



EARTH ENVIRONMENTAL
& GEOTECHNICAL

GeoEnvironmental
Investigation

Liberty Northern Moor

Wythenshawe

June 2022

On behalf of

Liberty Care Developments

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**GEOENVIRONMENTAL
INVESTIGATION REPORT**

LIBERTY NORTHERN MOOR

WYTHENSHAW

Report Ref: A4701/22/SI/V2

JUNE 2022

Prepared on Behalf of:

LIBERTY CARE DEVELOPMENTS

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GEOENVIRONMENTAL INVESTIGATION REPORT

LIBERTY NORTHERN MOOR, WYTHENSHAW

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1.0 EXECUTIVE SUMMARY

Appointment	A Site Investigation has been commissioned by Avison Young UK, on behalf of Liberty Care Developments (the Client) to examine ground conditions for a new care home on Yew Tree Lane, Wythenshawe.
The Investigation	The investigation comprised 5no. windowless sample boreholes (WS1 to WS5), in-situ testing, laboratory geotechnical and contamination testing.
The Site	The site is located off Yew Tree Lane and Willenhall Road, approximately 7km from Manchester City Centre. The approximate National Grid Reference for the centre of the site is SJ8213690583 (X: 382136, Y: 390583), with the closest postcode being M23 0EA.
Site History	The site was historically occupied by Beech House which comprised a dwelling, L-shaped building, and small outbuilding. Overtime, the dwelling has been extended, and several buildings fully or partially demolished. The site was once part of a Maternity and Child Welfare Centre around 1857. Currently the site is part of Yew Tree Manor Care Home which is occupied by residents. The site has two ramps leading to the existing dwelling, a paved path and patio, areas of soft landscaping and a tarmac vehicle parking area.
Ground Conditions Encountered	The exploratory holes encountered Topsoil (to a maximum depth of 0.50m bgl) or Made Ground (to a maximum depth of 1.30m bgl) beneath which were Glaciofluvial Sheet Deposits (to a maximum depth of 4.90m bgl) comprising predominantly medium dense to dense SAND, or a loose to dense SAND AND GRAVEL. A medium dense GRAVEL was also encountered in WS3. Soft to stiff CLAY was encountered towards the base of the boreholes (to a maximum depth of 5.0m bgl). Groundwater was encountered in exploratory hole location WS1 only at 3.0m bgl.
Geotechnical Assessment	Shallow strip/pad foundation placed in the Glaciofluvial Sheet Deposits are considered appropriate for the proposed residential dwelling, dependent on allowable bearing pressures and tolerance of structures to settlement. It should be noted that Made Ground was encountered to depths of 1.20m bgl in WS5. Pavement Design – preliminary design value = 60% in Sand, 1% in Made Ground Design Sulphate Class = DS-1 ACEC Site Classification = AC-1s
Contamination Assessment	Risk from contamination to groundworkers during development –Low Risk from contamination to future site users – Moderate to Low. Soil chemical exceedances in Lead - 3no. samples for residential with homegrown produce, 1no. sample for residential without homegrown produce. Asbestos was not encountered in the soil samples collected from the site. Soil Waste Assessment: All 7no. samples tested Non-Hazardous Waste Acceptance Criteria Testing: 1no. sample Inert, 1no. sample Hazardous due to a pH of 5.4. Proposed areas of soft landscaping in proximity to WS3 and WS5 will require remediation.
<i>This sheet is intended to provide a summary only of the report. It does not provide a definitive engineering analysis for the purposes of costing or construction and is subject to the limitation of the agreed brief.</i>	

2.0 INTRODUCTION

2.1 Background

A Site Investigation has been commissioned by Avison Young UK, on behalf of Liberty Care Developments (the Client) to examine ground conditions for a proposed care home development on Yew Tree Lane, Wythenshawe.

2.2 Terms of Reference

Earth Environmental and Geotechnical Ltd (EEG) have been commissioned by the Client, to undertake a Site Investigation of the site in accordance with proposal A4701/22 dated 25th March 2022. The objectives of this investigation are as follows:

- *Provide factual information on the work undertaken including sampling location plan, borehole logs, monitoring, geotechnical and chemical testing.*
- *Integrated Phase I Desk Study*
- *Tier 1 (semi-quantitative) risk assessment will be undertaken. This will compare the concentrations of soil contaminants identified against current and appropriate published guidelines, in relation to identified receptors, e.g. existing/ future end users and site neighbours.*
- *Classification of soil for offsite disposal.*
- *Assessment of ground conditions for foundation design.*

2.3 Report Scope

This report presents full factual records of the site work carried out, the ground conditions encountered in the exploratory holes, the in situ and laboratory test results. All information collected has been used to provide an interpretation of the ground conditions, with recommendations on geotechnical design and potential ground contamination risks for the proposed development.

2.4 Limitations of the Study

The report is written in the context of an agreed scope of work and budget and should not be used in a different context. New information, improved practices or changes in legislation may require a reinterpretation of the report in whole or in part. EEG reserve the right to amend either conclusions or recommendations considering any further information that may become available. The report is provided for the sole use by the client and is confidential to them.

Recommendations within this report are also based on exploratory records and examination of samples and, where applicable, laboratory tests. No liability can be accepted for conditions not revealed by the boreholes particularly at intervening locations. Whilst every effort is made to ensure accuracy of data supplied, all opinions expressed as to the spatial distribution of strata between sampling locations is for guidance only and no responsibility is accepted as to its accuracy.

3.0 SITE LOCATION & DESCRIPTION

The site is located off Yew Tree Lane, Wythenshawe, approximately 7km from Manchester City Centre. The approximate National Grid Reference for the centre of the site is SJ8213690583 (X: 382136, Y: 390583) with the closest postcode being M23 0EA.

The site investigation area is a roughly rectangular shaped parcel of land with current access via Yew Tree Lane to the south and Willenhall Road to the east. The maximum dimensions of the site are 57m north to south and 53m east to west. The site occupies an area of approximately 0.27hectares.

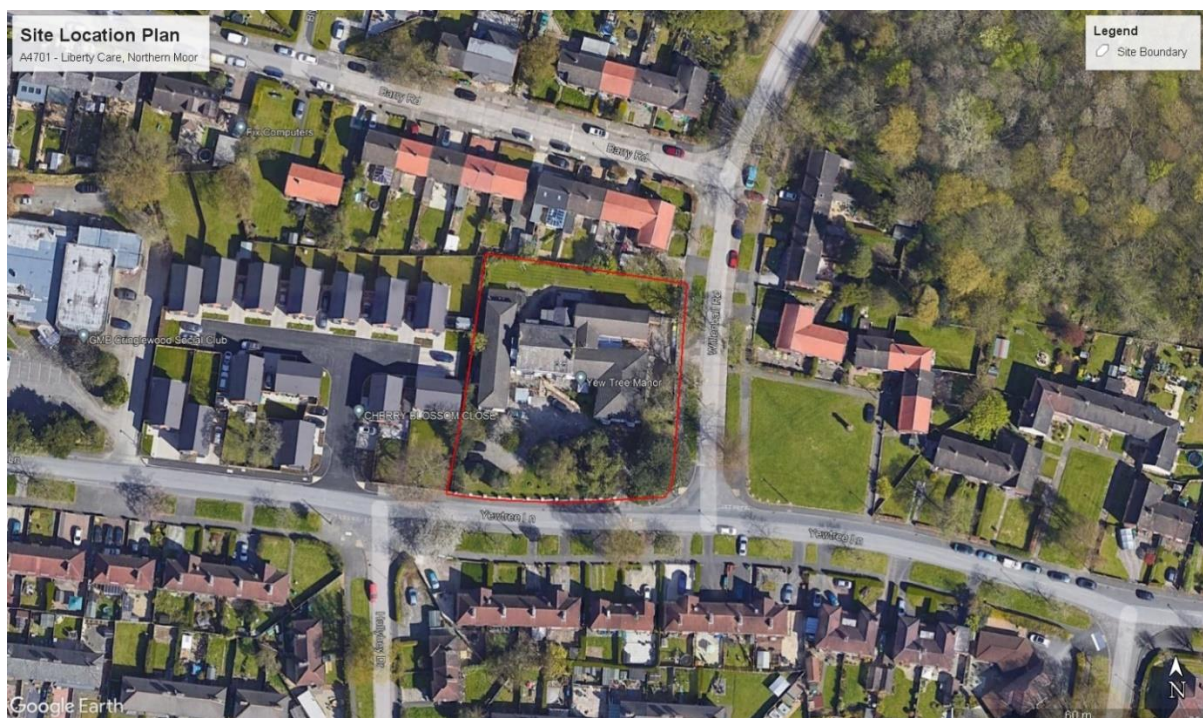
The site is currently occupied by Yew Tree Manor Nursing Home which is currently inhabited by residents. To the front of the building is an area of soft landscaping, with a driveway and vehicle parking areas surfaced in tarmac. The care home is accessed via a set of steps and a ramp leading to the front entrance. There is a temporary cabin located to the west of the building entrance.

At the side of the building is a path, small areas of soft landscaping and a refuse area with a double gate onto Willenhall Road. There is a shared residential garden to the north with soft landscaping, a ramp leading to a building doorway, a paved patio area and metal steps leading to a fire escape.

The site is demarcated by metal railings along Yew Tree Lane to the south. The shared residential garden and the site boundary along Willenhall Road are demarcated by wooden fence panels and hedgerows. The general surrounding area comprises predominantly of residential dwellings.

The site location is shown in the aerial photograph presented as Figure 1, below.

Figure 1: Site Location Plan



General site photographs are presented in Figure 2, below.

Figure 2: General Site Photographs

View of the site entrance from Yew Tree Lane, facing north



View of the shared garden and ramp leading to the care home, facing east



View of the refuse area at the side of care home building, facing north



View of the windowless sampling rig at the front entrance, facing northwest



3.1 Proposed Development

It is understood that the client wishes to demolish Yew Tree Manor Care Home to construct a new Care Home with a larger building footprint. The existing access route from Yew Tree Lane will be retained but utilised as a vehicle exit only. Another access route will be developed along Yew Tree Lane to be utilised as a vehicle entrance.

There will be provision for a total of 19no. car parking spaces, which include 2no. disabled parking spaces, 2no. electric charging bays and an ambulance drop off adjacent the building entrance. There will also be provision for 2no. motorcycle spaces. A new substation is proposed in the southwest corner of the site.

The proposed development layout details are shown in Figure 3, below.

Figure 3: Proposed Development Plan



4.0 REVIEW OF DESK STUDY INFORMATION

4.1 General

The following sections provide a review of the following information sources:

- British Geological Survey online maps.
- Google Earth imagery.
- Environment Agency online mapping data.
- Historical Ordnance Survey maps.
- The site and surrounding areas environmental, geological and mining data presented in the site specific GroundSure Enviro+Geo Insight report (Appendix 1).

4.2 Environmental Setting

The geology of the site is covered by British Geological Survey (BGS) online data and the site specific GroundSure Enviro+Geo Insight Report (Appendix 1).

Environmental conditions are covered by Environment Agency (EA) and British Geological Survey (BGS) online data, and the site specific GroundSure Enviro+Geo Insight Report (Appendix 1).

4.2.1 Geology

According to the British Geological Survey (BGS), the site is underlain by superficial deposits of Glaciofluvial Sheet Deposits, comprising Devensian sand and gravel.

The solid geology beneath the site is shown to be the Tarporley Siltstone Formation comprising siltstone.

There are no records of linear features or landslip activity within 500m of the site boundary.

There are 9no. borehole records identified within 250m of the site. The closest available record refers to a borehole located 150m to the north of the site (BGS Reference: SJ89SW62) drilled in 1966 and is summarised below:

- Loose cinder and rubbish fill (tip), silty at base to 1.98m
- Dense greyish brown coarse SAND and medium GRAVEL to 4.72m
- Stiff brown BOULDER CLAY to 5.03m
- Hard friable red and grey sandy MARL to 9.53m

4.2.2 Natural Ground Subsidence

The site is in an area where the hazard rating is negligible for shrink-swell clays, compressible deposits and soluble rocks. The hazard rating is very low for running sands, collapsible deposits and landslides.

4.2.3 Ground Workings

There is 1no. historical surface ground working feature recorded within 250m of the site. The record refers to an unspecified pit located 137m to the north of the site, dated 1978.

There are no records of British Pits within 500m of the site.

4.2.4 Mining and Other Underground Workings

There are no records of historical underground working features within 1km of the site.

There are no records for non-coal mining areas, non-coal cavities or natural cavities identified within 1km of the site.

The site is not located within the specified search distance (1km) of an identified coal mining area.

There are no areas of brine extraction, gypsum extraction, tin mining, or clay mining located on the site.

4.2.5 Railways and Tunnels

There are no historical railway and tunnel features identified within 250m of the site.

There are no historical railway lines or current active railway lines identified within 250m of the site.

There are no current records of a railway tunnels identified within 250m of the site.

The site is not located within 5km of the High Speed 2 rail projects or within 500m of the route of the Crossrail 1 project.

4.2.6 Radon Potential

According to the BGS and Public Health England, the site is not located within a Radon Affected Area as less than 1% of properties above the Action Level. Therefore, no radon protection measures are required.

4.2.7 Hydrogeology and Hydrology

The superficial deposits of Glaciofluvial Sheet Deposits are classified as a Secondary A Aquifer with an intergranular flow type and a high to very high permeability. The BGS states the following:

'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.'

The Tarporley Siltstone Formation is classified as a Secondary B aquifer with a fracture flow type and a moderate to low permeability. The BGS states the following:

'Predominantly lower permeability layers which may store/yield limited amounts of groundwater due to localised features such as fissures, thin permeable

horizons and weathering. These are generally the water-bearing parts of the former non-aquifers.'

The groundwater vulnerability and soil leaching potential of the site has been classified as medium bedrock vulnerability and high superficial vulnerability with a high leaching potential. The BGS states:

'High Vulnerability - Areas able to easily transmit pollution to groundwater. They are likely to be characterised by high leaching soils and the absence of low permeability superficial deposits.'

There are 9no. groundwater abstraction licence records within 2km of the site. The closest active licence refers to spray irrigation from a borehole at Chorlton-cum-Hardy Golf Club located 1.5km to the north of the site.

There are 2no. surface water abstraction licence records within 2km of the site. The closest licence is historical and refers to dust suppression at AMEC located 639m to the northeast of the site.

There are no potable abstraction licence records within 2km of the site.

The site is not located within 500m of a Source Protection Zone or a Source Protection Zone within a confined aquifer.

There are 2no. water network entries within 250m of the site. The closest record refers to an inland river not influenced by normal tidal action located 167m to the north of the site.

There is 1no. surface water features identified within 250m of the site.

There is 1no. record of a Water Framework Directive (WDF) surface water body located within 250m of the site. The record refers to the Mersey (upstream of Manchester Ship Canal) located 619m to the northeast of the site. The river had a fail chemical rating and a moderate ecological rating in 2019.

There is 1no. record of a Water Framework Directive (WDF) groundwater body located on site. The record refers to Weaver and Dane Quaternary Sand and Gravel Aquifers which had a poor chemical rating in 2019.

4.2.8 Industrial Land Use Information

There are 15no. records of historical potentially contaminative industrial land uses within 500m of the site. The closest record refers to an unspecified pit located 137m to the north of the site, dated 1978. Other records in the vicinity refer to cuttings, slags heap, unspecified heap, nurseries, unspecified ground workings and unspecified pit.

There are 4no. records of current potentially contaminative industrial land uses within 500m of the site. The closest record refers to Fix Computers, an electrical equipment and repair servicing located 47m to the west of the site.

There are 6no. records of historical tanks identified within 500m of the site. The closed record refers to an unspecified tank located 14m to the northeast of the site, dated 1935.

There are 18no. historical energy features recorded within 500m of the site. The closest record refers to an electricity substation located 185m to the east of the site, dated 1956.

There are no records of current or historical petrol and fuel sites, or historical garages and motor vehicle repair sites within 500m of the site.

There are no records of current National Grid underground electricity cables, or National Grid gas transmission pipelines within 250m of the site.

4.2.9 Environmental Permits, Incidents and Registers

There are 2no. records of Licensed Discharges to controlled waters within 500m of the site. The closest record refers to a manhole and interceptor for sewage discharge located 240m to the east of the site. The licence was revoked in March 1991.

There are 3no. records of Substantiated Pollution Incidents within 500m of the site. The closest record refers to the release of household waste located 113m to the northeast of the site. The incident had a Category 3 (Minor Impact) on land and Category 4 (No Impact) on water and air.

4.2.10 Landfill and Waste Management Activity

There are no records for current Environment Agency landfill sites or licensed waste sites within 500m of the site.

There is 1no. record of a historic Environment Agency landfill site within 500m of the site. The record refers to a landfill on Princess Road – Yew Tree Road located 332m to the north of the site. The landfill waste was last recorded in 1994, however the waste type is unknown.

There are no records of a BGS/DoE non-operational landfill sites within 500m of the study site.

There are no records of a historical landfill or historical waste sites from the Local Authority and Historical Mapping Records within 500m of the site.

There is 1no. record of a waste treatment, transfer or disposal site within 500m of the study site. The record refers to a treating water exemption on Sale Road located 380m to the west of the site. The license was for the sorting and de-naturing of controlled drugs for disposal.

4.2.11 Environmentally Sensitive Sites

There are 3no. records of a Site of Specific Interest (SSSI) within 2km of the study site. The closest record refers to Wythenshawe Park located 511m to the south of the site.

There are 3no. records of Designated Ancient Woodland located within 2km of the study site. The closest record refers to Black Field Wood located 1km to the south of the site.

There are 2no. records Green Belt land within 2km of the study site. The closest record refers to the Merseyside and Greater Manchester Green Belt located 38m to the northeast of the site.

4.2.12 Potential Flood Risks

Detailed assessment of flood risks is outside the scope of this report. However, an Environment Agency Flood Zone 2 and 3 are not located on site.

There are no records of flooding from rivers and sea (RoFRaS) within 50m of the site.

There are no records of flood defences or areas used for flood storage within 250m of the site.

The highest risk of surface water flooding occurring on-site is 1 in 1000 year, 0.1m-0.3m.

The highest risk of groundwater flooding occurring on-site is moderate.

4.3 Site History

The historical development of the site has been determined by reference historical plans and Google Earth imagery. The reviewed historical plans comprise only readily available records and may be limited; however, the information available to date indicates that additional searches are unlikely to add to our understanding of the site. The earliest available historical mapping covering the site dates to 1874.

The site history is summarised in Table 1, below.

Table 1: Summary of Site History

Date	Site	Surrounding Land Use
1874 (1:2,500)	A dwelling, L-shaped building and a smaller outbuilding are located on site labelled Beech House. Another small building is located on the northeast boundary. The remainder of the site comprises landscaped garden with trees.	The site is surrounded by agricultural fields with a few residential dwellings. A pond is located 30m to the southeast of the site.
1897 (1:10,560) 1898 (1:2,500)	No significant change.	Another residential dwelling has developed along Yew Tree Lane The pond is no longer present to the southeast. A police station is located 750m to the southeast of the site.
1905 (1:10,560) 1907 (1:2,500)	Bay windows have developed on the dwelling.	St. Hilda's R.C Church is located 500m to the east of the site. Tanks and a sewage works are located 650m to northeast of the site.
1910 (1:2,500) 1907-1911, (1:10,560)	The dwelling has been extended to the east to join the L-shaped building. Another small outbuilding has developed on the northeast of the site.	Two greenhouses and orchard trees have developed on the plot of the land along the northern site boundary.
1922 (1:2,500) 1923 (1:10,560)	No significant change.	A golf course has developed on the land 550m to the east of the site. Allotment gardens have developed 650m to the east of the site.
1934-1935 (1:2,500)	A small outbuilding has developed on the northeast corner of the site.	Residential dwellings have developed adjacent the site to the south along Yew Tree Lane.

Date	Site	Surrounding Land Use
1934-1938, 1938 (1:10,560)		A school and playing fields have developed 200m to the south of the site. Yew Tree Nurseries is located 400m to the west of the site.
1956, 1957 (1:1,250) 1954-1955, (1:10,560)	Part of the main building has been demolished to the east. The building is now labelled as a Maternity and Child Welfare Centre. The small outbuildings have all been demolished. A small rectangular outbuilding has developed on the north of the site.	Allotment gardens have developed on the land 125m to the southwest of the site. Tennis courts and a bowling green have developed along Yew Tree Lane, approximately 90m to the west of the site. Ground workings/cuttings are located 60m to the northeast of the site.
1966-1967, (1:10,560) 1977-1981 (1:10,000) 1976, 1975- 1977 (1:1,250)	No significant change.	A Child Guidance Centre and a corporation yard are located along the site boundary to the west of the site. Princess parkway has developed 200m to the west of the site. Allotment gardens are present 300m to the southeast of the site and 450m to the northwest of the site. Yew Tree Nurseries are now tennis courts.
1978-1982, 1987-1992, 1989-1992 (1:1,250)	The main building on site has been extended to the northeast.	Arden sixth form college is located 200m to the southwest of the site. Two small outbuildings/sheds have developed on the corporation yard adjacent the site to the west.
2003 (1:1,250) 2001 (1:10,000)	The building on site is labelled as Beech House Nursing Home.	No significant change.
Google Earth Imagery 2000	The building has been extended to the west and to the southeast.	No significant change.
Google Earth Imagery 2003 2010 (1:10,000)	No significant change.	The original school buildings and Arden Sixth Form College buildings have been demolished and replaced by a new college building 110m to the south.
Google Earth Imagery 2016	A ramp has been constructed at the front entrance and garden of the Nursing home for access.	The Child Guidance Centre and corporation yard along the site boundary to the west have been demolished and a new access road for a new residential development constructed.

Selected extracts from historical maps are presented in Figures 4 to 7, overleaf.

Figure 4 1874 OS Map Extract

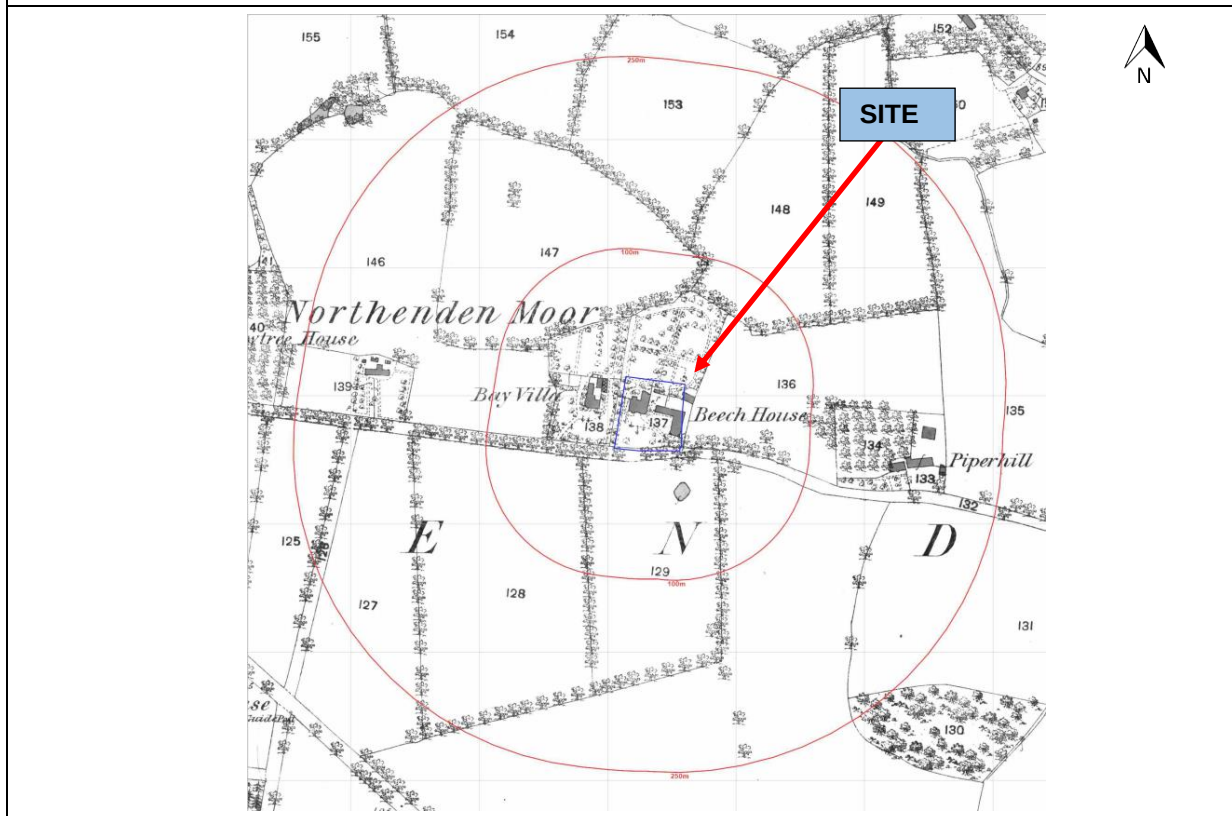
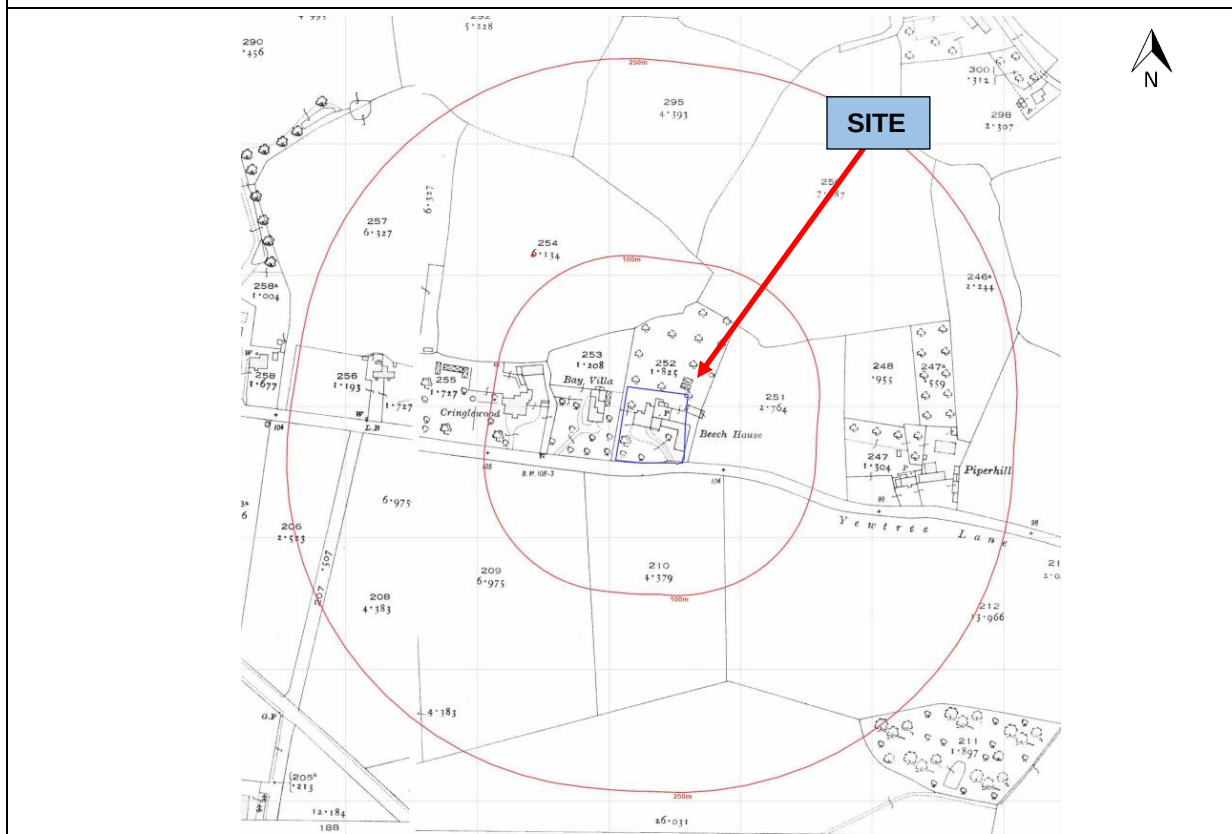


Figure 5 1922 OS Map Extract



4.4 Preliminary Contamination Risk Assessment

4.4.1 General

The following paragraphs outline a Preliminary Risk Assessment (PRA) for the site based on the above desk study information as defined by DEFRA and the EA Model Procedures for the Management of Land Contamination, CLR11⁽²⁰⁰⁴⁾.

Table 4 provides a Preliminary Conceptual Model (PCM) which considers the source-pathway-receptor linkages present alongside the likelihood, severity and risk level as defined within Table 2 and Table 3 below. The assessment of probability, a modified risk table, and certain consequence definitions are based on CIRIA C552 and CLR11.

Table 4 considers whether a pollution linkage is potentially present and provides a preliminary qualitative assessment of risk based on the information currently available. Where a possible linkage is identified, it does not necessarily mean that a significant risk exists but indicates that further information is required through appropriate site investigation to substantiate the conceptual model.

The PCM/PRA is based on a residential end use.

Table 2: Consequence, Probability and Risk

Probability	Consequence,	Risk
High Likelihood- There is a pollution linkage and an event either appears very likely in the short term and almost inevitable over the long term, or there is evidence at the receptor of harm or pollution	Very High – acute risk to the human health likely to result in significant harm. Risk of severe or irreversible effect on ground/surface water quality. Catastrophic damage to buildings / property.	Very High – there is a high potential that the source-pathway-receptor scenarios may give rise to harm to human health, or the environment and remedial action is likely to be required.
Likely – there is a pollution linkage, and all the elements are present, which means that it is probable an event will occur. Circumstances are such that an event is not inevitable, but possible in the short term and likely over the long term.	High – Severe or irreversible effect on human health. Temporary severe or irreversible effect on ground/surface water quality. Reduction of water quality rendering groundwater or surface water unfit to drink and/or substantial adverse impact on groundwater dependent environmental receptors.	High – it is likely that the source-pathway-receptor scenarios may give rise to an impact on human health or the environment, which may require remediation and/or control measures to mitigate risks
Low likelihood– there is a pollutant linkage and circumstances are possible for an event could occur. However, it is by no means certain that even over a longer period such event would take place, and is less likely in the shorter term	Moderate – Long term or short-term moderate effect on human health. Moderate effect on ground/surface water quality, reversible with time. Reduced reliability of a supply at a groundwater or surface water abstraction source	Moderate – it is possible that the source-pathway-receptor scenarios may give rise to an impact on human health or the environment, however it is either relatively unlikely that such would be severe, or if any harm were to occur it is more likely that harm would be mild.
Unlikely – there is a pollution linkage, but circumstances are such that it is doubtful that an event would occur even in the very long term.	Low – Non-permanent health effects to human health (easily prevented by means such as personal protective clothing etc.) Slight effect on ground/surface water quality, reversible with time. Marginal reduced reliability of a supply at a groundwater or surface water abstraction source.	Low – it is possible that harm could arise at the source, however it is likely that this would at worst be mild.
		Very Low – it is unlikely that the source-pathway-receptor scenarios will give rise to an impact on human health or the environment.

Table 3: Estimation of Level of Risk by Comparison of Consequence and Probability

		Consequence			
		High	Moderate	Low	Very low
Probability	High Likelihood	Very High	High risk	Moderate risk	Moderate to low risk
	Likely	High risk	Moderate risk	Moderate to low risk	Low risk
	Low Likelihood	Moderate risk	Moderate to low risk	Low risk	Very low risk
	Unlikely	Moderate to low risk	Low risk	Very low risk	Very low risk

4.4.2 Potential Sources

The site was historically occupied by a dwelling, an L-shaped building and small outbuilding which were part of Beech House. Overtime, small outbuildings have developed on site, the existing dwelling has been extended, and several buildings fully or partially demolished. Therefore, Made Ground is anticipated beneath the site. The main dwelling building became a Maternity and Child Welfare Centre around 1957. More recently the building became Yew Tree Manor Care home which is fully occupied by residents. Given the age of the building, asbestos may be present.

Potential off-site sources of contamination include a historical unspecified tank located 14m to the northeast of the site, dated 1935.

Therefore, there is potential for the presence of contamination associated with the following:

- Made Ground associated with demolished buildings (e.g., heavy metals, TPH, PAH)
- Asbestos containing materials (ACM) in the existing building and within the Made Ground.

4.4.3 Potential Receptors

The following receptors have been considered for the construction and operational stages of the proposed redevelopment.

- Current site users;
- Adjacent land users;
- Future land users;
- Construction workers during site development works;
- Groundwater within the underlying Aquifer;

4.4.4 Potential Pathways

The following pathways have been considered for the construction and operational stages of the proposed redevelopment.

- Dermal contact, ingestion, inhalation pathways of potentially contaminated soils;

- Downward vertical migration of leachate within the Made Ground to shallow groundwater;
- Vertical or lateral migration of ground gas associated with Made Ground.

Table 4: Preliminary Conceptual Model

Source	Pathway	Receptor	Probability	Consequence	Risk	Comment
Potential ground contamination associated with Made Ground and demolished buildings	Dermal contact, ingestion and inhalation of soils dust	Current Site Users	Unlikely	Moderate	Low risk	The site is currently occupied by Yew Tree Manor Care Home with areas of soft landscaping and hardstanding. Made Ground is likely present beneath the site, associated with demolished buildings. However, no historical buildings appear to be industrial and therefore contamination is unlikely. No homegrown produce is on site. The risk to current site users from potential contamination is LOW .
		Adjacent land users	Unlikely	Moderate	Low risk	The surrounding areas comprise predominantly of residential dwellings. Made Ground is likely present beneath the site, associated with demolished buildings, however contamination is unlikely. Usual dust control measures should be implemented as part of good site working practices during construction to reduce dust generation. Therefore, the risk is considered LOW .
		Future land users	Low Likelihood	Moderate	Moderate to Low risk	The proposed development includes demolition of Yew Tree Manor Care Home and construction of new care home with a larger footprint. It is unknown whether areas of soft landscaping are proposed as part of the new development. Therefore, the risk to future site users via direct exposure is MODERATE to LOW .
		Construction Workers	Unlikely	Moderate	Low risk	Construction workers may be exposed to Made Ground soils during construction works, however exposure duration will be short-term only. Appropriate health and safety measures (in line with CDM and other relevant health and safety guidance) will reduce the risk. Therefore, the risk to construction workers is LOW .
	Downward vertical migration of leachate to shallow groundwater	Groundwater within the underlying Aquifers	Unlikely	Low	Very Low risk	The underlying superficial soils are anticipated to be granular with a high leaching potential. The groundwater vulnerability is high to very high, however there are no obvious sources of leachable contaminants present on site. Therefore, the risk to groundwater is therefore considered VERY LOW .
	Lateral migration in surface waters	Surface water	Unlikely	Low	Very Low risk	There are no surface water features in close proximity to site. There are no obvious sources of leachable contaminants present on site. Therefore,

Source	Pathway	Receptor	Probability	Consequence	Risk	Comment
	Vertical or lateral migration of ground gas associated with Made Ground					the perceived risk to surface waters is VERY LOW .
		Current Site Users	Unlikely	Moderate	Low	Ground gas may be present on site associated with Made Ground, and underground voids from demolished buildings, albeit unlikely. The underlying superficial soils are granular, and it is likely any ground gases have now dissipated. The risk to from ground gas is considered LOW .
		Adjacent land users	Unlikely	Moderate	Low	The underlying superficial soils are granular which may cause lateral migration to adjacent land users. However, the presence of ground gases associated with the Made Ground is unlikely. Therefore, the risk to adjacent site users from ground gas is therefore considered LOW .
		Future land users	Unlikely	Moderate	Low	The proposed development includes demolition of Yew Tree Manor Care Home and construction of new care home with a larger footprint. Modern construction practices will provide a barrier and ventilation. The risk associated with future site users is LOW .
		Construction Workers	Low Likelihood	Moderate	Moderate to Low risk	Construction workers may be exposed to ground gas/depleted oxygen conditions in confined spaces and excavations; however, the duration will be short term. The risk to construction workers from ground gas is considered MODERATE to LOW .
Potential Asbestos containing materials (ACM) in the Made Ground.	Inhalation of fibres	Current Site Users	Unlikely	Moderate	Low	The site is currently occupied by Yew Tree Manor Care Home with areas of soft landscaping and hardstanding. Made Ground is likely present beneath the site, associated with demolished buildings which may contain asbestos, albeit unlikely. Therefore, the risk to current site users from asbestos is LOW .
		Adjacent land users	Unlikely	Moderate	Low	The surrounding areas comprise predominantly of residential dwellings. Asbestos may be present in the Made Ground, associated with demolished buildings or within the existing care home to be demolished. Usual dust control measures should be implemented as part of good site working practices during construction to reduce dust generation. The risk to site adjacent land users is therefore considered LOW .
		Future land users	Low Likelihood	Moderate	Moderate to Low risk	The proposed development includes demolition of Yew Tree Manor Care Home and construction of a new care home with a larger footprint. Asbestos

Source	Pathway	Receptor	Probability	Consequence	Risk	Comment
						may be present in the Made Ground, associated with demolished buildings or within the existing care home to be demolished. The risk to future end users is therefore considered MODERATE to LOW . A contamination assessment and a pre-demolition asbestos survey will reduce the risk to LOW .
		Construction Workers	Low Likelihood	Moderate	Moderate to Low risk	Construction workers may be exposed to ACM within the Made Ground Soils and demolition materials during the construction phase. The risk is considered MODERATE to LOW . An asbestos screen of the existing on-site soils would be required to determine the level of risk and necessary mitigation measures. A pre-demolition asbestos survey is recommended to reduce the risk to LOW .

4.4.5 Preliminary Risk Assessment

The overall risk from soil contamination to future end users and construction workers is concluded to be **LOW**. The risk to controlled waters is concluded to be **VERY LOW** and the risk from ground gas to end users is **LOW**.

A pre-demolition asbestos survey is recommended on the Yew Tree Manor Care Home building before development.

4.5 Geotechnical Hazards Associated with the Development

In addition to the environmental hazards there are also geotechnical hazards associated with the stability of the ground including load bearing capacity, slope stability and effects of ground mining activities. Local Authorities follow NPPF (2021) which requires that a site is suitable for its new use considering of ground conditions and land instability, including from natural hazards to former activities such as mining.

A summary of the geotechnical considerations is provided below in Table 5.

Table 5: Summary of Geotechnical Hazards

Geohazards:	
Highly Compressible Ground	Negligible
Collapsible Soils	Very low
Swelling Clay	Negligible
Running Sand	Very low
Ground Dissolution	Negligible
Landslip	Very low
Mining & Quarrying	No mining is recorded as taking place on site. The site is not located within a Coal Mining Reporting Area, therefore the risk is very low. Historical records show an unspecified pit was located 137m to the north, however it will not impact the site.
Geotechnical Design Considerations	
Site Clearance	Areas of the site are surfaced in granular Made Ground, tarmac and paving which will need to be broken out and removed off site. The material can be reused on site providing it is not contaminated.
Trees	Trees and hedgerows are located along the perimeter of the site. Three large trees are located adjacent the existing site access route from the southeast. A few young trees will need to be removed for proposed car parking spaces. The presence of trees may influence the depth at which foundations should be placed in cohesive soils, however granular soils are anticipated.
Existing Buildings/Obstructions	Yew Tree House Care Home is located on site and currently occupied by residents. The building will be demolished as part of the proposed development. Former buildings have previously been demolished on site and therefore obstructions within the Made Ground are anticipated. Underground services are shown to underlie the site which will need to be carefully exposed.
Foundations	The depth and type of proposed foundations would depend on the ground conditions present on site. The site is underlain by superficial deposits of Glaciofluvial Sheet Deposits, comprising sand and gravel. According to the BGS borehole record located 150m from the site, dense sand and gravel was encountered to 4.72m and stiff boulder clay to 5.03m beneath which was shallow bedrock. Therefore, shallow foundations may be suitable. An intrusive ground investigation is recommended prior to any construction works taking place to discover the most suitable foundation options for the site and to make sure the

	ground conditions are the same across the entire site.
Geotechnical Design Considerations	
Floor Slabs	Again, an intrusive geotechnical investigation is recommended prior to any construction works to discover the most suitable floor slab design for the on-site ground conditions.
Groundwater	Exact groundwater conditions are not known at this stage. For more detailed knowledge of the groundwater regime, an intrusive investigation would be needed. However, it is recorded that the site is underlain by the Tarporley Siltstone Formation, which is classified as a Secondary B Aquifer with a moderate to low permeability. The highest risk of groundwater flooding occurring on-site is moderate.
Earthworks	Extensive earthworks are unlikely to be required for the proposed development. However, the existing building, access ramps and steps will need to be removed and the car park area resurfaced.
Slopes	The site has a relative flat topography.
Retaining Walls	There are no retaining walls present on site.
Chemically aggressive ground conditions	Chemically aggressive ground conditions are not expected at this site. An intrusive geotechnical investigation would be necessary to confirm chemically aggressive ground.

5.0 SITE INVESTIGATION

5.1 Exploratory Fieldwork

The fieldwork was carried out by EEG on Wednesday 6th April 2022 and comprised:

- Five window sample boreholes (designated WS1 to WS5 inclusive) were each sunk to a depth of between 5.00m below existing ground level. Window sampler boring is carried out with a small, track-mounted rig, which uses a chain-driven trip hammer to drive sampling tubes or penetrometers into the ground. These tools are coupled to the anvil of the hammer by solid drill rods. Sampling tubes comprise “windowless samplers”, which are plain sampler tubes in which a continuous disturbed sample is recovered within a semi-rigid plastic liner. To reduce friction within the borehole, sampling tubes of progressively smaller diameter are used as the borehole depth increases. Sampler diameters generally range from between approximately 90mm to 50mm. Standard Penetration Tests (SPTs) were undertaken in the boreholes in accordance with BS EN ISO 22476-3. Groundwater observations were noted where possible. These observations relate to the time of the investigation only, and do not necessarily reflect seasonal fluctuations. Exploratory hole logs are included in Appendix 2.

Exploratory hole locations were chosen based on the proposed development and located on-site by an EEG engineer avoiding known services.

Table 6 below indicates the appropriate features targeted.

Table 6: Sampling Location Justification

Exploratory Hole	Sampling Location
WS1	Beneath the existing hardstanding/ proposed building footprint
WS2	Existing soft landscaped area/ proposed building footprint
WS3	Existing soft landscaped area/ proposed building footprint
WS4	Existing shared garden/ proposed building footprint
WS5	Existing shared garden/ proposed building footprint

Each exploratory location was scanned using a Cable Avoidance Tool (CAT) to locate unrecorded underground services, and the exploratory locations were repositioned if necessary. On completion, samples recovered from the site were taken to specialist laboratories for chemical and geotechnical testing.

Soil samples were recovered in 250g glass amber jars and 1kg plastic tubs. All the samples were labelled and stored in cool boxes prior to being collected by courier at the end of the day for delivery to the DETS laboratory.

If collection was not possible the same day, then samples were stored in the sample storage fridge at the EEG offices below 4°C.

Samples were tracked using appropriate Chain of Custody forms provided by DETS Ltd.

It should be noted that hexavalent chromium soil is analysed using the USEPA recommended method of alkaline leach. This method limits chromium (VI) reduction to chromium (III).

All site investigation work was supervised full time by a representative of EEG. The logging of soils and rocks has been carried out in accordance with BS5930^(2015+A1:2020) except where superseded by the soil and rock description methodology in BS EN14688-1⁽²⁰⁰²⁾, BS EN 14688-2⁽²⁰⁰⁴⁾ and BS EN 14689-1⁽²⁰⁰³⁾.

All sampling locations were surveyed by use of a handheld Trimble GeoXH GPS instrument that is capable of surveying to an accuracy of less than 10mm depending on satellite coverage, proximity to trees and building structures.

The descriptive terminologies such as firm, etc formerly used within older versions of BS5930 to describe strength now solely relate to consistency. Shear strength is now defined related to results obtained in the field (using a hand vane for example) or in the laboratory (from triaxial tests), as detailed in Table 7 below.

Table 7: Shear Strength Definitions

Term based on measurement	Undrained Strength (c_u) definition in kN/m ² (from BS EN ISO 14688-2: 2004, 5.3, Table 5)
Extremely Low Strength	<10
Very Low Strength	10 to 20
Low Strength	20 to 40
Medium Strength	40 to 75
High Strength	75 to 150
Very High Strength	130 to 300
Extremely High Strength	300 to 600

An Exploratory Hole Location Plan is presented as Figure 8, overleaf.

A summary of exploratory holes undertaken during the investigation are presented in Table 8 below.

Table 8: Summary of Exploratory Holes Undertaken

Hole	Type*	Depth Below Ground Level (m)	Date Started	Date Finished	Easting (m)	Northing (m)	Backfill Details**
WS1	WS	5.000	06/04/2022	06/04/2022	382131	390574	A
WS2	WS	5.000	06/04/2022	06/04/2022	382150	390574	A
WS3	WS	4.000	06/04/2022	06/04/2022	382157	390585	A
WS4	WS	5.000	06/04/2022	06/04/2022	382139	390602	A
WS5	WS	5.000	06/04/2022	06/04/2022	382151	390607	A
*WS=Windowless Sample							
**A=Arisings							

Figure 8: Exploratory Hole Location Plan



5.2 Laboratory Testing

5.2.1 Geotechnical Testing

A programme of laboratory testing was carried out on samples taken from the various strata to assist in classification and determine the engineering properties of the materials underlying the site. The tests were scheduled by EEG and carried out by Murray Rix. The test procedures used were generally in accordance with the methods described in BS1377:1990. Details of the specific tests used in each case are given in Table 9 below.

Table 9: Summary of Laboratory Geotechnical Tests Undertaken

TEST	STANDARD	No.
Moisture Content	BS1377:1990 Part 2, Clause 3.2	5
Liquid Limit, Plastic Limit, Plasticity Index	BS1377:1990 Part 2, Clause 4/5	5
Particle Size Distribution (Wet)	BS1377:1990 Part 2, Clause 9.2	3
Sulphate content of 2:1 soil: water extract	BS1377:1990 Part 3, Clause 5	6
pH value	BS1377:1990 Part 3, Clause 9	6

The results of the laboratory geotechnical tests are discussed in Section 7 and included in Appendix 3.

5.2.2 Environmental Testing

The environmental chemistry of the ground was investigated by specialist chemical analysis of selected samples, scheduled by EEG, and carried out by DETS, a UKAS and MCERTS accredited laboratory.

Chemical analyses were carried out on seven soil samples and were submitted for the following suite of determinants:

Asbestos Screen, Arsenic, Barium, Beryllium, Boron, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Selenium, Vanadium, Zinc, Cyanide, Phenol, Sulphate (SO₄), Sulphide, pH, Soil Organic Matter, Extractable Petroleum Hydrocarbons (EPH), Speciated Polyaromatic Hydrocarbons (PAH) and Speciated Petroleum Hydrocarbons.

The results of the laboratory contamination tests are discussed in Section 9 and included in Appendix 4.

6.0 GROUND CONDITIONS ENCOUNTERED

6.1 Soil Profile Encountered

BGS digital mapping shows that the site is underlain by superficial deposits of Glaciofluvial Sheet Deposits, comprising Devensian sand and gravel. The solid geology beneath the site is the Tarporley Siltstone Formation, comprising siltstone. The sequence of strata encountered beneath the site was as follows:

- **Made Ground** – Variable Made Ground was encountered in all exploratory hole locations to a maximum depth of 1.20m bgl, comprising:
 - Tarmac
 - Gravelly SAND containing red brick and siltstone
 - Slightly silty slightly gravelly SAND containing red brick, sandstone and siltstone (cobbles of red brick in WS5)
- **Topsoil** – Encountered in all borehole locations WS2 and WS3 to a maximum depth of 0.50m bgl, comprising:
 - Slightly silty SAND
- **Superficial Deposits** – were encountered in all exploratory locations to a maximum depth of 5.00m bgl. Comprising:
 - Medium dense sandy GRAVEL containing siltstone and sandstone (WS3 only)
 - Loose to dense SAND and GRAVEL containing siltstone and sandstone
 - Dense to medium dense gravelly SAND containing siltstone and sandstone
 - Medium dense silty gravelly SAND containing sandstone and siltstone
 - Medium dense silty SAND
 - Medium dense silty clayey SAND (WS4 only)
 - Soft to stiff slightly sandy CLAY.

The depths of the various materials encountered in the exploratory holes are summarised in Table 10, below.

Table 10: Summary of Ground Conditions Encountered

Hole	Depth to Stratum (m bgl)							Groundwater (m bgl)
	TOPSOIL	MADE GROUND		SUPERFICIAL DEPOSITS				
		TARMAC	SAND	SAND	SAND & GRAVEL	GRAVEL	CLAY	
WS1		GL – 0.10	0.10 – 0.30	0.30 – 2.20	2.20 – 3.80 4.00 – 4.90		3.80 – 4.00 4.90 – 5.00	3.00
WS2	GL – 0.50			0.50 – 3.00	3.00 – 3.80 4.00 – 4.70		3.80 – 4.00 4.70 – 5.00	
WS3	GL – 0.50			0.50 – 1.40	1.40 – 3.40	3.40 – 4.00		
WS4			GL – 1.00	1.00 – 3.50 4.00 – 4.60			3.50 – 4.00 4.60 – 5.00	
WS5			GL – 1.20	1.20 – 2.00 3.00 – 3.60 4.00 – 4.70	2.00 – 3.00		3.60 – 4.00 4.70 – 5.00	

6.2 Observable Indications of Contamination

No visual or olfactory indications of contamination were identified during the site investigation aside from Made Ground materials such as red brick which are considered inert.

6.3 Obstructions

Cobbles of red brick were encountered in the Made Ground in window sample borehole location WS5 between 0.90m and 1.20m bgl. Historically, several buildings were present on this area of the site which have since been demolished. No other man-made obstructions were encountered during the site investigation.

6.4 Groundwater

Groundwater was observed in window sample borehole location WS1 at 3.00m below ground level.

7.0 ENGINEERING PROPERTIES OF SOILS ENCOUNTERED

7.1 General

The following sections discuss the engineering properties of the strata encountered, based on results of in situ and laboratory testing obtained during this investigation.

Table 11: Summary of Laboratory Geotechnical Test Results

Location	Depth Below Ground Level (m)	Strata*	CLASSIFICATION								CHEMICAL	
			Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Modified Plasticity Index (%)	PSD Gravel (%)	PSD Sand (%)	PSD Silt (%)	pH Value	Water Soluble Sulphate SO ₄ (mg/l)
WS1	1.80	SAND	-	-	-	-	-	33	66	1	7.5	210
WS1	3.90	CLAY	24	37	15	22	20	-	-	-	-	-
WS2	2.50	SAND	-	-	-	-	-	-	-	-	7.3	280
WS2	4.90	CLAY	25	39	16	23	22	-	-	-	7.1	220
WS3	3.50	GRAVEL	-	-	-	-	-	55	41	4	7.0	160
WS4	3.70	CLAY	25	37	16	21	19	-	-	-	-	-
WS4	4.70	CLAY	29	40	16	24	23	-	-	-	7.2	120
WS5	3.10	SAND	-	-	-	-	-	25	70	5	7.0	190
WS5	3.90	CLAY	29	38	15	23	22	-	-	-	-	-

7.2 Made Ground

Made Ground was encountered in exploratory hole locations WS1, WS4 and WS5 between ground level and a maximum depth of 1.20m below ground level.

An SPT test carried out in the Made Ground was corrected for drilling energy efficiency and overburden pressure and resulted in an N1(60) value of 14, as shown on the SPT v Depth Plot in Figure 9 (overleaf).

Made Ground is not considered a suitable material for foundations and as such no further geotechnical testing has been carried out on this lithology.

7.3 Superficial Deposits

As discussed in Section 6, soils interpreted to represent the Glaciofluvial Sheet Deposits were encountered across the site as medium dense to dense SAND, or a loose to dense SAND AND GRAVEL. A medium dense GRAVEL was also encountered in WS3. Soft to stiff CLAY was encountered towards the base of the boreholes.

7.3.1 SAND

Sand was encountered in all exploratory hole locations below the Made Ground and Topsoil, at depths between 0.30m and 4.70m below ground level.

The **water-soluble sulphate** content of three sand samples ranged from 190mg/l to 280mg/l SO₄, with a **pH value** of between 7.0 and 7.5.

Particle Size Distribution (PSD) tests were carried out on two samples of sand. The laboratory described the material as a brown silty SAND with frequent gravel (70% sand) or a brown silty SAND & GRAVEL (66% sand).

SPT tests carried out in the sand were corrected for drilling energy efficiency and overburden pressure and resulted in N1(60) values of between 12 and 44, as shown on the SPT v Depth Plot in Figure 9 (overleaf). This result suggests the sand is dense to medium dense.

Recommended N values and derived design values for the granular soils are summarised in Table 12, below.

Table 12: Summary of Design Parameters (Sand)

Depth	SPT N1(60) Value Range	Average N1(60) Value	Design N1(60) Value*	Equivalent Soil Density	Angle of Internal Friction (degrees°)**
1.0	14 - 44	26	16	Medium Dense	31.9
2.0	21 - 31	25	22	Medium Dense	33.7
3.0	14 - 18	16	15	Medium Dense	31.6
4.0	12	12	12	Medium Dense	30.6
*Based on lower quartile N1(60) value					
**Based on the correlation by Peck, Hanson and Thornburn ⁽¹⁹⁷⁴⁾					

It is recommended that for assessing ultimate bearing capacities, where the lower values are critical, the lower quartile value of N values is used.

Based on the correlation by Peck, Hanson and Thornburn ⁽¹⁹⁷⁴⁾, this gives an **angle of shearing resistance** of between $\phi=31.9$ at 1.0m bgl.

For assessing settlements average ground conditions will give a more realistic value of settlements, and the Average of N values should be used.

7.3.2 SAND AND GRAVEL

Sand and gravel was encountered in all exploratory hole locations below the sand, at depths between 1.40m and 4.90m below ground level.

SPT tests carried out in the sand and gravel were corrected for drilling energy efficiency and overburden pressure and resulted in N1(60) values of between 8 and 36, as shown on the SPT v Depth Plot in Figure 9 (overleaf). This result suggests the sand and gravel is loose to dense.

Recommended N values and derived design values for the granular soils are summarised in Table 13, overleaf.

Table 13: Summary of Design Parameters (Sand and Gravel)

Depth	SPT N1(60) Value Range	Average N1(60) Value	Design N1(60) Value*	Equivalent Soil Density	Angle of Internal Friction (degrees°)**
2.0	35 - 36	36	35	Dense	37.4
3.0	8 - 28	19	14	Medium Dense	31.3
4.0	13 - 21	17	15	Medium Dense	31.6
*Based on lower quartile N1(60) value					
**Based on the correlation by Peck, Hanson and Thornburn ⁽¹⁹⁷⁴⁾					

It is recommended that for assessing ultimate bearing capacities, where the lower values are critical, the lower quartile value of N values is used.

Based on the correlation by Peck, Hanson and Thornburn ⁽¹⁹⁷⁴⁾, this gives an **angle of shearing resistance** of between $\phi=37.4$ at 1.0m bgl.

For assessing settlements average ground conditions will give a more realistic value of settlements, and the Average of N values should be used.

7.3.3 GRAVEL

Gravel was encountered in exploratory hole location WS3 only below the sand and gravel, at depths between 3.40m and 4.00m below ground level.

The **water-soluble sulphate** content of one gravel sample was 160mg/l SO₄, with a **pH value** of 7.0.

Particle Size Distribution (PSD) tests were carried out on one sample of gravel. The laboratory described the material as brown slightly silty SAND & GRAVEL (55% gravel).

An SPT test carried out in the gravel was corrected for drilling energy efficiency and overburden pressure and resulted in a N1(60) value of 22, as shown on the SPT v Depth Plot in Figure 9 (overleaf). This result suggests the gravel is medium dense.

Recommended N values and derived design values for the granular soils are summarised in Table 14, below.

Table 14: Summary of Design Parameters (Gravel)

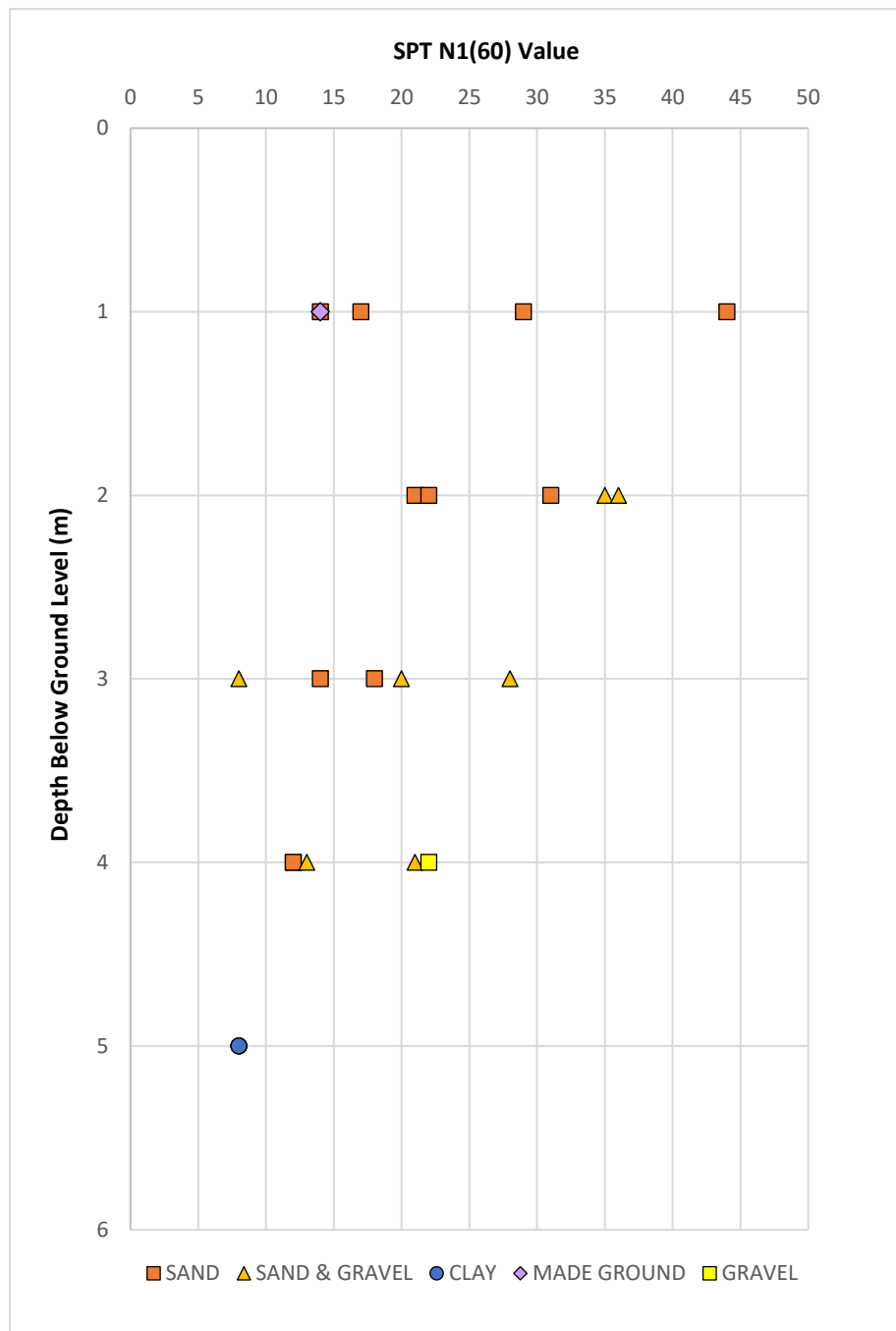
Depth	SPT N1(60) Value Range	Average N1(60) Value	Design N1(60) Value*	Equivalent Soil Density	Angle of Internal Friction (degrees°)**
4.0	22	22	22	Medium Dense	33.7
*Based on lower quartile N1(60) value					
**Based on the correlation by Peck, Hanson and Thornburn ⁽¹⁹⁷⁴⁾					

It is recommended that for assessing ultimate bearing capacities, where the lower values are critical, the lower quartile value of N values is used.

Based on the correlation by Peck, Hanson and Thornburn ⁽¹⁹⁷⁴⁾, this gives an **angle of shearing resistance** of between $\phi=33.7$ at 4.0m bgl.

For assessing settlements average ground conditions will give a more realistic value of settlements, and the Average of N values should be used.

Figure 9: SPT v Depth Plot



7.3.4 CLAY

Clay was encountered in exploratory hole locations WS1, WS2, WS4 and WS5 beneath the granular material, at depths between 3.50m and a maximum depth of 5.00m below ground level.

SPT tests carried out in the clay were corrected for drilling energy efficiency and overburden pressure and resulted in N1(60) values of 8, as shown on the SPT v Depth Plot, in Figure 9 (above). The results suggest the clay is soft to firm.

In-situ **hand penetrometer** (HP) tests were carried out on the recovered soils, the results of which generally ranged between 48kPa (kN/m²) to 96kPa, suggesting the clay tested is medium to high strength.

For design purposes, the more conservative N1(60) values were used, as the gravel content of the clay can affect the hand penetrometer readings. Recommended N values and derived design values for clay soils are summarised in Table 15, below.

Table 15: Summary of Design Parameters (Clay)

Depth (m)	SPT N1(60) Value Range	Average N1(60) Value	Design N1(60) Value*	Equivalent Shear Strength** (kN/m ²)	Coefficient of Volume Compressibility** (mv)
5.0	8	8	8	41 (Medium Strength)	0.25
*Based on lower quartile N value and correlations by Peck Hanson and Thornburn ⁽¹⁹⁷⁴⁾					
**Based on correlation by Stroud & Butler ⁽¹⁹⁷⁵⁾					

It is recommended that for assessing ultimate bearing capacities, where the lower values are critical, the lower quartile value of N values is used. Based on the N Value in the above table, the equivalent shear strength value was 41kN/m².

Atterberg Limit tests were carried out on five samples of the clay. Results of the test reported **liquid limit** values in the range of 37% to 40% and **plastic limit** values in the range of 15% to 16%, resulting in values of **plasticity index** in the range of 21% to 24%. These results suggest the clay to be of **intermediate plasticity**. Results are shown on the Plasticity Chart in Figure 11, overleaf.

For design purposes, a value of plasticity index = 23% is recommended, based on the upper quartile value of the results.

The **coefficient of volume compressibility (mv)** has been estimated using the following correlation by Stroud and Butler ⁽¹⁹⁷⁵⁾: for a clay with a plasticity index of 23%, $mv = 1 / (0.51 \times N \text{ value})$. This correlation gives values of coefficient of volume compressibility of 0.25m²/MN as shown in Table 15. The results suggest the clay has a **medium compressibility**.

In accordance with NHBC Chapter 4.2 Building Near Trees ⁽²⁰⁰³⁾ soils can be classified in terms of volume change potential, using the relationship:

$$I'_p = I_p \times \frac{\% \text{ less than } 425\mu\text{m}}{100\%}$$

I'_p = modified plasticity index,
 I_p = plasticity index.

Based on the laboratory test results, the above relationship and Table 1 of NHBC Chapter 4.2, the samples of Clay are shown to have **low to medium volume change potential**.

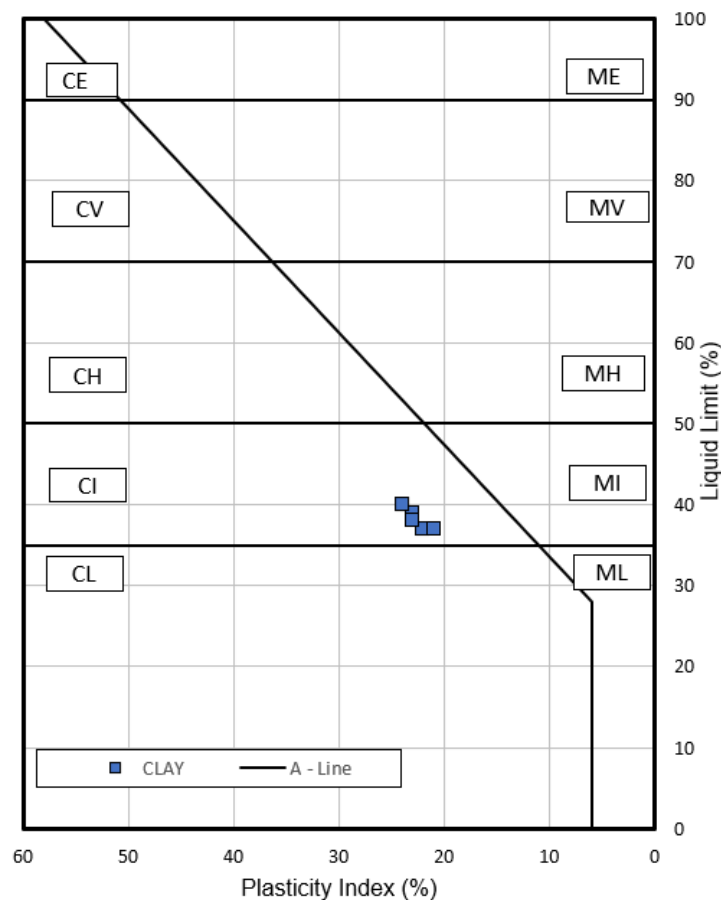
The **Natural Moisture Content** (NMC) and **Liquid Limit** (LL) of the soil can be used to give an indication of **soil desiccation**, i.e., where the NMC is less than 40% of the LL, the soil is inferred to be desiccated, as summarised in Table 16, below.

Table 16: Soil Desiccation Indicators in the Clay

Location	Depth (m)	Liquid Limit (%)	40% Liquid Limit (%)	Natural Moisture Content (%)	Desiccation
WS1	3.90	37	15	24	No
WS2	4.90	39	16	25	No
WS4	3.70	37	15	25	No
WS4	4.70	40	16	29	No
WS5	3.90	38	15	29	No

The results in the above table show none of the clay samples collected show evidence of desiccation.

Figure 10: Plasticity Chart



8.0 GEOTECHNICAL ASSESSMENT

8.1 Proposed Development

It is understood that the client wishes to demolish Yew Tree Manor Care Home to construct a new Care Home with a larger building footprint. The existing access route from Yew Tree Lane will be retained but utilised as a vehicle exit only. Another access route will be developed along Yew Tree Lane to be utilised as a vehicle entrance.

Detailed information regarding structural loadings and proposed foundation type was not available, however, we anticipate the loadings to be similar to those of a typical two-storey house (50kN/m² to 75kN/m²).

8.2 Ground Conditions Encountered

The exploratory holes encountered Made Ground in locations WS1, WS4 and WS5 to a maximum depth of 1.20m bgl (WS5) and Topsoil in locations WS2 and WS3 to a maximum depth of 0.50m bgl.

Underlying the Made Ground and Topsoil were Glaciofluvial Sheet Deposits comprising predominantly medium dense to dense SAND, or a loose to dense SAND AND GRAVEL. A medium dense GRAVEL was also encountered in WS3. Soft to stiff CLAY was encountered beneath the granular soils, towards the base of the boreholes.

Groundwater was encountered in exploratory hole location WS1 only at 3.0m bgl.

8.3 Foundation Considerations

Based on the ground conditions encountered, it is anticipated that conventional shallow strip/pad foundations are considered suitable for the site, providing the structural loadings are relatively low and subject to tolerance of structure to settlement.

The foundations should be placed in the Glaciofluvial Sheet Deposits. It should be noted that Made Ground was encountered to depths of 1.20m bgl in WS5.

Should the allowable bearing pressure and settlement prove unfavourable, then alternative foundations options will need to be considered.

The shallow strip/pad foundations are discussed below in 7.3.1.

8.3.1 *Conventional Shallow Depth Strip/Pad Foundations*

Strip/Pad foundations should be taken down below any Made Ground and placed in the Glaciofluvial Sheet Deposits. If any Made Ground, particularly loose or soft material, is encountered at foundation level this should be excavated and replaced with suitable granular fill or the foundation extended at least 150mm into suitable natural strata.

Foundations should be placed in materials of similar bearing and consolidation characteristics to avoid potential differential settlement occurring. Should foundations cross from cohesive to granular soils, nominal reinforcement should be incorporated to avoid the effects of differential settlement.

Table 17 below summarises anticipated allowable bearing pressures for strip/pad foundations placed in the sand. The bearing capacities are calculated based on Hansen's ⁽¹⁹⁷⁸⁾ method and assuming a factor of safety against bearing capacity failure of 3. Groundwater was encountered during the site investigation in WS1 only at 3.0m bgl. For the purpose of the calculation, groundwater has been assumed to be at 3.0m bgl in all boreholes to present a worst-case scenario.

Table 17: Summary of Allowable Bearing Pressures

Foundation Strata	Design Value (Section 7)	Foundation Depth (m bgl)	Foundation Type	Foundation Size (m)	Allowable Bearing Pressure (kN/m ²)
SAND	$\phi = 31.9^\circ$	1.5	Strip	0.4	340
				0.9	357
			Pad	1.0 x 1.0	514
				2.0 x 2.0	519
	$\phi = 33.7^\circ$	2.0	Strip	0.4	554
				0.9	578
			Pad	1.0 x 1.0	870
				2.0 x 2.0	860
SAND & GRAVEL	$\phi = 37.4^\circ$	2.0	Strip	0.4	868
				0.9	923
			Pad	1.0 x 1.0	1443
				2.0 x 2.0	1438

Table 18 below summarise anticipated settlements of the above foundations in clay based on N values discussed in Section 7. Settlement in granular soils typically comprises a large amount of immediate settlement as loads are applied and a smaller proportion of consolidation settlement, which will occur over a longer period.

For the purposes of the calculations the strata over the depth of influence of the foundation is assumed as the same type. As the proposed foundation loading is not known, for the purposes of these calculations a foundation loading of 75kN/m² has been used.

Table 18: Summary of Anticipated Settlement

Foundation Strata		Foundation Type	Foundation Size (m)	Foundation Loading (kN/m ²)	Settlement* (mm)		
					Lower Limit	Upper Limit	Best Estimate
SAND	1.5	Strip	0.4	75	1	2	1
			0.9	75	1	4	2
		Pad	1.0 x 1.0	75	1	3	1
			2.0 x 2.0	75	1	5	2
	2.0	Strip	0.4	75	1	3	1
			0.9	75	1	5	2
		Pad	1.0 x 1.0	75	1	3	1
			2.0 x 2.0	75	1	5	2
SAND & GRAVEL	2.0	Strip	0.4	75	0	1	1
			0.9	75	1	3	1
		Pad	1.0 x 1.0	75	0	2	1
			2.0 x 2.0	75	1	3	1

*Immediate settlement

Floor slabs should be designed as suspended if Made Ground of 600mm thickness or greater is present. Made ground is not considered an appropriate bearing stratum due to its variable

nature. Floor slabs may be designed as ground bearing where Made Ground is excavated and replaced with suitable granular fill.

If cohesive soils are encountered the depth of foundations will need to be adjusted for the effects of nearby trees in accordance with NHBC guidance.

All foundation excavations should be inspected by a suitable qualified engineer to prove that the founding strata is suitable and uniform along the length of the foundation, and capable of taking the anticipated structural loadings. If foundations cross from granular to cohesive soils, nominal reinforcement should be incorporated.

8.4 Pavement Design

The ground investigation identified the soil type at subgrade level to typically be Made Ground or Sand Based on the recommendations for design CBR values provided in Interim advice note 73/06, Revision 1 (2009), a conservative design CBR value of 1% should be adopted in areas where Made Ground is encountered at subgrade level.

If pavement design is altered so that the subgrade comprises Natural Strata (typically at depths in the region of 1.20m bgl), a CBR value of 60% should be adopted for the sand.

Consideration should be given to the potential differing ground conditions near surface, which could cause pavements to be constructed on variable made ground. In this context a flexible pavement design may be required.

Consideration should also be given to the use of geotextiles to allow reduction of capping thickness. For examples biaxial geogrids such as Tensar SSLA20 and SSLA30 are often used to reduce capping thickness. The advice of a suitable contractor should be sought as to the most appropriate type of geotextile to use in the ground conditions encountered at this site. Table 19 below gives a comparison of granular layer thickness with and without the use of a geotextile, in accordance with the requirement of HA25/94 Part 2.

It should be noted the type of construction will depend on proposed finished pavement levels across the site and it is recommended the pavement design is reviewed once these levels are known. In this context, it is essential further in situ CBR testing is carried out once formation levels are known to confirm design CBR values.

Table 19: Comparison of Capping Thickness with and without Geotextile

CBR	Unreinforced			Reinforced with Tensar Geogrid				
	Sub-base	Capping	Total	Sub-base	Capping	No. of grids	Total	Thickness saving
0.5%	Design not suitable			200mm	400mm	2	600mm	-
1.0%	150mm	600mm	750mm	400mm	0	1	400mm	350mm
1.5%	150mm	600mm	750mm	310mm	0	1	310mm	440mm
2.0%	150mm	600mm	750mm	260mm	0	1	260mm	490mm
3.0%	150mm	350mm	500mm	210mm	0	1	210mm	290mm
4.0%	150mm	300mm	450mm	175mm	0	1	175mm	275mm
5.0%	150mm	250mm	400mm	160mm	0	1	160mm	240mm
These figures are suitable for light access roads and car parks, based on 1000 standard axles. For heavier loaded pavements the advice of specialist contractor should be sought.								

All formation excavations should be examined by a suitably experienced engineer or inspector to check for soft or unsuitable material, which should be removed and replaced with compacted granular fill. Also, to ensure good compaction and remove unevenness, the formation should

be compacted with equipment suitable for use in the ground conditions encountered. Careful inspection of this work will also help identify any soft spots at or just below formation level.

8.5 Chemical Attack on Buried Concrete

Chemical tests, (see Appendix 3) showed low concentrations of water-soluble sulphates and near neutral conditions. Based on these conditions, it is recommended that for concrete placed in natural strata the Design Sulphate Class for the site, as defined in BRE Special Digest 1⁽²⁰⁰⁵⁾, be taken as DS-1, and the Aggressive Chemical Environment for Concrete (ACEC) site classification be taken as AC-1s. The recommendations of BRE Special Digest 1 should be followed for concrete foundations and ground bearing floor slabs.

8.6 Suitability of Excavated Materials

Acceptability criteria and testing, and methods of compaction/placement will depend on the type of contract and specification used for the construction of the proposed development and it is recommended that earthworks specifications are reviewed by a suitably qualified engineer once these have been prepared by the relevant parties.

Any cohesive Made Ground is unlikely to be suitable as structural fill and should be used for landscaping purposes only, providing it is not contaminated.

Granular Made Ground could be suitable for re-use as structural fill, providing it is not contaminated and does not contain excessive amounts of clay and providing moisture contents are controlled during placement. The control of moisture contents will be important as the cohesive content of this stratum is likely to be sensitive to moisture content changes.

8.7 Temporary Works

Formations will be susceptible to damage both by weather and trafficking, and should be protected immediately on exposure, particularly in areas where construction plant will access the site.

Excavations in Made Ground are likely to be unstable and should be battered back to an angle of 1 in 2, or a system of close sheeting and shoring adopted to ensure stability, and where personnel are required to enter excavations. All excavations should be adequately supported where personnel are required to enter.

Groundwater seepages could be encountered near surface within excavations, particularly during the wetter months of the year. Pumping of excavations from a suitable located sump is likely to be required to keep excavations dry.

All natural materials on site should be capable of being excavated using conventional excavating machinery.

9.0 SOIL CONTAMINATION RISK ASSESSMENT

9.1 Tier I Human Health Soil Risk Assessment – Groundworkers During Development

To assess the risk of soil contamination to construction and ground workers during development, guidelines from the HSE Document 'Protection of workers and the public during development of contaminated land' ⁽¹⁹⁹¹⁾ are used. The document assesses soil contamination test results and classifies the site as being uncontaminated or contaminated with varying degrees of contamination from 'slight' to 'unusually heavy'. The guideline values and laboratory test results are summarised in the following table:

Table 20: Summary of Guideline Values for Protection of Workers and the General Public During Development of Contaminated Land

Contaminant	Typical Values* for:					Test Results	Class
	Uncontaminated Soils	Slight Contamination	Contaminated	Heavy Contamination	Unusually Heavy Contamination		
	Class A	Class B	Class C	Class D	Class E		
pH (acid)	6 - 7	5 - 6	4 - 5	2 - 4	<2	5.4 - 6.7	A - B
pH (alkaline)	7 - 8	8 - 9	9 - 10	10 - 12	12	7.3 - 7.7	A
Arsenic	0 - 30	30 - 50	50 - 100	100 - 500	500	5 - 19	A
Cadmium	0 - 1	1 - 3	3 - 10	10 - 50	50	< 0.2	A
Chromium	0 - 100	100 - 200	200 - 500	500 - 2500	2500	5 - 11	A
Copper	0 - 100	100 - 200	200 - 500	500 - 2500	2500	6 - 36	A
Lead	0 - 500	500 - 1000	1000 - 2000	2000 - 1%	1.0%	11 - 363	A
Mercury	0 - 1	1 - 3	3 - 10	10 - 50	50	< 1	A
Nickel	0 - 20	20 - 50	50 - 200	200 - 1000	1000	3 - 10	A
Zinc	0 - 250	250 - 500	500 - 1000	1000 - 5000	5000	20 - 112	A
Boron	0 - 2	2 - 5	5 - 50	50 - 250	250	< 1	A
Selenium	0 - 1	1 - 3	3 - 10	10 - 50	50	< 3	A
Barium	0-500	500-1000	1000-2000	2000-1.0%	1.0%	25 - 192	A
Beryllium	0 - 5	5 - 10	10 - 20	20 - 50	50	< 0.5 - 0.8	A
Vanadium	0 - 100	100 - 200	200 - 500	500 - 2500	2500	7 - 20	A
Sulphate	0 - 2000	2000 - 5000	5000 - 1%	1% - 5%	5.05%	<200 - 549	A
Sulphide	0 - 10	10 - 20	20 - 100	100 - 500	500	< 5	A
Cyanide (free)	0 - 1	1 - 5	5 - 50	50 - 100	100	< 2	A
Phenol	0 - 2	2 - 5	5 - 50	50 - 250	250	< 2	A

Based on the above results it is considered there is a **LOW** potential risk from soil contamination to construction workers, ground workers and members of the public during construction. Appropriate measures, such as PPE, site health plans, and appropriate disposal of material arisings will mitigate any risk.

9.2 Tier I Human Health Soil Risk Assessment – Future Site Users

The following section provides a Human Health Soil Assessment for future site users. The following section compares the results of contamination analyses to residential types of end development as specified by Defra/LQM/CIEH. As part of the contamination assessment, the chemical results obtained by EEG have been screened against accepted compliance criteria, namely:

- Defra C4SL Health Criteria Values (March 2014), where available; and
- Tier 1 assessment values - based on LQM/CIEH Suitable 4 Use Levels ⁽²⁰¹⁵⁾ (S4ULs).

The contaminated land guidance has recently changed the evaluation of risk from 'minimal' (SGVs) to 'low' (referred to as Lowest Level of Toxicological Concern (LLTCs)). The policy companion document and supporting letter by DEFRA, states that C4SLs 'could be used under the planning regime, as well as within Part 2A'.

Based on these comments EEG considers the justifications and assumptions used to generate 'low' risk are suitable for the planning regime.

Where no C4SLs have been generated EEG will use the LQM S4ULs. Similar assumptions and land use to C4SLs have been used. However, toxicological information has been based on 'minimal risk' as per previous guidelines and assumptions. If contaminants are not present as C4SLs or S4ULs then LEEG will use CL: AIRE GACs. These follow the 'minimal' risk principal and more stringent exposure parameters and will be conservative.

EEG consider the main risk drivers for PAHs are benzo(a)pyrene (B(a)P) and naphthalene. This is due to B(a)P possibly being a carcinogen and most toxic of the PAHs and naphthalene the most volatile and soluble. The new C4SLs indicate B(a)P as a surrogate marker for carcinogenic PAHs, since the risk from other non-carcinogenic PAHs are considered negligible. Naphthalene will be treated separately using the LQM S4ULs.

As a preliminary screening assessment, all results have been compared to residential end use criteria.

The soil chemical testing results are summarised in Table 21, overleaf.

Table 21: Soil Results Comparison with C4SL/S4UL Values

Determinand	C4SL/S4UL Levels Residential with Homegrown Produce (mg/kg) (a)	C4SL/S4UL Levels Residential without Homegrown Produce (mg/kg) (b)	WS1 0.30m MG	WS1 1.00m MG	WS2 0.20m MG	WS3 0.50m MG	WS4 1.10m MG	WS5 0.40m MG	WS5 1.20m MG	No of Exceedances
Metals										
Arsenic	37	40	5	5	9	13	5	16	19	0
Beryllium	1.7	1.7	< 0.5	< 0.5	< 0.5	0.6	< 0.5	0.7	0.8	0
Boron	290	11000	< 1	< 1	< 1	< 1	< 1	< 1	< 1	0
Cadmium	22	150	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	0
Chromium	910	910	5	11	10	12	6	11	11	0
Chromium VI	21	21	< 2	< 2	< 2	< 2	< 2	< 2	< 2	0
Copper	2400	7100	6	14	23	28	10	32	36	0
Lead	200	310	11	40	131	363	111	230	280	3 for (a), 1 for (b)
Inorganic Mercury	1.2	56	< 1	< 1	< 1	< 1	< 1	< 1	< 1	0
Nickel	180	180	3	5	5	9	5	10	10	0
Selenium	250	430	< 3	< 3	< 3	< 3	< 3	< 3	< 3	0
Vanadium	410	1200	7	13	15	18	9	20	20	0
Zinc	3700	40000	20	28	41	58	39	109	112	0
Petroleum Hydrocarbons										
Benzene	0.087	0.38	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0
Toluene	130	880	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0
Ethylbenzene	47	83	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0
o-xylenes	60	88	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0
m-xylenes	59	82	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0
p-xylenes	56	79	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0
Aliphatic EC >5-6	42	42	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0
Aliphatic EC >6-8	100	100	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0
Aliphatic EC >8-10	27	27	< 2	< 2	< 2	< 2	< 2	< 2	< 2	0
Aliphatic EC >10-12	130 (v)	130 (v)	< 2	< 2	< 2	< 2	< 2	< 2	< 2	0
Aliphatic EC >12-16	1100 (s)	1100 (s)	< 3	< 3	< 3	< 3	< 3	< 3	< 3	0
Aliphatic EC >16-21	65000 (s)	65000 (s)	< 3	< 3	< 3	< 3	< 3	< 3	< 3	0
Aliphatic EC >21-35	65000 (s)	65000 (s)	24	< 10	< 10	< 10	< 10	< 10	< 10	0
Aromatic EC >5-7	70	370	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0
Aromatic EC >7-8	130	860	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0
Aromatic EC >8-10	34	47	< 2	< 2	< 2	< 2	< 2	< 2	< 2	0
Aromatic EC >10-12	74	250	3	< 2	< 2	< 2	3	< 2	< 2	0
Aromatic EC >12-16	140	1800	3	< 2	< 2	< 2	2	< 2	4	0
Aromatic EC >16-21	260	1900	24	6	< 3	< 3	6	< 3	13	0
Aromatic EC >21-35	1100	1900	100	15	< 10	< 10	32	< 10	34	0

Determinand	C4SL/S4UL Levels Residential with Homegrown Produce (mg/kg) (a)	C4SL/S4UL Levels Residential without Homegrown Produce (mg/kg) (b)	WS1 0.30m MG	WS1 1.00m MG	WS2 0.20m MG	WS3 0.50m MG	WS4 1.10m MG	WS5 0.40m MG	WS5 1.20m MG	No of Exceedances
Polycyclic Aromatic Hydrocarbons										
Naphthalene	2.3	2.3	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0
Acenaphthylene	170	2900	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0
Acenaphthene	210	3000	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0
Fluorene	170	2800	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0
Phenanthrene	95	1300	2.5	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0
Anthracene	2400	31000	1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0
Fluoranthene	280	1500	4.4	< 0.1	0.8	1.3	0.6	1	< 0.1	0
Pyrene	620	3700	3.4	< 0.1	0.9	1.1	0.5	0.9	< 0.1	0
Benzo(a)anthracene	7.2	0.31	1.2	< 0.1	0.5	0.3	< 0.1	0.4	< 0.1	0
Chrysene	15	30	1.1	< 0.1	0.3	0.4	< 0.1	0.4	< 0.1	0
Benzo(a)pyrene	5	5.3	1.2	< 0.1	< 0.1	0.8	0.2	0.3	< 0.1	0
Benzo(b)fluoranthene	2.6	3.9	0.7	< 0.1	< 0.1	0.4	< 0.1	0.2	< 0.1	0
Benzo(k)fluoranthene	77	110	0.5	< 0.1	< 0.1	0.3	< 0.1	0.2	< 0.1	0
Indeno(1,2,3-cd) pyrene	27	45	0.5	< 0.1	0.2	0.3	< 0.1	< 0.1	< 0.1	0
Dibenzo (a, h) anthracene	0.24	0.31	0.2	< 0.1	0.1	0.1	< 0.1	< 0.1	< 0.1	0
Benzo(ghi)perylene	320	390	0.7	< 0.1	0.3	0.5	< 0.1	0.4	< 0.1	0
Phenols										
Phenol	280	750	< 2	< 2	< 2	< 2	< 2	< 2	< 2	0
MG = Made Ground Concentrations in red are above the assessment criteria based on a Residential End Use with or without Homegrown Produce.										

Based on the above table, 3no. soil samples tested contained concentrations of contaminants in exceedance of the screening criteria relevant to a residential end use with homegrown produce, as summarised below:

- Sample WS3 at 0.50m bgl has an elevated level of **lead** (363mg/kg),
- Sample WS5 at 0.40m bgl has an elevated level of **lead** (230mg/kg),
- Sample WS5 at 2.20m bgl has an elevated level of **lead** (280mg/kg).

However, when compared to the screening criteria without homegrown produce, only WS3 at 0.50m bgl was in exceedance.

Asbestos fibres or fragments were not identified in any of the samples tested during this investigation.

9.3 Soil Waste Assessment

An assessment of the disposal characteristics of the soil in accordance with Environment Agency guidance WM3.1, edition of June 2018, "Guidance on the classification and assessment of waste" has been carried out on soils recovered from the site, using HazWasteOnline.

The results are summarised in Table 22 below and presented in full in Appendix 5.

Table 22: Waste Classification of Soils

Location	Depth (m bgl)	WM3.1 Classification	WAC Classification	Comments
WS1	0.30	Non-Hazardous	Inert	
WS1	1.00	Non-Hazardous	-	
WS2	0.20	Non-Hazardous	-	
WS3	0.50	Non-Hazardous	Hazardous	Hazardous due to pH of 5.4
WS4	1.10	Non-Hazardous	-	
WS5	0.40	Non-Hazardous	-	
WS5	1.20	Non-Hazardous	-	

The above table shows that all 7no. samples tested were classified as Non-Hazardous in accordance with WM3.1.

For Waste Acceptance Criteria (WAC) testing, EEGL have compared solid waste and leachate values with guideline values in Landfill Regulations. The following table summarises the results of the solid waste analysis and leachate testing, together with limit values for Non-Hazardous waste and Hazardous waste as described in the Landfill Regulations.

The results summarised in Table 23, overleaf show that the soil sample retrieved from WS1 at 0.30m had concentrations of contaminants within the recommended level for Inert Waste.

However, the soil sample retrieved from WS3 at 0.50m had a pH value of 5.4 which exceeds the recommended level for Stable Non-Reactive Hazardous Waste. Therefore, the soils from this area of the site will be accepted at a **Hazardous Waste Facility**.

Table 23: Summary of WAC Test Results

Determinand	Landfill Regulations Limits (mg/kg unless otherwise indicated)			WS1 0.30m (mg/kg)	WS3 0.50m (mg/kg)
	Inert Waste	Stable Non- Reactive non-hazardous waste	Hazardous Waste		
TOC (%)	3%	5%	6%	0.3	2
Loss on ignition (%)	-	-	10%	0.61	4.90
BTEX (mg/kg)	6	-	-	< 0.05	< 0.05
Sum of PCBs (mg/kg)	1	-	-	< 0.1	< 0.1
Mineral Oil (mg/kg)	500	-	-	53	< 10
Total PAH (mg/kg)	100	-	-	17	5.6
pH (units)	-	>6	-	7.7	5.4
Acid Neutralisation Capacity (mol/kg)	-	To be evaluated		< 1	< 1
Arsenic	0.5	2	25	< 0.2	< 0.2
Barium	20	100	300	< 0.1	0.1
Cadmium	0.04	1	5	< 0.02	< 0.02
Chromium	0.5	10	70	< 0.20	< 0.20
Copper	2	50	100	< 0.5	< 0.5
Mercury	0.01	0.2	2	< 0.005	< 0.005
Molybdenum	0.5	10	30	< 0.1	< 0.1
Nickel	0.4	10	40	< 0.2	< 0.2
Lead	0.5	10	50	< 0.2	< 0.2
Antimony	0.06	0.7	5	< 0.05	< 0.05
Selenium	0.1	0.5	7	< 0.05	< 0.05
Zinc	4	50	200	< 0.2	< 0.2
Chloride	800	15000	25000	28	19
Fluoride	10	150	500	< 1	< 1
Sulphate	1000	20000	50000	21	36
Total Dissolved Solids	4000	60000	100000	574	218
Phenol Index	1	-	-	< 0.5	< 0.5
DOC	500	800	1000	149	124

10.0 CONCLUSIONS & RECOMMENDATIONS

10.1 Soil Contamination

There is a low potential risk from soil contamination to construction workers and ground workers during development, and appropriate measures such as PPE, site health plans, appropriate disposal of material arisings will mitigate any risk.

Based on the results of the chemical testing, lead concentrations were found in exceedance of the screening criteria relevant to a residential end use with homegrown produce at borehole locations WS3 and WS5. However, only borehole WS3 was in exceedance without homegrown produce.

The soil contamination is encountered in the existing shared garden to the north, and the soft landscaped area to the east. Proposed development plans show these locations will be beneath the new building footprint, therefore removing any potential source-pathway-pollutant linkage

However, there is a low to moderate risk from soil contamination to end users if the development includes areas of soft landscaping near the lead hotspots. In this case, further delineation sampling surrounding the hotspots is recommended to ensure no risk to human health.

Alternatively, any proposed garden areas should be capped with a minimum 600mm of validated clean cover soils. Areas of proposed hardcover will not require any remediation as these areas effectively seal contamination beneath.

10.2 Asbestos

Asbestos fibres or fragments were not identified in any of the samples tested during this investigation.

Based on the age of the existing care home building, a pre-demolition asbestos survey is recommended. If any asbestos containing materials are encountered, they should be disposed of in accordance with current guidelines.

10.3 Foundations

Shallow strip/pad foundations placed in the Glaciofluvial Sheet Deposits are considered suitable for the proposed care home dwelling, providing the anticipated structural loadings are relatively low and subject to tolerance of structure to settlement.

10.4 Soil Disposal

Soils should be disposed of at a suitable site, registered to take the levels of contamination encountered. All soil samples collected have been classified as Non-Hazardous for the purpose of off-site disposal in accordance with Environment Agency guidance WM3.1.

Further Waste Acceptance Criteria (WAC) testing showed that the material from location WS1 is acceptable at an Inert Waste Facility. However, the material from location WS3 is acceptable as Hazardous Waste Facility.

10.5 Risk to Buried (Water) Services

It is considered that, due to the absence of any significant hydrocarbon contamination, standard materials should be acceptable for new water pipes. Further advice should be sought from the local water company.

Previous guidance on buried water pipes was contained in Water Regulations Advisory Scheme (WRAS) Guidance Note No. 9-04-03⁽²⁰⁰²⁾, however this has been superseded by the UK Water Industry Research Report 'Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites' Ref 10/WM/03/21 (January 2011).

10.6 Site Personnel

As with all construction sites, personnel working on the site during the construction period should be encouraged to maintain a high standard of personal hygiene and on-site washing facilities should be available.

10.7 Other Matters

Due diligence is required during the construction period, and should any further evidence of contamination be found, appropriate investigation and / or action should be taken. The significance of any contamination not discovered by this investigation is outside the scope of this report.

APPENDIX 1

GROUNDSURE REPORTS

APPENDIX 2

EXPLORATORY HOLE LOGS

APPENDIX 3

GEOTECHNICAL TESTING RESULTS

APPENDIX 4

CHEMICAL TESTING RESULTS

APPENDIX 5

SOIL WASTE ASSESSMENT

APPENDIX 6

REPORT LIMITATIONS

REPORT LIMITATIONS

This contract was completed by Earth Environmental & Geotechnical Ltd based on a defined programme and scope of works and terms and conditions agreed with the client. This report was compiled with all reasonable skill, and care, bearing in mind the project objectives, the agreed scope of works, the prevailing site conditions, the budget, and staff resources allocated to the project.

Other than that, expressly contained in the above paragraph, Earth Environmental & Geotechnical Ltd provides no other representation or warranty whether express or implied, is made in relation to the services. Unless otherwise agreed this report has been prepared exclusively for the use and reliance of the client in accordance with generally accepted consulting practices and for the intended purposes as stated in the agreement under which this work was completed. This report may not be relied upon, or transferred to, by any other party without the written agreement of a Director of Earth Environmental & Geotechnical Ltd.

If a third party relies on this report, it does so wholly at its own and sole risk and Earth Environmental & Geotechnical Ltd disclaims any liability to such parties.

It is Earth Environmental & Geotechnical Ltd understanding that this report is to be used for the purpose described in the introduction to the report. That purpose was an important factor in determining the scope and level of the services. Should the purpose for which the report is used, or the proposed use of the site change, this report will no longer be valid and any further use of, or reliance upon the report in those circumstances by the client without Earth Environmental & Geotechnical Ltd review and advice shall be at the client's sole and own risk.

The report was written in 2022 and should be read considering any subsequent changes in legislation, statutory requirements, and industry best practices. Ground conditions can also change over time and further investigations, or assessment should be made if there is any significant delay in acting on the findings of this report. The passage of time may result in changes in site conditions, regulatory or other legal provisions, technology or economic conditions which could render the report inaccurate or unreliable. The information and conclusions contained in this report should not be relied upon in the future without the written advice of Earth Environmental & Geotechnical Ltd. In the absence of such written advice of Earth Environmental & Geotechnical Ltd, reliance on the report in the future shall be at the client's own and sole risk. Should Earth Environmental & Geotechnical Ltd be requested to review the report in the future, Earth Environmental & Geotechnical Ltd shall be entitled to additional payment at the then existing rate or such other terms as may be agreed between Earth Environmental & Geotechnical Ltd and the client.

The observations and conclusions described in this report are based solely upon the services that were provided pursuant to the agreement between the client and Earth Environmental & Geotechnical Ltd. Earth Environmental & Geotechnical Ltd has not performed any observations, investigations, studies or testing not specifically set out or mentioned within this report.

Earth Environmental & Geotechnical Ltd is not liable for the existence of any condition, the discovery of which would require performance of services not otherwise contained in the services. For the avoidance of doubt, unless otherwise expressly referred to in the introduction to this report, Earth Environmental & Geotechnical Ltd did not seek to evaluate the presence on or off the site of electromagnetic fields, lead paint, radon gas or other radioactive materials.

The services are based upon Earth Environmental & Geotechnical Ltd observations of existing physical conditions at the site gained from a walkover survey of the site together with Earth Environmental & Geotechnical Ltd interpretation of information including documentation, obtained from third parties and from the client on the history and usage of the site. The findings and recommendations contained in this report are based in part upon information provided by third parties, and whilst Earth Environmental & Geotechnical Ltd have no reason to doubt the accuracy and that it has been provided in full of those it was requested from, the items relied on have not been verified.

No responsibility can be accepted for errors within third party items presented in this report. Further Earth Environmental & Geotechnical Ltd was not authorised and did not attempt to independently verify the accuracy or completeness of information, documentation or materials received from the client or third parties, including laboratories and information services, during the performance of the services. Earth Environmental & Geotechnical Ltd is not liable for any inaccurate information, misrepresentation of data or conclusions, the discovery of which inaccuracies required the doing of any act including the gathering of any information which was not reasonably available to Earth Environmental & Geotechnical Ltd and including the doing of any independent investigation of the information provided to Earth Environmental & Geotechnical Ltd save as otherwise provided in the terms of the contract between the client and Earth Environmental & Geotechnical Ltd.

Where field investigations have been carried out these have been restricted to a level of detail required to achieve the stated objectives of the work. Ground conditions can also be variable and as investigation excavations only allow examination of the ground at discrete locations. The potential exists for ground conditions to be encountered which are different to those considered in this report. The extent of the limited area depends on the soil and groundwater conditions, together with the position of any current structures and underground facilities and natural and other activities on site. In addition, chemical analysis was carried out for a limited number of parameters [as stipulated in the contract between the client and Earth Environmental & Geotechnical Ltd] based on an understanding of the available operational and historical information, and it should not be inferred that other chemical species are not present.

The groundwater conditions entered on the exploratory hole records are those observed at the time of investigation. The normal speed of investigation usually does not permit the recording of an equilibrium water level for any one water strike. Moreover, groundwater levels are subject to seasonal variation or changes in local drainage conditions and higher groundwater levels may occur at other times of the year than were recorded during this investigation.

Any site drawing(s) provided in this report is (are) not meant to be an accurate base plan but is (are) used to present the general relative locations of features on, and surrounding, the site.