepherds Hill London N6 5RR

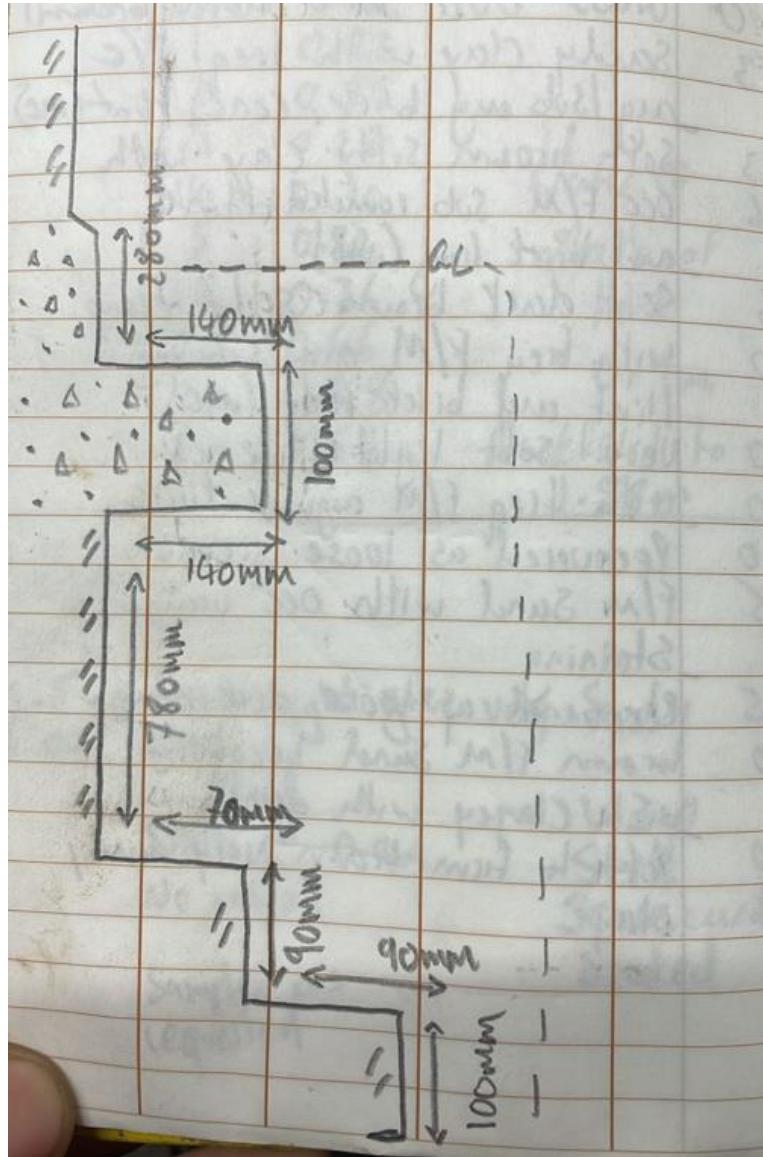
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Figure 11 – Trial Hole Location Plan

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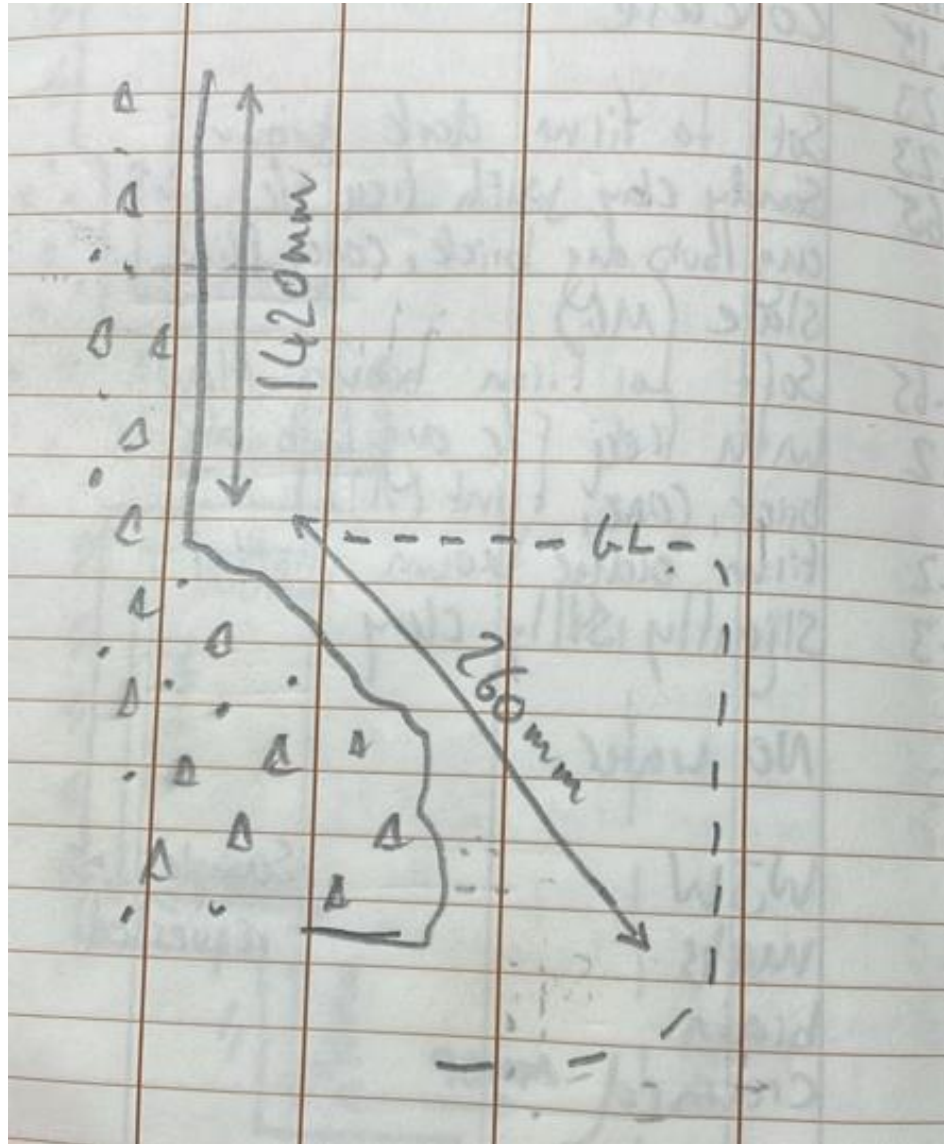
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Figure 12 – TP/FE01

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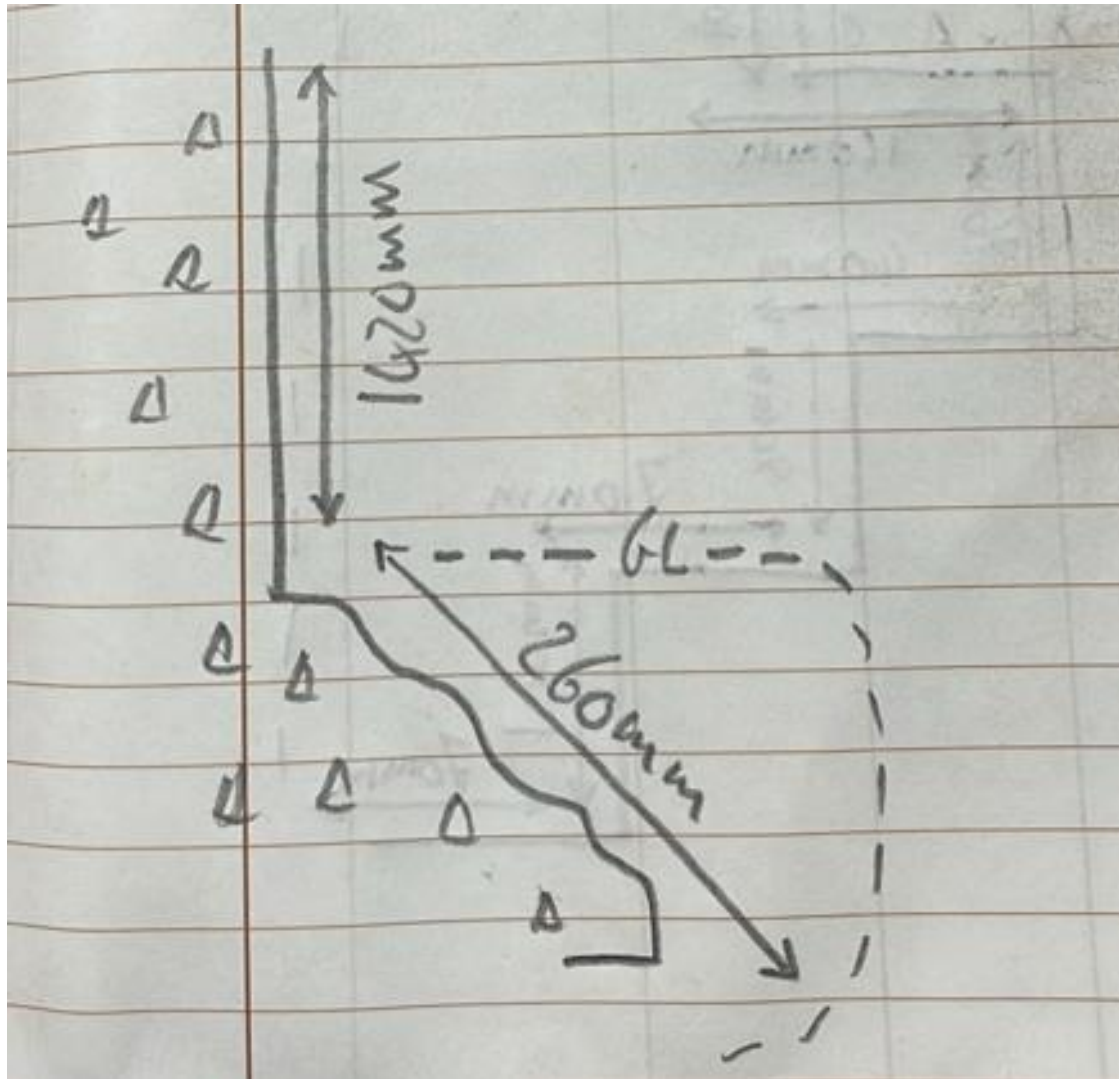
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Figure 13 – TP/FE02 (East Wall)

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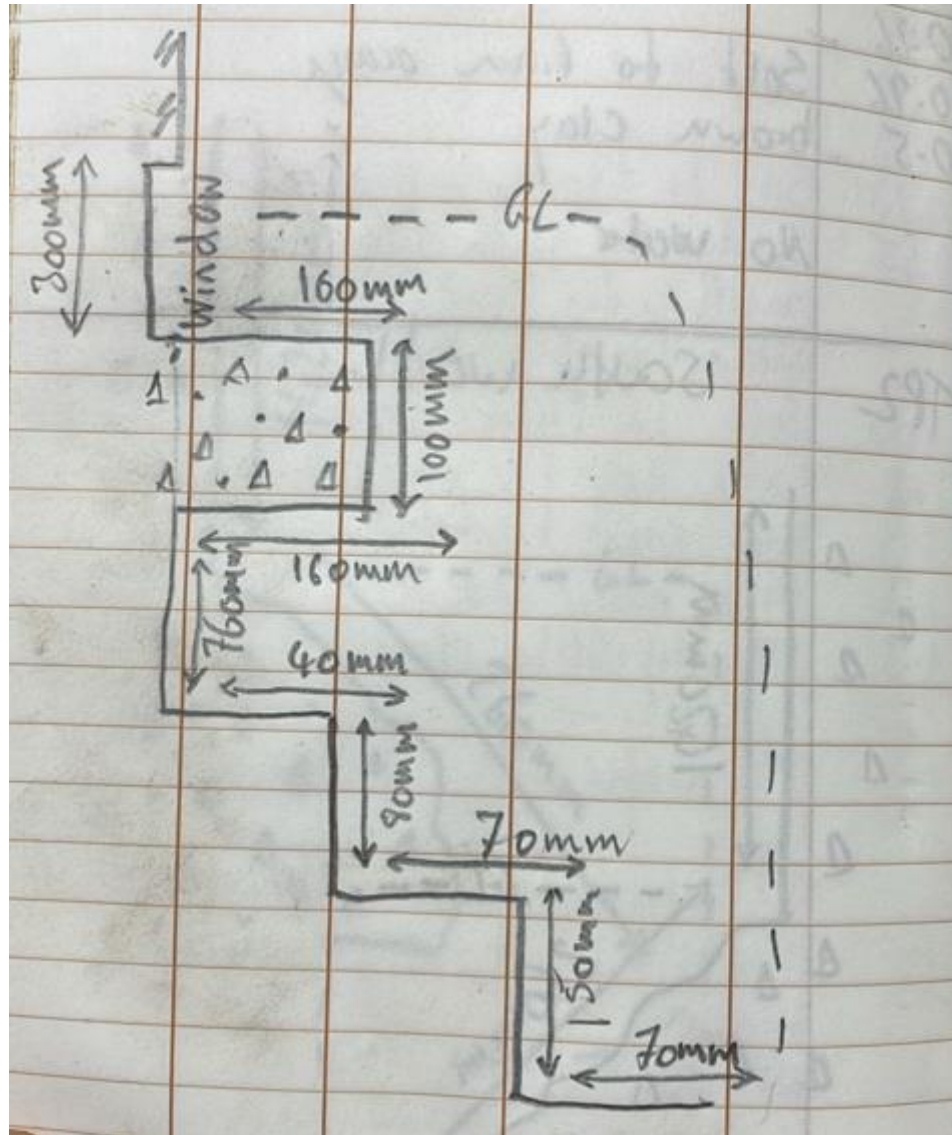
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Figure 14 – TP/FE02 (South Wall)

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Figure 15– TP/FE05

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APPENDIX A: Conditions and Limitations

The ground is a product of continuing natural and artificial processes. As a result, the ground will exhibit a variety of characteristics that vary from place to place across a site, and also with time. Whilst a ground investigation will mitigate to a greater or lesser degree against the resulting risk from variation, the risks cannot be eliminated.

The report has been prepared on the basis of information, data and materials which were available at the time of writing. Accordingly, any conclusions, opinions or judgements made in the report should not be regarded as definitive or relied upon to the exclusion of other information, opinions and judgements.

The investigation, interpretations, and recommendations given in this report were prepared for the sole benefit of the client in accordance with their brief; as such these do not necessarily address all aspects of ground behaviour at the site. No liability is accepted for any reliance placed on it by others unless specifically agreed in writing.

Any decisions made by you, or by any organisation, agency or person who has read, received or been provided with information contained in the report ("you" or "the Recipient") are decisions of the Recipient and we will not make, or be deemed to make, any decisions on behalf of any Recipient. We will not be liable for the consequences of any such decisions.

Current regulations and good practice were used in the preparation of this report. An appropriately qualified person must review the recommendations given in this report at the time of preparation of the scheme design to ensure that any recommendations given remain valid in light of changes in regulation and practice, or additional information obtained regarding the site.

Any Recipient must take into account any other factors apart from the Report of which they and their experts and advisers are or should be aware. The information, data, conclusions, opinions and judgements set out in the report may relate to certain contexts and may not be suitable in other contexts. It is your responsibility to ensure that you do not use the information we provide in the wrong context.

This report is based on readily available geological records, the recorded physical investigation, the strata observed in the works, together with the results of completed site and laboratory tests. Whilst skill and care has been taken to interpret these conditions likely between or below investigation points, the possibility of other characteristics not revealed cannot be discounted, for which no liability can be accepted. The impact of our assessment on other aspects of the development required evaluation by other involved parties.

The opinions expressed cannot be absolute due to the limitations of time and resources within the

context of the agreed brief and the possibility of unrecorded previous in ground activities. The ground conditions have been sampled or monitored in recorded locations and tests for some of the more common chemicals generally expected. Other concentrations of types of chemicals may exist. It was not part of the scope of this report to comment on environment/contaminated land considerations.

The conclusions and recommendations relate to 42 Shepherds Hill, London, N6 5RR.

Trial hole is a generic term used to describe a method of direct investigation. The term trial pit, borehole or window sampler borehole implies the specific technique used to produce a trial hole.

The depth to roots and/or of desiccation may vary from that found during the investigation. The client is responsible for establishing the depth to roots and/or of desiccation on a plot-by-plot basis prior to the construction of foundations. Where trees are mentioned in the text this means existing trees, recently removed trees (approximately 15 years to full recovery on cohesive soils) and those planned as part of the site landscaping.

Ownership of copyright of all printed material including reports, laboratory test results, trial pit and borehole log sheets, including drillers log sheets, remain with Ground and Water Limited. Licence is for the sole use of the client and may not be assigned, transferred or given to a third party.

Only our client may rely on this report and should this report or any information contained in it be provided to any third party we accept no responsibility to the third party for the contents of this report save to the extent expressly outlined by us in writing in a reliance letter addressed from us to the third party.

Recipients are not permitted to publish this report outside of their organisation without our express written consent.

APPENDIX B: Technical Glossary

TECHNICAL GLOSSARY

The list of possible definitions within the report may be seen below. Please note that some definitions may not be relevant to this report.

HYDROGEOLOGY:

A **Principal Aquifer** is a layer of rock or drift deposits that have high intergranular and/or fracture permeability - meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale. In most cases, principal aquifers are aquifers previously designated as major aquifer.

Secondary (A) Aquifers consist of deposits with permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as Minor Aquifers.

Secondary (B) Aquifers consist of deposits with predominantly lower permeability layers with may stoke and yield limited amounts of groundwater due to localised features such as fissures, think permeable horizons and weathering. These are generally the water-bearing parts of the former non-aquifers.

Secondary Aquifers (Undifferentiated) are assigned in cases where it has not been possible to attribute either category A or B to a rock type. In most cases, this means that the layer in question has previously been designated as both a minor aquifer and non-aquifer in different locations due to the variable characteristics of the rock type.

Unproductive Strata are rock layers with low permeability that have negligible significance for water supply or river base flow. These were formerly classified as non-aquifers.

FLOOD ZONES:

Environment Agency Flood Zone 2, defined as; land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding; or land having between a 1 in 200 and 1 in 1,000 annual probability of sea flooding.

Environment Agency Flood Zone 3 shows the extent of a river flood with a 1 in 100 (1% or greater chance of occurring in any year or a sea flood with a 1 in 200 (0.5%) or greater chance of occurring in any year.

Environment Agency Flood Zone 3 area that benefits from flood defences, defined as; land and property in this flood zone would have a high probability of flooding without the local flood defences. These protect the area against a river flood with a 1% chance of happening each year, or a flood from the sea with a 0.5% chance of happening each year.

GROUNDWATER SOURCE PROTECTION ZONES (SPZS):

Inner Zone (SPZ1): This zone is 50 day travel time of pollutant to source with a 50 metres default minimum radius.

Outer Zone (SPZ2): This zone is 400 day travel time of pollutant to source. This has a 250 or 500 metres minimum radius around the source depending on the amount of water taken.

Total Catchment (SPZ3): This is the area around a supply source within which all the groundwater ends up at the abstraction point. This is the point from where the water is taken. This could extend some distance from the source point.

Zone of Special Interest (SPZ4): This zone is where local conditions require additional protection.

IN-SITU STRENGTH GEOTECHNICAL TESTING:

Windowless Sample and/or Cable Percussion and/or Rotary Boreholes provide samples of the ground for assessment but they do not give any engineering data. The standard penetration test (SPT) is an in-situ dynamic penetration test designed to provide information on the geotechnical engineering properties of soil. The test uses a thick-walled sample tube, with an outside diameter of 50mm and an inside diameter of 35mm, and a length of around 650mm. This is driven into the ground at the bottom of a borehole by blows from a slide hammer with a weight of 63.5kg falling through a distance of 760mm. The sample tube is driven 150mm into the ground and then the number of blows needed for the tube to penetrate each 75mm up to a depth of 450mm is recorded. The sum of the number of blows is termed the "standard penetration resistance" or the "N-value".

Dynamic Probing involves the driving of a metal cone into the ground via a series of steel rods. These rods are driven from the surface by a hammer system that lifts and drops a 63.5kg (SHDP) hammer onto the top of the rods through a set height, thus ensuring a consistent energy input. The number of hammer blows that are required to drive the cone down by each 100mm increment are recorded. These blow counts then provide a comparative assessment from which correlations have been published, based on dynamic energy, which permits engineering parameters to be generated. (The Dynamic Probe 'Super Heavy' (SHDP) Tests were conducted in accordance with BS 1377; 1990; Part 9, Clause 3.2).

APPENDIX C: Trial Hole Logs



Percussion Drilling Log

Project Name: 42 Shepherds Hill		Client: Harry Travers		Date: 06/02/2024	
Location: London, N6 5RR		Contractor:			
Project No. : GWPR5826		Crew Name:		Drilling Equipment:	
Borehole Number WS01	Hole Type BH	Level	Logged By AS	Scale 1:50	Page Number Sheet 1 of 2

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.40			MADE GROUND. Dark orangish brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is fine to coarse sub-angular to sub-rounded flint (60%), brick (20%), plastic (10%) and carbonaceous material (10%).	
		1.00	SPT	N=9 (1,1/2,2,2,3)				Dark orangish brown mottled with dark brownish grey slightly sandy silty CLAY. Sand is fine. (LONDON CLAY FORMATION)	1
		2.00	SPT	N=8 (2,2/2,2,2,2)					2
		3.00	SPT	N=12 (3,3/3,3,3,3)					3
		4.00	SPT	N=8 (2,2/2,2,2,2)					4
		5.00	SPT	N=13 (2,3/3,3,3,4)					5
		6.00	SPT	N=12 (3,3/3,3,3,3)	5.70			Dark brownish grey slightly sandy silty CLAY. Sand is fine. (LONDON CLAY FORMATION)	6
		7.00	SPT	N=16 (4,4/4,4,4,4)					7
		8.00	SPT	N=18 (4,4/4,4,5,5)					8
		9.00	SPT	N=20 (4,4/5,5,5,5)					9
		10.00	SPT	N=22 (4,5/5,6,5,6)					10

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation

Remarks	
Hole terminated with fresh roots to 1.00m bgl, no groundwater. strikes were recorded.	

		Percussion Drilling Log									
Project Name: 42 Shepherds Hill				Client: Harry Travers				Date: 06/02/2024			
Location: London, N6 5RR				Contractor:							
Project No. : GWPR5826				Crew Name:				Drilling Equipment:			
Borehole Number WS01		Hole Type BH		Level		Logged By AS		Scale 1:50		Page Number Sheet 2 of 2	
Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description			
		Depth (m)	Type	Results							
					10.45			Dark brownish grey slightly sandy silty CLAY. Sand is fine. (LONDON CLAY FORMATION)			
								End of Borehole at 10.450m			
										11	
										12	
										13	
										14	
										15	
										16	
										17	
										18	
										19	
										20	
Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation
Remarks											
Hole terminated with fresh roots to 1.00m bgl, no groundwater. strikes were recorded.											



Trial Pit Log

Project Name: 42 Shepherds Hill		Client: Harry Travers		Date: 06/02/2024	
Location: London, N6 5RR		Contractor:			
Project No. : GWPR5826		Crew Name:		Equipment:	
Location Number TP/FE01	Location Type TP	Level	Logged By TP	Scale 1:25	Page Number Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					1.20			MADE GROUND. Dark orangish brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is fine to coarse sub-angular to sub-rounded flint (50%), brick (40%) and concrete (10%)	1
					1.30			Dark orangish brown mottled with dark brownish grey slightly sandy silty CLAY. Sand is fine. (LONDON CLAY FORMATION) End of Borehole at 1.300m	2
									3
									4
									5

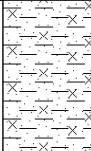
Dimensions		Trench Support and Comment			Pumping Data		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Date	Rate	Remarks

Remarks
Hole terminated with no roots or groundwater.



Trial Pit Log

Project Name: 42 Shepherds Hill		Client: Harry Travers		Date: 06/02/2024	
Location: London, N6 5RR		Contractor:			
Project No. : GWPR5826		Crew Name:		Equipment:	
Location Number TP/FE02	Location Type TP	Level	Logged By AS	Scale 1:25	Page Number Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.50			Dark orangish brown mottled with dark brownish grey slightly sandy silty CLAY. Sand is fine. (LONDON CLAY FORMATION)	
								End of Borehole at 0.500m	
									1
									2
									3
									4
									5

Dimensions		Trench Support and Comment			Pumping Data		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Date	Rate	Remarks

Remarks Hole terminated with no roots or groundwater.	
--	---

Trial Pit Log

Project Name: 42 Shepherds Hill		Client: Harry Travers		Date: 06/02/2024	
Location: London, N6 5RR		Contractor:			
Project No. : GWPR5826		Crew Name:		Equipment:	
Location Number TP/FE05	Location Type TP	Level	Logged By AS	Scale 1:25	Page Number Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					1.10			MADE GROUND. Dark reddish brown gravelly clayey fine to coarse SAND. Gravel is fine to coarse sub-angular to sub-rounded brick (70%) and flint (30%).	1
					1.20			Dark orangish brown mottled with dark brownish grey slightly sandy silty CLAY. Sand is fine. (LONDON CLAY FORMATION)	2
									3
									4
									5

Dimensions		Trench Support and Comment			Pumping Data		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Date	Rate	Remarks

Remarks Hole terminated with no roots or groundwater.							
---	--	--	--	--	--	--	---

APPENDIX D: Geotechnical Laboratory Testing



Laboratory Report



Contract Number: 71106

Client Ref: **GWPR5826**

Client PO: **GWPR5826**

Date Received: **07-02-2024**

Date Completed: **15-02-2024**

Report Date: **15-02-2024**

Client: **Ground and Water Limited**

This report has been checked and approved by:

Contract Title: **42 Stephens Hill, London, N6 5RR**

For the attention of: **Aubyn Shortland**

Brendan Evans
Office Administrator

Description	Qty
Moisture Content BS 1377:1990 - Part 2 : 3.2 - * UKAS	4
1 Point Liquid & Plastic Limit BS 1377:1990 - Part 2 : 4.4 & 5.3 - * UKAS	4
Disposal of samples for job	1

Notes: Observations and Interpretations are outside the UKAS Accreditation

* - denotes test included in laboratory scope of accreditation

- denotes test carried out by approved contractor

@ - denotes non accredited tests

This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This test report/certificate shall not be reproduced except in full, without the approval of GEO Site & Testing Services Ltd. Any opinions or interpretations stated - within this report/certificate are excluded from the laboratories UKAS accreditation.

Approved Signatories:

Brendan Evans (Office Administrator) - Darren Bourne (Quality Senior Technician) - Paul Evans (Director)
Richard John (Quality/Technical Manager) - Shaun Jones (Laboratory manager) - Shaun Thomas (Site Manager)
Wayne Honey (Human Resources/ Health and Safety Manager)

**NATURAL MOISTURE, LIQUID LIMIT, PLASTIC LIMIT AND
PLASTICITY INDEX
(BS 1377:1990 - Part 2 : 4.4 & 5.3)**

Contract Number	71106	
Project Name	42 Stephens Hill, London, N6 5RR	
Date Tested	15/02/2024	
	DESCRIPTIONS	

[illegible]

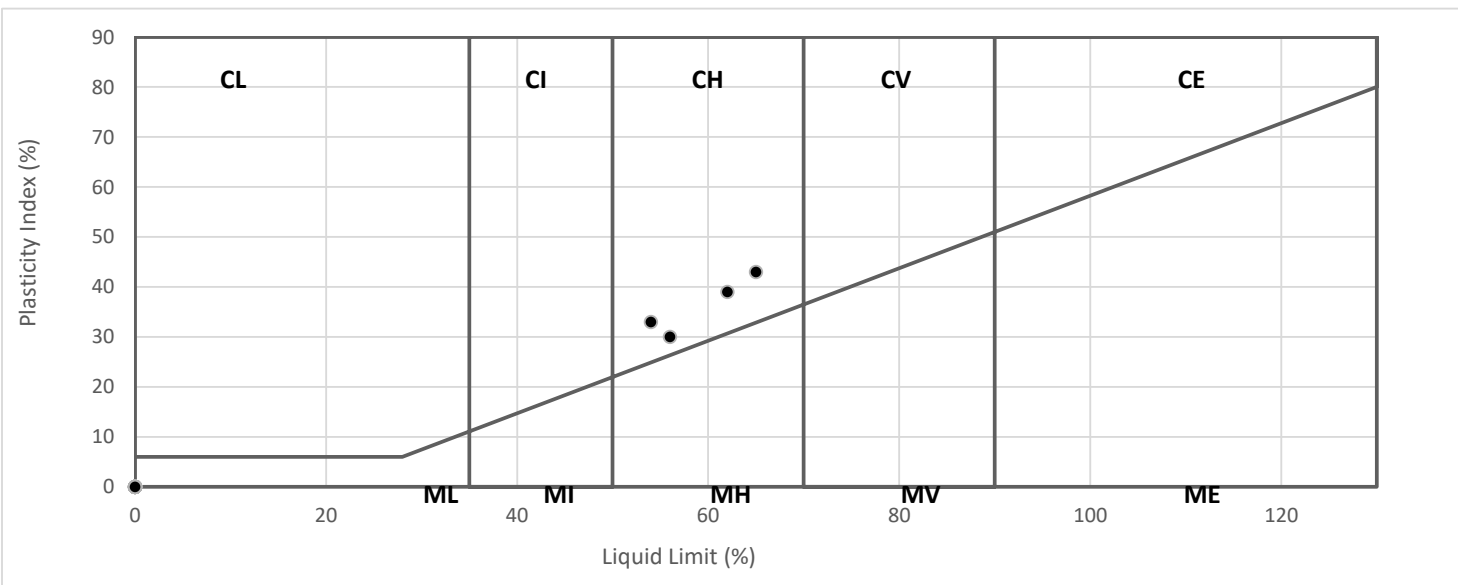
Operator
Clayton Jenkins

Contract Number	71106	
Project Name	42 Stephens Hill, London, N6 5RR	
Date Tested	15/02/2024	

[illegible]

Symbols: NP : Non Plastic # : Liquid Limit and Plastic Limit Wet Sieved

PLASTICITY CHART FOR CASAGRANDE CLASSIFICATION BS 5930:2015+A1:2020



Operator
Clayton Jenkins

APPENDIX E: Chemical Laboratory Testing



Units 7-8 Hawarden Business Park
Manor Road (off Manor Lane)
Hawarden
Deeside
CH5 3US
Tel: (01244) 528777
email: hawardencustomerservices@alsglobal.com
Website: www.alsenvironmental.co.uk

Ground and Water Ltd
Head Office
2 The Long Barn
Norton Farm, Selborne Road
Alton
Hampshire
GU34 3NB
Attention: Aubyn Shortland

CERTIFICATE OF ANALYSIS

Date of report Generation:	14 February 2024
Customer:	Ground and Water Ltd
Sample Delivery Group (SDG):	240207-77
Your Reference:	GWPR5826
Location:	42 Shepherds Hill London N6 5RR
Report No:	720099
Order Number:	GWPR5826

We received 4 samples on Wednesday February 07, 2024 and 4 of these samples were scheduled for analysis which was completed on Wednesday February 14, 2024. Accredited laboratory tests are defined within the report, but opinions, interpretations and on-site data expressed herein are outside the scope of ISO 17025 accreditation.

Should this report require incorporation into client reports, it must be used in its entirety and not simply with the data sections alone.

Chemical testing (unless subcontracted) performed at ALS Laboratories (UK) Limited Hawarden.

All sample data is provided by the customer. The reported results relate to the sample supplied, and on the basis that this data is correct.

Incorrect sampling dates and/or sample information will affect the validity of results.

The customer is not permitted to reproduce this report except in full without the approval of the laboratory.

Approved By:

Sonia McWhan

Operations Manager



1291



CERTIFICATE OF ANALYSIS

Validated

SDG: 240207-77
Client Ref.: GWPR5826

Report Number: 720099
Location: 42 Shepherds Hill London N6 5RR

Superseded Report:

Received Sample Overview

Lab Sample No(s)	Customer Sample Ref.	AGS Ref.	Depth (m)	Sampled Date
29326961	WS01		0.30	31/01/2024
29326968	WS01		1.00	31/01/2024
29326972	WS01		10.00	31/01/2024
29326970	WS01		6.00	31/01/2024

Only received samples which have had analysis scheduled will be shown on the following pages.



CERTIFICATE OF ANALYSIS

Validated

SDG: 240207-77
Client Ref.: GWPR5826

Report Number: 720099
Location: 42 Shepherds Hill London N6 5RR

Superseded Report:

Results Legend X Test N No Determination Possible Sample Types - S - Soil/Solid UNS - Unspecified Solid GW - Ground Water SW - Surface Water LE - Land Leachate PL - Prepared Leachate PR - Process Water SA - Saline Water TE - Trade Effluent TS - Treated Sewage US - Untreated Sewage RE - Recreational Water DW - Drinking Water Non-regulatory UNL - Unspecified Liquid SL - Sludge G - Gas OTH - Other	Lab Sample No(s)		29326970	29326972	29326968	29326961
	Customer Sample Reference		WS01	WS01	WS01	WS01
	AGS Reference					
	Depth (m)		6.00	10.00	1.00	0.30
	Container		1kg TUB with Handle	1kg TUB with Handle	1kg TUB with Handle	250g Amber Jar (ALE210)
	Sample Type		S	S	S	S
Ammoniacal N as NH ₄ in 2:1 extract	All	NDPs: 0 Tests: 2		X	X	
ANC at pH4 and ANC at pH 6	All	NDPs: 0 Tests: 1	X			
Anions by Kone (soil)	All	NDPs: 0 Tests: 4	X	X	X	X
Anions by Kone (w)	All	NDPs: 0 Tests: 1	X			
Asbestos ID in Solid Samples	All	NDPs: 0 Tests: 1	X			
Boron Water Soluble	All	NDPs: 0 Tests: 1	X			
CEN Readings	All	NDPs: 0 Tests: 1	X			
Coronene	All	NDPs: 0 Tests: 1	X			
Cyanide Comp/Free/Total/Thiocyanate	All	NDPs: 0 Tests: 1	X			
Dissolved Metals by ICP-MS	All	NDPs: 0 Tests: 1	X			
Dissolved Organic/Inorganic Carbon	All	NDPs: 0 Tests: 1	X			
EPH by GCxGC-FID	All	NDPs: 0 Tests: 1	X			
EPH CWG GC (S)	All	NDPs: 0 Tests: 1	X			
Fluoride	All	NDPs: 0 Tests: 1	X			
GRO by GC-FID (S)	All	NDPs: 0 Tests: 1			X	



CERTIFICATE OF ANALYSIS

Validated

SDG: 240207-77
Client Ref.: GWPR5826

Report Number: 720099
Location: 42 Shepherds Hill London N6 5RR

Superseded Report:

Results Legend X Test N No Determination Possible Sample Types - S - Soil/Solid UNS - Unspecified Solid GW - Ground Water SW - Surface Water LE - Land Leachate PL - Prepared Leachate PR - Process Water SA - Saline Water TE - Trade Effluent TS - Treated Sewage US - Untreated Sewage RE - Recreational Water DW - Drinking Water Non-regulatory UNL - Unspecified Liquid SL - Sludge G - Gas OTH - Other	Lab Sample No(s)		29326970	29326972	29326968	29326961
	Customer Sample Reference		WS01	WS01	WS01	WS01
	AGS Reference					
	Depth (m)		6.00	10.00	1.00	0.30
	Container		1kg TUB with Handle	1kg TUB with Handle	1kg TUB with Handle	250g Amber Jar (ALE210)
	Sample Type		S	S	S	S
Hexavalent Chromium (s)	All	NDPs: 0 Tests: 1	X			
Loss on Ignition in soils	All	NDPs: 0 Tests: 1	X			
Magnesium (BRE)	All	NDPs: 0 Tests: 2		X	X	
Mercury Dissolved	All	NDPs: 0 Tests: 1	X			
Metals in solid samples by OES	All	NDPs: 0 Tests: 1	X			
NO3, NO2 and TON by KONE (s)	All	NDPs: 0 Tests: 2		X	X	
PAH 16 & 17 Calc	All	NDPs: 0 Tests: 1	X			
PAH by GCMS	All	NDPs: 0 Tests: 1	X			
PCBs by GCMS	All	NDPs: 0 Tests: 1	X			
pH	All	NDPs: 0 Tests: 4	X	X	X	X
pH Value of Filtered Water	All	NDPs: 0 Tests: 1	X			
Phenols by HPLC (S)	All	NDPs: 0 Tests: 1	X			
Phenols by HPLC (W)	All	NDPs: 0 Tests: 1	X			
Sample description	All	NDPs: 0 Tests: 4	X	X	X	X
Total Organic Carbon	All	NDPs: 0 Tests: 1	X			

SDG: 240207-77

Report Number: 720099

Superseded Report:

Client Ref.: GWPR5826

Location: 42 Shepherds Hill London N6 5RR

Results Legend X Test N No Determination Possible Sample Types - S - Soil/Solid UNS - Unspecified Solid GW - Ground Water SW - Surface Water LE - Land Leachate PL - Prepared Leachate PR - Process Water SA - Saline Water TE - Trade Effluent TS - Treated Sewage US - Untreated Sewage RE - Recreational Water DW - Drinking Water Non-regulatory UNL - Unspecified Liquid SL - Sludge G - Gas OTH - Other	Lab Sample No(s)	Customer Sample Reference	AGS Reference	Depth (m)	Container	Sample Type					
					250g Amber Jar (ALE210) 1kg TUB with Handle	S	S				
	29326961	WS01		0.30	60g VOC (ALE215) Handle	S	S				
	29326968	WS01		1.00	1kg TUB with Handle	S	S		X	X	
	29326972	WS01		10.00	1kg TUB with Handle	S	S				
	29326970	WS01		6.00	1kg TUB with Handle	S	S				
Total Sulphate	All	NDPs: 0 Tests: 2									
Total Sulphur	All	NDPs: 0 Tests: 2									
TPH CWG GC (S)	All	NDPs: 0 Tests: 1									
VOC MS (S)	All	NDPs: 0 Tests: 1									



CERTIFICATE OF ANALYSIS

Validated

SDG: 240207-77
Client Ref.: GWPR5826

Report Number: 720099
Location: 42 Shepherds Hill London N6 5RR

Superseded Report:

Sample Descriptions

Grain Sizes

very fine	<0.063mm	fine	0.063mm - 0.1mm	medium	0.1mm - 2mm	coarse	2mm - 10mm	very coarse	>10mm
-----------	----------	------	-----------------	--------	-------------	--------	------------	-------------	-------

Lab Sample No(s)	Customer Sample Ref.	Depth (m)	Colour	Description	Inclusions	Inclusions 2
29326961	WS01	0.30	Light Brown	Sandy Clay Loam	Stones	None
29326968	WS01	1.00	Light Brown	Silty Clay	None	None
29326970	WS01	6.00	Light Brown	Silty Clay	None	None
29326972	WS01	10.00	Dark Brown	Clay	None	None

These descriptions are only intended to act as a cross check if sample identities are questioned, and to provide a log of sample matrices with respect to MCERTS validation. They are not intended as full geological descriptions.

We are accredited to MCERTS for sand, clay and loam/topsoil, or any of these materials - whether these are derived from naturally occurring soil profiles, or from fill/made ground, as long as these materials constitute the major part of the sample.

Other coarse granular materials such as concrete, gravel and brick are not accredited if they comprise the major part of the sample.



CERTIFICATE OF ANALYSIS

Validated

SDG: 240207-77
Client Ref.: GWPR5826

Report Number: 720099
Location: 42 Shepherds Hill London N6 5RR

Superseded Report:

Results Legend		Customer Sample Ref.	WS01	WS01	WS01	WS01		
#	ISO17025 accredited.	Depth (m) Sample Type Date Sampled Sampled Time Date Received SDG Ref Lab Sample No.(s) AGS Reference	0.30	1.00	10.00	6.00		
M	mCERTS accredited.		Soil/Solid (S)	Soil/Solid (S)	Soil/Solid (S)	Soil/Solid (S)		
aq	Aqueous / settled sample.		31/01/2024	31/01/2024	31/01/2024	31/01/2024		
diss,filtr	Dissolved / filtered sample.		00:00	00:00	00:00	00:00		
tot.unfilt	Total / unfiltered sample.		07/02/2024	07/02/2024	07/02/2024	07/02/2024		
*	Subcontracted - refer to subcontractor report for accreditation status.		240207-77	240207-77	240207-77	240207-77		
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery		29326961	29326968	29326972	29326970		
(F)	Trigger breach confirmed							
1-4.5@	Sample deviation (see appendix)							
Component	LOD/Units	Method						
Moisture Content Ratio (% of as received sample)	%	PM024	20	19	18	18		
Loss on ignition	<0.7 %	TM018	3.82					
Phenol	<0.01 mg/kg	TM062 (S)	<0.01					
Cresols	<0.01 mg/kg	TM062 (S)	<0.01					
Xylenols	<0.015 mg/kg	TM062 (S)	<0.015					
Phenols, Total Detected monohydric	<0.035 mg/kg	TM062 (S)	<0.035					
Organic Carbon, Total	<0.2 %	TM132	0.959					
Sulphur, Total	<0.02 %	TM132		0.0206 #	0.443 #			
Soil Organic Matter (SOM)	<0.35 %	TM132	1.65 #					
pH	1 pH Units	TM133	8.7	5.1	8.23	7.59		
Chromium, Hexavalent	<0.6 mg/kg	TM151	<0.6					
Cyanide, Total	<1 mg/kg	TM153	<1					
PCB congener 28	<0.003 mg/kg	TM168	<0.003					
PCB congener 52	<0.003 mg/kg	TM168	<0.003					
PCB congener 101	<0.003 mg/kg	TM168	<0.003					
PCB congener 118	<0.003 mg/kg	TM168	<0.003					
PCB congener 138	<0.003 mg/kg	TM168	<0.003					
PCB congener 153	<0.003 mg/kg	TM168	<0.003					
PCB congener 180	<0.003 mg/kg	TM168	<0.003					
Sum of detected PCB 7 Congeners	<0.021 mg/kg	TM168	<0.021					
Arsenic	<0.6 mg/kg	TM181	14.8					
Cadmium	<0.02 mg/kg	TM181	0.595					
Chromium	<0.9 mg/kg	TM181	37.5					
Copper	<1.4 mg/kg	TM181	22.9					
Lead	<0.7 mg/kg	TM181	406					
Mercury	<0.1 mg/kg	TM181	<0.1					
Nickel	<0.2 mg/kg	TM181	18.9					
Selenium	<1 mg/kg	TM181	<1					
Vanadium	<0.2 mg/kg	TM181	63.2					
Zinc	<1.9 mg/kg	TM181	655					
ANC @ pH 4	<0.03 mol/kg	TM182	0.0902					
ANC @ pH 6	<0.03 mol/kg	TM182	<0.03					

SDG: 240207-77
Client Ref.: GWPR5826

Report Number: 720099

Superseded Report:

Location: 42 Shepherds Hill London N6 5RR

[illegible]

SDG: 240207-77
Client Ref.: GWPR5826

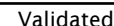
Report Number: 720099

Superseded Report:

Location: 42 Shepherds Hill London N6 5RR

PAH by GCMS

[illegible]



Location: 42 Shepherds Hill London N6 5RR

SDG: 240207-77
Client Ref.: GWPR5826

Report Number: 720099

Superseded Report:

Location: 42 Shepherds Hill London N6 5RR

VOC MS (S)

[illegible]



CERTIFICATE OF ANALYSIS

Validated

SDG: 240207-77
Client Ref.: GWPR5826

Report Number: 720099
Location: 42 Shepherds Hill London N6 5RR

Superseded Report:

Asbestos Identification - Solid Samples

Results Legend

ISO17025 accredited.
M mCERTS accredited.
* Subcontracted test.
(F) Trigger breach confirmed
1-5&+@ Sample deviation (see appendix)

Cust. Sample Ref.	WS01 0.30 SOLID	08/02/2024	Agnieszka Chelmowska	-	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected
Depth (m)											
Sample Type	31/01/2024 00:00:00										
Date Sampled	07/02/2024 05:00:00										
Date Received	240207-77										
SDG	29326961										
Original Sample Method Number	TM048										



CERTIFICATE OF ANALYSIS

Validated

SDG: 240207-77
Client Ref.: GWPR5826Report Number: 720099
Location: 42 Shepherds Hill London N6 5RR

Superseded Report:

CEN 10:1 SINGLE STAGE LEACHATE TEST

CEN ANALYTICAL RESULTS

REF : BS EN 12457/2

Client Reference

Mass Sample taken (kg) 0.106

Mass of dry sample (kg) 0.090

Particle Size <4mm >95%

Site Location

42 Shepherds Hill London N6 5RR

Natural Moisture Content (%) 17.7

Dry Matter Content (%) 85

Case

SDG 240207-77

Lab Sample Number(s) 29326961

Sampled Date 31-Jan-2024

Customer Sample Ref. WS01

Depth (m) 0.30

Landfill Waste Acceptance
Criteria Limits

Solid Waste Analysis

Result

Total Organic Carbon (%) 0.959

Loss on Ignition (%) 3.82

Sum of BTEX (mg/kg) <0.007

Sum of 7 PCBs (mg/kg) <0.021

Mineral Oil (mg/kg) (EH_2D_AL) 10.4

PAH Sum of 17 (mg/kg) <10

pH (pH Units) 8.7

ANC to pH 6 (mol/kg) <0.03

ANC to pH 4 (mol/kg) 0.0902

Inert Waste Landfill	Stable Non-reactive Hazardous Waste in Non- Hazardous Landfill	Hazardous Waste Landfill
3	5	6
-	-	10
6	-	-
1	-	-
500	-	-
100	-	-
-	>6	-
-	-	-
-	-	-

Eluate Analysis

C2

Concⁿ in 10:1 eluate (mg/l)

A2

10:1 concⁿ leached (mg/kg)Limit values for compliance leaching test
using BS EN 12457-3 at L/S 10 l/kg

	Result	Limit of Detection	Result	Limit of Detection			
Arsenic	0.00402	<0.0005	0.0402	<0.005	0.5	2	25
Barium	0.306	<0.0002	3.06	<0.002	20	100	300
Cadmium	<0.00008	<0.00008	<0.0008	<0.0008	0.04	1	5
Chromium	0.00132	<0.001	0.0132	<0.01	0.5	10	70
Copper	0.00351	<0.0003	0.0351	<0.003	2	50	100
Mercury Dissolved (CVAf)	<0.00001	<0.00001	<0.0001	<0.0001	0.01	0.2	2
Molybdenum	0.00522	<0.003	0.0522	<0.03	0.5	10	30
Nickel	0.000714	<0.0004	0.00714	<0.004	0.4	10	40
Lead	0.00337	<0.0002	0.0337	<0.002	0.5	10	50
Antimony	0.00224	<0.001	0.0224	<0.01	0.06	0.7	5
Selenium	<0.001	<0.001	<0.01	<0.01	0.1	0.5	7
Zinc	0.0105	<0.001	0.105	<0.01	4	50	200
Chloride	<2	<2	<20	<20	800	15000	25000
Fluoride	0.852	<0.5	8.52	<5	10	150	500
Sulphate (soluble)	<2	<2	<20	<20	1000	20000	50000
Total Dissolved Solids	85.8	<10	858	<100	4000	60000	100000
Total Monohydric Phenols (W)	<0.016	<0.016	<0.16	<0.16	1	-	-
Dissolved Organic Carbon	5.61	<3	56.1	<30	500	800	1000

Leach Test Information

Date Prepared 08-Feb-2024
pH (pH Units) 8.58
Conductivity (µS/cm) 112
Volume Leachant (Litres) 0.884

Solid Results are expressed on a dry weight basis, after correction for moisture content where applicable

Leachates prepared in accordance with BS EN 12457 will be carried out at room temperature (20±5°C)

Stated limits are for guidance only and ALS Laboratories (UK) Limited cannot be held responsible for any discrepancies with current legislation

14/02/2024 09:28:00

09:27:51 14/02/2024



CERTIFICATE OF ANALYSIS

Validated

SDG: 240207-77
Client Ref.: GWPR5826

Report Number: 720099
Location: 42 Shepherds Hill London N6 5RR

Superseded Report:

Table of Results - Appendix

Method No	Description
PM024	Soil preparation including homogenisation, moisture, screens of soils for Asbestos Containing Material
PM115	Leaching Procedure for CEN One Stage Leach Test 2:1 & 10:1 1 Step
TM018	Determination of Loss on Ignition
TM048	Identification of Asbestos in Bulk Material
TM062 (S)	Determination of Phenols in Soils by HPLC
TM089	Determination of Gasoline Range Hydrocarbons (GRO) by Headspace GC-FID (C4-C12)
TM090	Determination of Total Organic Carbon/Total Inorganic Carbon in Water and Waste Water
TM104	Determination of Fluoride using the Kone Analyser
TM116	Determination of Volatile Organic Compounds by Headspace / GC-MS
TM132	ELTRA CS800 Operators Guide
TM133	Determination of pH in Soil and Water using the GLpH pH Meter
TM151	Determination of Hexavalent Chromium using Kone analyser
TM152	Analysis of Aqueous Samples by ICP-MS
TM153	Determination of Total Cyanide, Free (Easily Liberatable) Cyanide and Thiocyanate using the Skalar SANS+ System Segmented Flow Analyser
TM168	Determination of WHO12 and EC7 Polychlorinated Biphenyl Congeners by GC-MS in Soils
TM181	Determination of Routine Metals in Soil by iCap 6500 Duo ICP-OES
TM182	Determination of Acid Neutralisation Capacity (ANC) Using Autotitration in Soils
TM183	Determination of Trace Level Mercury in Waters and Leachates by PSA Cold Vapour Atomic Fluorescence Spectrometry
TM184	The Determination of Anions in Aqueous Matrices using the Kone Spectrophotometric Analysers
TM218	The determination of PAH in soil samples by GC-MS
TM221	Determination of Acid Extractable Sulphate in Soils by ICP OES
TM222	Determination of Hot Water Soluble Boron in Soils (10:1 Water:Soil) by ICP OES.
TM243	Mixed Anions In Soils By Kone
TM248	Determination of Ammonium BRE (2:1 Extract) on solids
TM256	Determination of pH, EC, TDS and Alkalinity in Aqueous samples
TM259	Determination of Phenols in Waters and Leachates by HPLC
TM282	Extraction of Magnesium by BRE Method
TM410	Determination of Coronene in soils by GCMS
TM414	Determination of Speciated Extractable Petroleum Hydrocarbons in Soils by GCxGC-FID
TM415	Determination of Extractable Petroleum Hydrocarbons in Soils by GCxGC-FID

NA = not applicable.

Chemical testing (unless subcontracted) performed at ALS Laboratories (UK) Limited Hawarden (Method codes TM).



CERTIFICATE OF ANALYSIS

Validated

SDG: 240207-77
Client Ref.: GWPR5826

Report Number: 720099
Location: 42 Shepherds Hill London N6 5RR

Superseded Report:

Test Completion Dates

Lab Sample No(s)	29326961	29326968	29326970	29326972
Customer Sample Ref.	WS01	WS01	WS01	WS01
AGS Ref.				
Depth	0.30	1.00	6.00	10.00
Type	Soil/Solid (S)	Soil/Solid (S)	Soil/Solid (S)	Soil/Solid (S)
Ammoniacal N as NH4 in 2:1 extract		09-Feb-2024		09-Feb-2024
ANC at pH4 and ANC at pH 6	09-Feb-2024			
Anions by Kone (soil)	12-Feb-2024	12-Feb-2024	12-Feb-2024	12-Feb-2024
Anions by Kone (w)	12-Feb-2024			
Asbestos ID in Solid Samples	08-Feb-2024			
Boron Water Soluble	12-Feb-2024			
CEN 10:1 Leachate (1 Stage)	08-Feb-2024			
CEN Readings	13-Feb-2024			
Coronene	09-Feb-2024			
Cyanide Comp/Free/Total/Thiocyanate	13-Feb-2024			
Dissolved Metals by ICP-MS	12-Feb-2024			
Dissolved Organic/Inorganic Carbon	14-Feb-2024			
EPH by GCxGC-FID	09-Feb-2024			
EPH CWG GC (S)	09-Feb-2024			
Fluoride	12-Feb-2024			
GRO by GC-FID (S)	09-Feb-2024			
Hexavalent Chromium (s)	13-Feb-2024			
Loss on Ignition in soils	09-Feb-2024			
Magnesium (BRE)		12-Feb-2024		12-Feb-2024
Mercury Dissolved	13-Feb-2024			
Metals in solid samples by OES	12-Feb-2024			
Moisture at 105C	08-Feb-2024			
NO3, NO2 and TON by KONE (s)		13-Feb-2024		13-Feb-2024
PAH 16 & 17 Calc	09-Feb-2024			
PAH by GCMS	09-Feb-2024			
PCBs by GCMS	09-Feb-2024			
pH	14-Feb-2024	13-Feb-2024	13-Feb-2024	13-Feb-2024
pH Value of Filtered Water	13-Feb-2024			
Phenols by HPLC (S)	09-Feb-2024			
Phenols by HPLC (W)	13-Feb-2024			
Sample description	07-Feb-2024	07-Feb-2024	07-Feb-2024	07-Feb-2024
Total Organic Carbon	12-Feb-2024			
Total Sulphate		13-Feb-2024		13-Feb-2024
Total Sulphur		13-Feb-2024		12-Feb-2024
TPH CWG GC (S)	09-Feb-2024			
VOC MS (S)	08-Feb-2024			



CERTIFICATE OF ANALYSIS

Validated

SDG: 240207-77
Client Ref.: GWPR5826

Report Number: 720099
Location: 42 Shepherds Hill London N6 5RR

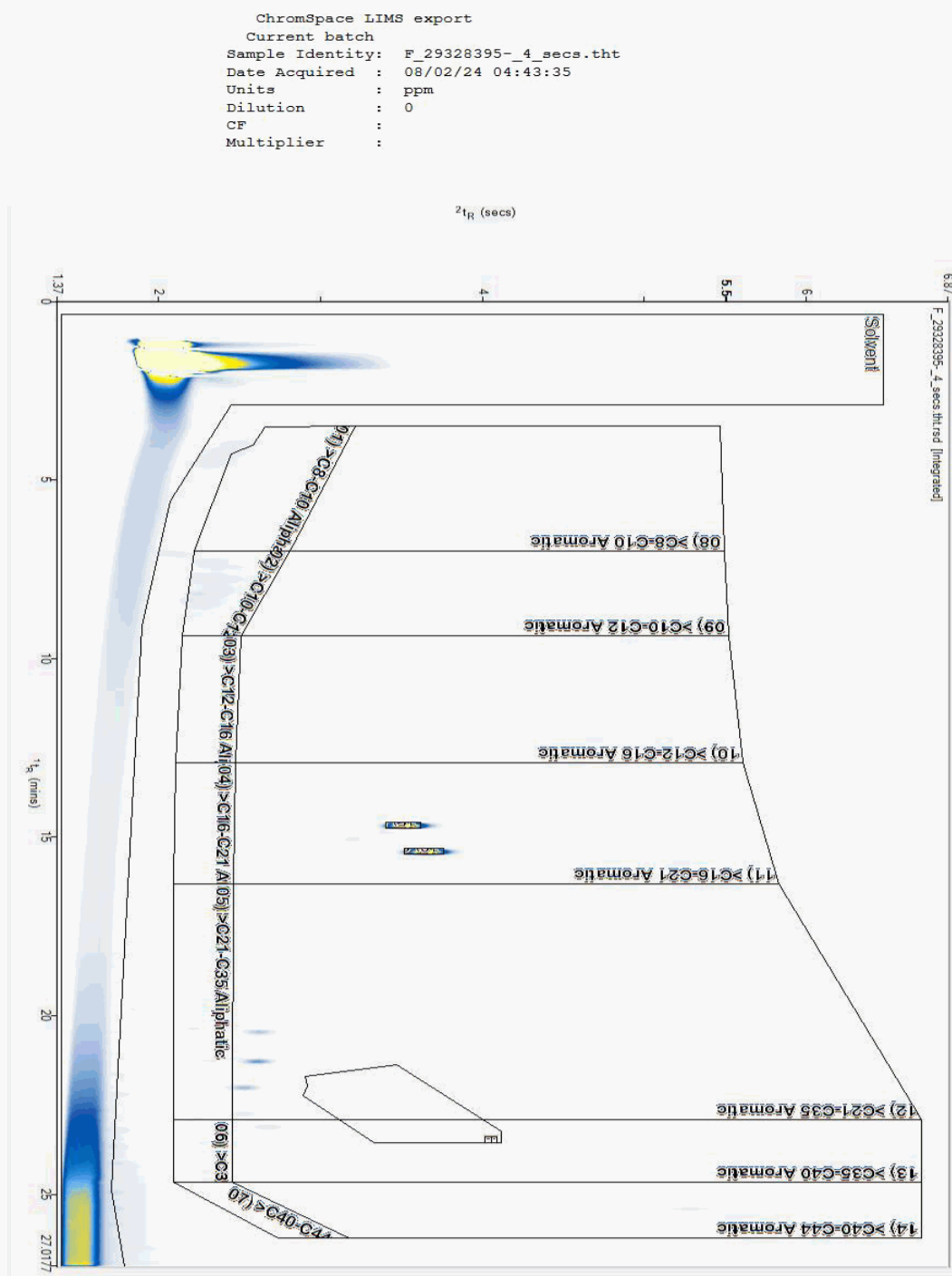
Superseded Report:

Chromatogram

Analysis: EPH CWG GC (S)

Sample No : 29328395
Sample ID : WS01

Depth : 0.30





CERTIFICATE OF ANALYSIS

Validated

SDG: 240207-77
Client Ref.: GWPR5826

Report Number: 720099
Location: 42 Shepherds Hill London N6 5RR

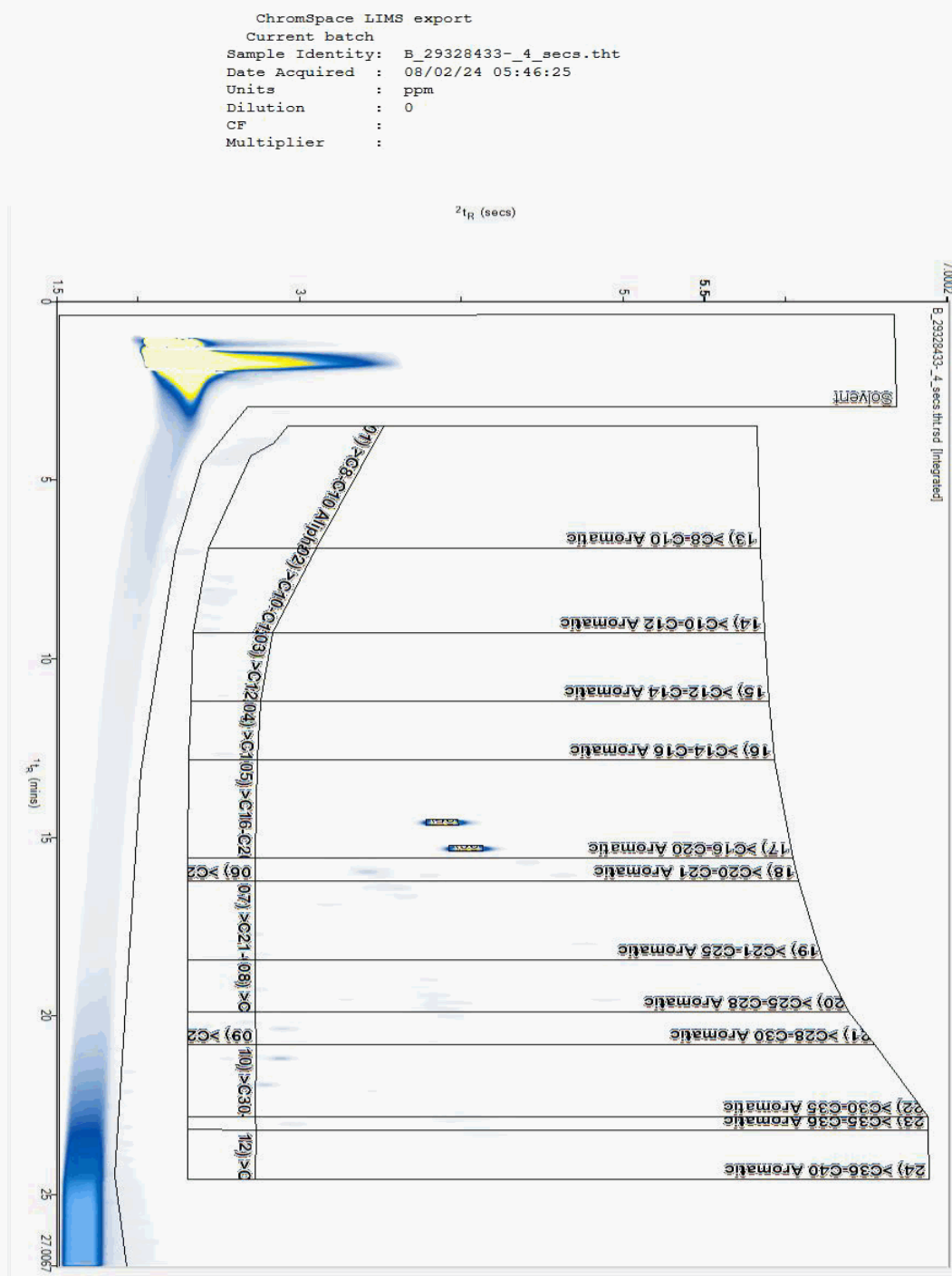
Superseded Report:

Chromatogram

Analysis: EPH by GCxGC-FID

Sample No : 29328433
Sample ID : WS01

Depth : 0.30





CERTIFICATE OF ANALYSIS

Validated

SDG: 240207-77
Client Ref.: GWPR5826

Report Number: 720099
Location: 42 Shepherds Hill London N6 5RR

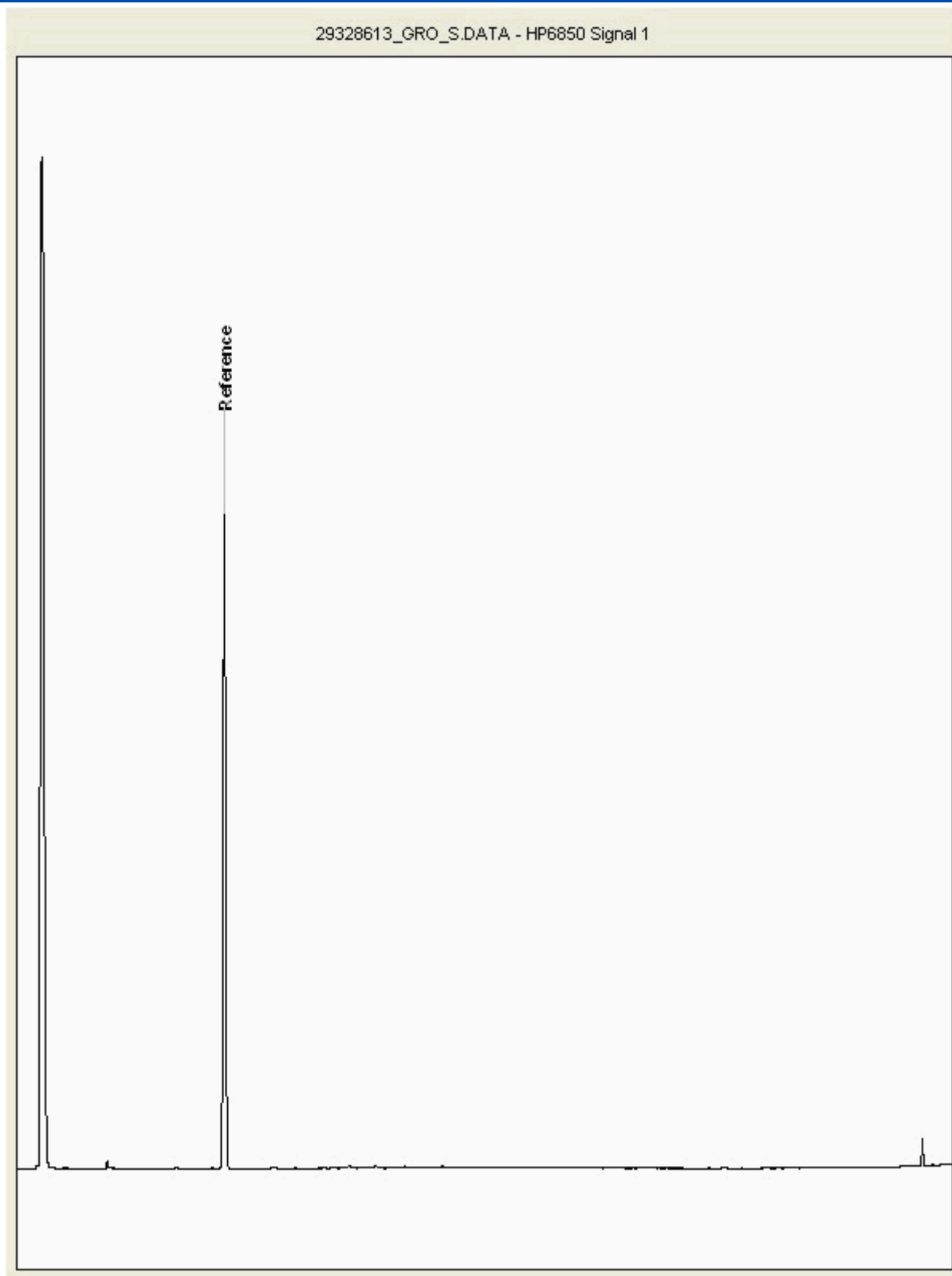
Superseded Report:

Chromatogram

Analysis: GRO by GC-FID (S)

Sample No : 29328613
Sample ID : WS01

Depth : 0.30





CERTIFICATE OF ANALYSIS

SDG: 240207-77
Client Ref: GWPR5826

Report Number: 720099

Location: 42 Shepherds Hill London N6 5RR

Superseded Report:

Appendix

1. Results are expressed on a dry weight basis (dried at 35°C) for all soil analyses except for the following: NRA and CEN Leach tests, flash point LOI, pH, ammonium as NH₄ by the BRE method, VOC TICs and SVOC TICs.

2. If sufficient sample is received a sub sample will be retained free of charge for 15 days after analysis is completed (e-mailed) for all sample types unless the sample is destroyed on testing. The prepared soil sub sample that is analysed for asbestos will be retained for a period of 6 months after the analysis date. All bulk samples will be retained for a period of 6 months after the analysis date. All samples received and not scheduled will be disposed of 15 days after the date of receipt unless we are instructed to the contrary. Once the initial period has expired, a storage charge will be applied for each month or part thereof until the client cancels the request for sample storage. ALS reserve the right to charge for samples received and stored but not analysed.

3. With respect to turnaround, we will always endeavour to meet client requirements wherever possible, but turnaround times cannot be absolutely guaranteed due to so many variables beyond our control.

4. We take responsibility for any test performed by sub-contractors (marked with an asterisk). We endeavour to use UKAS/MCERTS Accredited Laboratories, who either complete a quality questionnaire or are audited by ourselves. For some determinands there are no UKAS/MCERTS Accredited Laboratories, in this instance a laboratory with a known track record will be utilised.

5. If no separate volatile sample is supplied by the client, or if a headspace or sediment is present in the volatile sample, the integrity of the data may be compromised. This will be flagged up as an invalid VOC on the test schedule and the result marked as deviating on the test certificate.

6. NDP - No determination possible due to insufficient/unsuitable sample.

7. Results relate only to the items tested.

8. LoDs (Limit of Detection) for wet tests reported on a dry weight basis are not corrected for moisture content.

9. **Surrogate recoveries** - Surrogates are added to your sample to monitor recovery of the test requested. A % recovery is reported, results are not corrected for the recovery measured. Typical recoveries for organics tests are 70-130%. Recoveries in soils are affected by organic rich or clay rich matrices. Waters can be affected by remediation fluids or high amounts of sediment. Test results are only ever reported if all of the associated quality checks pass; it is assumed that all recoveries outside of the values above are due to matrix affect.

10. Stones/debris are not routinely removed. We always endeavour to take a representative sub sample from the received sample.

11. In certain circumstances the method detection limit may be elevated due to the sample being outside the calibration range. Other factors that may contribute to this include possible interferences. In both cases the sample would be diluted which would cause the method detection limit to be raised.

12. For dried and crushed preparations of soils volatile loss may occur e.g volatile mercury

13. For leachate preparations other than Zero Headspace Extraction (ZHE) volatile loss may occur.

14. For the BSEN 12457-3 two batch process to allow the cumulative release to be calculated, the volume of the leachate produced is measured and filtered for all tests. We therefore cannot carry out any unfiltered analysis. The tests affected include volatiles GCFID/GCMS and all subcontracted analysis.

15. Analysis and identification of specific compounds using GCFID is by retention time only, and we routinely calibrate and quantify for benzene, toluene, ethylbenzenes and xylenes (BTEX). For total volatiles in the C5-C12 range, the total area of the chromatogram is integrated and expressed as ug/kg or ug/l. Although this analysis is commonly used for the quantification of gasoline range organics (GRO), the system will also detect other compounds such as chlorinated solvents, and this may lead to a falsely high result with respect to hydrocarbons only. It is not possible to specifically identify these non-hydrocarbons, as standards are not routinely run for any other compounds, and for more definitive identification, volatiles by GCMS should be utilised.

16. We are accredited to MCERTS for sand, clay and loam/topsoil, or any of these materials - whether these are derived from naturally occurring soil profiles, or from fill/made ground, as long as these materials constitute the major part of the sample. Other coarse granular material such as concrete, gravel and brick are not accredited if they comprise the major part of the sample.

17 Data retention. All records, communications and reports pertaining to the analysis are archived for seven years from the date of issue of the final report.

General

18. **Tentatively Identified Compounds (TICs)** are non-target peaks in VOC and SVOC analysis. All non-target peaks detected with a concentration above the LoD are subjected to a mass spectral library search. Non-target peaks with a library search confidence of >75% are reported based on the best mass spectral library match. When a non-target peak with a library search confidence of <75% is detected it is reported as "mixed hydrocarbons". Non-target compounds identified from the scan data are semi-quantified relative to one of the deuterated internal standards, under the same chromatographic conditions as the target compounds. This result is reported as a semi-quantitative value and reported as Tentatively Identified Compounds (TICs). TICs are outside the scope of UKAS accreditation and are not moisture corrected.

19. Sample Deviations

If a sample is classed as deviated then the associated results may be compromised.

1	Container with Headspace provided for volatiles analysis
2	Incorrect container received
3	Deviation from method
4	Matrix interference
♦	Sample holding time exceeded in laboratory
@	Sample holding time exceeded due to late arrival of instructions or samples
§	Sampled on date not provided

20. Asbestos

When requested, the individual sub sample scheduled will be analysed in house for the presence of asbestos fibres and asbestos containing material by our documented in house method TM048 based on HSG 248 (2021), which is accredited to ISO17025. If a specific asbestos fibre type is not found this will be reported as "Not detected". If no asbestos fibre types are found all will be reported as "Not detected" and the sub sample analysed deemed to be clear of asbestos. If an asbestos fibre type is found it will be reported as detected (for each fibre type found). Testing can be carried out on asbestos positive samples, but, due to Health and Safety considerations, may be replaced by alternative tests or reported as No Determination Possible (NDP). The quantity of asbestos present is not determined unless specifically requested.

Identification of Asbestos in Bulk Materials & Soils

The results for identification of asbestos in bulk materials and soils are obtained from supplied bulk materials and soils which have been examined to determine the presence of asbestos fibres using ALS (Hawarden) in-house method of transmitted/polarised light microscopy and central stop dispersion staining, based on HSG 248 (2021).

The results for identification of asbestos in soils are obtained from a homogenised sub sample which has been examined to determine the presence of asbestos fibres using ALS (Hawarden) in-house method of transmitted/polarised light microscopy and central stop dispersion staining.

Asbestos Type	Common Name
Chrysotile	White Asbestos
Amosite	Brown Asbestos
Crocidolite	Blue Asbestos
Fibrous Actinolite	-
Fibrous Anthophyllite	-
Fibrous Tremolite	-

Visual Estimation Of Fibre Content

Estimation of fibre content is not permitted as part of our UKAS accredited test other than: - Trace - Where only one or two asbestos fibres were identified.

Respirable Fibres

Respirable fibres are defined as fibres of <3 µm diameter, longer than 5 µm and with aspect ratios of at least 3:1 that can be inhaled into the lower regions of the lung and are generally acknowledged to be most important predictor of hazard and risk for cancers of the lung.

Further guidance on typical asbestos fibre content of manufactured products can be found in HSG 264.

The identification of asbestos containing materials and soils falls within our schedule of tests for which we hold UKAS accreditation, however opinions, interpretations and all other information contained in the report are outside the scope of UKAS accreditation.

APPENDIX F: Soil Assessment Criteria

Ground and Water Limited

Soil Guideline Values and Generic Assessment Criteria

The Contaminated Land Regime reflects the UK Government's stated objectives of achieving sustainable development through the 'suitable for use approach'. At preliminary risk assessment stage, risks are evaluated qualitatively. As the site investigation progresses to a generic or detailed quantitative risk assessment, data is collected and assessment criteria are utilised to evaluate whether the contaminants represent an unacceptable risk to the identified receptors.

1. Contaminated Land Exposure Assessment Model (CLEA)

Current United Kingdom risk assessment practice is based on the Contaminated Land Exposure Assessment Model (CLEA).

The CLEA Guidance comprises the following documents:

- 1) EA Science Report SC050021/SR2: Human health toxicological assessment of contaminants in soil.
- 2) EA Science Report SC050021/SR3: Updated technical background to the CLEA model.
- 3) EA CLEA Bulletin (2009).
- 4) CLEA software version 1.07 (2015)
- 5) Toxicological reports and SGV technical notes.

The CLEA guidance and tools:

- Do not cover other types of risk to humans, such as fire, suffocation or explosion, or short-term and acute exposures;
- Do not cover risks to the environment, such as groundwater, ecosystems or buildings;
- Do not provide a definitive test for telling when human health risks are significant; and
- Are not a legal requirement in assessing land contamination risks. They are not part of the legal regime for Part 2A of the Environmental Protection Act 1990.

The CLEA guidance derives soil concentrations of contaminants above which (in the opinion of the EA) there may be a concern that warrants further investigation. It does not provide a definitive test for establishing that the risk is significant.

1.1. Land-use Scenarios

The CLEA model uses a range of standard land-use scenarios to develop conceptual exposure models outlined in the following sections.

1.1.1. Residential (with home grown produce) (RwHP)

Generic scenario assumes a typical two-storey house built on a ground bearing slab with a private garden having a lawn, flowerbeds and a small fruit and vegetable patch.

- Critical receptor is a young female child (zero to six years old)
- Exposure duration is six years.
- Exposure pathways include direct soil and indoor dust ingestion, consumption of homegrown produce and any adhering soil, skin contact with soils and indoor dust and inhalation of indoor and outdoor dust and vapours.
- Building type is a two-storey small-terraced house.

A sub-set of this land-use is residential apartments with communal landscaped gardens where the consumption of home grown vegetables will not occur. (Residential without homegrown produce (RwoHP)).

1.1.2. Allotments

Provision of open space (about 250sq.m) commonly made available to tenants by the local authority to grow fruit and vegetable for their own consumption. Typically, there are a number of plots to a site which may have a total area of up to 1 hectare. The tenants are assumed to be adults and that young children make occasional accompanied visits.

Although some allotment holders may choose to keep animals including rabbits, hens, and ducks, potential exposure to contaminated meat and eggs is not considered.

- Critical receptor is a young female child (zero to six years old)
- Exposure duration is six years.
- Exposure pathways include direct soil ingestion, consumption of homegrown produce and any adhering soil, skin contact with soils and inhalation of outdoor dust and vapours.
- There is no building.

1.1.3. Commercial/Industrial

The generic scenario assumes a typical commercial or light industrial property comprising a three-storey building at which employees spend most time indoors and are involved in office-based or relatively light physical work.

- Critical receptor is a working female adult (aged 16 to 65 years old).
- Exposure duration is a working lifetime of 49 years.
- Exposure pathways include direct soil and indoor dust ingestion, skin contact with soils and dusts and inhalation of dust and vapours.
- Building type is a three-storey office (pre 1970).

2. LQM/CIEH Suitable 4 Use Levels (S4UL)

For derivation of these S4UL reference must be made to:

Nathanial, P., McCaffrey, C., Gillet, A., Ogden, R., Nathanial, J., *The LQM/CIEH S4UL's for Human Health Risk Assessment*. Land Quality Press. 2015

2.1. S4UL Background

The Land Quality Management/Chartered Institute of Environmental Health (LQM/CIEH) S4UL for a given land use is the concentration of the contaminant in soil at which the predicted daily exposure,

as calculated by the CLEA software, equals the Health Criteria Value. The S4ULs have been derived for substances based on various generic land use and soil organic matter contents.

The final output for each contaminant represents a synthesis of new toxicological (and fate and transport) reviews published since the preparation of the 2nd edition LQM/CIEH GAC's (Nathanial et al., 2009).

In the derivation of LQM/CIEH S4UL's the principles of 'minimal' or 'tolerable' risk enshrined in SR2, which has not been withdrawn, has been maintained.

2.2. S4UL Land-use

S4UL's have been derived for the basic CLEA land-uses, as described in section 1.2, and for two new land uses:

- Public Open Spaces near Residential Housing (POSresi).
- Public Park (POSpark).

2.2.1. Public Open Spaces near Residential Housing (POSresi)

Includes the predominantly grassed areas adjacent to high density housing, the central green area on many 1930's – 1970's housing estates, and smaller areas commonly incorporated in newer developments as informal grassed areas or more formal landscaped areas with a mixture of open space and covered soils with planting. It is assumed that the close proximity to the place of residence will allow tracking back of soil to occur.

2.2.2. Public Park (POSpark)

An area of open space, usually owned and maintained by the local authority, provided for recreational uses including family visits and picnics, children's play area, informal sporting activities (not a dedicated sports pitch), and dog walking. It is assumed that tracking back of soils into places of residence will be negligible.

The following LQM/CIEH S4ULs (Copyright Land Quality Management Limited) have been reproduced with permission, to the publication number S4UL3072.

3. Category 4 Screening Levels (C4SLs)

In the case of Lead, no SGV or GAC has been published to date. This is likely to be due to the toxicity review that is currently being undertaken by the Environment Agency. In the absence of updated toxicity information the SGV derived using CLEA 1.07 methodology and related toxicity will be used.

The overall objective of the C4SLs research project was to assist the provision of technical guidance in support of Defra's revised Statutory Guidance (SG) for Part 2A of the Environmental Protection Act 1990 (Part 2A) (Defra, 2012a). Specifically, the project aimed to deliver:

- A methodology for deriving C4SLs for four generic land-uses comprising residential, commercial, allotments and public open space; and
- A demonstration of the methodology, via the derivation of C4SLs for six substances – arsenic, benzene, benzo(a)pyrene, cadmium, chromium (VI) and lead.

To help achieve a more targeted approach to identifying and managing contaminated land in relation to the risk (or possibility) of harm to human health, the revised SG presented a new four category

system for considering land under Part 2A, ranging from Category 4, where there is no risk that land poses a significant possibility of significant harm (SPOSH), or the level of risk is low, to Category 1, where the risk that land poses a significant possibility of significant harm (SPOSH) is unacceptably high. More specific guidance on what type of land should be considered as Category 4 (Human Health) is provided in Paragraphs 4.21 and 4.22 of the revised SG, as follows:

“4.21 The local authority should consider that the following types of land should be placed into Category 4: Human Health:

(a) Land where no relevant contaminant linkage has been established.

(b) Land where there are only normal levels of contaminants in soil, as explained in Section 3 of this Guidance.

(c) Land that has been excluded from the need for further inspection and assessment because contaminant levels do not exceed relevant generic assessment criteria in accordance with Section 3 of this Guidance, or relevant technical tools or advice that may be developed in accordance with paragraph 3.30 of this Guidance.

(d) Land where estimated levels of exposure to contaminants in soil are likely to form only a small proportion of what a receptor might be exposed to anyway through other sources of environmental exposure (e.g. in relation to average estimated national levels of exposure to substances commonly found in the environment, to which receptors are likely to be exposed in the normal course of their lives).

4.22 The local authority may consider that land other than the types described in paragraph 4.21 should be placed into Category 4: Human Health if following a detailed quantitative risk assessment it is satisfied that the level of risk posed is sufficiently low.”

The C4SLs are intended as “relevant technical tools” (in relation to Paragraph 4.21(c)) to help local authorities and others when deciding to stop further assessment of a site, on the grounds that it falls within Category 4 (Human Health).

The Impact Assessment (IA), which accompanied the revised SG (Defra, 2012b) provides further information on the nature and potential role of the C4SLs. Paragraph 47(h) of the IA states that:

“The new statutory guidance will bring about a situation where the current SGVs/GACs are replaced with more pragmatic (but still strongly precautionary) Category 4 screening levels (C4SLs) which will provide a higher simple test for deciding that land is suitable for use and definitely not contaminated land.”

A key distinction between the Soil Guideline Values (SGVs) and the C4SLs is the level of risk that they describe. As described by the Environment Agency (2009a):

“SGVs are guidelines on the level of long-term human exposure to individual chemicals in soil that, unless stated otherwise, are tolerable or pose a minimal risk to human health.”

The implication of Paragraph 47(h) of the IA is that minimal risk is well within Category 4 and that the C4SLs should describe a higher level of risk which, whilst not minimal, can still be considered low enough to allow a judgement to be made that land containing substances at, or below, the C4SLs would typically fall within Category 4. This reflects Paragraph 4.20 of the revised SG, which states:

“4.20 The local authority should not assume that land poses a significant possibility of significant harm if it considers that there is no risk or that the level of risk posed is low. For the purposes of this Guidance, such land is referred to as a “Category 4: Human Health” case. The authority may decide that the land is a Category 4: Human Health case as soon as it considers it has evidence to this effect, and this may happen at any stage during risk assessment including the early stages.”

C4SLs, therefore, should not be viewed as “SPOSH levels” and they should not be used as a legal trigger for the determination of land under Part 2A.

The generic screening values referred to before usually take the form of risk-based Soil Guideline Values (SGVs) or other Generic Assessment Criteria (GACs) that are most typically derived using the Environment Agency’s Contaminated Land Exposure Assessment (CLEA) model, as described in the Environment Agency’s SR2, SR3 and SR7 reports (EA, 2009b & c; EA, 2008). It is anticipated that C4SLs will be used in a similar manner; as generic screening criteria that can be used within a GQRA, albeit describing a higher level of risk than the SGVs.

The suggested approach to the development of C4SLs consists of the retention and use of the CLEA framework, modified according to considerations of the underlying science within the context of Defra’s policy objectives relating to the revised SG. Within this context, it is suggested that the development of C4SLs may be achieved in one of three ways, namely:

- By modifying the toxicological parameters used within CLEA (while maintaining current exposure parameters);
- By modifying the exposure parameters embedded within CLEA (while maintaining current toxicological “minimal risk” interpretations); and
- By modifying both toxicological and exposure parameters.

There is also a suggested check on “other considerations” (e.g., background levels, epidemiological data, sources of uncertainty) within the approach, applicable to all three options.

It is suggested that a new term is defined for the toxicological guidance values associated with the derivation of C4SLs – a Low Level of Toxicological Concern (LLTC). A LLTC should represent an intake of low concern that remains suitably protective of health, and definitely does not approach an intake level that could be defined as SPOSH.

4. CL:AIRE Generic Assessment Criteria (GAC)

For derivation of the CL:AIRE Generic Assessment Criteria (GAC) reference should be made to the following report:

CL:AIRE, *The Soil Generic Assessment Criteria for Human Health Risk Assessment. Contaminated Land: Applications in the Real Environment*. 2009.

Within this report, Contaminated Land: Applications in Real Environments (CL:AIRE) provided Generic Assessment Criteria (GAC) in accordance with the CLEA software and the principles outlined previously for a further 35 contaminants sometimes encountered on land affected by contamination.

5. SoBRA Acute GAC

The Society of Brownfield Risk Assessment (SoBRA) identified that most human health risk assessments focus on the chronic risks arising from long-term exposure to specific substances. As chronic risks often occur at lower doses than acute risks, they are often the key drivers, however, in some instances the acute dose may also be an important consideration within risk assessments.

The methodology for deriving the acute GAC were related to two distinct receptor groups:

- Members of the public, where the 'critical' receptor for this group will typically be a female child, which is consistent with CLEA residential and Public Open Space/allotments land-uses;
- Workers involved with excavations. The critical receptor for this group is assumed to be a female working adult, without the use of PPE.

The acute GACs relate to short term exposure of high concentrations of a substance that lead to acute effects. They are not considered to be average exposures across a specific / defined area. As a result, the GACs should be normally be compared with the maximum likely concentration that the individual may be exposed to, and not the average concentration within a specific area.

The SoBRA acute GAC will primarily be used for contaminants that do not currently have any GAC, most notably Cyanide.

6. Detailed Quantitative Risk Assessments (DQRA)

Where the adoption of a GAC is not appropriate, for instance when the intended land-use is at variance the CLEA standard land-uses, then a DQRA may be undertaken to develop site specific values for relevant soil contaminants.

- | |
|---|
| <ul style="list-style-type: none">▪ Establishing the plausibility that generic exposure pathways exist in practice by measurement and observation.▪ Developing more accurate parameters using site data. |
|---|

7. Phytotoxicity

CLEA guidance only addresses human health toxicity; assessment of plant toxicity (phytotoxicity) is based on threshold trigger values obtained from the following source:

- BS3882:2015 – *Specification for Topsoil*

The trigger values are relevant only to those contaminants, where present in excess, have the potential to inhibit plant growth, or kill plants (Cu, Ni and Zn). The criteria have been based on a wide range of planting that are common within a multi-purpose topsoil.

8. Statistical Tests

DEFRA R&D Publication CLR 7 (DOE 1994) addressed the statistical treatment of test results and their comparison to Soil Guideline Values.

Consideration must be given to the appropriate area of land to be considered termed the critical averaging area.

For a communal open space or commercial land-use, the critical averaging area will depend on the proposed layout. For a residential use with private gardens the averaging area is the individual plot.

It may be appropriate to compare the upper 95th percentile concentration with the Soil Guideline Value, subject to applying a statistical test to establish that the range of concentrations are reasonably consistent and belonging to the same underlying distribution of data.

CL:AIRE published guidance in 2020, *Guidance in comparing soil contamination data with a critical concentration*, superseding the CL:AIRE/CIEH 2008 report of the same name. The guidance provides ways to assist land contamination stakeholders to apply statistical methods to their data to enable decisions under the legislative framework; either planning system or Part 2A of the Environmental Protection Act 1990.

The use of the statistical tests should only be applied if the following statements are valid for the datasets:

- Averaging areas, as well as the smallest area of concern have been identified on the basis of the CSM, including the desk study and/or the site walkover;
- The sample locations were chosen using a simple random, stratified random or stratified systematic (square, herringbone or triangular grid) sampling pattern, rather than being targeted to locations suspected of being contaminated;
- The sample locations are relatively evenly spread across the area and are not clustered, to avoid giving undue weight to some parts of the site over others in the calculated statistics;
- The analyses do not suggest a hotspot or outlier of contamination that should be treated as a separate zone. This has been established by a histogram and/or a names statistical test;
- The sample locations are all taken from one population (i.e. the same material);
- Where an averaging zone encompasses several averaging areas, analyses do not show a spatial trend or other spatial pattern across that zone; and
- The number of samples has been shown to be sufficient for a statistical analysis.

Any included statistical spreadsheet is based on an in-house method of statistical analysis, in line with those outlined within the CL:AIRE guidance (2020).

Treatment of Hot-Spots

- A statistical test is applied to establish whether the data is a part of a single set, or whether data outliers are present.
- Provided that the data is based on random sampling and no distinct contamination source was present at the sampling location, the hot-spot(s) may be excluded and the mean of the remaining data assessed.

9. Ground and Water Limited Soil Assessment Criteria

The Soil Assessment Criteria used in the preparation of the Generic Quantitative Risk Assessment are tabulated in the following pages, where the source of each has been outlined in the previous sections.

9.1. Inorganics

SoBRA – Acute Generic Assessment Criteria						
Determinand	RwHP (mg/kg)	RwoHP (mg/kg)	Allotment (mg/kg)	Commercial (mg/kg)	POSresi (mg/kg)	POSpark (mg/kg)
Cyanide	24	24	24	1400	24	24

9.2. Metals

C4SL Low Level of Toxicological Concern						
Determinand	RwHP (mg/kg)	RwoHP (mg/kg)	Allotment (mg/kg)	Commercial (mg/kg)	POSresi (mg/kg)	POSpark (mg/kg)
Lead	< 200	< 310	< 80	< 2300	< 630	< 1300

LQM/CIEH Suitable 4 Use Levels – Metals and Semi-metals						
Determinand	RwHP (mg/kg)	RwoHP (mg/kg)	Allotment (mg/kg)	Commercial (mg/kg)	POSresi (mg/kg)	POSpark (mg/kg)
Arsenic	37	40	43	640	79	170
Beryllium	1.7	1.7	35	12	2.2	63
Boron	290	11000	45	240000	21000	46000
Cadmium	11	85	1.9	190	120	532
Chromium (III)	910	910	18000	8600	1500	33000
Chromium (VI)	6	6	1.8	33	7.7	220
Copper	2400	7100	520	68000	12000	44000
Elemental Mercury	1.2	1.2	21	58	16	30
Inorganic Mercury	40	56	19	1100	120	240
Methylmercury	11	15	6	320	40	68
Nickel	130	180	53	980	230	800
Selenium	250	430	88	12000	1100	1800
Vanadium	410	1200	91	9000	2000	5000
Zinc	3700	40000	620	730000	81000	170000

Phytotoxicity (Harmful to Plants) Threshold Trigger Values			
Determinand	Soil pH < 6.0 (mg/kg)	Soil pH 6.0 – 7.0 (mg/kg)	Soil pH > 7.0 (mg/kg)
Copper	100	135	200
Nickel	60	75	110
Zinc	200	200	300
Notes: BS3882:2015 – <i>Specification for Topsoil</i> . Based on a wide range of common plants that will be exposed to multi-purpose topsoil. Toxicity of contaminant may also be impacted by pH of soils. Site observation of plant vitality may give additional guidance.			

CL:AIRE Soil Generic Assessment Criteria				
Determinand	Residential (mg/kg)	Residential without plant uptake (mg/kg)	Allotment (mg/kg)	Commercial (mg/kg)
Antimony	ND	550	ND	7500
Barium	ND	1300	ND	22000
Molybdenum	ND	670	ND	17000
ND – Not derived				

9.3. Total Petroleum Hydrocarbons (TPHs)

9.3.1. BTEX Compounds

LQM/CIEH Suitable 4 Use Levels – BTEX Compounds							
Determinand	Soil Organic Matter	RwHP (mg/kg)	RwoHP (mg/kg)	Allotment (mg/kg)	Commercial (mg/kg)	POSresi (mg/kg)	POSpark (mg/kg)
Benzene	1.0% SOM	0.087	0.38	0.017	27	72	90
	2.5% SOM	0.170	0.70	0.034	47	72	100
	6.0% SOM	0.370	1.40	0.075	90	73	110
Toluene	1.0% SOM	130	880	22	56000	56000	87000
	2.5% SOM	290	1900	51	110000	56000	95000
	6.0% SOM	660	3900	120	180000	56000	100000
Ethylbenzene	1.0% SOM	47	83	16	5700	24000	17000
	2.5% SOM	110	190	39	13000	24000	22000
	6.0% SOM	260	440	91	27000	25000	27000
o-Xylene	1.0% SOM	60	88	28	6600	41000	17000
	2.5% SOM	140	210	67	15000	42000	24000
	6.0% SOM	330	480	160	33000	43000	33000
m-Xylene	1.0% SOM	59	82	31	6200	41000	17000
	2.5% SOM	140	190	74	14000	42000	24000
	6.0% SOM	320	450	170	31000	43000	33000
p-Xylene	1.0% SOM	56	79	29	5900	41000	17000
	2.5% SOM	130	180	69	14000	42000	23000
	6.0% SOM	310	430	160	30000	43000	31000

SOM = Soil Organic Matter Content (%)

9.3.2. Total Petroleum Hydrocarbons – Aliphatic

LQM/CIEH Suitable 4 Use Levels For TPH							
Aliphatic		RwHP (mg/kg)	RwoHP (mg/kg)	Allotment (mg/kg)	Commercial (mg/kg)	POSresi (mg/kg)	POSpark (mg/kg)
EC 5-6	1.0% SOM	42	42	730	3,200 (304) sol	570,000 (304) sol	95,000 (304) sol
	2.5% SOM	78	78	1,700	5,900 (558) sol	590,000	130,000 (558) sol
	6.0% SOM	160	160	3,900	12,000 (1150) sol	600,000 (1150) sol	180,000 (1150) sol
EC >6-8	1.0% SOM	100	100	2,300	7,800 (144) sol	600,000	150,000 (144) sol
	2.5% SOM	230	230	5,600	17,000 (322) sol	610,000	220,000 (322) sol
	6.0% SOM	530	530	13,000	40,000 (736) sol	620,000	320,000 (736) sol
EC >8-10	1.0% SOM	27	27	320	2,000 (78) sol	13,000	14,000 (78) sol
	2.5% SOM	65	65	770	4,800 (118) vap	13,000	18,000 (118) vap
	6.0% SOM	150	150	1,700	11,000 (451) vap	13,000	21,000 (451) vap
EC >10-12	1.0% SOM	130 (48) vap	130 (48) vap	2,200	9,700 (48) sol	13,000	21,000 (48) sol
	2.5% SOM	330 (118) vap	330 (118) vap	4,400	23,000 (118) vap	13,000	23,000 (118) vap
	6.0% SOM	760 (283) vap	760 (283) vap	7,300	47,000 (283) vap	13,000	24,000 (283) vap
EC >12-16	1.0% SOM	1,100 (24) sol	1,100 (24) sol	11,000	59,000 (24) sol	13,000	25,000 (24) sol
	2.5% SOM	2,400 (59) sol	2,400 (59) sol	13,000	82,000 (59) sol	13,000	25,000 (59) sol
	6.0% SOM	4,300 (142) sol	4,400 (142) sol	13,000	90,000 (142) sol	13,000	26,000 (142) sol
EC >16-35	1.0% SOM	65,000 (8.48) sol	65,000 (8.48) sol	260,000	1,600,000	250,000	450,000
	2.5% SOM	92,000 (21) sol	92,000 (21) sol	270,000	1,700,000	250,000	480,000
	6.0% SOM	110,000	110,000	270,000	1,800,000	250,000	490,000
EC >35-44	1.0% SOM	65,000 (8.48) sol	65,000 (8.48) sol	260,000	1,600,000	250,000	450,000
	2.5% SOM	92,000 (21) sol	92,000 (21) sol	270,000	1,700,000	250,000	480,000
	6.0% SOM	110,000	110,000	270,000	1,800,000	250,000	490,000

SOM = Soil Organic Matter Content (%)

vap – GAC presented exceeds the vapour saturation limit, which is presented in brackets.

sol – GAC presented exceeds the soil saturation limit, which is presented in brackets.

9.3.3. Total Petroleum Hydrocarbons – Aromatic

LQM/CIEH Suitable 4 Use Levels For TPH							
Aromatic		RwHP (mg/kg)	RwoHP (mg/kg)	Allotment (mg/kg)	Commercial (mg/kg)	POSresi (mg/kg)	POSpark (mg/kg)
EC 5-7 (Benzene)	1.0% SOM	70	370	13	26,000 (1220) ^{sol}	56,000	76,000 (1220) ^{sol}
	2.5% SOM	140	690	27	46,000 (2260) ^{sol}	56,000	84,000 (2260) ^{sol}
	6.0% SOM	300	1,400	57	86,000 (4710) ^{sol}	56,000	92,000 (4710) ^{sol}
EC >7-8 (Toluene)	1.0% SOM	130	860	22	56,000 (869) ^{vap}	56,000	87,000 (869) ^{sol}
	2.5% SOM	290	1,800	51	110,000 (1920) ^{sol}	56,000	95,000 (1920) ^{sol}
	6.0% SOM	660	3,900	120	180,000 (4360) ^{vap}	56,000	100,000 (4360) ^{vap}
EC >8-10	1.0% SOM	34	47	8.6	3,500 (613) ^{vap}	5,000	7,200 (613) ^{vap}
	2.5% SOM	83	110	21	8,100 (1500) ^{vap}	5,000	8,500 (1500) ^{vap}
	6.0% SOM	190	270	51	17,000 (3850) ^{vap}	5,000	9,300 (3580) ^{vap}
EC >10-12	1.0% SOM	74	250	13	16,000 (364) ^{sol}	5,000	9,200 (364) ^{sol}
	2.5% SOM	180	590	31	28,000 (899) ^{sol}	5,000	9,700 (889) ^{sol}
	6.0% SOM	380	1,200	74	34,000 (2150) ^{sol}	5,000	10,000
EC >12-16	1.0% SOM	140	1,800	23	36,000 (169) ^{sol}	5,100	10,000
	2.5% SOM	330	2,300 (419) ^{sol}	57	37,000	5,100	10,000
	6.0% SOM	660	2,500	130	38,000	5,000	10,000
EC >16-21	1.0% SOM	260	1,900	46	28,000	3,800	7,600
	2.5% SOM	540	1,900	110	28,000	3,800	7,700
	6.0% SOM	930	1,900	260	28,000	3,800	7,800
EC >21-35	1.0% SOM	1,100	1,900	370	28,000	3,800	7,800
	2.5% SOM	1,500	1,900	820	28,000	3,800	7,800
	6.0% SOM	1,700	1,900	1,600	28,000	3,800	7,900
EC >35-44	1.0% SOM	1,100	1,900	370	28,000	3,800	7,800
	2.5% SOM	1,500	1,900	820	28,000	3,800	7,800
	6.0% SOM	1,700	1,900	1,600	28,000	3,800	7,900
EC >44-70	1.0% SOM	1,600	1,900	1,200	28,000	3,800	7,800
	2.5% SOM	1,800	1,900	2,100	28,000	3,800	7,800
	6.0% SOM	1,900	1,900	3,000	28,000	3,800	7,900
SOM = Soil Organic Matter Content (%)							
^{vap} – GAC presented exceeds the vapour saturation limit, which is presented in brackets.							
^{sol} – GAC presented exceeds the soil saturation limit, which is presented in brackets.							

9.4. Polycyclic Aromatic Hydrocarbons (PAHs)

LQM/CIEH Suitable 4 Use Levels For Polycyclic Aromatic Hydrocarbons (PAHs)							
Determinands		RwHP (mg/kg)	RwoHP (mg/kg)	Allotment (mg/kg)	Commercial (mg/kg)	POSresi (mg/kg)	POSpark (mg/kg)
Acenaphthene	1.0% SOM	210	3,000 (57.0) ^{sol}	34	84,000(57.0) ^{sol}	15,000	29,000
	2.5% SOM	510	4,700(141) ^{sol}	85	97,000(141) ^{sol}	15,000	30,000
	6.0% SOM	1100	6,000(336) ^{sol}	200	100,000	15,000	30,000
Acenaphthylene	1.0% SOM	170	2,900(86.1) ^{sol}	28	83,000(86.1) ^{sol}	15,000	29,000
	2.5% SOM	420	4,600(212) ^{sol}	69	97,000(212) ^{sol}	15,000	30,000
	6.0% SOM	920	6,000(506) ^{sol}	160	100,000	15,000	30,000
Anthracene	1.0% SOM	2,400	31,000(1.17) ^{vap}	380	520,000	74,000	150,000
	2.5% SOM	5,400	35,000	950	540,000	74,000	150,000
	6.0% SOM	11,000	37,000	2,200	540,000	74,000	150,000
Benzo(a)anthracene	1.0% SOM	7.20	11	2.90	170	29	49
	2.5% SOM	11	14	6.50	170	29	56
	6.0% SOM	13	15	13	180	29	62
Benzo(a)pyrene	1.0% SOM	2.20	3.20	0.97	35	5.70	11
	2.5% SOM	2.70	3.20	2.00	35	5.70	12
	6.0% SOM	3.00	3.20	3.50	36	5.70	13
Benzo(b)flouranthene	1.0% SOM	2.60	3.90	0.99	44	7.10	13
	2.5% SOM	3.30	4.00	2.10	44	7.20	15
	6.0% SOM	3.70	4.00	3.90	45	7.20	16
Benzo(ghi)perylene	1.0% SOM	320	360	290	3,900	640	1,400
	2.5% SOM	340	360	470	4,000	640	1,500
	6.0% SOM	350	360	640	4,000	640	1,600
Benzo(k)flouranthene	1.0% SOM	77	110	37	1,200	190	370
	2.5% SOM	93	110	75	1,200	190	410
	6.0% SOM	100	110	130	1,200	190	440
Chrysene	1.0% SOM	15	30	4.10	350	57	93
	2.5% SOM	22	31	9.40	350	57	110
	6.0% SOM	27	32	19	350	57	120
Dibenzo(ah)anthracene	1.0% SOM	0.24	0.31	0.14	3.50	0.57	1.10
	2.5% SOM	0.28	0.32	0.27	3.50	0.57	1.30
	6.0% SOM	0.30	0.32	0.43	3.60	0.58	1.40
Flouranthene	1.0% SOM	280	1,500	52	23,000	3,100	6,300
	2.5% SOM	560	1,600	130	23,000	3,100	6,300
	6.0% SOM	890	1,600	290	23,000	3,100	6,300
Flourene	1.0% SOM	170	2,800 (30.9) ^{sol}	27	63,000(30.9) ^{sol}	9,900	20,000
	2.5% SOM	400	3,800(76.5) ^{sol}	67	68,000	9,900	20,000
	6.0% SOM	860	4,500(183) ^{sol}	160	71,000	9,900	20,000
Indeno(123-cd)pyrene	1.0% SOM	27	45	9.50	500	82	150
	2.5% SOM	36	46	21	510	82	170
	6.0% SOM	41	46	39	510	82	180
Napthalene	1.0% SOM	2.30	2.6	4.10	190 (76.4) ^{sol}	4,900	1,200(76.4) ^{sol}
	2.5% SOM	5.60	5.6	10	460 (183) ^{sol}	4,900	1,900(183) ^{sol}
	6.0% SOM	13	13	24	1,100 (432) ^{sol}	4,900	3,000
Phenanthrene	1.0% SOM	95	1,300(183) ^{sol}	15	22,000	3,100	6,200
	2.5% SOM	220	1,500	38	22,000	3,100	6,200
	6.0% SOM	440	1,500	90	23,000	3,100	6,300
Pyrene	1.0% SOM	620	3,700	110	54,000	7,400	15,000
	2.5% SOM	1200	3,800	270	54,000	7,400	15,000
	6.0% SOM	2000	3,800	620	54,000	7,400	15,000
Coal Tar (Benzo(a)pyrene used as marker compound)	1.0% SOM	0.79	1.2	0.32	15	2.20	4.40
	2.5% SOM	0.98	1.2	0.67	15	2.20	4.70
	6.0% SOM	1.10	1.2	1.20	15	2.20	4.80
SOM = Soil Organic Matter Content (%)							
^{vap} – GAC presented exceeds the vapour saturation limit, which is presented in brackets.							
^{sol} – GAC presented exceeds the soil saturation limit, which is presented in brackets.							

9.5. Volatile and Semi-volatile Organic Compounds

LQM CIEH General Assessment Criteria: Volatile and Semi-Volatile Organic Compounds							
Determinands		RwHP (mg/kg)	RwoHP (mg/kg)	Allotment (mg/kg)	Commercial (mg/kg)	POSresi (mg/kg)	POSpark (mg/kg)
<i>Chloroalkanes & alkenes</i>							
1,2 Dichloroethane	1.0% SOM	0.0071	0.0092	0.0046	0.67	29	21
	2.5% SOM	0.011	0.013	0.0083	0.97	29	24
	6.0% SOM	0.019	0.023	0.016	1.70	29	28
1,1,2,2 Tetrachloroethane	1.0% SOM	1.60	3.90	0.41	270	1,400	1,800
	2.5% SOM	3.40	8.00	0.89	550	1,400	2,100
	6.0% SOM	7.50	17	2.00	1,100	1,400	2,300
1,1,1,2 Tetrachloroethane	1.0% SOM	1.20	1.50	0.79	110	1,400	1,500
	2.5% SOM	2.80	3.50	1.90	250	1,400	1,800
	6.0% SOM	6.40	8.20	4.40	560	1,400	2,100
Tetrachloroethene	1.0% SOM	0.18	0.18	0.65	19	1,400	810 ^{sol} (424)
	2.5% SOM	0.39	0.40	1.50	42	1,400	1,100 ^{sol} (951)
	6.0% SOM	0.90	0.92	3.60	95	1,400	1,500
1,1,1 Trichloroethane	1.0% SOM	8.80	9.00	48	660	140,000	57,000 ^{vap} (1425)
	2.5% SOM	18	18	110	1,300	140,000	76,000 ^{vap} (2915)
	6.0% SOM	39	40	240	3,000	140,000	100,000 ^{vap} (6392)
Tetrachloromethene	1.0% SOM	0.026	0.026	0.45	2.90	890	190
	2.5% SOM	0.056	0.056	1.00	6.30	920	270
	6.0% SOM	0.130	0.130	2.40	14	950	400
Trichloroethene	1.0% SOM	0.016	0.017	0.041	1.20	120	70
	2.5% SOM	0.034	0.036	0.091	2.60	120	91
	6.0% SOM	0.075	0.080	0.210	5.70	120	120
Trichloromethane	1.0% SOM	0.91	1.20	0.42	99	2,500	2,600
	2.5% SOM	1.70	2.10	0.83	170	2,500	2,800
	6.0% SOM	3.40	4.20	1.70	350	2,500	3,100
Vinyl Chloride	1.0% SOM	0.00064	0.00077	0.00055	0.059	3.50	4.80
	2.5% SOM	0.00087	0.00100	0.00100	0.077	3.50	5.00
	6.0% SOM	0.00014	0.00150	0.00180	0.120	3.50	5.40
<i>Explosives</i>							
2,4,6 Trinitrotoluene	1.0% SOM	1.60	65	0.24	1,000	130	260
	2.5% SOM	3.70	66	0.58	1,000	130	270
	6.0% SOM	8.10	66	1.40	1,000	130	270
RDX (Hexogen/Cyclonite/1,3,5-trinitro-1,3,5-triazacyclohexane)	1.0% SOM	120	13,000	17	210,000	26,000	49,000(18.7) ^{sol}
	2.5% SOM	250	13,000	38	210,000	26,000	51,000
	6.0% SOM	540	13,000	85	210,000	27,000	53,000
HMX (Octogen/1,3,5,7-tetrenitro-1,3,5,7-tetrazacyclo-octane)	1.0% SOM	5.70	67,00	0.86	110,000	13,000	23,000(0.35) ^{vap}
	2.5% SOM	13	67,00	1.90	110,000	13,000	23,000(0.39) ^{vap}
	6.0% SOM	26	67,00	3.90	110,000	13,000	24,000(0.48) ^{vap}
Atrazine	1.0% SOM	3.30	610	0.50	9,300	1,200	2,300
	2.5% SOM	7.60	620	1.20	9,400	1,200	2,400
	6.0% SOM	17.40	620	2.70	9,400	1,200	2,400

^{vap} – GAC presented exceeds the vapour saturation limit, which is presented in brackets.
^{sol} – GAC presented exceeds the soil saturation limit, which is presented in brackets.

VOC and SVOC table continued overleaf

VOC and SVOC table continued from previous page

LQM CIEH General Assessment Criteria: Volatile and Semi-Volatile Organic Compounds							
Determinands		RwHP (mg/kg)	RwoHP (mg/kg)	Allotment (mg/kg)	Commercial (mg/kg)	POSresi (mg/kg)	POSpark (mg/kg)
Pesticides							
Aldrin	1.0% SOM	5.70	7.30	3.20	170	18	30
	2.5% SOM	6.60	7.40	6.10	170	18	31
	6.0% SOM	7.10	7.50	9.60	170	18	31
Dieldrin	1.0% SOM	0.97	7.00	0.17	170	18	30
	2.5% SOM	2.00	7.30	0.41	170	18	30
	6.0% SOM	3.50	7.40	0.96	170	18	31
Dichlorvos	1.0% SOM	0.032	6.40	0.0049	140	16	26
	2.5% SOM	0.066	6.50	0.0100	140	16	26
	6.0% SOM	0.140	6.60	0.0220	140	16	27
Alpha - Endosulfan	1.0% SOM	7.40	160(0.003) ^{vap}	1.20	5,600(0.003) ^{vap}	1,200	2,400
	2.5% SOM	18	280(0.007) ^{vap}	2.90	7,400(0.007) ^{vap}	1,200	2,400
	6.0% SOM	41	410(0.016) ^{vap}	6.80	8,400(0.016) ^{vap}	1,200	2,400
Beta - Endosulfan	1.0% SOM	7.00	190(0.00007) ^{vap}	1.10	6,300(0.00007) ^{vap}	1,200	2,400
	2.5% SOM	17	320(0.0002) ^{vap}	2.70	7,800(0.0002) ^{vap}	1,200	2,400
	6.0% SOM	39	440(0.0004) ^{vap}	6.40	8700	1,200	2,500
Alpha - Hexachlorocyclohexanes	1.0% SOM	0.23	6.90	0.035	170	24	47
	2.5% SOM	0.55	9.20	0.087	180	24	48
	6.0% SOM	1.20	11	0.210	180	24	48
Beta - Hexachlorocyclohexanes	1.0% SOM	0.085	3.70	0.013	65	8.10	15
	2.5% SOM	0.200	3.80	0.032	65	8.10	15
	6.0% SOM	0.460	3.80	0.077	65	8.10	16
Gamma - Hexachlorocyclohexanes	1.0% SOM	0.06	2.90	0.0092	67	8.2	14
	2.5% SOM	0.14	3.30	0.0230	69	8.2	15
	6.0% SOM	0.33	3.50	0.0540	70	8.2	15
Chlorobenzenes							
Chlorobenzene	1.0% SOM	0.46	0.46	5.90	56	11,000	1,300(675) ^{sol}
	2.5% SOM	1.00	1.00	14	130	13,000	2,000(1520) ^{sol}
	6.0% SOM	2.40	2.40	32	290	14,000	2,900
1,2-Dichlorobenzene	1.0% SOM	23	24	94	2,000 (571) ^{sol}	90,000	24,000(571) ^{sol}
	2.5% SOM	55	57	230	4,800 (1370) ^{sol}	95,000	36,000(1370) ^{sol}
	6.0% SOM	130	130	540	11,000 (3240) ^{sol}	98,000	51,000(3240) ^{sol}
1,3-Dichlorobenzene	1.0% SOM	0.40	0.44	0.25	30	300	390
	2.5% SOM	1.00	1.10	0.60	73	300	440
	6.0% SOM	2.30	2.50	1.50	170	300	470
1,4-Dichlorobenzene	1.0% SOM	61	61	15	4,400 (224) ^{vap}	17,000 ^g	36,000 (224) ^{vap}
	2.5% SOM	150	150	37	10,000 (540) ^{vap}	17,000 ^g	36,000 (540) ^{vap}
	6.0% SOM	350	350	88 ^g	25,000 (1280) ^{vap}	17,000 ^g	36,000 (1280) ^{vap}
1,2,3,-Trichlorobenzene	1.0% SOM	1.50	1.50	4.70	102	1,800	770(134) ^{vap}
	2.5% SOM	3.60	3.70	12	250	1,800	1,100(330) ^{vap}
	6.0% SOM	8.60	8.80	28	590	1,800	1,600(789) ^{vap}
1,2,4,-Trichlorobenzene	1.0% SOM	2.60	2.60	55	220	15,000	1,700(318) ^{vap}
	2.5% SOM	6.40	6.40	140	530	17,000	2,600(786) ^{vap}
	6.0% SOM	15	15	320	1,300	19,000	4,000(1880) ^{vap}
1,3,5,-Trichlorobenzene	1.0% SOM	0.33	0.33	4.70	23	1,700	380(36.7) ^{vap}
	2.5% SOM	0.81	0.81	12	55	1,700	590(90.8) ^{vap}
	6.0% SOM	1.90	1.90	140	130	1,800	860(217) ^{vap}
^{vap} – GAC presented exceeds the vapour saturation limit, which is presented in brackets.							
^{sol} – GAC presented exceeds the soil saturation limit, which is presented in brackets.							

VOC and SVOC table continued overleaf

VOC and SVOC table continued from previous page

LQM CIEH General Assessment Criteria: Volatile and Semi-Volatile Organic Compounds							
Determinands		RwHP (mg/kg)	RwoHP (mg/kg)	Allotment (mg/kg)	Commercial (mg/kg)	POSresi (mg/kg)	POSpark (mg/kg)
Chlorobenzenes (cont.)							
1,2,3,4,- Tetrachlorobenzene	1.0% SOM	15	24	4.40	1,700(122) ^{vap}	830	1,500(122) ^{vap}
	2.5% SOM	36	56	11	3,080(304) ^{vap}	830	1,600
	6.0% SOM	78	120	26	4,400(728) ^{vap}	830	1,600
1,2,3,5,- Tetrachlorobenzene	1.0% SOM	0.66	0.75	0.38	49(39.4) ^{vap}	78	110(39) ^{vap}
	2.5% SOM	1.60	1.90	0.90	120(98.1) ^{vap}	79	120
	6.0% SOM	3.70	4.30	2.20	240(235) ^{vap}	79	130
1,2,4, 5,- Tetrachlorobenzene	1.0% SOM	0.33	0.73	0.06	42(19.7) ^{sol}	13	25
	2.5% SOM	0.77	1.70	0.16	72(49.1) ^{sol}	13	26
	6.0% SOM	1.60	3.50	0.37	96	13	26
Pentachlorobenzene	1.0% SOM	5.80	19	1.20	640(43.0) ^{sol}	100	190
	2.5% SOM	12	30	3.10	770(107) ^{sol}	100	190
	6.0% SOM	22	38	7.00	830	100	190
Hexachlorobenzene	1.0% SOM	1.80(0.20) ^{vap}	4.10 (0.20) ^{vap}	0.47	110(0.20) ^{vap}	16	30
	2.5% SOM	3.30(0.50) ^{vap}	5.70 (0.50) ^{vap}	1.10	120	16	30
	6.0% SOM	4.90	6.70 (1.2) ^{vap}	2.50	120	16	30
Phenols & Chlorophenols							
BTEX	1.0% SOM	280	750	66	760 ^{dir} (31,000)	760 ^{dir} (11,000)	760 ^{dir} (8,600)
	2.5% SOM	550	1,300	140	1,500 ^{dir} (35,000)	1,500 ^{dir} (11,000)	1,500 ^{dir} (9,700)
	6.0% SOM	1100	2,300	280	3,200 ^{dir} (37,000)	3,200 ^{dir} (11,000)	3,200 ^{dir} (11,000)
	6.0% SOM	1100	2,300	280	3,200 ^{dir} (37,000)	3,200 ^{dir} (11,000)	3,200 ^{dir} (11,000)
Chlorophenols (4 Congeners)	1.0% SOM	0.87	94	0.13	3,500	620	1,100
	2.5% SOM	2.00	150	0.30	4,000	620	1,100
	6.0% SOM	4.50	210	0.70	4,300	620	1,100
Pentachlorophenols	1.0% SOM	0.22	27(16.4) ^{vap}	0.03	400	60	110
	2.5% SOM	0.52	29	0.08	400	60	120
	6.0% SOM	1.20	31	0.19	400	60	120
Others							
Carbon Disulphide	1.0% SOM	0.14	0.14	4.80	11	11,000	1,300
	2.5% SOM	0.29	0.29	10	22	11,000	1,900
	6.0% SOM	0.62	0.62	23	47	12,000	2,700
Hexachloro-1,3- Butadiene	1.0% SOM	0.29	0.32	0.25	31	25	48
	2.5% SOM	0.70	0.78	0.61	68	25	50
	6.0% SOM	1.60	1.80	1.40	120	25	51
^{vap} – GAC presented exceeds the vapour saturation limit, which is presented in brackets.							
^{sol} – GAC presented exceeds the soil saturation limit, which is presented in brackets.							

VOC and SVOC table continued overleaf

VOC and SVOC table continued from previous page

CL:AIRE General Assessment Criteria: Volatile and Semi-Volatile Organic Compounds					
Determinands		RwHP (mg/kg)	RwoHP (mg/kg)	Allotment (mg/kg)	Commercial (mg/kg)
1,1,2 Trichloroethane	1.0% SOM	0.60	0.88	0.28	94
	2.5% SOM	1.20	1.8	0.61	190
	6.0% SOM	2.70	3.9	1.40	400
1,1-Dichloroethane	1.0% SOM	2.40	2.50	9.20	280
	2.5% SOM	3.90	4.10	17	450
	6.0% SOM	7.40	7.70	35	850
1,1-Dichloroethene	1.0% SOM	0.23	0.23	2.80	26
	2.5% SOM	0.40	0.41	5.60	46
	6.0% SOM	0.82	0.82	12	92
1,2,4-Trimethylbenzene	1.0% SOM	0.35	0.41	0.38	42
	2.5% SOM	0.85	0.99	0.93	99
	6.0% SOM	2.00	2.30	2.20	220
1,2-Dichloropropane	1.0% SOM	0.024	0.024	0.62	3.3
	2.5% SOM	0.042	0.042	1.20	5.9
	6.0% SOM	0.084	0.085	2.60	12
2,4-Dimethylphenol	1.0% SOM	19	210	3.10	16000*
	2.5% SOM	43	410	7.20	24000*
	6.0% SOM	97	730	17	30000*
2,4-Dinitrotoluene	1.0% SOM	1.50	170*	0.22	3700*
	2.5% SOM	3.20	170	0.49	3700*
	6.0% SOM	7.20	170	1.10	3800*
2,6-Dinitrotoluene	1.0% SOM	0.78	78	0.12	1900*
	2.5% SOM	1.70	84	0.27	1900*
	6.0% SOM	3.90	87	0.61	1900*
2-Chloronaphthalene	1.0% SOM	3.70	3.80	40	390*
	2.5% SOM	9.20	9.30	98	960*
	6.0% SOM	22	22	230	2200*
Biphenyl	1.0% SOM	66*	220*	14	18000*
	2.5% SOM	160	500*	35	33000*
	6.0% SOM	360	980*	83	48000*
Bis (2-ethylhexyl) phthalate	1.0% SOM	280*	2700*	47*	85000*
	2.5% SOM	610*	2800*	120*	86000*
	6.0% SOM	1100*	2800*	280*	86000*
Bromobenzene	1.0% SOM	0.87	0.91	3.2	97
	2.5% SOM	2.0	2.1	7.6	220
	6.0% SOM	4.7	4.9	18	520
Bromodichloromethane	1.0% SOM	0.016	0.019	0.016	2.1
	2.5% SOM	0.030	0.034	0.032	3.7
	6.0% SOM	0.061	0.070	0.068	7.6
Bromoform	1.0% SOM	2.8	5.2	0.95	760
	2.5% SOM	5.9	11	2.1	1500
	6.0% SOM	13	23	4.6	3100
Butyl benzyl phthalate	1.0% SOM	1400*	42000*	220*	940000*
	2.5% SOM	3300*	44000*	550*	940000*
	6.0% SOM	7200*	44000*	1300*	950000*

*soil concentration above saturation limit

VOC and SVOC table continued from previous page

CL:AIRE General Assessment Criteria: Volatile and Semi-Volatile Organic Compounds					
Determinands		RwHP (mg/kg)	RwoHP (mg/kg)	Allotment (mg/kg)	Commercial (mg/kg)
Chloroethane	1.0% SOM	8.3	8.4	110	960
	2.5% SOM	11	11	200	1300
	6.0% SOM	18	18	380	2100
Chloromethane	1.0% SOM	0.0083	0.0085	0.066	1.0
	2.5% SOM	0.0098	0.0099	0.13	1.2
	6.0% SOM	0.013	0.013	0.23	1.6
<i>Cis</i> 1,2 Dichloroethene	1.0% SOM	0.11	0.12	0.26	14
	2.5% SOM	0.19	0.20	0.50	24
	6.0% SOM	0.37	0.39	1.0	47
Dichloromethane	1.0% SOM	0.58	2.10	0.10	270
	2.5% SOM	0.98	2.80	0.19	360
	6.0% SOM	1.70	4.50	0.34	560
Diethyl Phthalate	1.0% SOM	120*	1800*	19*	150000*
	2.5% SOM	260*	3500*	41*	220000*
	6.0% SOM	570*	6300*	94*	290000*
Di- <i>n</i> -butyl phthalate	1.0% SOM	13*	450*	2.00	15000*
	2.5% SOM	31*	450*	5.00	15000*
	6.0% SOM	67*	450*	12	15000*
Di- <i>n</i> -octyl phthalate	1.0% SOM	2300*	3400*	940*	89000*
	2.5% SOM	2800*	3400*	2100*	89000*
	6.0% SOM	3100*	3400*	3900*	89000*
Hexachloroethane	1.0% SOM	0.20	0.22	0.27	22*
	2.5% SOM	0.48	0.54	0.67	53*
	6.0% SOM	1.10	1.30	1.60	120*
Isopropylbenzene	1.0% SOM	11	12	32	1400*
	2.5% SOM	27	28	79	3300*
	6.0% SOM	64	67	190	7700*
Methyl <i>tert</i> -butyl ether (MTBE)	1.0% SOM	49	73	23	7900
	2.5% SOM	84	120	44	13000
	6.0% SOM	160	220	90	24000
Propylbenzene	1.0% SOM	34	40	34	4100*
	2.5% SOM	82	97	83	9700*
	6.0% SOM	190	230	200	21000*
Styrene	1.0% SOM	8.10	35	1.60	3300*
	2.5% SOM	19	78	3.70	6500*
	6.0% SOM	43	170	8.70	11000*
Total Cresols (2-, 3-, and 4-methylphenol)	1.0% SOM	80	3700	12	160000
	2.5% SOM	180	5400	27	180000*
	6.0% SOM	400	6900	63	180000*
<i>Trans</i> 1,2 Dichloroethene	1.0% SOM	0.19	0.19	0.93	22
	2.5% SOM	0.34	0.35	1.90	40
	6.0% SOM	0.70	0.71	0.24	81
Tributyl tin oxide	1.0% SOM	0.25	1.40	0.042	130*
	2.5% SOM	0.59	3.10	0.100	180*
	6.0% SOM	1.30	5.70	0.240	200*

*soil concentration above saturation limit

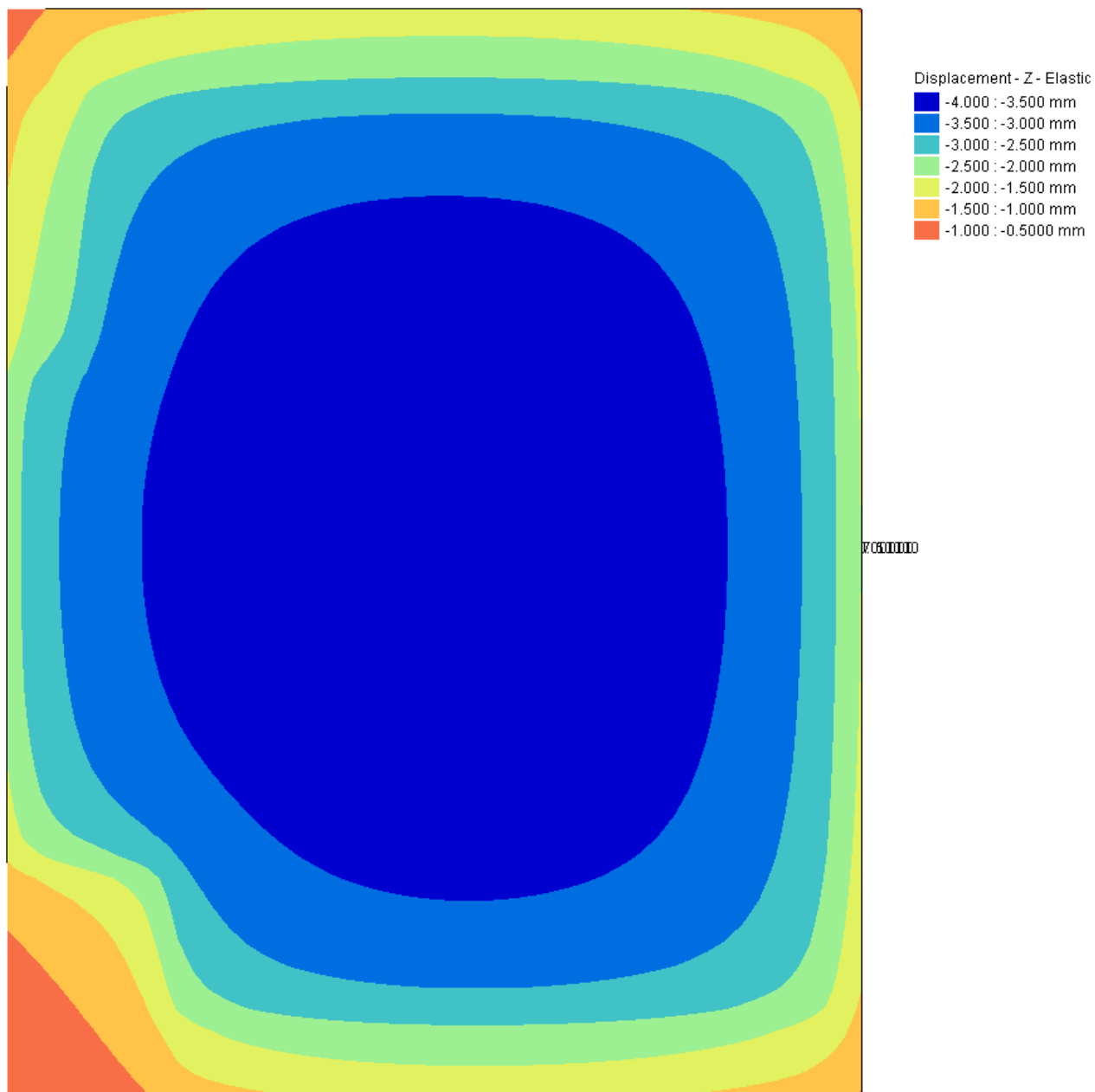
C4SL Low Level of Toxicological Concern							
Determinands		RwHP (mg/kg)	RwoHP (mg/kg)	Allotment (mg/kg)	Commercial (mg/kg)	POSresi (mg/kg)	POSpark (mg/kg)
1,2-Dichloroethane (Ethylene Dichloride)	1.0% SOM	0.11	0.16	0.054	12	300	300
	2.5% SOM	0.18	0.24	0.10	17	310	330
	6.0% SOM	0.31	0.41	0.19	29	310	380
Cis-1,2-Dichloroethene	1.0% SOM	0.46	0.50	0.89	38	3,800	2,000
	2.5% SOM	0.78	0.84	1.7	64	3,800	2,400
	6.0% SOM	1.5	1.6	3.6	120	3,900	3,100
Tetrachloroethene (PCE)	1.0% SOM	0.31	0.32	2	24	3,200	1,400
	2.5% SOM	0.70	0.71	4.8	55	3,300	1,900
	6.0% SOM	1.60	1.60	11	130	3,400	2,500
Trans-1,2-Dichloroethene	1.0% SOM	0.90	0.93	3.70	69	13,000	5,600
	2.5% SOM	1.60	1.70	7.50	120	13,000	7,000
	6.0% SOM	3.30	3.40	16	260	13,000	9,100
Trichloroethene (TCE)	1.0% SOM	0.0093	0.0097	0.032	0.73	76	41
	2.5% SOM	0.020	0.020	0.072	1.5	78	54
	6.0% SOM	0.043	0.045	0.16	3.4	79	69
Vinyl Chloride (Chloroethene)	1.0% SOM	0.0064	0.015	0.0017	1.1	7.8	18
	2.5% SOM	0.010	0.019	0.0031	1.4	7.8	19
	6.0% SOM	0.017	0.029	0.0058	2.2	7.8	19

9.6. Asbestos

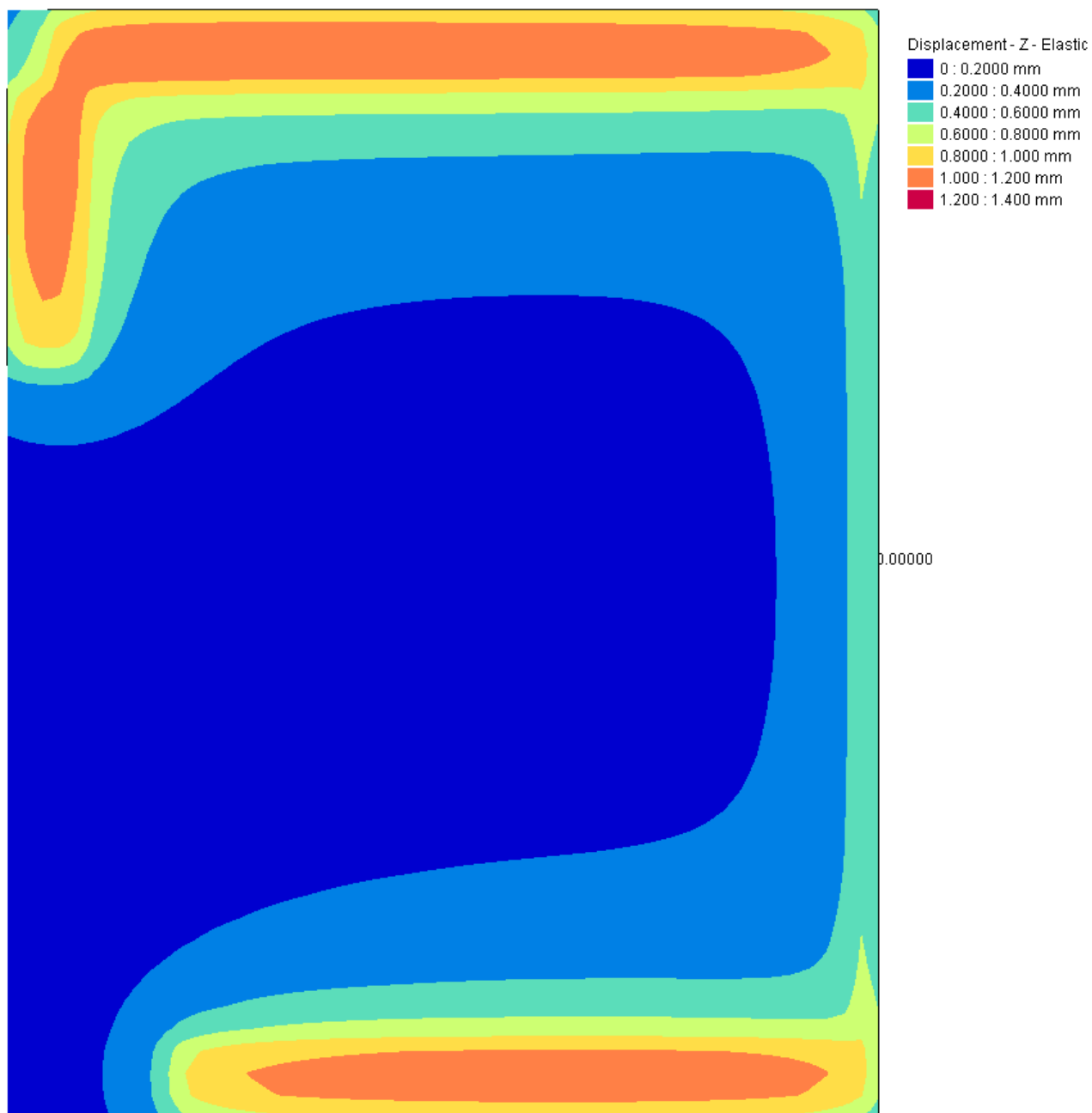
No asbestos or asbestos containing materials (ACM's) are considered acceptable on-site from a human health perspective. Therefore the GAC for asbestos & ACM's within any imported material should be none detected (ND).

APPENDIX G: Settlement and Heave Analysis Modelling

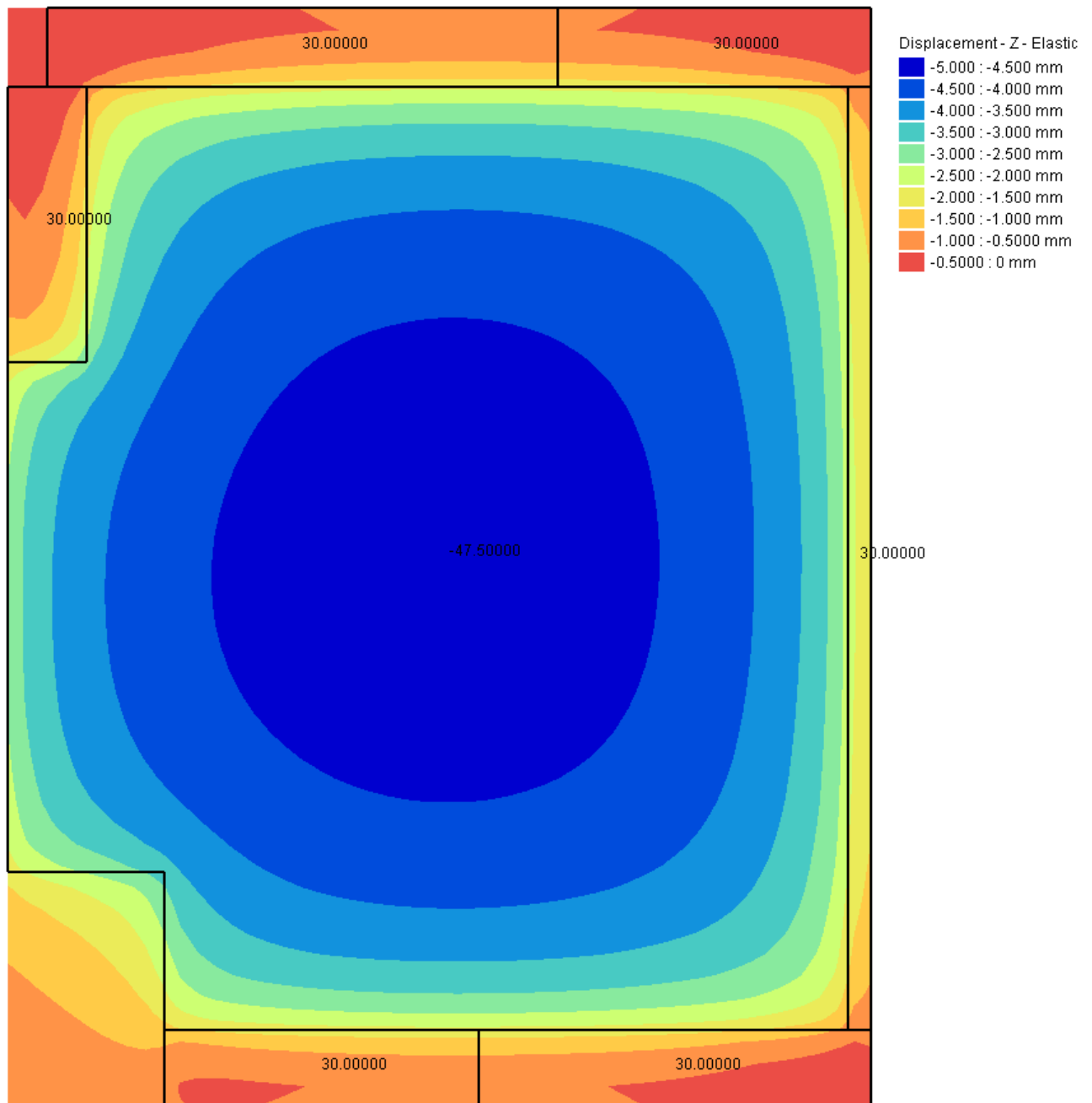
Model 1



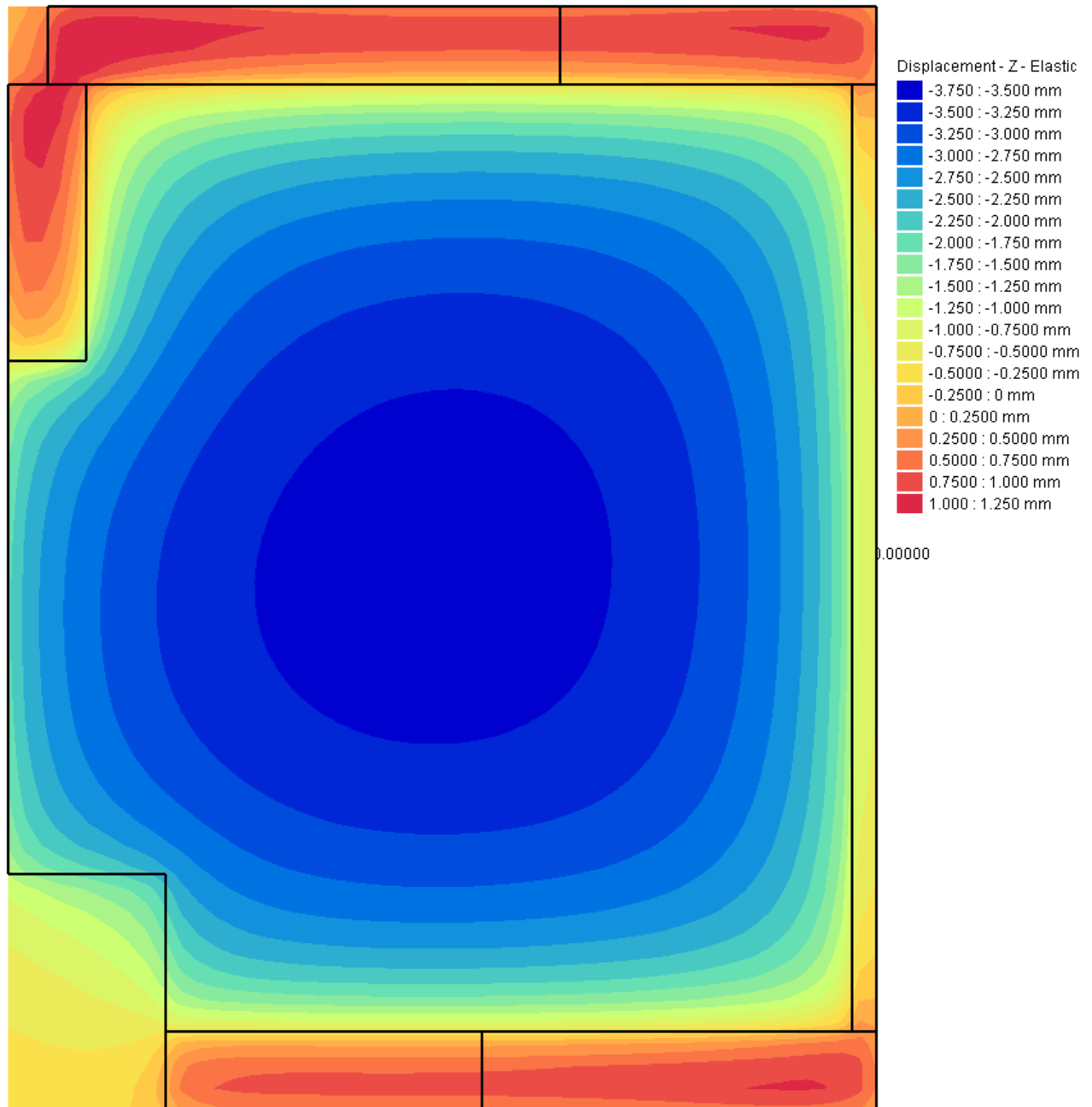
Model 2



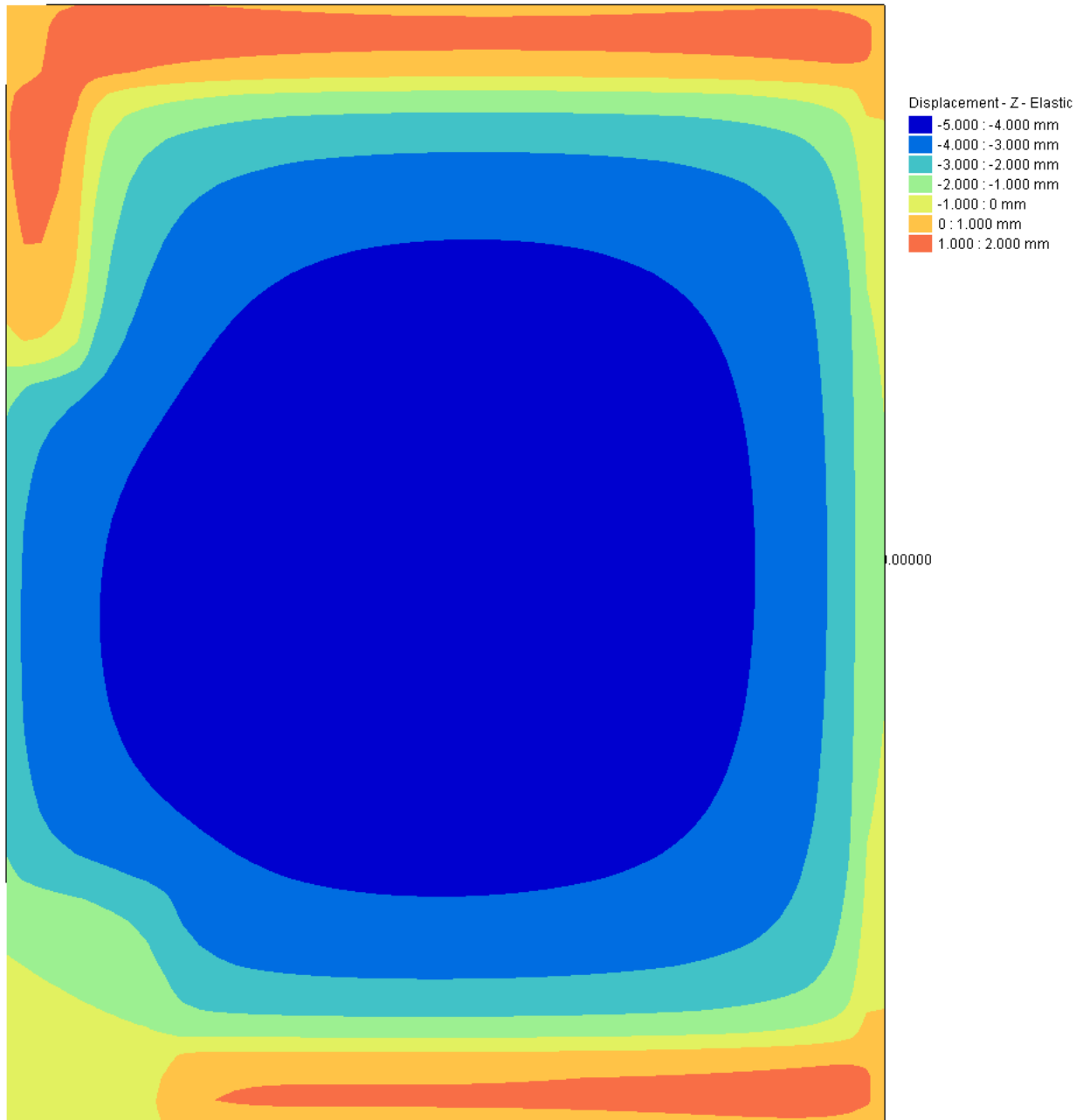
Model 3



Model 4



Model 5



APPENDIX H: Waste Hazard Assessment

Waste Classification Report

HazWasteOnline™ classifies waste as either **hazardous** or **non-hazardous** based on its chemical composition, related legislation and the rules and data defined in the current UK or EU technical guidance (Appendix C) (note that HP 9 Infectious is not assessed). It is the responsibility of the classifier named below to:

- understand the origin of the waste
- select the correct List of Waste code(s)
- confirm that the list of determinands, results and sampling plan are fit for purpose
- select and justify the chosen metal species (Appendix B)
- correctly apply moisture correction and other available corrections
- add the meta data for their user-defined substances (Appendix A)
- check that the classification engine is suitable with respect to the national destination of the waste (Appendix C)



10R6M-SGUTT-2ZOG6

To aid the reviewer, the laboratory results, assumptions and justifications managed by the classifier are highlighted in pale yellow.

Job name

240207-77

Description/Comments

Project

GWPR5826

Site

42 Shepherds Hill

Classified by

Name: **Aubyn Shortland**
 Date: **19 Feb 2024 17:17 GMT**
 Telephone:
 Company: **Ground and Water**
2 The Long Barn, Norton Farm
Selborne Road
Alton
GU34 3NB

HazWasteOnline™ provides a two day, hazardous waste classification course that covers the use of the software and both basic and advanced waste classification techniques. Certification has to be renewed every 3 years.

HazWasteOnline™ Certification:

Course
 Hazardous Waste Classification

Date

Purpose of classification

4 - Classification of Waste Products

Address of the waste

Post Code

SIC for the process giving rise to the waste

Description of industry/producer giving rise to the waste

Description of the specific process, sub-process and/or activity that created the waste

Description of the waste

Job summary

#	Sample name	Depth [m]	Classification Result	Hazard properties	Page
1	WS01-310124--0.30		Non Hazardous		3

Related documents

#	Name	Description
1	240207-77.hwol	ALS Hawarden .hwol file used to populate the Job

Report

Created by: Aubyn Shortland

Created date: 19 Feb 2024 17:17 GMT

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Appendix A: Classifier defined and non GB MCL determinands	6
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Classification of sample: WS01-310124--0.30

✔ **Non Hazardous Waste**
Classified as **17 05 04**
in the List of Waste

Sample details

Sample name:	LoW Code:
WS01-310124--0.30	Chapter: 17: Construction and Demolition Wastes (including excavated soil from contaminated sites)
Moisture content:	Entry: 17 05 04 (Soil and stones other than those mentioned in 17 05 03)
20% (wet weight correction)	

Hazard properties

None identified

Determinands

Moisture content: 20% Wet Weight Moisture Correction applied (MC)

#	Determinand			CLP Note	User entered data	Conv. Factor	Compound conc.	Classification value	MC Applied	Conc. Not Used
	EU CLP index number	EC Number	CAS Number							
1	acenaphthene	201-469-6	83-32-9		<0.04 mg/kg		<0.04 mg/kg	<0.000004 %		<LOD
2	acenaphthylene	205-917-1	208-96-8		<0.06 mg/kg		<0.06 mg/kg	<0.000006 %		<LOD
3	anthracene	204-371-1	120-12-7		<0.08 mg/kg		<0.08 mg/kg	<0.000008 %		<LOD
4	arsenic { arsenic trioxide }	033-003-00-0	215-481-4	1327-53-3	14.8 mg/kg	1.32	15.633 mg/kg	0.00156 %	✓	
5	benzo[a]anthracene	601-033-00-9	200-280-6	56-55-3	0.286 mg/kg		0.229 mg/kg	0.0000229 %	✓	
6	benzene	601-020-00-8	200-753-7	71-43-2	<0.001 mg/kg		<0.001 mg/kg	<0.0000001 %		<LOD
7	benzo[a]pyrene; benzo[def]chrysene	601-032-00-3	200-028-5	50-32-8	0.248 mg/kg		0.198 mg/kg	0.0000198 %	✓	
8	benzo[b]fluoranthene	601-034-00-4	205-911-9	205-99-2	0.324 mg/kg		0.259 mg/kg	0.0000259 %	✓	
9	benzo[ghi]perylene	205-883-8	191-24-2		<0.12 mg/kg		<0.12 mg/kg	<0.000012 %		<LOD
10	benzo[k]fluoranthene	601-036-00-5	205-916-6	207-08-9	0.123 mg/kg		0.0984 mg/kg	0.00000984 %	✓	
11	boron { boron tribromide }	005-003-00-0	233-657-9	10294-33-4	<1 mg/kg	23.173	<23.173 mg/kg	<0.00232 %		<LOD
12	cadmium { cadmium sulfide }	048-010-00-4	215-147-8	1306-23-6	0.595 mg/kg	1.285	0.612 mg/kg	0.0000476 %	✓	
13	chromium in chromium(VI) compounds { chromium(VI) oxide }	024-001-00-0	215-607-8	1333-82-0	<0.6 mg/kg	1.923	<1.154 mg/kg	<0.000115 %		<LOD
14	chrysene	601-048-00-0	205-923-4	218-01-9	0.302 mg/kg		0.242 mg/kg	0.0000242 %	✓	
15	copper { dicopper oxide; copper (I) oxide }	029-002-00-X	215-270-7	1317-39-1	22.9 mg/kg	1.126	20.626 mg/kg	0.00206 %	✓	
16	coronene	205-881-7	191-07-1		<0.2 mg/kg		<0.2 mg/kg	<0.00002 %		<LOD
17	cyanides { salts of hydrogen cyanide with the exception of complex cyanides such as ferrocyanides,				<1 mg/kg	1.884	<1.884 mg/kg	<0.000188 %		<LOD

#	Determinand			CLP Note	User entered data	Conv. Factor	Compound conc.	Classification value	MC Applied	Conc. Not Used
	EU CLP index number	EC Number	CAS Number							
	ferricyanides and mercuric oxycyanide and those specified elsewhere in this Annex }									
	006-007-00-5									
18	dibenz[a,h]anthracene				<0.115 mg/kg		<0.115 mg/kg	<0.0000115 %		<LOD
	601-041-00-2	200-181-8	53-70-3							
19	ethylbenzene				<0.001 mg/kg		<0.001 mg/kg	<0.0000001 %		<LOD
	601-023-00-4	202-849-4	100-41-4							
20	fluoranthene				0.574 mg/kg		0.459 mg/kg	0.0000459 %	✓	
		205-912-4	206-44-0							
21	fluorene				<0.05 mg/kg		<0.05 mg/kg	<0.000005 %		<LOD
		201-695-5	86-73-7							
22	indeno[123-cd]pyrene				<0.09 mg/kg		<0.09 mg/kg	<0.000009 %		<LOD
		205-893-2	193-39-5							
23	lead { lead chromate }			1	406 mg/kg	1.56	506.628 mg/kg	0.0325 %	✓	
	082-004-00-2	231-846-0	7758-97-6							
24	mercury { mercury dichloride }				<0.1 mg/kg	1.353	<0.135 mg/kg	<0.0000135 %		<LOD
	080-010-00-X	231-299-8	7487-94-7							
25	tert-butyl methyl ether; MTBE; 2-methoxy-2-methylpropane				<0.0005 mg/kg		<0.0005 mg/kg	<0.00000005 %		<LOD
	603-181-00-X	216-653-1	1634-04-4							
26	naphthalene				<0.045 mg/kg		<0.045 mg/kg	<0.0000045 %		<LOD
	601-052-00-2	202-049-5	91-20-3							
27	nickel { nickel dihydroxide }				18.9 mg/kg	1.579	23.882 mg/kg	0.00239 %	✓	
	028-008-00-X	235-008-5 [1] 234-348-1 [2]	12054-48-7 [1] 11113-74-9 [2]							
28	pH				8.7 pH		8.7 pH	8.7 pH		
			PH							
29	phenanthrene				0.196 mg/kg		0.157 mg/kg	0.0000157 %	✓	
		201-581-5	85-01-8							
30	phenol				<0.01 mg/kg		<0.01 mg/kg	<0.000001 %		<LOD
	604-001-00-2	203-632-7	108-95-2							
31	pyrene				0.471 mg/kg		0.377 mg/kg	0.0000377 %	✓	
		204-927-3	129-00-0							
32	selenium { selenium compounds with the exception of cadmium sulphoselenide and those specified elsewhere in this Annex }				<1 mg/kg	1.405	<1.405 mg/kg	<0.000141 %		<LOD
	034-002-00-8									
33	polychlorobiphenyls; PCB				<0.021 mg/kg		<0.021 mg/kg	<0.0000021 %		<LOD
	602-039-00-4	215-648-1	1336-36-3							
34	toluene				<0.001 mg/kg		<0.001 mg/kg	<0.0000001 %		<LOD
	601-021-00-3	203-625-9	108-88-3							
35	TPH (C6 to C40) petroleum group				10.5 mg/kg		8.4 mg/kg	0.00084 %	✓	
			TPH							
36	vanadium { divanadium pentaoxide; vanadium pentoxide }				63.2 mg/kg	1.785	90.259 mg/kg	0.00903 %	✓	
	023-001-00-8	215-239-8	1314-62-1							
37	zinc { zinc sulphate (hydrous) (mono-, hexa- and hepta hydrate); [1] zinc sulphate (anhydrous) [2] }				655 mg/kg	4.398	2304.513 mg/kg	0.23 %	✓	
	030-006-00-9	231-793-3 [1] 231-793-3 [2]	7446-19-7 [1] 7733-02-0 [2]							
38	xylene				<0.004 mg/kg		<0.004 mg/kg	<0.0000004 %		<LOD
	601-022-00-9	202-422-2 [1] 203-396-5 [2] 203-576-3 [3] 215-535-7 [4]	95-47-6 [1] 106-42-3 [2] 108-38-3 [3] 1330-20-7 [4]							
39	chromium in chromium(III) compounds { chromium(III) oxide (worst case) }				37.5 mg/kg	1.462	43.847 mg/kg	0.00438 %	✓	
		215-160-9	1308-38-9							
Total:								0.286 %		

Key

	User supplied data
	Determinand values ignored for classification, see column 'Conc. Not Used' for reason
•	Determinand defined or amended by HazWasteOnline (see Appendix A)
	Speciated Determinand - Unless the Determinand is Note 1, the Conversion Factor is used to calculate the compound concentration
<LOD	Below limit of detection
CLP: Note 1	Only the metal concentration has been used for classification

Supplementary Hazardous Property Information

HP 3(i): Flammable "flammable liquid waste: liquid waste having a flash point below 60°C or waste gas oil, diesel and light heating oils having a flash point > 55°C and <= 75°C"

Force this Hazardous property to non hazardous because Non-flammable <1000mg/kg.

Hazard Statements hit:

Flam. Liq. 3; H226 "Flammable liquid and vapour."

Because of determinand:

TPH (C6 to C40) petroleum group: (conc.: 0.00084%)

Appendix A: Classifier defined and non GB MCL determinands

■ acenaphthene (EC Number: 201-469-6, CAS Number: 83-32-9)

Description/Comments: Data from C&L Inventory Database
Data source: <http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database>
Data source date: 17 Jul 2015
Hazard Statements: Eye Irrit. 2; H319, STOT SE 3; H335, Skin Irrit. 2; H315, Aquatic Acute 1; H400, Aquatic Chronic 1; H410, Aquatic Chronic 2; H411

■ acenaphthylene (EC Number: 205-917-1, CAS Number: 208-96-8)

Description/Comments: Data from C&L Inventory Database
Data source: <http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database>
Data source date: 17 Jul 2015
Hazard Statements: Acute Tox. 4; H302, Acute Tox. 1; H330, Acute Tox. 1; H310, Eye Irrit. 2; H319, STOT SE 3; H335, Skin Irrit. 2; H315

■ anthracene (EC Number: 204-371-1, CAS Number: 120-12-7)

Description/Comments: Data from C&L Inventory Database
Data source: <http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database>
Data source date: 17 Jul 2015
Hazard Statements: Eye Irrit. 2; H319, STOT SE 3; H335, Skin Irrit. 2; H315, Skin Sens. 1; H317, Aquatic Acute 1; H400, Aquatic Chronic 1; H410

■ benzo[ghi]perylene (EC Number: 205-883-8, CAS Number: 191-24-2)

Description/Comments: Data from C&L Inventory Database; SDS Sigma Aldrich 28/02/2015
Data source: <http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database>
Data source date: 23 Jul 2015
Hazard Statements: Aquatic Acute 1; H400, Aquatic Chronic 1; H410

■ coronene (EC Number: 205-881-7, CAS Number: 191-07-1)

Description/Comments: Data from C&L Inventory Database; no entries in Registered Substances or Pesticides Properties databases; SDS: Sigma Aldrich, 1907/2006 compliant, dated 2012 - no entries; IARC – Group 3, not carcinogenic.
Data source: <http://clp-inventory.echa.europa.eu/SummaryOfClassAndLabelling.aspx?SubstanceID=17010&HarmOnly=no?fc=true&lang=en>
Data source date: 16 Jun 2014
Hazard Statements: STOT SE 2; H371

■ salts of hydrogen cyanide with the exception of complex cyanides such as ferrocyanides, ferricyanides and mercuric oxycyanide and those specified elsewhere in this Annex

GB MCL index number: 006-007-00-5
Description/Comments: Conversion factor based on a worst case compound: sodium cyanide
Additional Hazard Statement(s): EUH032 >= 0.2 %
Reason for additional Hazards Statement(s):
20 Nov 2021 - EUH032 >= 0.2 % hazard statement sourced from: WM3, Table C12.2

■ ethylbenzene (EC Number: 202-849-4, CAS Number: 100-41-4)

GB MCL index number: 601-023-00-4
Description/Comments:
Additional Hazard Statement(s): Carc. 2; H351
Reason for additional Hazards Statement(s):
20 Nov 2021 - Carc. 2; H351 hazard statement sourced from: IARC Group 2B (77) 2000

■ fluoranthene (EC Number: 205-912-4, CAS Number: 206-44-0)

Description/Comments: Data from C&L Inventory Database
Data source: <http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database>
Data source date: 21 Aug 2015
Hazard Statements: Acute Tox. 4; H302, Aquatic Acute 1; H400, Aquatic Chronic 1; H410

■ fluorene (EC Number: 201-695-5, CAS Number: 86-73-7)

Description/Comments: Data from C&L Inventory Database
Data source: <http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database>
Data source date: 06 Aug 2015
Hazard Statements: Aquatic Acute 1; H400, Aquatic Chronic 1; H410

■ indeno[123-cd]pyrene (EC Number: 205-893-2, CAS Number: 193-39-5)

Description/Comments: Data from C&L Inventory Database
Data source: <http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database>
Data source date: 06 Aug 2015
Hazard Statements: Carc. 2; H351

▪ **pH** (CAS Number: PH)

Description/Comments: Appendix C4
Data source: WM3 1st Edition 2015
Data source date: 25 May 2015
Hazard Statements: None.

▪ **phenanthrene** (EC Number: 201-581-5, CAS Number: 85-01-8)

Description/Comments: Data from C&L Inventory Database
Data source: <http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database>
Data source date: 06 Aug 2015
Hazard Statements: Acute Tox. 4; H302 , Eye Irrit. 2; H319 , STOT SE 3; H335 , Carc. 2; H351 , Skin Sens. 1; H317 , Aquatic Acute 1; H400 , Aquatic Chronic 1; H410 , Skin Irrit. 2; H315

▪ **pyrene** (EC Number: 204-927-3, CAS Number: 129-00-0)

Description/Comments: Data from C&L Inventory Database; SDS Sigma Aldrich 2014
Data source: <http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database>
Data source date: 21 Aug 2015
Hazard Statements: Skin Irrit. 2; H315 , Eye Irrit. 2; H319 , STOT SE 3; H335 , Aquatic Acute 1; H400 , Aquatic Chronic 1; H410

▪ **polychlorobiphenyls; PCB** (EC Number: 215-648-1, CAS Number: 1336-36-3)

GB MCL index number: 602-039-00-4
Description/Comments: Worst Case: IARC considers PCB Group 1; Carcinogenic to humans;

POP specific threshold from ATP1 (Regulation 756/2010/EU) to POPs Regulation (Regulation 850/2004/EC). Where applicable, the calculation method laid down in European standards EN 12766-1 and EN 12766-2 shall be applied.

Additional Hazard Statement(s): Carc. 1A; H350

Reason for additional Hazards Statement(s):

20 Nov 2021 - Carc. 1A; H350 hazard statement sourced from: IARC Group 1 (23, Sup 7, 100C) 2012

▪ **TPH (C6 to C40) petroleum group** (CAS Number: TPH)

Description/Comments: Hazard statements taken from WM3 1st Edition 2015; Risk phrases: WM2 3rd Edition 2013
Data source: WM3 1st Edition 2015
Data source date: 25 May 2015
Hazard Statements: Flam. Liq. 3; H226 , Asp. Tox. 1; H304 , STOT RE 2; H373 , Muta. 1B; H340 , Carc. 1B; H350 , Repr. 2; H361d , Aquatic Chronic 2; H411

▪ **chromium(III) oxide (worst case)** (EC Number: 215-160-9, CAS Number: 1308-38-9)

Description/Comments: Data from C&L Inventory Database
Data source: <https://echa.europa.eu/information-on-chemicals/cl-inventory-database/-/discli/details/33806>
Data source date: 17 Jul 2015
Hazard Statements: Acute Tox. 4; H332 , Acute Tox. 4; H302 , Eye Irrit. 2; H319 , STOT SE 3; H335 , Skin Irrit. 2; H315 , Resp. Sens. 1; H334 , Skin Sens. 1; H317 , Repr. 1B; H360FD , Aquatic Acute 1; H400 , Aquatic Chronic 1; H410

Appendix B: Rationale for selection of metal species

arsenic {arsenic trioxide}

Most likely worst-case

boron {boron tribromide}

worst-case

cadmium {cadmium sulfide}

Most likely worst-case

chromium in chromium(VI) compounds {chromium(VI) oxide}

Most likely worst-case

copper {dicopper oxide; copper (I) oxide}

Most likely worst-case

cyanides {salts of hydrogen cyanide with the exception of complex cyanides such as ferrocyanides, ferricyanides and mercuric oxycyanide and those specified elsewhere in this Annex}

Most likely worst-case

lead {lead chromate}

worst-case

mercury {mercury dichloride}

Most likely worst-case

nickel {nickel dihydroxide}

Most likely worst-case

selenium {selenium compounds with the exception of cadmium sulphoselenide and those specified elsewhere in this Annex}

Most likely worst-case

vanadium {divanadium pentaoxide; vanadium pentoxide}

Most likely worst-case

zinc {zinc sulphate (hydrous) (mono-, hexa- and hepta hydrate); [1] zinc sulphate (anhydrous) [2]}

Most likely worst case

chromium in chromium(III) compounds {chromium(III) oxide (worst case)}

worst case

Appendix C: Version

HazWasteOnline Classification Engine: **WM3 1st Edition v1.2.GB - Oct 2021**

HazWasteOnline Classification Engine Version: 2024.30.5942.10989 (30 Jan 2024)

HazWasteOnline Database: 2024.26.5938.10982 (26 Jan 2024)

This classification utilises the following guidance and legislation:

WM3 v1.2.GB - Waste Classification - 1st Edition v1.2.GB - Oct 2021

CLP Regulation - Regulation 1272/2008/EC of 16 December 2008

1st ATP - Regulation 790/2009/EC of 10 August 2009

2nd ATP - Regulation 286/2011/EC of 10 March 2011

3rd ATP - Regulation 618/2012/EU of 10 July 2012

4th ATP - Regulation 487/2013/EU of 8 May 2013

Correction to 1st ATP - Regulation 758/2013/EU of 7 August 2013

5th ATP - Regulation 944/2013/EU of 2 October 2013

6th ATP - Regulation 605/2014/EU of 5 June 2014

WFD Annex III replacement - Regulation 1357/2014/EU of 18 December 2014

Revised List of Waste 2014 - Decision 2014/955/EU of 18 December 2014

7th ATP - Regulation 2015/1221/EU of 24 July 2015

8th ATP - Regulation (EU) 2016/918 of 19 May 2016

9th ATP - Regulation (EU) 2016/1179 of 19 July 2016

10th ATP - Regulation (EU) 2017/776 of 4 May 2017

HP14 amendment - Regulation (EU) 2017/997 of 8 June 2017

13th ATP - Regulation (EU) 2018/1480 of 4 October 2018

14th ATP - Regulation (EU) 2020/217 of 4 October 2019

15th ATP - Regulation (EU) 2020/1182 of 19 May 2020

The Chemicals (Health and Safety) and Genetically Modified Organisms (Contained Use)(Amendment etc.) (EU Exit)

Regulations 2020 - UK: 2020 No. 1567 of 16th December 2020

The Waste and Environmental Permitting etc. (Legislative Functions and Amendment etc.) (EU Exit) Regulations 2020 - UK:

2020 No. 1540 of 16th December 2020

GB MCL List - version 1.1 of 09 June 2021

GB MCL List v2.0 - version 2.0 of 20th October 2023