DBS environmental

The Newcastle Car Wash Ltd

Former South Moor Service Station, Sunderland

Preliminary Phase 2 Geoenvironmental Ground Investigation

November 2020






Creating the Environment for Business

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Report for

Newcastle Car Wash Ltd
c/o Nova Castria Design
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Ponteland Road
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Issued by

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The Newcastle Car Wash Ltd

Former South Moor Service Station, Sunderland

Preliminary Phase 2 Geoenvironmental Ground Investigation

November 2020

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1358R002i1	-	24 October 2020	Issue of draft report for client comment	DG/DN	DN
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1. Introduction

1.1 Introduction

This report is prepared in accordance with instructions received from Nova Castria Design on behalf of The Newcastle Car Wash Ltd. DBS Environmental Limited (DBS) were instructed to prepare a Preliminary Phase 2 Geoenvironmental Ground Investigation (GI) report for an approximate 0.086 hectare site located at Westholme Terrace, Grangetown, Sunderland (the site).

The site comprises a former petrol filling station that is currently derelict. The site is to be redeveloped for residential use.

Planning permission has been awarded by Sunderland City Council (SCC) for the development, subject to the satisfactory discharge of a number of pre-commencement conditions, of which several relate to contaminated land.

This report presents the findings of a Preliminary Phase 2 intrusive GI undertaken at the site by DBS. The aim of the intrusive investigation was to provide contemporary information on ground conditions and site chemistry and to further develop the sites initial Conceptual Model (CM). The investigation was also designed to obtain preliminary geotechnical information to support foundation design for the new dwellings and associated infrastructure.

1.1.1 Scope of Work

This report presents the findings of the following scope of work:

- Sink five window sample boreholes within the site to maximum depths of 5.0m bgl and install three boreholes with combined gas and groundwater monitoring provisions;
- Sink one cable percussion borehole to a depth of 10.0m bgl;
- Obtain in situ geotechnical information comprising SPTs;
- Take representative soil samples from across the site for subsequent chemical analysis in an MCERTS accredited testing laboratory;
- Take two samples of groundwater for analysis in an MCERTS accredited testing laboratory;

- Take representative soil samples for geotechnical laboratory analysis;
- Monitor three boreholes for a minimum period of six visits for hydrocarbon vapours and groundwater levels;
- A generic quantitative risk assessment (GQRA) of soils results;
- Development of the sites Conceptual Model (CM); and
- Recommendations for additional works, if necessary, to remediate the site and break identified pollutant linkages.

This report has been prepared in accordance with Environment Agency (EA) "Land Contamination: Risk Management" guidance.

1.1.2 Regulatory Context

The proposed development is regulated under planning and development controls, which are briefly described below. The 'contaminated land regime' is also described, as the approach to risk assessment under planning controls follows this regime.

Planning approval was granted for development at the site by SCC, namely:

Planning Permission: 19/01593/FUL	**CHANGE OF USE FROM DISUSED PETROL STATION TO C3 RESIDENTIAL CLASS USE FOR THE ERECTION OF 8NO. 4 BEDROOM TOWNHOUSES WITH ASSOCIATED 12NO PARKING BAYS TO REAR.** **FORMER TOTAL UK LIMITED (S659) WESTHOLME TERRACE, SUNDERLAND, SR2 9QA.**

The outline planning consent was awarded subject to pre-commencement conditions imposed by SCC and their statutory consultee the Environment Agency; the conditions need to be satisfied prior to development.

The pertinent conditions relating to contaminated land and the Phase 2 intrusive works are Conditions 4 (Part 2 – Site Investigation Scheme) and Condition 5 (Phase II Report). Conditions 6 to 9 and 13 and 14 will be addressed following the agreement and approval of this report.

Condition 4

No development shall commence until a remediation strategy to deal with the risks associated with contamination of the site in respect of the development hereby approved has been submitted to and approved in writing by the Local Planning Authority. This strategy will include the following components:

1. A preliminary risk assessment which has identified:
all previous uses
potential contaminants associated with those uses
a conceptual model of the site indicating sources, pathways and receptors potentially unacceptable risks arising from contamination at the site

2. A site investigation scheme, based on (1) to provide information for a detailed assessment of the risk to all receptors that may be affected, including those off-site.

3. The results of the site investigation and the detailed risk assessment referred to in (2) and, based on these, an options appraisal and remediation strategy giving full details of the remediation measures required and how they are to be undertaken.

4. A verification plan providing details of the data that will be collected in order to demonstrate that the works set out in the remediation strategy in (3) are complete and identifying any requirements for longer-term monitoring of pollutant linkages, maintenance and arrangements for contingency action.

Any changes to these components require the written consent of the local planning authority.

Reason: To ensure that the development does not contribute to, and is not put at unacceptable risk from or adversely affected by, unacceptable levels of water pollution in line with paragraph 170 of the National Planning Policy Framework and to prevent deterioration of a water quality and to protect the Magnesian Limestone, principal aquifer.

Condition 5

No development shall commence until a Phase II: Site Investigation report has been submitted to and approved, in writing, by the Local Planning Authority. The Phase II report shall be based upon the findings of the approved Phase I report and any additional comments provided by the Local Planning Authority, shall be completed in accordance with a recognised code of practice for site investigations, such as BS10175:2001 and shall include:

i) a survey of the extent, scale and nature of contamination
ii) an assessment of the potential risks to:
   a. human health
   b. property (existing or proposed) including building, crops, livestock, pets, woodland and service line pipes
   c. adjoining land
   d. groundwaters and surface waters e. ecological systems
   f. archaeological sites and ancient monuments

iii) a site specific risk assessment and an appraisal of remedial options and proposal of the preferred options if a hazard or hazards are identified on the site from any form of contaminant.

Reason: To ensure that risks from land contamination to future users of the land, neighbouring land, controlled waters and ecological systems are minimised and to ensure that the development can be carried out safely without unacceptable risks to workers, neighbours and other offsite receptors, in accordance with policy HS1 of the Core Strategy and paragraph 109 and 120 of the National Planning Policy Framework.

Condition 6

If any hazards are identified from any form of contaminant by any site investigation which require remediation, as determined by the Local Planning Authority, no development shall commence until a detailed Remediation Strategy and Verification Plan to bring the site to a condition suitable for the intended use by removing unacceptable risks to human health, buildings and other property and the natural and historical environment has been submitted to and approved, in writing, by the Local Planning Authority. The strategy shall include all works to be undertaken, proposed remediation objectives and remediation criteria, timetable of works and site management procedures and must ensure that the site will not qualify as contaminated land under Part 2A of the Environment Protection Act 1990 in relation to the residential use of the land.

Reason: To ensure that risks from land contamination to future users of the land, neighbouring land, controlled waters and ecological systems are minimised and to ensure that the development can be carried out safely without unacceptable risks to workers, neighbours and other offsite receptors, in accordance with policy HS1 of the Core Strategy of the Unitary Development Plan and paragraph 109 and 120 of the National Planning Policy Framework.

Condition 7

No development shall commence until a monitoring and maintenance plan in respect of contamination, including a timetable of monitoring and submission of reports to the Local Planning Authority, has been submitted to, and approved in writing by, the local planning authority. Reports as specified in the approved plan, including details of any necessary contingency action arising from the monitoring, shall be submitted to and approved in writing by the Local Planning Authority.

Reason: To ensure that the site does not pose any further risk to human health or the water environment by managing any ongoing contamination issues and completing all necessary long-term remediation measures; in accordance with paragraph 170 of the National Planning Policy Framework and to prevent deterioration of a water quality of the Magnesian Limestone, Principal Aquifer.

Condition 8

In the event that contamination is found at any time when carrying out the approved development that was not previously identified, all works within the affected part of the site shall cease until an investigation and risk assessment and, when remediation is necessary, a remediation scheme in accordance with the details of the respective conditions set out above have been submitted to and approved, in writing, by the Local Planning Authority and any necessary remediation is carried out in accordance with the approved details.

Reason: To ensure that risks from land contamination to future users of the land, neighbouring land, controlled waters and ecological systems are minimised and to ensure that the development can be carried out safely without unacceptable risks to workers, neighbours and other offsite receptors, in accordance with policy HS1 of the Core Strategy and paragraph 109 and 120 of the National Planning Policy Framework**.**

Condition 9

No piling shall take place using penetrative methods until details of those methods has been submitted to and approved in writing by the Local Planning Authority. The development shall thereafter be carried out in accordance with the approved details.

Reason: Piling using penetrative methods can result in risks to potable supplies from, for example, pollution/turbidity. There is also a risk of mobilising contamination, drilling through different aquifers and creating preferential pathways. Groundwater is particularly sensitive in this location because the proposed development site is located upon a principal aquifer.

Condition 13

No dwelling house shall be occupied until a verification report demonstrating the completion of works set out in the approved remediation strategy and the effectiveness of the remediation shall has been submitted to and approved in writing by the Local Planning Authority. The report shall include results of sampling and monitoring carried out in accordance with the approved verification plan to demonstrate that the site remediation criteria have been met.

Reason: To ensure that the site does not pose any further risk to human health or the water environment by demonstrating that the requirements of the approved verification plan have been met and that remediation of the site is complete. This is in line with paragraph 170 of the National Planning Policy Framework and to prevent deterioration of a water quality of the Magnesian Limestone, Principal Aquifer.

Condition 14

If any hazards are identified from any form of contaminant by any site investigation which require remediation, as determined by the Local Planning Authority, the use shall not commence until the approved remediation works have been completed in accordance with the approved Remediation Strategy and a verification report that demonstrates the effectiveness of the remediation works and accords with the terms of the approved Verification Plan has been submitted to and approved, in writing, by the Local Planning Authority.

Reason: To ensure that risks from land contamination to future users of the land, neighbouring land, controlled waters and ecological systems are minimised and to ensure that the development can be carried out safely without unacceptable risks to workers, neighbours and other offsite receptors, in accordance with policy HS1 of the Core Strategy and paragraph 109 and 120 of the National Planning Policy Framework

1.1.3 Planning

Under the planning process, SCC needs to satisfy itself that the land in question will be 'suitable for use', with respect to its proposed new use. The overall policy objective is to safeguard human health and the environment. Planning guidance, regarding the development of land affected by contamination, is contained within the National Planning Policy framework (NPPF).

The NPPF states that Planning decisions should ensure that:

- a site is suitable for its new use taking account of ground conditions and land instability, including risks from natural hazards or former activities such as mining, pollution arising from previous uses and any proposals for mitigation including land remediation or impacts on the natural environment arising from that remediation;
- after remediation, as a minimum, land should not be capable of being determined as contaminated land under Part 2A of the Environmental Protection Act 1990; and
- adequate site investigation information, prepared by a competent person, is presented.

In addition, the NPPF states that the planning system should contribute to and enhance the natural and local environment by preventing both new and existing development from contributing to or being put at unacceptable risk from, or being adversely affected by unacceptable levels of soil, air, water or noise pollution or land instability.

The statutory definition of contaminated land is given in Part 2A of the Environmental Protection Act 1990 (Part 2A). This does not include land that is already regulated through other means, such as Waste Management Legislation or the Integrated Pollution Prevention and Control (IPPC) regime.

For planning purposes, the assessment of risks arising from contamination and remediation requirements are considered on the basis of both the current use and circumstances of the land and its proposed new use. The approach to identifying and dealing with risks is similar to that under Part 2A of the Environmental Protection Act 1990.

1.1.4 Building Regulations

The requirements of the Building Regulations will apply to the proposed building development on the site.

The Building Regulations contain provisions relating to the preparation of a site for building construction. In particular, Regulation C1 requires that the ground to be covered by the building should be reasonably free of vegetable matter. Regulation C2 requires that precautions should be taken to avoid danger to

health and safety caused by substances on or in the ground to be covered by the building, including soil gases and/or vapours.

1.1.5 Other Regulatory Controls

Contaminated Land Regime

The statutory regime for the identification and remediation of contaminated land contained in Part 2A of the Environmental Protection Act 1990 came into force in England on 1 April 2000. The primary legislation (i.e. the 1990 Act) is complemented by the Contaminated Land (England) Regulations 2000, and the Defra Part 2A Contaminated Land Statutory Guidance 2012.

The regulations reinforce the 'suitable for use' approach to the assessment and remediation of contaminated land, which recognises that the risks presented by contamination vary according to the use of the land and other circumstances. The concept of a 'pollutant linkage' (i.e. a linkage between a 'contaminant' and a 'receptor' by means of a 'pathway') is used in the assessment of risk to human health and the environment. All three elements (i.e. a source, a receptor and a viable linking pathway) must be present for a pollutant linkage to exist.

A 'significant contaminant linkage' must be identified for any land to be regarded as 'contaminated land' on the basis that significant harm is being caused, or that there is a significant possibility of such harm being caused, or that pollution of controlled waters is being, or is likely to be caused. The situations where harm is to be regarded as 'significant' are defined in the statutory guidance.

The decision on whether the possibility of significant harm being caused by contamination is significant is a regulatory decision to be undertaken by the relevant local authority, and the statutory guidance documents four categorisations (categories 1 to 4) to assist local authorities in deciding whether land can be considered contaminated or not, based on the grounds of significant possibility of significant harm (SPOSH) to human health. Categories 1 and 2 encompass land that is capable of being determined as contaminated land, categories 3 and 4 encompass land that is not capable of being determined as contaminated land.

The rational for placing land into a specific category is documented in the statutory guidance.

Defra released Category 4 Screening Levels (C4SL) in March 2014 to support decision making using the Statutory Guidance and Category 4 low risk scenarios. The aim of the screening criteria is to prevent situations where unnecessary remediation is undertaken, and as such, the screening levels are considered pragmatic based on "low risk", as opposed to "minimal risk" that underpins Soil Guideline Values (SGVs) and other Generic Assessment Criteria (GAC) used in the UK in a planning context.

1.1.6 Development Proposals

The site for residential use; comprising eight terraced town houses with twelve off-street car parking spaces and small rear gardens.

The LPA will require the developer to demonstrate that the condition of the site is suitable for residential with gardens use. This report further develops the risk assessment process to evaluate the site and to address any geoenvironmental constraints.

A proposed site layout plan is provided in Appendix A.

1.1.7 Sources of Information

The assessment is based upon the following sources of information:

- EA Guidance on Requirements for Land Contamination Reports, July 2005;
- EA Land Contamination Risk Management (LCRM) guidance, October 2020;
- DBS Environmental Limited, Phase 1 Geoenvironmental Desk Study report, January 2019 (report ref: 1358R001i1 Final, October 2019);
- CL:AIRE Petroleum Hydrocarbons in Groundwater: guidance on assessing petroleum hydrocarbons using existing hydrogeological risk assessment methodologies, 2017;
- WHO Petroleum Products in Drinking Water 2008;
- The Water Supply (Water Quality) Regulations 2010;
- WHO Guidelines for Drinking Water Quality 2011 (4th Edition);
- The LQM/CIEH S4ULs for Human Health Risk Assessment, Land Quality Management Ltd and the Chartered Institute of Environmental Health, 2015;
- EA Land Contamination Risk Management (LCRM) guidance, October 2020;
- BS 10175:2011+A2:2017 Investigation of Potentially Contaminated Sites, Code of Practice, British Standards Institute;
- BS8576:2013 Guidance on Investigations for ground gas. Permanent gases and Volatile Organic Compounds;
- CIRIA C552 - Contaminated Land Risk Assessment, a Guide to Good Practice, 2001;

- BS5930:2015+A1:2020 Code of Practice for Ground Investigations;
- CIRIA C665 (2007) Assessing risks posed by hazardous gases to buildings;
- NHBC/RSK (2007) Guidance on evaluation of development proposals on sites where methane and carbon dioxide are present, report edition No. 04;
- BS8485:2015+A1:2019 Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings; and
- BRE Special Digest 1, Concrete in Aggressive Ground, (2005).

1.2 Report Structure

This report summarises background information on the site taken from a Phase 1 Desk Study report (aka preliminary risk assessment) prepared by DBS to support a planning application for a change of use, along with the findings of the sites initial Conceptual Model (CM). It then presents the findings of a recent Phase 2 intrusive GI with an appraisal of ground conditions in light of potential foundations solutions, a GQRA of site chemistry data and a ground gas risk assessment taking into account human health, controlled waters and property receptors.

Based on the findings of this additional risk assessment, the pollutant linkages as identified as potentially significant in the Phase 1 Desk Study report in 2019 are re-assessed and the sites CM revised.

Finally, a statement on the sites suitability for use is provided, along with any recommendations for further work and/or remedial requirements.

2. Background Information

2.1 Site Location and Description

The site comprises a former Total UK Petrol Filling Station (PFS) located at Westholme Terrace, Grangetown, Sunderland, SR2 9QA. It is located approximately 1.7km south of Sunderland City Centre.

The site is situated at National Grid Reference 440544, 554905, covering an area of approximately 0.086 hectares.

The site is currently derelict, all above ground filling station structures including former fuel pumps have been removed, the concrete forecourt remains, along with the canopy. Access and egress is provided by two junctions with Ryhope Road, although access to the site is currently prohibited by herras fencing.

A site location plan is provided in Appendix A.

2.2 Surrounding Land Use

The site is located in a residential area; it is generally surrounded by a range of commercial premises within a local shopping street, residential streets, schools and a road network.

2.3 Initial Conceptual Model Findings

The initial CM established in the Phase 1 Desk Study report in 2019 identified ten potential pollutant linkages at the site as a result of the sites past use/location. Of these, six were considered potentially significant, the linkages related to human health, controlled waters and property and the sites former use as a PFS. Potential contaminants of concern on site included metals/metalloids, acids/alkalis (as pH), sulphates, petroleum hydrocarbons, BTEX, PAHs and MTBE.

The CM also identified a potential risk of ground gas (hydrocarbon vapours) from former fuel storage and refuelling operations. No other sources of ground gas were identified on or off site.

The objective of the Phase 2 ground investigation was therefore to obtain intrusive information on ground conditions and to establish long term ground gas and groundwater monitoring wells with a subsequent hydrocarbon vapour monitoring programme, in order to identify if the pollutant linkages identified at Phase 1 are significant or not. The investigation was also designed to obtain initial geotechnical information to support foundation design.

2.4 Geology, Hydrogeology and Hydrology

2.4.1 Geology – Superficial Deposits

Published geological records indicates that the site is underlain by superficial deposits comprising Glaciolacustrine deposits comprising Clay and Silt of Devensian age.

2.4.2 Geology – Bedrock

The solid geology underlying the site comprises the Roker Formation comprising Dolostone (Dolomitic Limestone) of the Permian Period.

2.4.3 Hydrology

There are no surface water courses on site or within 500m of it. The North Sea is present approximately 670m to the east of the site. According to Groundsure the site is not located within an area of Flood Risk from rivers or sea. There is no surface water quality data available for any water course within 1.0km of the site. There are no records of surface water abstraction license within 1.0km of the site.

2.4.4 Hydrogeology

The Groundsure Report states that the site is located within an area designated as a Principal Aquifer (former major aquifer) as classified by the EA in accordance with the Water Framework Directive.

Principal aquifers have high intergranular and/or fracture permeability and can provide a high level of water storage and may support water supply and river base flow on a strategic scale.

The superficial deposits are classified by the EA as Unproductive Strata.

The site is not located within a Source Protection Zone.

There are no active licensed groundwater abstractions within a 1km radius of the site. There are three historical abstractions for Hendon Paper Mill located 682m to the south west of the site, the paper mill is now closed and has been demolished, with the site reclaimed for housing.

3. Phase 2 Ground Investigation

3.1 Aims and Objectives

The aims of the Phase 2 ground investigation were to provide contemporary information on ground conditions, to fill data gaps, to investigate potentially significant pollutant linkages (as identified in the initial CM), and to enable additional tiers of risk assessment to be undertaken to determine the sites suitability for use in accordance with the UK's tiered approach to addressing contaminated land risks.

The investigation comprised sinking a series of boreholes across the site to provide information on ground conditions, to enable recovery of groundwater and shallow Made Ground samples, as well as natural ground and to provide preliminary geotechnical information to support foundation design.

Combined gas and groundwater monitoring installations were to be established in three of the boreholes to allow a post works monitoring programme for groundwater and hydrocarbon vapour monitoring to be completed.

The investigation was designed to obtain information relating to the underlying ground conditions, potential pollutant linkages of concern and to refine the CM. The investigation followed current best practice as detailed within CLR11, BS 10175, BS EN ISO 14668-1, BS EN ISO 14668-2, BS EN ISO 14689.

The objectives of the investigation were:

- To provide site chemistry data to determine the form and extent of any ground contamination at the site in light of the site redevelopment proposals;
- To provide chemical data identified as a potential risk in the initial CM;
- Provide information on the shallow hydrogeology of the site;
- Provide installations for the subsequent monitoring of hydrocarbon vapours and groundwater levels;
- Provide preliminary geotechnical information to support foundation design;
- Provide information to further develop the CM;
- To identify the scope of further investigation works, if required; and
- Provide information to allow environmentally sustainable remediation options, if required, to render the site suitable for use.

3.2 Methodology

The ground investigation was undertaken on 22nd July 2020 and was completed in one day. The drilling work was undertaken by the specialist geoenvironmental contractor RD Drilling Ltd of Northumberland. All work was undertaken under the supervision of an experienced DBS geoenvironmental engineer who was responsible for setting out the exploratory holes, and the logging and sampling of arisings.

The investigation consisted of the following scope of works:

- Obtaining services plans from utility providers in advance of the work;
- Completion of ground penetrating radar survey by the specialist contractor Discovery Surveys Ltd of Doncaster; the survey mapped all subsurface PFS infrastructure and services and provided clearance for boreholes;
- Clearance of on-site services at all exploratory hole locations prior to commencement of the investigation;
- Progression of six window sample boreholes to maximum depths of 5.0m bgl;
- Sinking of one cable percussion borehole to 10.0m bgl;
- In situ testing in boreholes (SPTs);
- Collection of representative soil samples for chemical analysis in a UKAS accredited laboratory;
- Collection of soil samples for geotechnical laboratory analysis;
- Installation of combined groundwater / gas monitoring installations in three boreholes; and
- Post works monitoring for hydrocarbon vapours and groundwater levels.

All exploratory hole locations were logged and sampled for chemical analysis by a DBS environmental engineer on site in accordance with BS EN ISO 14668-1:2018 and BS EN ISO 14668-2:2018 and BS EN ISO 14689:2018.

An exploratory hole location plan is provided in Appendix A. Exploratory hole logs are presented in Appendix B, and Photographic plates from the intrusive investigation are presented in Appendix C.

3.2.1 Subsurface Infrastructure Survey

The Phase 1 Desk Study report prepared by DBS confirmed that subsurface layout drawings for the former PFS infrastructure were not available; contact with both the Petroleum Officer of Tyne & Wear Fire and

Rescue Service and Building Control of SCC confirmed that no information was available for the site. To ensure that the GI proceeded safely, to ensure that a contamination incident was avoided and to enable the targeting of boreholes at contamination sources on site, DBS appointed the specialist contractor Discovery Surveys of Doncaster to map the subsurface using ground penetrating radar. The survey confirmed the position of the former fuel tanks on site (4 No tanks located together), interceptor chambers and lines and buried services. The survey confirmed that there was only one tank farm on site in the north below the visible hatches in the forecourt apron; there was no evidence of any other fuel tanks that may have been replaced and left in situ over the years.

The survey also confirmed that the fuel tanks have been decommissioned by filling with foam, and have direct filling points via hatches within the forecourt. External vent pipes are not visible and have possibly been removed along with the former forecourt pumps.

A copy of the survey plan is provided in Appendix A.

3.2.2 Window Sample Boreholes

Six window sample boreholes (WS1, WS3, WS3A, WS4, WS5, WS6) were sunk within the site. Borehole WS2 was abandoned on site due to buried services. Borehole WS3A was sunk next to borehole WS3 to try and puncture through a hard buried obstruction, assumed on site to be a relic concrete floor slab/foundation.

The boreholes were sunk using a Premier 110 dynamic sampling rig with target depths of 5.0m bgl to determine the depth, presence and nature of the underlying Made Ground and superficial deposits.

All of the window sample boreholes were positioned on hard surface cover comprising concrete hardstanding and asphalt.

The locations were targeted/positioned to investigate the tank farm, the former fuel pump areas and the general forecourt areas.

3.2.3 Cable Percussion Boreholes

One cable percussion borehole (CP1) was sunk at the site during the investigation. The borehole was sunk using a Dando 2000 drilling rig with a target depth of 10.0m bgl to determine the depth, presence and nature of the underlying superficial deposits.

3.2.4 Borehole Installations

Upon completion, three boreholes were installed with 45 mm HDPE well screen and completed with combined gas and groundwater sampling tops. Details of installations within the borehole are provided in Table 3.1.

Table 3.1 Borehole Installations

Borehole	Installation of Slotted Screen Section (m bgl)	Stratum
WS1	1.00 to 5.00	Made Ground
WS4	3.00 to 5.00	Natural Ground (Clay & Sand - Glacial deposits)
CP1	3.00 to 7.00	Natural Ground (Clay & Sand - Glacial deposits)

The boreholes were screened with response zones in the natural ground (Glacial deposits) and the Made Ground. The monitoring wells were installed with a bentonite seal from ground level so as to prevent potential for cross boundary travel of contaminants, and borehole CP1 had a bentonite seal from the base of the borehole (10.0m bgl) to the underside of the monitoring well (7.0m bgl). The wells were fitted with an end cap, filter sock and a gravel pack surround. The installations were targeted at obtaining groundwater samples from the deeper natural deposits to determine potential risks to the underlying principal aquifer from any site derived contamination, and vapours next to the tank farm.

3.3 Sampling and Testing

Chemical soil analysis was undertaken by i2 Analytical (UKAS and MCERTS accredited).

Representative samples were collected and placed into laboratory prepared containers by the DBS environmental engineer. These were stored in cool boxes with ice packs and delivered to the laboratory using full chain of custody documentation. Individual soil samples were taken using sterile nitrile gloves to prevent the potential for cross contamination of samples between strata and/or exploratory hole locations.

All samples taken during the investigation were put forward for analysis, no deviating samples were reported by the laboratory.

The engineer used a Photo-ionisation detector (PID) on site during the work to confirm potential volatile organic contaminants (VOCs) for sample prioritisation.

3.3.1 Soils

Soil samples were scheduled for analysis based on the sites initial CM, and observations made on site during the works. Samples were scheduled based on the following suite of determinands:

- Metals and metalloids (arsenic, cadmium, chromium, chromium lll, chromium hexavalent, copper, lead, mercury, nickel, selenium and zinc);
- Water Soluble Sulphate;
- Organic Matter;
- pH;
- Speciated PAH (EPA 16);
- BTEX;
- MTBE;
- Petroleum Hydrocarbons (TPH CWG ali/aro split); and
- Asbestos ID.

3.3.2 Groundwater

The boreholes were left to recharge and stabilise for several weeks prior to sampling. The groundwater sampling was completed on 10th September 2020; the groundwater wells were productive and a full set of sample containers were filled with groundwater from locations CP1 and WS4. Samples were taken by "grab sampling" using dedicated PVC bailers for each borehole suitable for sampling Non Aqueous Phase Liquids (NAPL). Due to the potential for LNAPL (floating product) on the surface of the groundwater the wells were not purged prior to sampling. The samples were forwarded to the testing laboratory on the same day that they were taken to prevent any parameters being reported as "deviating" for exceeding holding times.

Samples were scheduled based on the following suite of determinands:

- Metals and metalloids (arsenic, cadmium, chromium, chromium lll, chromium hexavalent, copper, lead, mercury, nickel, selenium and zinc);
- Electrical conductivity;

- Alkalinity;
- Chemical Oxygen Demand;
- Dissolved oxygen;
- Speciated PAH (EPA 16);
- BTEX;
- MTBE; and
- Petroleum Hydrocarbons (TPH CWG ali / aro split).

3.3.3 Ground Gas and Groundwater Monitoring

Three boreholes (WS1, CP1, WS4) were installed as combined gas and groundwater monitoring installations and monitored for hydrocarbon vapours and groundwater levels post completion of the GI. Also, as Made Ground was detected during the GI, monitoring was also undertaken for soil gas concentrations (flammable gas, carbon dioxide, hydrogen sulphide, carbon monoxide, oxygen and flow). Monitoring has taken place fortnightly on six occasions to date (six visits over 3 months in accordance with the requirements of CIRIA C665 guidance). None of the monitoring rounds took place during a period of falling atmospheric pressure due to monitoring taking place in summer months when weather conditions are settled. The focus of the monitoring was hydrocarbon vapours which are more mobile due to diffusion transport and vapour pressure/temperature variables, rather than atmospheric pressure drops. One visit was undertaken during a period of low pressure of 998mb on 11th August 2020.

Post works groundwater levels are documented in Table 3.2 below.

Table 3.2 Groundwater Monitoring Results

Borehole	During Drilling (m bgl)	Monitored Groundwater Levels (m bgl)						Flooded
		28/07/20	11/08/20	24/08/20	07/09/20	28/09/20	13/10/20	
WS1	NR*	3.0	2.90	2.88	2.84	2.83	2.71	No
WS4	NR*	2.73	2.71	2.62	2.6	2.55	2.58	Yes
CP1	5.35	2.88	2.91	2.88	2.85	2.80	2.70	Yes

*NR = None recorded

4. Ground Conditions

4.1 General

The following stratigraphy was encountered in the exploratory holes undertaken on the site.

- Made Ground;
- Glacial Deposits;

The typical geology encountered across the site is summarised in Table 4.1 below:

Table 4.1 Site Geology Summary

Stratum	Description	Depth Range Encountered (m bgl)	Recorded Thickness (m)
Made Ground	Concrete (Absent from WS3 and WS3A)	GL	0.17 – 0.30
Made Ground	Sub-Base comprising yellow dolomitic gravel aggregate or crushed concrete (Absent from CP1)	GL – 0.20	0.23 – 1.20
Made Ground	Asphalt (WS3 and WS3A only)	0.90	0.25
Made Ground	Black sandy ashy GRAVEL of brick and clinker	0.30 – 1.40	0.15 – 2.40
Made Ground	Firm to stiff blackish brown to grey gravelly CLAY. Gravel includes brick and coal (WS1 and WS4 only)	1.90 – 2.00	0.70 – 0.80
Glacial Deposits	Firm to stiff becoming stiff and very stiff with depth light brown to dark brown silty sandy gravelly CLAY. Gravel is subangular to subrounded fine to coarse of mudstone, sandstone and coal. Layers of medium dense brown to greenish brown clayey silty, locally gravelly SAND. Gravel is of coal (CP1, WS1 and WS4 only)	2.70	Not proven (>7.30)

The encountered geology does not concur with the published geology, which indicated the presence of glaciolacustrine deposits. It is possible that, due to the potentially soft and compressible nature of these deposits, that they were removed to the top of the Glacial Deposits, and replaced with fill material to allow development to take place. This indicates that the fill material is engineered to a degree, although this is unlikely to have been done in accordance with current best practice. For this reason, in the following sections, conservative values have been recommended for the Made Ground, for design purposes.

4.1.1 Made Ground

Made Ground was encountered in all of the Window Sample exploratory holes, to a maximum depth of 2.70m bgl. The Made Ground predominantly comprised an upper surface of concrete, underlain by sub-base material of variable thickness. The sub-base predominantly comprised yellow dolomitic limestone aggregate, although in WS4 this had been overlain by a layer of crushed concrete aggregate, indicating that the original sub-base had been topped up at some point in the site's history. The base of the sub-base was underlain by an obstruction in WS6, which halted progress.

In the majority of the exploratory holes, the sub-base was underlain by black sandy, ashy gravel including clinker and fragments of brick. This was underlain by obstructions in WS3, WS3A and WS5, at depths of between 1.30m and 1.90m bgl, all of which halted progress. In WS1 and WS4, the granular Made Ground layer was underlain by firm to stiff black to brown gravelly CLAY, with the gravel including coal and brick.

4.1.2 Glacial Deposits

Glacial Deposits were encountered beneath the Made Ground in CP1, WS1 and WS4, at a depth of 2.7m bgl in each hole. The stratum comprised firm light brown to dark brown silty, sandy, gravelly CLAY, becoming stiff to very stiff with increasing depth. The gravel comprised subangular to subrounded, fine to coarse coal, sandstone and mudstone. This material was present until the base of WS1 at a depth of 5.45m bgl. However, the initial layer of clay was underlain by medium dense brown to greenish brown clayey silty, locally gravelly SAND in CP1 and WS4, at depths of 4.5m and 3.7m bgl respectively. The base of the sand was not penetrated in WS4, but had a proven thickness of 2.7m in CP1. This was then underlain by stiff to very stiff dark brown sandy gravelly CLAY to the base of the borehole at 10.0m bgl.

4.1.3 Groundwater

Groundwater was encountered within the glacial sand in CP1, at a depth of 6.5m bgl, rising to a depth of 5.35m bgl after a monitoring period of 20 minutes.

4.1.4 Characteristic Ground Model

Based on an interpretation of the exploratory hole data presented above, the representative ground model for the site, to be used in outline geotechnical design, is presented in Table 4.2 below.

Table 4.2 Representative Ground Model

Stratum	Description	Depth To Base (m bgl)	Representative Thickness (m)
Made Ground	Sub-Base underlain by Black sandy ashy GRAVEL of brick and clinker)	2.00	2.00
Made Ground	Firm to stiff blackish brown to grey gravelly CLAY. Gravel includes brick and coal (WS1 and WS4 only)	2.70	0.70
Glacial Deposits	Firm to stiff light brown to dark brown silty sandy gravelly CLAY.	4.00	1.30
Glacial Deposits	Medium dense brown to greenish brown clayey silty, locally gravelly SAND.	6.50	2.50
Glacial Deposits	Stiff to very stiff with light brown to dark brown silty sandy gravelly CLAY.	>10.00	>3.50

4.1.5 Geotechnical Properties

Granular Made Ground

Four Standard Penetration Tests (SPT) were carried out within the granular Made Ground, at depths of between 1.0m and 1.2m bgl; which gave SPT 'N' values of 6-30 (mean 13, median 9), indicating loose to medium dense material, with the mean falling in the medium dense range. Based on the correlation chart postulated by Peck *et* al, this equates to angles of internal shearing resistance of between 28° and 36°. For design purposes, a value of 30° is recommended. No discernible pattern between 'N' values and depth could be identified.

Based on the characteristic density of soils suggested in BS8004:2015 Code of Practice for Foundations, a density value of 17kN/m^3 is recommended for loose to medium dense gravel.

In accordance with CIRIA Report 143, an approximation of the drained stiffness can be established using the relationship E' = 2N, where N is the SPT N-value ranging from a minimum of 6 to a maximum of 30. This results in a drained soil stiffness ranging from 12 MN/m^2 to 60 MN/m^2. A characteristic value for the drained modulus of 18MN/m^2 is therefore recommended for design based on a characteristic N60 of 9, representing loose granular soil.

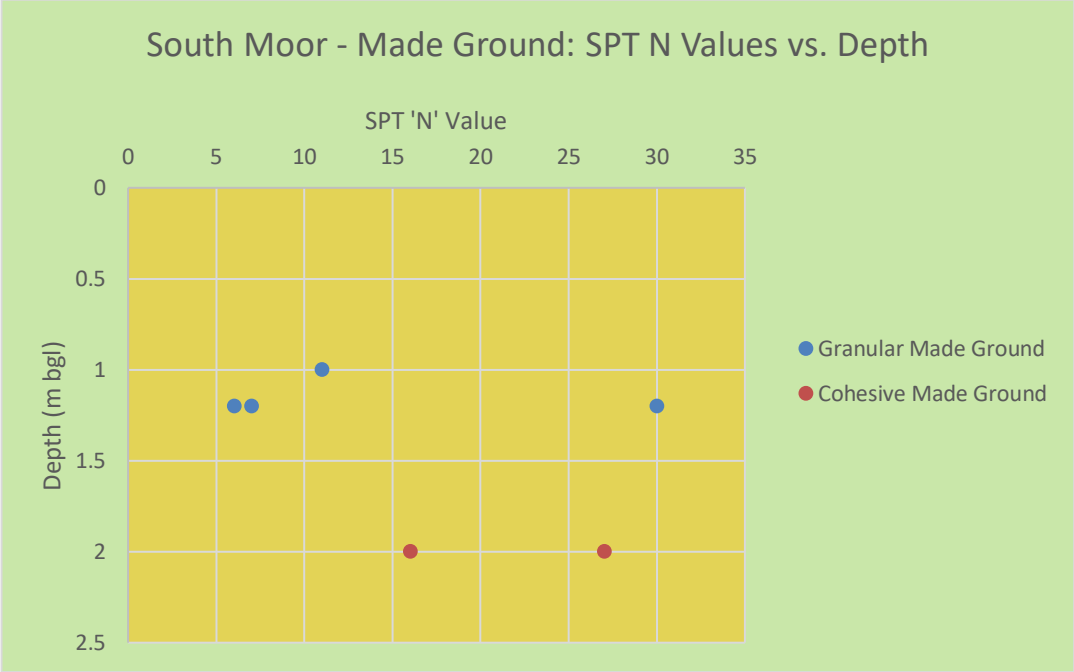
Cohesive Made Ground

Two SPT's were carried out within the cohesive Made Ground at a depth of 2.0m bgl, which gave SPT 'N' values of 16 and 27. Based on the correlation postulated by Stroud, this equates to undrained shear

strengths of 72 kPa and 121 kPa, indicating firm to stiff material. Due to the limited data range, and the potential for variability within this material, a design value of 40kPa is recommended for the cohesive Made Ground.

The SPT results for the Made Ground are presented graphically in Figure 1 below:

Figure 1 – Distribution of Standard Penetration 'N' value With Depth – Made Ground



Based on the characteristic density of soils suggested in BS8004:2015 Code of Practice for Foundations, a density value of 17kN/m^3 is recommended for medium to high strength clay.

An approximate correlation can be made between shear strength and the modulus of volume compressibility, with roughly equates to 10/Cu, which when applied to the shear strengths obtained from SPT testing, gives values of 0.139 and 0.082m$^{2/}$MN respectively, indicating clay of low to medium compressibility. For a design shear strength of 40kPa, a corresponding mv of 0.250m$^{2/}$MN is obtained, which is recommended for design purposes.

No direct testing of the effective angle of shearing resistance was carried out on this material, and no Atterberg Limit testing was carried out to enable a correlation to be made. Therefore, a conservative angle of shearing resistance of 20° is recommended for the cohesive made ground, for design purposes.

The undrained modulus (E_u) has been derived from the relationships recommended by Jamiolkowski et al (1979), this is related to the plasticity of the clay, which is not known. Therefore, a conservative ratio of $E_u = 200xC_u$ is recommended, resulting in a value of E_u = 8MN/m^2, representing soft to firm clay.

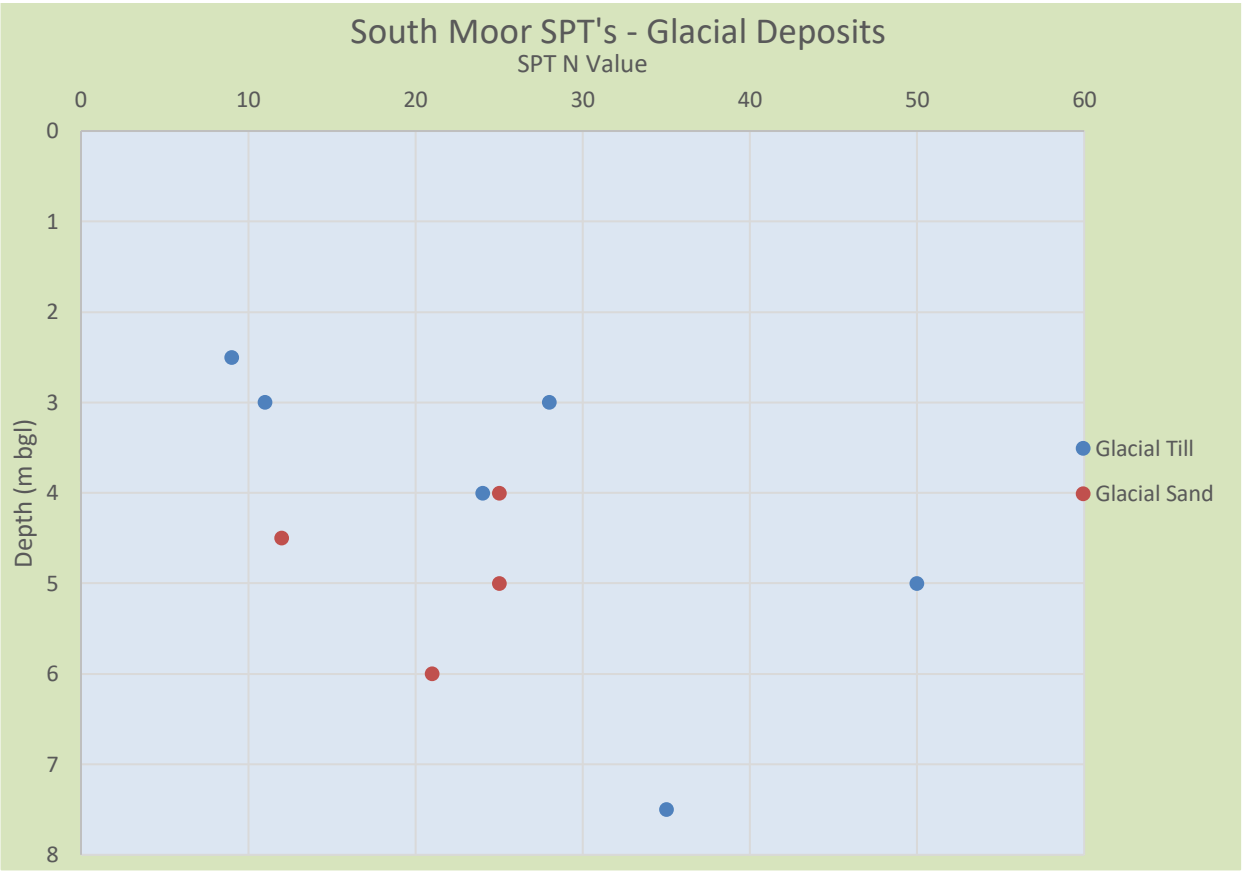
The effective drained modulus has been determined from the relationship; $E' = 0.6E_u$. As a result, an E' value of 4.8MN/m^2 has been derived.

Cohesive Glacial Deposits

A total of six SPT's were performed in material logged as cohesive Glacial Deposits, at depths of between 2.5m and 7.5m bgl, which gave 'N' values of between 9 and 50 (mean and median 26). Based on the Stroud correlation, this equates to undrained shear strengths of between 40 kPa and 225 kPa (mean and median 117kPa) indicating firm to very stiff material, with the mean falling in the stiff range.

The SPT results do indicate a broadly discernible trend of increasing N value with depth, as illustrated in Figure 2 below.

Figure 2 – Distribution of Standard Penetration 'N' value With Depth – Glacial Deposits

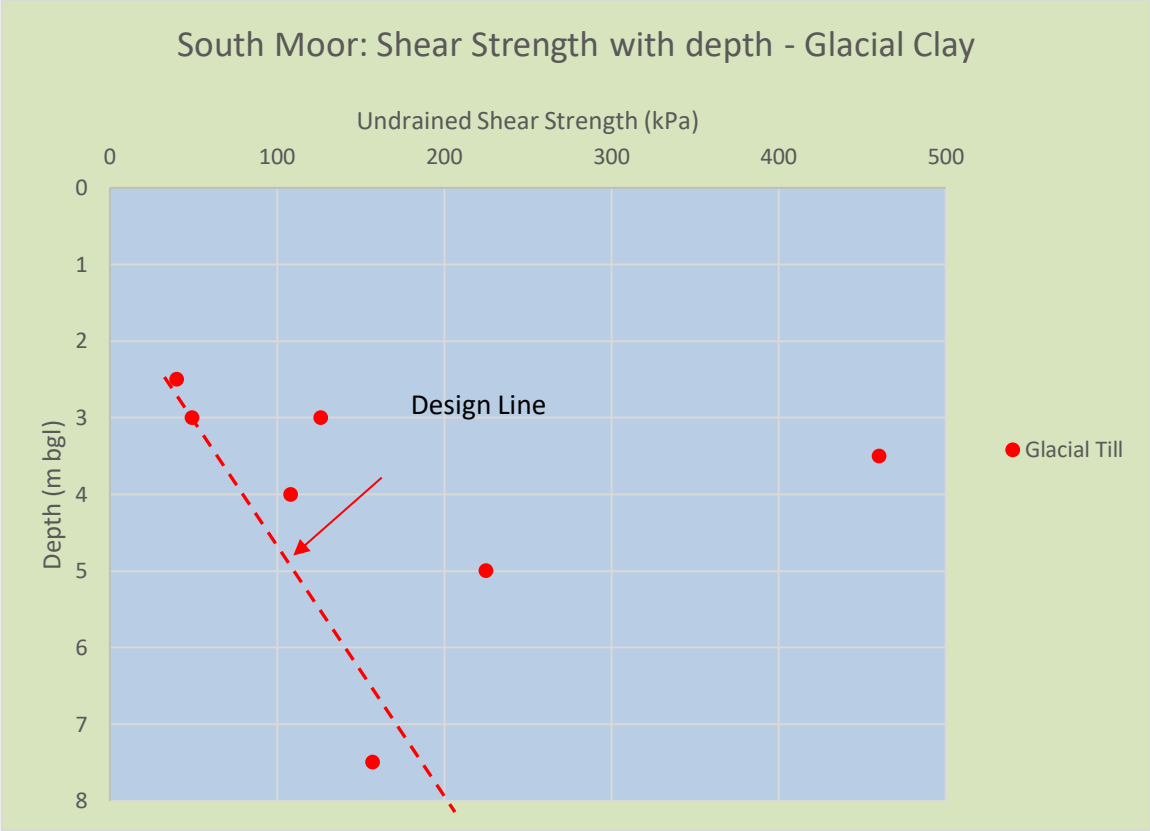


Based on the characteristic density of soils suggested in BS8004:2015 Code of Practice for Foundations, a density value of 18kN/m^3 is recommended for medium to high strength clay.

In addition to the in-situ strength testing, an undrained triaxial compression test was carried out on a sample of cohesive glacial deposits at a depth of 3.5m bgl, which gave an undrained shear strength of 460kPa, which seems abnormally high, even for a competent material such as this.

Figure 3 shows the distribution of correlated undrained shear strength with depth.

Figure 3 – Distribution of Undrained Shear Strength With Depth – Glacial Deposits



Based on the above, the following relationship between depth and undrained shear strength can be identified:

$$Cu = 50 + (30\ x\ z - 3)$$

Figure 3 shows the distribution of correlated undrained shear strength with depth.

Where:

C_u = Undrained Shear Strength in kPa

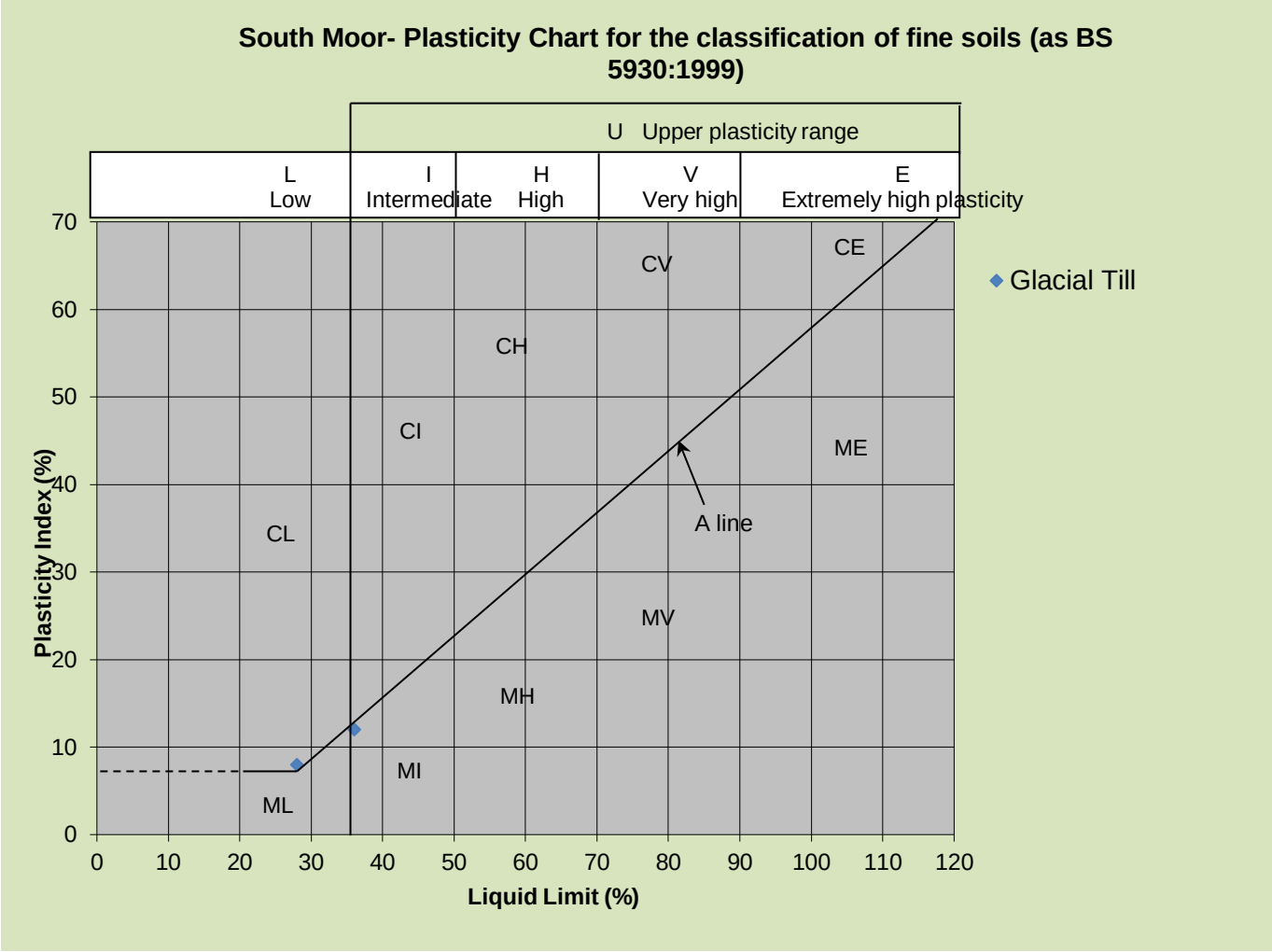
z = depth below ground level in metres.

This relationship gives the following design shear strengths:

- At 3m bgl C_u = 50kPa
- At 4m bgl C_u = 80kPa
- At 7m bgl C_u = 170kPa
- At 8m bgl C_u = 200kPa

Two samples of glacial deposits from depths of 3.5m and 6.0m bgl were recovered for classification testing, which gave moisture contents of 25%, and Plasticity index values of 8% and 12% respectively. The results, when plotted out on a plasticity chart, indicate that the clay is of low and intermediate plasticity, as shown in Figure 4 below.

Figure 4 – Plasticity Chart for samples of Glacial Deposits



An approximation of the angle of shearing resistance can be made using Equation 1 of BS8004 (2015): Code of practice for Foundations, where BS8004 where:

$$\emptyset' = 42 - 12.5Log10Ip$$

Where Ip is the Plasticity Index.

Based on the obtained Plasticity Index values of 8 and 12%, calculated effective angle of shearing resistance values of 31° and 29° are derived. Based on the limited data set, and experience of this material, a more conservative figure of 26° is recommended for design.

It is noted that the sample form 6.0m bgl, was taken from material logged as sand. Due to the fact that this sample exhibits plasticity, it can be surmised that the material contains a significant fraction of fine material.

An approximate correlation can be made between shear strength and the modulus of volume compressibility (m_v), with roughly equates to 10/Cu, which when applied to the design shear strengths outlined above, give the following design values of m_v.

- At 3m bgl $m_v = 0.200m^2/MN$
- At 4m bgl $m_v = 0.125m^2/MN$
- At 7m bgl $m_v = 0.059m^2/MN$
- At 8m bgl $m_v = 0.050m^2/MN$

Which indicates clay of medium compressibility, grading to clay of low compressibility, which would be as expected for glacial clays.

The undrained modulus (E_u) has been derived from the relationships recommended by Jamiolkowski et al (1979), $E_u = 600xC_u$ resulting in the following values of E_u:

- At 3m bgl $E_u = 30MN/m^2$
- At 4m bgl $E_u = 48MN/m^2$
- At 7m bgl Eu = $102MN/m^2$
- At 8m bgl $E_u = 120MN/m^2$

The effective drained modulus has been determined from the relationship; $E' = 0.6E_u$. As a result, the following E' values have been derived.

- At 3m bgl $E' = 18MN/m^2$
- At 4m bgl $E' = 29MN/m^2$
- At 7m bgl $E_u = 61MN/m^2$
- At 8m bgl $E_u = 72MN/m^2$

Geotechnical laboratory testing results are presented in Appendix D.

Granular Glacial Deposits

Four SPT's were performed on material logged as granular glacial deposits, as indicated in Figure 2. The resulting 'N' values ranged from 12 to 25 (mean 21, median 23), indicating medium dense material. No discernible trend between 'N' value and increasing depth could be identified.

Based on the correlation chart postulated by Peck *et* al, this equates to angles of internal shearing resistance of between 31° and 35°. For design purposes, a value of 32° is recommended.

Based on the characteristic density of soils suggested in BS8004:2015 Code of Practice for Foundations, a density value of 18kN/m^3 is recommended for medium dense sand.

In accordance with CIRIA Report 143, an approximation of the drained stiffness can be established using the relationship E' = 2N, where N is the SPT N-value ranging from a minimum of 12 to a maximum of 25. This results in a drained soil stiffness ranging from 24 MN/m^2 to 50 MN/m^2. A characteristic value for the drained modulus of 30MN/m^2 is therefore recommended for design based on a characteristic N of 15, representing medium dense granular soil.

4.1.6 Characteristic Geotechnical Properties

Based on the geotechnical data outlined above, the following characteristic geotechnical properties are recommended for the on-site materials. These are summarised in Table 4.2 below.

Table 4.2 Characteristic Geotechnical Parameters

Stratum	Unit Weight (kN/m^3)	Undrained Shear Strength (kN/m^2)	Angle of Shearing Resistance (°)	Co-efficient of Volume Compressibility (m^2/MN)	Undrained Stiffness (MN/m^2)	Drained Stiffness (MN/m^2)
Granular Made Ground	17	NA	30	NA	NA	18
Cohesive Made Ground	17	40	20	0.250	8	4.8
Cohesive Glacial Deposits	18	50 (3m bgl) 110 (5m bgl) 200 (8m bgl)	26	0.200 (3m bgl) 0.091 (5m bgl) 0.050 (8m bgl)	30 (3m bgl) 66 (5m bgl) 120 (8m bgl)	18 40 72
Granular Glacial Deposits	18	NA	32	NA	NA	30

4.1.7 Geotechnical Considerations

Foundations, Roads and Hardstandings

The site is underlain by Made Ground to a proven depth of 2.70m bgl, as identified in three of the exploratory holes. The Made Ground comprises granular sub-base material, underlain by a granular fill material comprising sandy, ashy gravel, brick and clinker fragments, which is locally underlain at 2.0m bgl by firm silty sandy clay.

The expected glaciolacustrine deposits were not encountered, despite being indicated to be present in the geological mapping. It is possible that this potentially soft, compressible material has been excavated and replaced with mixed fill materials to allow the historical development to take place. It is possible that this material was engineered, but it is unlikely that this was carried out in accordance with current best practice, and the suitability of the material for use as fill is unknown.

For the purposes of this initial foundation assessment it is understood that the site will be developed for residential purposes, comprising 2-3 storey houses with rear gardens. Structural loads are not known at this stage.

Made Ground is not recommended as a suitable bearing stratum for conventional strip foundations, due to its variability and the potential for gross total and differential settlement.

It is understood that the developer is proposing to utilise raft foundations for the development, the details of this are not known, but based on the conservative geotechnical parameters outlined above, it is considered that a raft foundation would be suitable for the development. At a founding depth of 0.45m bgl, it is envisaged that a raft foundation would comfortably achieve a bearing capacity in excess of 100kN/m^2, with total settlements of less than 10mm. The raft would need to incorporate sufficient rigidity to ensure that differential settlement due to variability in the underlying material is minimised.

An alternative solution may be to carry out localised ground improvement measures to allow more economical foundations to be constructed. Liaison would be required with specialist Contractors to ascertain the feasibility and potential costs associated with such measures.

The layout plans indicate that the building footprints do not coincide with the infilled former fuel tanks. However, should layouts change in such a way as to cause foundations to straddle the interface between infilled buried structures and the surrounding ground, the foundation design will require revision to ensure that this does not lead to excess differential settlement or tilt.

Preliminary CBR testing has not been carried out as part of the investigation. Therefore, a preliminary design CBR value of 2.5% is assumed for the expected geology at formation level. This should be confirmed on site by CBR testing prior to detailed design.

All excavation and formation levels should be inspected by a qualified person and any unsuitable formation materials should be removed and replaced with additional foundation concrete or compacted granular fill. Any relic foundations should also be removed where encountered in excavations.

4.1.8 Excavations

Based on the findings of the ground investigation, it is envisaged that excavations for foundations and services will largely be within the capabilities of conventional hydraulic plant. The possibility for the ingress of perched groundwater should not be discounted, it is envisaged that in such instances, the excavation could be dewatered by pumping to deepened sumps.

4.2 Aggressive Ground Conditions

The concentrations of water-soluble sulphate (SO4) encountered ranged from 30 mg/l to 800 mg/l.

Assuming brownfield sites with mobile groundwater, in accordance with BRE Special Digest 1:2005 the design sulphate class is DS-2, and the ACEC class is AC-2.

The recommendations of BRE Special Digest 1 should be taken into account in the design of all below ground concrete, and this should be evaluated further by a structural consultant at the detailed design stage.

4.3 Visual and Olfactory Evidence of Contamination

There was visual evidence of suspected contamination identified during the investigation as follows:

- A black oily residue was experienced on the engineers gloves when sampling the recovered core at 1.5m bgl in WS1; there was no associated odour and there were no volatiles detected with the PID.
- A feint hydrocarbon odour was experienced in WS4 at a depth of 1.9m bgl, no volatiles were detected with the PID.

4.4 Headspace Testing Results

Headspace testing of all samples was undertaken on site at the end of the day of the investigation using a miniRae PID to identify the presence of volatile organic compounds / vapour analytes within the sample. The headspace testing confirmed the absence of significant vapours, results for each sample are provided in Table 4.1.

Table 4.1 Headspace Testing Results

Sample Number	Depth (m bgl)	Maximum PPM	Steady PPM
WS1	1.5	0	0
WS1	4.5	0	0
WS3	0.5	0	0
WS3	1.0	0	0
WS4	0.6	0	0
WS4	2.5	0	0
WS4	4.5	1.0	0.2
WS5	1.5	0	0
WS6	0.5	0	0
CP1	2.5	0	0
CP1	4.0	0	0

5. Site Chemistry

5.1 Introduction

When undertaking a Generic Quantitative Risk Assessment (GQRA), chemical analysis data is compared with appropriate generic assessment criteria (GAC), where available, in order to identify potential contaminants of concern and to assist in determining whether further assessment / work is required to address risk. The assessment criteria used at the GQRA stage depends upon the source media (soil, groundwater etc.), and the receptor under consideration be it human health, controlled waters and/or property.

For any contaminants that are elevated based on the GQRA, then further work could comprise additional intrusive investigation to obtain more data to further understand risk, undertaking a detailed quantitative risk assessment (DQRA) on the contaminants of concern, or, proceeding directly to site remediation.

5.2 Data Assessment

The site is to be developed for town houses, as such GAC for residential end use with gardens have been used for data assessment for soils.

Background to the selection and/or derivation of appropriate assessment criteria for soils is presented in Table 5.1 below, listed in order of preference.

Table 5.1 Generic Assessment Criteria (GAC) – Soils

Source	Type	Year Published	Comments
Soil			
Land Quality Management (LQM) and The Chartered Institute of Environmental Health (CIEH)	GAC for Human Health Risk Assessment, S4ULs*	2015	Replacement to LQM/CIEH 2011 GAC
Defra	Category 4 Screening Levels	2014	Part 2A, used for lead only

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The individual contaminant concentrations in each appropriate dataset have been compared against appropriate assessment criteria.

When assessing the risks to controlled waters, various GAC are available; the appropriate GAC to use depends on the sites Conceptual Model and the receptor of concern. As the site is located above a Principal Aquifer, the standards defined in The Water Supply (Water Quality) Regulations are considered appropriate, followed by WHO drinking water guidelines in the absence of UK assessment criteria. UK EQS for freshwaters can then be used for any contaminants without any respective groundwater GAC.

Background to the selection and/or derivation of appropriate assessment criteria for groundwater is presented in Table 5.2, listed in order of preference.

Table 5.2 Generic Assessment Criteria (GAC) - Groundwater

Source	Type	Year Published	Comments
Groundwater			
Statutory Instrument No. 614	The Water Supply (Water Quality) Regulations	2010	These are known as the United Kingdom Drinking Water Standards (UKDWS)
World Health Organisation	WHO Guidelines for Drinking Water Quality 4th Edition	2011	Used for selective contaminants where no UK standard exists
World Health Organisation	WHO Guidelines for Drinking Water Quality	2008	Used for THPCWG fractions
Environment Agency	Environmental Quality Standards	2009	Freshwater Priority Substances (PS) and Priority Hazardous Substances (PHS) (as AA). MAC used in absence of AA. Values for some substances are dependent upon the water hardness
ATRISK	GAC as Water Screening Value (WSV) for residential land use	2011	Derived for volatile contaminants in shallow groundwater using RBCA model in accordance with EA SR3 guidance

In accordance with the Environment Agency's Remedial Targets Methodology, the GAC for controlled waters are termed "target concentrations"; the appropriate target concentration is selected based on the order of hierarchy in table 5.2 above.

5.2.1 Soil Organic Matter Content

Several published GAC for organic compounds are dependent on the content of organic matter in soil, known as Soil Organic Matter or SOM. This value can be calculated from the fraction of organic carbon (*foc*) results and the total organic carbon (TOC) results.

Therefore, the GQRA has specifically utilised the appropriate GAC based on the site derived SOM data.

5.2.2 Averaging Areas

When assessing data in respect to human health, the concept of averaging areas should be applied. An averaging area can be defined as an area of interest in which a receptor is exposed to soils that create hazardous conditions as a result of the sites past use.

For data assessment purposes, the site is classified as a single averaging area; it is considered that contaminants could be present across it from either on or off site sources, considering its small size and past use as a garage/PFS.

Certificates of analysis for all samples are contained in Appendix D, with collated analytical data tabulated in Appendix E.

A summary of the findings are summarised below.

5.3 Soils

A total number of eleven soil samples were collected from across the site during the investigation. A worst case SOM of 2.5% was used to screen organic contamination, based on the results of the laboratory testing (average %SOM value observed was 3.98%).

5.3.1 Inorganic Contaminants

All metals/metalloids were either not detected (below LOD of analysing technique) or were recorded at concentrations an order of magnitude below their respective GAC with the exception of lead. Lead was detected at a concentration of 620 mg/kg in location WS4 at a depth of 0.60m bgl, elevated above the GAC of 200 mg/kg, lead also marginally exceeded the GAC at location WS6 at a depth of 0.50m bgl; both samples are elevated within the Made Ground. The arithmetic mean for lead within all Made Ground samples is 170.87 mg/kg, well below the GAC.

pH levels ranged from 7.6 to 9.7 (slightly alkaline to alkaline ground conditions).

5.3.2 Organic Contaminants

PAHs

Several speciated PAH determinands were elevated above their respective GAC for Made Ground only. Benzo(a)anthracene was detected above the GAC of 11 mg/kg in samples WS1 (18 mg/kg @ 1.50m bgl),

WS3 (45 mg/kg @ 1.0m bgl), WS4 (34 mg/kg @ 0.60m bgl), and WS5 (43 mg/kg @ 1.50m bgl). The mean concentration of benzo(a)anthracene in Made Ground is 21.9 mg/kg, which is almost double the GAC.

Chrysene was elevated above the GAC of 22 mg/kg in three out of seven samples taken from the Made Ground. Samples WS3 (24 mg/kg @ 1.0m bgl), WS4 (25 mg/kg @ 0.6m bgl) and WS5 (26 mg/kg @ 1.5m bgl) were elevated for chrysene. The arithmetic mean for chrysene in Made Ground is 14.02 mg/kg, which is well below the GAC.

Benzo(b)flouranthene was elevated above the GAC of 3.3 mg/kg in five out of seven samples taken from the Made Ground. Samples WS1 (21 mg/kg @ 1.5m bgl), WS3 (46 mg/kg @ 1.0m bgl), WS4 (54 mg/kg @ 0.6), WS5 (45 mg/kg @ 1.5m bgl) and WS6 (11 mg/kg @ 0.5m bgl). The arithmetic mean for benzo(a)flouranthene in Made Ground is 2.76 mg/kg, which is below the GAC of 3.3 mg/kg.

Benzo(a)pyrene was elevated above the GAC of 2.7 mg/kg in five out of seven samples taken within the Made Ground. Samples WS1 (24 mg/kg @ 1.5m bgl), WS3 (36 mg/kg @ 1.0m bgl), WS4 (29 mg/kg @ 0.6m bgl), WS5 (33 mg/kg @ 1.5 mg/kg) and WS6 (8 mg/kg @ 0.5m bgl). The arithmetic mean for benzo(a)pyrene in Made Ground is 18.93 mg/kg, well above the GAC of 2.7 mg/kg.

Dibenz(a,h)anthracene was elevated above the GAC of 0.28 mg/kg in five out of seven samples within Made Ground. Samples WS1 (4.1 mg/kg @ 1.5m bgl), WS3 (5.3 mg/kg @ 1.0m bgl), WS4 (4.9 mg/kg @ 0.6 mg/kg), WS5 (4.3 mg/kg @ 1.5m bgl), WS6 (1.2 mg/kg @ 0.5m bgl). The arithmetic mean for dibenzo(a,h)anthracene within the Made Ground is 2.84 mg/kg, well above the GAC.

BTEX

BTEX was not detected, results were recorded below the LOD of the analysis technique of 1 µg/kg for every sample in both Made Ground and natural ground.

MTBE

MTBE was not detected; results were below the LOD of 1 µg/kg for all samples.

Petroleum Hydrocarbons

Lighter fraction petroleum hydrocarbons were not detected, results for aliphatic EC5 to EC8 and aromatic EC5 to EC10 were below the LOD of the analysis technique of 0.001 mg/kg. Slight detects were recorded for both aliphatic and aromatic heavier end fractions up to EC35, but were well below speciated GAC by an order of magnitude with the exception of aromatic fractions in a single sample out of a total of seven samples.

The highest detects were recorded in the EC21 to EC35 range for sample WS4 at a depth of 0.60m bgl; this is a sample location where suspected petroleum hydrocarbon contamination was observed during the work on site comprising a feint hydrocarbon odour. Aliphatic fraction EC21 – EC35 was recorded at a concentration of 260 mg/kg in WS4 at a depth of 0.60m bgl, an order of magnitude below the GAC of 92,000 mg/kg. Aromatic fraction EC16 to EC21 was slightly elevated above the GAC of 540 mg/kg with a concentration of 800 mg/kg detected, and EC21 – EC35 was slightly elevated above the GAC of 1500 mg/kg with a concentration of 2100 mg/kg detected. The elevated results were in a single sample of Made Ground only; the arithmetic mean for all samples in Made Ground for EC16-EC21 was 226.7 mg/kg, well below the GAC of 540 mg/kg, and for EC21 – EC35 it was 550 mg/kg, well below the GAC of 1500 mg/kg.

The results confirm low concentrations of petroleum hydrocarbons to be generally present on site, with two exceedances of GAC at location WS4 only; the results where elevated are indicative of highly weathered product. Samples were also scheduled for TPH CWG (ali/aro) on deeper samples at location WS4 at 2.5m bgl and 4.5m bgl, none of the samples were elevated above GAC; in sample WS4 at a depth of 2.5m all results for TPH CWG for both aliphatic and aromatic fractions were not detected with the exception of a trace detect for aromatic EC21-EC35 of 13 mg/kg, compared to the GAC of 1500 mg/kg, with all results for WS4 at a depth of 4.5m bgl being below the LOD for each fraction, petroleum hydrocarbons were not detected.

5.3.3 Other Contaminants

Asbestos was not identified in any sample within the Made Ground.

5.4 Groundwater

Two samples of shallow groundwater were taken post completion of the investigation from locations CP1 and WS4; the samples were taken using grab sampling with disposable PVC bailers, with a separate bailer dedicated to each well to prevent cross contamination during sampling.

5.4.1 Inorganic Contaminants

In location CP1 lead was detected at a concentration of 1800 µg/l which is highly elevated above the target concentration (UKDWS) of 25 µg/l. Mercury is marginally elevated above the target concentration of 0.07 µg/l, with 0.08 µg/l detected. Zinc was detected at a concentration of 470 µg/l, highly elevated

in comparison to the target value of 10.9 µg/l. Copper was elevated above the target value (EQS) of 1 µg/l with a concentration of 11 µg/l detected. All other metals were recorded below their respective target concentrations in CP1.

In location WS4 Chromium (total chromium, chromium III and dissolved), was elevated above the target concentration (UKDWS) of 50 µg/l, with concentrations of 183 µg/l (total chromium), 140 µg/l (chromium III) and 140 µg/l (chromium dissolved) recorded. Hexavalent chromium was not detected. Arsenic was recorded above the target concentration of 10 µg/l with a concentration of 22.1 µg/l detected. Lead was highly elevated above the target concentration of 25 µg/l with a concentration of 2700 µg/l detected. Selenium was recorded at 13 µg/l, slightly elevated above the target concentration of 10 µg/l. Zinc is highly elevated above the target concentration of 10.9 µg/l, with 2000 µg/l recorded. Copper was recorded at a concentration of 130 µg/l, highly elevated above the target concentration of 1 µg/l. Mercury was not detected in WS4, the result was below the LOD of the analysis technique.

5.4.2 Organic Contaminants

PAHs

No speciated PAHs were detected within borehole location CP1 located next to the tank farm, all results for every speciated determinand (EPA 16) were below the LOD of the analysis technique (<0.01 µg/l).

Speciated PAHs were generally not detected in location WS4 with the exception of slights detects for naphthalene (9.48 µg/l), acenaphthene (0.41 µg/l) and fluorene (0.21 µg/l). Naphthalene is above its target value (EQS) of 2 µg/l. There are no GAC for acenaphthene and/or fluorene.

Naphthalene is well below the ATRISK WSV for vapour intrusion of 952 µg/l.

BTEX

BTEX was not detected, all results were below the LOD of the analysis technique for both CP1 and WS4 (<1.0 µg/l).

MTBE

MTBE was not detected, the results for both boreholes was below the LOD of the analysis technique (<1.0 µg/l).

Petroleum Hydrocarbons

Petroleum hydrocarbons were not detected in CP1 located next to the tank farm; all aliphatic and aromatic fractions within the range C5 – C35 were not detected; all results were less than the LOD for each fraction (either <1 µg/l or <10 µg/l).

In location WS4; C5 to C10 fractions were not detected (both aromatic and aliphatic). Slight detects were recorded for aliphatic C10 – C12 @ 150 µg/l and C12 – C16 @ 210 µg/l, both are below their target concentrations (WHO DWS) of 300 µg/l . Detects were also recorded for aliphatic C16 - C21 @ 110 µg/l and C21 – C35 @ 850 µg/l; there are no GAC available for these heavier fractions.

All aromatic fractions for location WS4 were not detected with the exception of a single detect for fraction C10 - C12 where a concentration of 780 µg/l was detected, this exceeds its target value (WHO DWS) of 90 µg/. Aliphatic fractions C10 - C12 and C12 - C16 are above ATRISK WSVs for vapour intrusion of 22.8 µg/l and 5.47 µg/l respectively. The single detect of aromatic C10 – C12 of 780 µg/l is an order of magnitude below the ATRISK WSV for vapour intrusion of 3,870 µg/l.

5.5 Summary

5.5.1 Soils

Based on the findings of the ground investigation, contamination is absent in the natural soils at the site.

Contamination is present in Made Ground comprising lead (detected in two locations above the GAC), petroleum hydrocarbons (aromatic C16 – C35 slightly elevated above the GAC in one location only), and the speciated PAHs benzo(a)anthracene, chrysene, benzo(b)flouranthene, benzo(a)pyrene and dibenz(a,h)anthracene.

The only contaminants with an arithmetic mean recorded above their respective GAC were the speciated PAHs benzo(a)anthracene, benzo(b)flouranthene, benzo(a)pyrene and dibenz(a,h)anthracene; these determinands are highly elevated within Made Ground compared to their GAC.

All other results for inorganic and organic soils determinands were either below the LOD of the analysing technique, or, were orders of magnitude below the relevant human health GAC for a residential end use.

BTEX, MTBE and asbestos were not detected in either Made Ground or natural ground.

In the ground conditions section it was surmised that the natural glaciolacustrine deposits were removed from site when it was originally developed in the 1940s/1950s and replaced with an engineered fill; a

common practice at the time was to import suitable wastes from surrounding industry which was numerous in this area of Sunderland at the time. The Made Ground has clinker and ash components, it is possible/likely that the lead and PAH contamination detected during the investigation is an inherent component of this fill material, rather than being contamination from the garage and PFS operations, considering the lack of any other organic contamination detected in soils within the site.

5.5.2 Groundwater

Monitoring of the shallow groundwater below the site has confirmed the presence of metal contamination in groundwater which is elevated above the relevant GAC; chromium, arsenic, lead, mercury, selenium, zinc and copper are present within the shallow groundwater above their assessment criteria.

Organic contamination typically associated with PFS such as BTEX and MTBE were not detected in groundwater in either borehole, and no PAHs or Petroleum hydrocarbons (as TPHCWG) were detected in WS1, all results were below the respective LOD of the analysis technique. A single detect for petroleum hydrocarbon aromatic fraction C10 – C12 was recorded in WS4, this is elevated in comparison to its target concentration comprising WHO drinking water standards.

Aliphatic C10 – C16 has been recorded at concentrations in groundwater that present a potential vapour risk to human health receptors from petroleum hydrocarbon contamination in groundwater in location WS4 only.

5.6 Ground Gas

Three boreholes were installed with combined ground gas and groundwater monitoring wells during the Phase 2 investigation and monitored post completion of the works, a borehole location plan is provided in Appendix A.

Ground gas monitoring commenced on 28 July 2020 and at the time of writing six visits have been completed. Six fortnightly visits are considered to be sufficient considering the potential gas source comprising Made Ground which was possibly placed over seventy years ago when the garage was originally established (the Phase 1 report confirmed a garage on the site from 1953). Table 5.5a of CIRIA C665 states that for a very low potential source of gas with a high sensitivity development (i.e. residential), the typical idealised period of monitoring is three months, with a frequency of six rounds. The monitoring programme completed at the site has conformed to this. The Phase 1 report identified no source of ground gas other than vapours; due to a significant thickness of Made Ground being encountered on site

(although obvious evidence of materials capable of microbial degradation and respiration were not present), a ground gas monitoring programme was undertaken in addition to vapour monitoring.

VOC monitoring has also been undertaken at the same time as ground gas monitoring; VOCs were not found to be elevated during the investigation and laboratory testing has confirmed that BTEX and lighter fraction petroleum hydrocarbons are not present.

The findings of monitoring data are as follows.

Ground gas monitoring results are presented in Appendix F, and summarised in Table 5.2 below.

Table 5.2 Summary of Ground Gas Monitoring

Borehole ID	Maximum Methane (% v/v)	Maximum Carbon Dioxide (% v/v)	Minimum Oxygen (% v/v)	Maximum Steady Flow (l/h)	Maximum Hydrogen Sulphide (ppm)	Maximum Carbon Monoxide (ppm)	Maximum VOC (ppm)
WS1	0.0	0.1	17.2	0.0	0.0	0.0	0.1
WS4	0.1	3.0	15.4	-0.7	0.0	0.0	22.3
CP1	0.0	6.3	8.9	2.4	0.0	0.0	1.3

5.6.1 Oxygen

Oxygen concentrations were normal to moderately depleted throughout monitoring, with the exception of location CP1 where oxygen was experienced to be moderately depleted to depleted, with a low of 8.9 % v/v recorded on 24 August 2020.

5.6.2 Methane

Methane was not detected in any borehole during the period of monitoring with the exception of a trace concentration of 0.1% v/v detected in location WS4 on 28 September 2020. This concentration is equivalent to the MCERTS calibration tolerances of the GFM-436 gas detector used during monitoring, meaning methane may not have actually been present. Considering that methane was not detected during any other monitoring visit it is likely to be a spurious result.

5.6.3 Carbon Dioxide

Carbon dioxide was detected up to a maximum concentration of 6.3% v/v recorded on a single occasion in location CP1. The next highest carbon dioxide concentration recorded in CP1 was 4.9% v/v recorded on 13 October 2020. Carbon dioxide was recorded at a maximum concentration of 0.1% v/v in WS1 (recorded on three occasions), and a maximum concentration of 3.0% v/v in WS4 recorded on 28 September 2020.

5.6.4 Hydrogen Sulphide

Hydrogen sulphide was not detected in any borehole during the monitoring period.

5.6.5 Carbon Monoxide

Carbon monoxide was not detected in any borehole during the monitoring period.

5.6.6 Volatile Organic Compounds (VOCs)

VOCs were recorded on a single occasion in borehole WS1 with a peak concentration of 0.1ppm detected on 24 August 2020, the steady reading was zero ppm.

VOCs were recorded on each monitoring visit within location WS4 reaching a peak concentration of 23 ppm during the third monitoring round and a steady concentration of 9.1 ppm, falling to 2.2 ppm (peak and steady reading) during the final sixth visit on 13 October 2020.

In location CP1 VOCs were experienced to be low, a maximum peak concentration of 1.3ppm was recorded on the first monitoring visit of 28 July 2020, with a steady concentration of zero ppm, results then fell during subsequent monitoring rounds and no VOCs were detected in CP1 during monitoring rounds 3 to 6.

5.7 Ground Gas Risk Assessment

The architect for the project has confirmed that the proposed dwellings will be constructed on raft foundations without a ventilated subfloor void. As such, the proposed development at the site relates to Situation A as defined in CIRIA C665 which is the chosen methodology to screen the ground gas results, with cognisance to BS8485:2015+A1:2019.

Gas screening values (GSVs) have been calculated for each borehole location and screened against CIRIA C665 guidance to identify a Characteristic Situation for ground gas results obtained to date. GSVs are calculated for individual boreholes and the site as a whole using the highest peak flow and peak carbon dioxide concentrations (i.e. worst case). Methane was not detected other than a single occurrence at 0.1% v/v in WS4 which is within the calibration tolerances of the instrument and possibly a spurious result.

GSVs are present in Table 5.3 below.

Table 5.3 Gas Screening Values

	Gas Screening Value			
Borehole Location	**Maximum CO_2 Concentration (% v/v)**	**Steady Flow (l/hr)**	**Individual GSV**	**Characteristic Situation**
WS1	0.1	0.1	0.0	1
WS4	3.0	0.7*	0.021	1
CP1	6.3	2.4	0.1512	2
Overall Site				
All Locations	6.3	2.4	0.1512	2

*Note: Negative flow value as recorded in field has been used as a positive number – assumes negative flow value could become positive in borehole

Based on six rounds of gas monitoring the site is classified as in accordance with CIRIA C665 the site is classified as **Characteristic Situation 2 – low risk** in accordance with CIRIA C665. Therefore, based on six ground gas monitoring rounds undertaken to date, basic ground gas protection measures for methane and/or carbon dioxide are required for future dwellings on the site.

The recommendations for basic gas protection measures for a Situation A development are in Table 5.4 as follows.

Table 5.4 Basic Gas Protection Measures – Situation A

Residential Building other the Situation B		
Characteristic Situation (CS)	**Number of levels of protection**	**Typical scope of protective measures**
2	2	a) Reinforced concrete cast in situ floor slab (suspended, non suspended or raft) with at least 1200g DPM and underfloor venting.
		b) Beam and block or pre cast concrete and 2000g DPM / reinforced gas membrane and underfloor venting.
		All joints and penetrations sealed.

The main issue surrounding specifying gas resistant membranes is their ability to survive the construction process intact and to resist any differential settlements. Membranes should be selected based on their performance characteristics and ability to survive the construction phase. An unreinforced 1200g membrane is unlikely to achieve this, therefore the recommended minimum thickness of a gas resistant membrane proposed for a low-risk site is unreinforced 2000g.

Significant hydrocarbon vapours have not been detected on site during monitoring, and volatiles have not been detected in the soils laboratory testing results. However, as the site comprises a former PFS, with concentrations of petroleum hydrocarbons in groundwater presenting a potential vapour risk, to be conservative it is recommended that the chosen ground gas protection membrane should also be resistant to hydrocarbon vapours, to mitigate any latent vapours that may present within the Made Ground, or with a potential to partition from groundwater.

As an alternative methodology for establishing the ground gas protection measures required at the site for Characteristic Situation 2, the eventual designer of the foundations could utilise the methodology within BS8485:2015+A1:2019, this should be considered further at the detailed design stage.

5.7.1 Other Ground Gases

CIRIA C665/NHBC (or BS8485:2015+A1:2019) does not take into account risks from other ground gases such as carbon monoxide. The occupational exposure limits (OEL) as an eight hour long term time weighted average (TWA) as reported in the Health and Safety Executive (HSE) guidance document "EH40/2005 Workplace Exposure Limits" can be used as a screen for these gases.

Hydrogen sulphide and carbon monoxide was not detected during the monitoring programme. The trace gases hydrogen sulphide and carbon monoxide are therefore not of concern to the development proposals based on monitoring results to date.

5.7.2 Recommendations

The findings of six rounds of ground gas monitoring post completion of the ground investigation, including a round undertaken during a period of falling atmospheric pressure has identified that the site is "Characteristic Situation 2" in accordance with current guidance.

6. Generic Quantitative Risk Assessment and Revised Conceptual Model

6.1 Introduction

Based on the preceding information the initial CM has been revised and an environmental risk assessment has been undertaken.

The environmental risk assessment has been based on a CONTAMINANT (Source) – PATHWAY – RECEPTOR methodology where:

CONTAMINANT: Contamination that has the potential to cause harm to environmental receptors. In a broader sense sources can also include particular ground conditions that have the potential to impact upon ground structures, including services and utilities.

PATHWAY: The route by which the contaminant is brought into contact with the receptor. This can include the transport of contamination via groundwater, wind borne dust, vapours, excavation and deposition.

RECEPTORS: Human beings, Ecological Systems, Controlled Waters (surface water and ground water), Property (including crops and livestock) as defined in Table A of Chapter A of DETR Circular 01/2006, Flora and Fauna.

The CONTAMINANT-PATHWAY-RECEPTOR relationship, referred to as pollutant linkages, allows an assessment of potential environmental risk to be determined, based on the nature of the contaminant, the degree of exposure of a receptor to a contaminant and the sensitivity of the receptor.

The identified potential environmental risks have been evaluated with respect to the potential for impacts on:

- future site users (human health);
- controlled waters (groundwater – principal aquifer without SPZ or abstractions);
- property (future dwellings).

Central to the requirements for the assessment of risk is the development of a CM. The CM is based on the available information and identifies all potential pollutant linkages.

The model has been derived using a SOURCE – PATHWAY – RECEPTOR methodology to enable potential pollutant linkages to be identified, assessed and ranked in terms of importance.

6.2 Environmental Risk Assessment

In accordance with the current UK Government policy of the "suitable for use" approach to the remediation of contaminated land, a quantitative contamination risk assessment of the site has been undertaken, with regard to the proposed site use, and in relation to the wider environment. The site is being redeveloped for residential dwellings with gardens; the site is therefore assessed against Generic Assessment Criteria (GAC) derived for a residential with home grown produce land use scenario.

The implications of the potential contamination sources identified in Section 2 have been assessed by consideration of:

1. The presence and degree of integrity of pollution linkages
2. Evaluation of the significance of contamination risk based upon the severity of harm and sensitivity of receptors to which harm or pollution may be caused.

The identification and significance of potential "pollutant linkages" discussed above is a key component in the evaluation of potentially contaminated land. An approach based on CIRIA C552 - *Contaminated Land Risk Assessment, a Guide to Good Practice (2001)* has been used as a basis for risk assessment in this report.

The classification of risk is presented in Tables 6.1 to 6.3, with the Generic Quantitative Risk Assessment (revised Conceptual Model) presented in Table 6.4.

6.3 Risk Assessment Approach/Method

6.3.1 Stage 1 - Potential Consequence of Contaminant

Potential consequences relating to contaminants are detailed in Table 6.1 below.

Table 6.1 Potential Consequence of Contaminant

Classification	Human Health	Controlled Water	Ecology, Flora & Fauna	Property	
				Structures	Crops & Animals
Severe	Irreversible damage to human health	Substantial pollution of sensitive water resources	Significant change to the number of one or more species or ecosystems	Irreparable damage to buildings, structures or the environment	Loss in value of livestock / crops resulting from death, disease or physical damage
Moderate	Non-permanent health effects to humans	Pollution of non-sensitive water resources or small scale pollution of sensitive water resources	Change to population densities of non-sensitive species	Damage to sensitive buildings, structures or the environment	Non-permanent health effects from disease or physical damage which result in reduction in value
Mild	Slight short term effects to humans	Slight pollution of non-sensitive water resources	Some change to population densities but with no negative effects on the function of the ecosystem	Easily repairable effects of damage to buildings or structures	Slight or short term health effects which result in slight reduction in values
Negligible	No measurable effects on humans	Insubstantial pollution to non-sensitive water resources	No significant changes to population densities in the environment or in any ecosystem	Very slight non-structural damage or cosmetic harm to buildings or structures	No significant reduction in value

6.3.2 Stage 2 - Likelihood of Contaminant Linkage

Stage 2 assesses the probability of the selected contaminant and receptor being linked by the identified pathway. The probability is based on site specific conditions and ranked in Table 6.2.

Table 6.2 Likelihood of Contaminant Linkage

Likelihood of Contaminant Linkage	
Very unlikely	0% to 5%
Unlikely	5% to 45%
Possible	45% to 55%
Likely	55% to 95%
Almost certain	95% to 100% (i.e. impact noted during investigation)

6.3.3 Stage 3 - Overall Risk Classification

Stage 3 provides an overall assessment of the actual risk based on the consequence of the risk being realised and the likelihood of the risk being realised. The risk classifications are assigned using the consequence / likelihood matrix presented in Table 6.3.

Table 6.3 Risk Classification

	Likelihood				
Potential Consequence	**Very Unlikely**	**Unlikely**	**Possible**	**Likely**	**Almost Certain**
Severe	Low	Low to Moderate	Moderate to High	High	Very High
Moderate	Negligible to Low	Low	Moderate	Moderate to High	High
Mild	Negligible	Low	Low	Low to Moderate	Moderate
Negligible	Negligible	Negligible	Negligible to Low	Low	Low

Overall risks are described as follows:

Very High	There is a high probability that severe harm could arise to a designated receptor from an unidentified contaminant without appropriate remedial action.
High	A designated receptor is likely to experience significant harm from an identified contaminant without remedial action.
Moderate	It is possible that harm could arise to a designated receptor from an identified contaminants, but it is likely that such harm would be relatively localised or non-permanent. Remedial action may be necessary.
Low	It is possible that harm could arise to a designated receptor from an identified contaminant; however, this is likely to be mild.
Negligible	The presence of the identified contaminant does not give rise to the potential to cause significant harm.

6.4 Revised Conceptual Model

The initial CM established within the Phase 1 Desk Study report has been revised based upon information obtained by the ground investigation. Table 6 presents the generic quantitative risk assessment findings (GQRA) and revised CM.

The main developments to the CM are summarised below:-

Human Health

- All metals/metalloids have been eliminated from the CM with the exception of lead.
- Petroleum hydrocarbons have been eliminated from the CM with the exception of EC16 – EC21 at location WS4 in Made Ground. Samples of deeper ground at this location have confirmed that the contamination is not moving vertically within the soil profile to groundwater.
- Asbestos has been eliminated from the CM.
- BTEX and MTBE have been eliminated from the CM.
- PAH contamination has been confirmed in Made Ground.
- Risks to human health from ground gas (carbon dioxide) and petroleum hydrocarbon vapours have been confirmed as a significant contaminant linkage which needs to be mitigated during construction by way of gas protection measures to CS2 standard.

Controlled Waters

- Metal contamination is present in shallow groundwater, and aromatic fraction EC10 – EC12.
- BTEX and MTBE have been eliminated from the CM.
- PAHs have been eliminated from the CM.

Property

- Risks from methane (explosion) have been eliminated from the CM.
- In ground concrete requires DS-2 – AC-2 classification (to be evaluated further by structural consultant at detailed design stage).

Table 6.4

Revised Conceptual Model

Original Linkage ID Number *	Source	Contaminant	Receptor	Pathway	Potential Effect	Potential Consequence of Linkage	Likelihood Linkage	Risk Classification	Comment
	Service Station (fuel storage) (on site)	Metals/metalloids, acids/alkalis, sulphates, petroleum hydrocarbons, BTEX, PAHs, MTBE	**Human Health**						
2			Future Site Users	Dermal contact, ingestion, inhalation	Toxic carcinogenic, hazardous to human health	Severe	Possible	Moderate to High	Lead and PAH contamination present in Made Ground.
			Controlled Waters						
4			Shallow Groundwater	Leaching through soil profile	Groundwater contamination	Moderate	Possible	Moderate	Metals and Localised hydrocarbon contamination present in shallow groundwater. Numerous former

Table 6.4

Revised Conceptual Model

Original Linkage ID Number *	Source	Contaminant	Receptor	Pathway	Potential Effect	Potential Consequence of Linkage	Likelihood Linkage	Risk Classification	Comment
									heavy industry's present off site in local area including gas works, spelter works, paper works and oil stores that will have impacted the shallow hydrogeology.
5			Deeper Groundwater (Principal Aquifer)	Leaching through soil profile	Groundwater contamination	Moderate	Unlikely	Low	Principal Aquifer below site, however, no SPZ or abstraction licenses present within 1.0km, no surface waters within 0.5km. Significant unit of low permeability Glacial Till present below site. Shallow

Table 6.4

Revised Conceptual Model

Original Linkage ID Number *	Source	Contaminant	Receptor	Pathway	Potential Effect	Potential Consequence of Linkage	Likelihood Linkage	Risk Classification	Comment
									groundwater confined in sand layer above stiff Glacial Till.
			Property						
6			Future buildings, foundations and services	Permeation through soil profile, direct contact	Degradation of building materials	Moderate	Unlikely	Future buildings, foundations and services	Widespread gross contamination that could impact property not present.
	Service Station/Ground Gas	Hydrocarbon Vapours / Ground Gas	**Human Health**						
8			Future Site Users	Dermal contact, ingestion and inhalation	Toxic carcinogenic, hazardous to human health	Severe	Possible	Moderate to High	CS2 basic protection required due to slightly elevated CO2 only. Membrane should also be resistant

Table 6.4

Revised Conceptual Model

Original Linkage ID Number *	Source	Contaminant	Receptor	Pathway	Potential Effect	Potential Consequence of Linkage	Likelihood Linkage	Risk Classification	Comment
									to hydrocarbon vapours.
			Property						
10			Future buildings, foundations and services	Permeation through soil profile, direct contact	DPM and drinking water pipework attack	Moderate	Unlikely	Low	Methane not detected; elevated vapours not detected. Services should be installed within clean corridors and DPM requires gas and vapour protection which will not be vulnerable to attack.

*Note: Original Contaminant Linkage number carried across from initial CM established in Phase 1 report (preliminary risk assessment).

7. Conclusions and Recommendations

7.1 Geotechnical

7.1.1 General

The encountered geology was not in accordance with the geology indicated in the published BGS data, with Glaciolacustrine Deposits not being present beneath the site. The surface geology comprised Made Ground to a depth of 2.7m bgl, comprising sub-base, underlain in turn by granular fill comprising ashy gravel with fragments of brick and clinker, and firm gravelly clay. It is possible that the potentially soft and compressible Glaciolacustrine deposits were removed and replaced with locally sourced fill materials when development of the site took place. Due to the age of the site, it is unlikely that the fill materials were sourced and placed in accordance with current best practice and standards.

The Glacial deposits underlying the Made Ground generally took the form of an upper layer of firm to stiff sandy gravelly clay, underlain by a granular layer comprising clayey silty sand. This was then underlain by stiff to very stiff sandy gravelly clay. The gravel in the clay strata comprised subangular to subrounded fine to coarse mudstone, sandstone and coal. The base of this layer was not penetrated.

Shallow strip foundations would not be suitable for the proposed residential development of the site, due to the thickness of Made Ground. The development may be founded on a raft foundation placed on the Made Ground at a depth of 450mm, although the raft will need to be designed with sufficient stiffness to ensure that excess differential settlement does not occur due to variations within the Made Ground, or at the interface with infilled buried structures. Alternative solutions such as localised Ground Improvement measures may provide a more economical solution, liaison with specialist Contractors would be required to explore the feasibility and potential costs of these options.

All excavation and formation levels should be inspected by a qualified person and any unsuitable formation materials should be removed and replaced with additional foundation concrete or compacted granular fill.

7.1.2 Buried Concrete / Aggressive Ground

The chemical testing undertaken determined soluble sulphate levels of between 0.03 and 0.80g/l. Assuming brownfield sites with mobile groundwater, in accordance with BRE Special Digest 1:2005 the design sulphate class is DS-2, and the ACEC class is AC-2.

The recommendations of BRE Special Digest 1 should be taken into account in the design of all below ground concrete, and this should be evaluated further by a structural consultant at the detailed design stage.

7.1.3 Geotechnical Recommendations

Preliminary CBR testing has not been carried out as part of the investigation. Therefore, a preliminary design CBR value of 2.5% is assumed for the expected materials at formation level. This should be confirmed on site by CBR testing prior to detailed design.

The geotechnical assessment has been carried out based on initial information obtained in the ground investigation. The report findings should be re-evaluated, and further ground investigation undertaken to fill data gaps, if required, should the redevelopment proposals change.

Further targeted ground investigation and testing could also be carried out to optimise design parameters once the site layouts are finalised, if required, to facilitate detailed design.

7.2 Contamination

7.2.1 General

The site has been subjected to a geoenvironmental ground investigation. The investigation comprised a combination of window sample and cable percussion boreholes, with the installation of combined gas and groundwater monitoring wells in three boreholes with a post works monitoring programme implemented for hydrocarbon vapours, ground gas and groundwater levels. Ground gas was not expected on site based on the findings of the sites initial CM, due to Made Ground being present across the site to 2.7m bgl a post works ground gas monitoring programme was also completed (discussed in section 7.2.3 below).

The exploratory hole locations were based on a judgemental sampling approach due to the small size of the site and the presence of below ground former PFS infrastructure comprising fuel tanks, lines and interceptors. The presence of below ground infrastructure with a potential for contamination and explosion

risk during drilling if punctured meant that a statistically relevant grid approach was not feasible on this site.

Prior to the investigation being completed, a survey was commissioned of the subsurface to document the subsurface features, so that they could be targeted and at the same time avoided during the intrusive work. The survey work confirmed the presence of four former fuel tanks in the north of the site, with interceptors, lines and services present. The survey work confirmed that the fuel tanks have been decommissioned by foam filling, and that filling points are by direct access below manhole chambers in the forecourt, breather pipes appear to have been removed.

7.2.2 Human Health

The findings of the intrusive investigation has demonstrated that contamination is present within the Made Ground at the site, comprising lead and speciated PAHs. Lead was elevated at one location (WS4) at a depth of 0.60m bgl (620 mg/kg detected compared to the GAC of 200 mg/kg), and marginally elevated at location WS6 at a depth of 0.5m bgl, with 210 mg/kg detected. However, the arithmetic mean for all lead within the Made Ground is well below the GAC.

Several speciated PAHs have been detected within the Made Ground, where present they are typically found together; comprising benzo(a)anthracene, chrysene, benzo(b)flouranthene, benzo(a)pyrene and dibenz(a,h)anthracene.

The arithmetic mean for all PAHs in Made Ground exceeded the GAC for benzo(a)anthracene, benzo(a)pyrene and dibenz(a,h)anthracene only.

Other contaminants typically association with fuel storage and dispensing were not detected on site; BTEX and MTBE were not detected in the Made Ground, or natural ground, all results were below the LOD of the analysis technique for both of these determinands. Petroleum hydrocarbons were also typically not elevated on site other than for a single detect at location WS4 in Made Ground at a depth of 0.60m bgl for aromatic fractions in the range EC16 – EC35. A concentration of 800 mg/kg was detected for aromatic fraction EC16 – EC21, against a GAC of 540 mg/kg, and 2,100 mg/kg was detected for EC21-EC35, which is slightly above the GAC of 1,500 mg/kg. TPHCWG analysis on deeper samples recovered at this location at 2.5m bgl and 4.5m bgl confirmed that the elevated hydrocarbon contamination is not present at depth, suggesting that the material is not moving vertically within the soil profile to groundwater.

All other results for petroleum hydrocarbons were either representative of trace detects an order of magnitude below GAC, or, were not detected.

The geotechnical appraisal indicated that the natural glaciolacustrine deposits were removed from the site when it was originally developed in the late 1940s / early 1950s and replaced with imported wastes from nearby off site industry to be used as an engineered fill material to replace compressible/soft ground, as Made Ground is present across the site to a consistent depth that is compact. The contaminant profile on site indicates that the lead and PAH contamination detected is possibly a component of this material, as it contains ash and clinker, indicating a product of combustion. PAHs are generated by the combustion of organic materials, they are also a component of fuels, mainly diesel, but the lack of other contamination associated with hydrocarbon fuels and the widespread nature of the PAH contamination suggests it is inherently present within the Made Ground generated by the process that created the source material.

All other contaminants including acids/alkalis (as pH), BTEX, MTBE and asbestos were not detected, all other metals/metalloids were either not detected or were detected at concentrations an order of magnitude below their respective GAC for a residential end use.

Contamination is not present within the natural ground suggesting contamination in Made Ground is not moving vertically to groundwater.

Based on the findings of the ground investigation, the initial CM has been revised. This has resulted in a single contaminant linkage for human health to be present on site; the linkage relates to Made Ground and the presence of lead and PAH contamination.

7.2.3 Controlled Waters

Monitoring of the shallow groundwater below the site has confirmed the presence of metal contamination and aromatic C10 – C12 contamination. All other organic contamination typically associated with PFS such as BTEX, MTBE and PAHs are not present, with the exception of detects for naphthalene and acenaphthene in location WS4 only. The use of drinking water standards to evaluate contamination on site, and freshwater EQS are considered overly conservative considering the sites Conceptual Model. Whilst groundwater below the site comprises a Principal Aquifer, there are no SPZ or water abstraction licenses present within 1.0km of the site. There are no surface waters present within 0.5km of the site that could be a receptor to shallow groundwater moving out of the site, and the presence of a significant unit of stiff to very stiff Glacial Till is expected to significantly retard the vertical migration of localised contamination in shallow groundwater (classified by the EA as "Unproductive Strata"). A BGS borehole record for a borehole sunk for Hendon Paper Mill to the south west of the site (BGS ref: NZ45SW208) confirmed the Glacial deposits to be circa 20m thick.

Significant heavy industry was present in the off site area historically including spelter works (Spelter Works Road is present to the immediate north of the site), gas works, paper works and oil stores. Railway land is present in the vicinity of the site currently. This industry is also located above the Principal Aquifer and is likely to have impacted on the shallow groundwater quality locally.

Organic contamination typically associated with PFS such as BTEX and MTBE have not been detected in groundwater in either borehole, and no PAHs or Petroleum hydrocarbons (as TPHCWG) were detected in borehole WS1 located next to the tank farm, all results were below the respective LOD of the analysis technique.

Slight detects for petroleum hydrocarbon aliphatic fractions were recorded in shallow groundwater in WS4 in the range C10 - C35, all are below GAC. Petroleum hydrocarbon aromatic fractions C10 – C12 were also recorded in shallow groundwater in WS4, this is elevated in comparison to WHO drinking water standards which is a highly conservative GAC considering the site setting.

It is considered that whilst the shallow groundwater body has contamination present, there are no receptors present to this contamination, with shallow groundwater locally likely to have been impacted by heavy industry and other industry present in the locality.

The PAH contaminant profile in groundwater is different to the contaminants found in the overlying Made Ground, and, PAH contamination is not present in the natural ground of the site. This suggests that the contamination in groundwater is from an off site source, not site derived.

7.2.4 Ground Gas

Ground gas monitoring to date indicates that risks from explosive gases are not present at the site; the ground gas risk assessment considered the site to be Characteristic Situation 2 – low risk, due to the presence of carbon dioxide.

It is likely that the carbon dioxide is a result of natural processes in the Glacial Till, concentration of up to 8% v/v in Glacial Till is not unusual; and does not provide a risk to built development. However, due to the presence of Made Ground, and localised hydrocarbon contamination in groundwater the possibility of carbon dioxide being generated from aerobic degradation of hydrocarbons cannot be entirely ruled out.

To be health protective it is recommended that basic gas protection is incorporated within the proposed new dwellings to mitigate risks of carbon dioxide. Significant hydrocarbon vapours have not been experienced on site, but due to the sites past use as a PFS the presence of latent vapours within the subsurface should be considered possible, and partitioning of vapours from shallow groundwater. The

chosen gas resistant membrane solution for the development should mitigate hydrocarbon vapours, as well as ground gas.

Based on results to date, it is considered that ground gas and vapour protection measures are required for the proposed new dwellings.

7.2.5 Contamination Recommendations

- Subsurface PFS infrastructure is present on the site. It is recommended that this is permanently made safe by removing it from site ahead of redevelopment. The work should be undertaken by experienced contractors conversant with the risks of decommissioning filling stations. Fuel tanks, lines and interceptors should be removed from site and the ground reinstated to a suitable geotechnical specification.
- A Remediation Strategy should be prepared for the site that confirms how the remediation is to proceed, and how contaminant linkages in Made Ground are to be mitigated so that the site can be developed safely. An Options Appraisal should form a part of the remediation strategy to confirm the most sustainable solutions for the development of the site. It is likely that the preferred remedial solution for the site is encapsulation of the site with an in ground concrete raft below properties with gas protection, hard cover for car parking and access areas and a capping barrier layer for gardens. Source removal of hydrocarbon contamination in WS4 may also be preferred.
- Any topsoil/subsoil to be imported to site to form garden and capping materials should be chemically tested as being suitable for use prior to import and placement on site; the results should be reviewed by a suitably qualified geoenvironmental consultant and agreed before import. The specification for capping and soils forming materials in gardens should be confirmed in the Remediation Strategy.
- WAC testing may be required to support the removal of any soils to landfill to achieve formation levels and/or for service trench construction.
- Metal and aromatic hydrocarbon contamination in shallow groundwater is confined in a sand layer above a unit of stiff to very stiff Glacial Till. There are no SPZ or water abstractions within 1.0km of the site, or nearby surface water receptors. Significant off site industry has been present around this area of Sunderland including spelter works (metal works), gas works, paper works and various other industry. Shallow groundwater is likely to be impacted locally from this industrial use. As no receptors are considered to be present to shallow groundwater, there is considered to be no

driver for undertaking remediation of the shallow groundwater body; removal and validation of the subsurface PFS infrastructure will provide "betterment" for groundwater, along with the source removal of any residual contamination identified during the work. The chemical status of the underlying aquifer has not been investigated during this work; the minimal contaminants identified in shallow groundwater during the investigation are not considered a risk to the underlying aquifer due to the presence of low permeability Glacial Till. Contamination present within shallow groundwater is possibly not all site derived as the PAH profile is different and other than lead, metals/metalloids have not been experienced above GAC in the overlying Made Ground. The Water Framework Directive allows a risk based and a cost benefit approach to be applied to groundwater contamination. Exceedance of GAC does not necessarily imply that an unacceptable risk exists, or that remediation is required either on a cost benefit or technical basis. This approach will need to be agreed with the Environment Agency following their review of this report.

- If redevelopment proposals change, then the findings of this report should be re-evaluated.

This report supports the discharge of Condition 4 (part 2 - site investigation scheme) and Condition 5 (Phase II report) of planning consent 19/01593/FUL imposed on the development by Sunderland City Council.

A Phase 1 Desk Study report (aka preliminary risk assessment) has already been prepared by DBS to support the planning application for a change of use on site which supports the discharge of part 1 of Condition 4 (preliminary risk assessment).

As significant pollutant linkages have been confirmed on site for lead and PAHs in Made Ground, and ground gas/vapours, an Options Appraisal and Remediation Strategy with a subsequent Verification Plan will need to be prepared for the site to fully discharge Condition 4 (parts 3 and 4) and Conditions 6 and 7. Condition 8 (Unexpected Contamination) will remain in place until the development is complete. Conditions 13 (Remediation) and 14 (Verification) will remain in place until an approved remediation scheme is completed on site and a verification report prepared.

All work should be agreed with the regulators prior to proceeding to the next stage.

The work should be undertaken in accordance with the requirements of the Environment Agency guidance document "Land Contamination Risk Management guidance, October 2020" and all other relevant statutory and non statutory guidance.

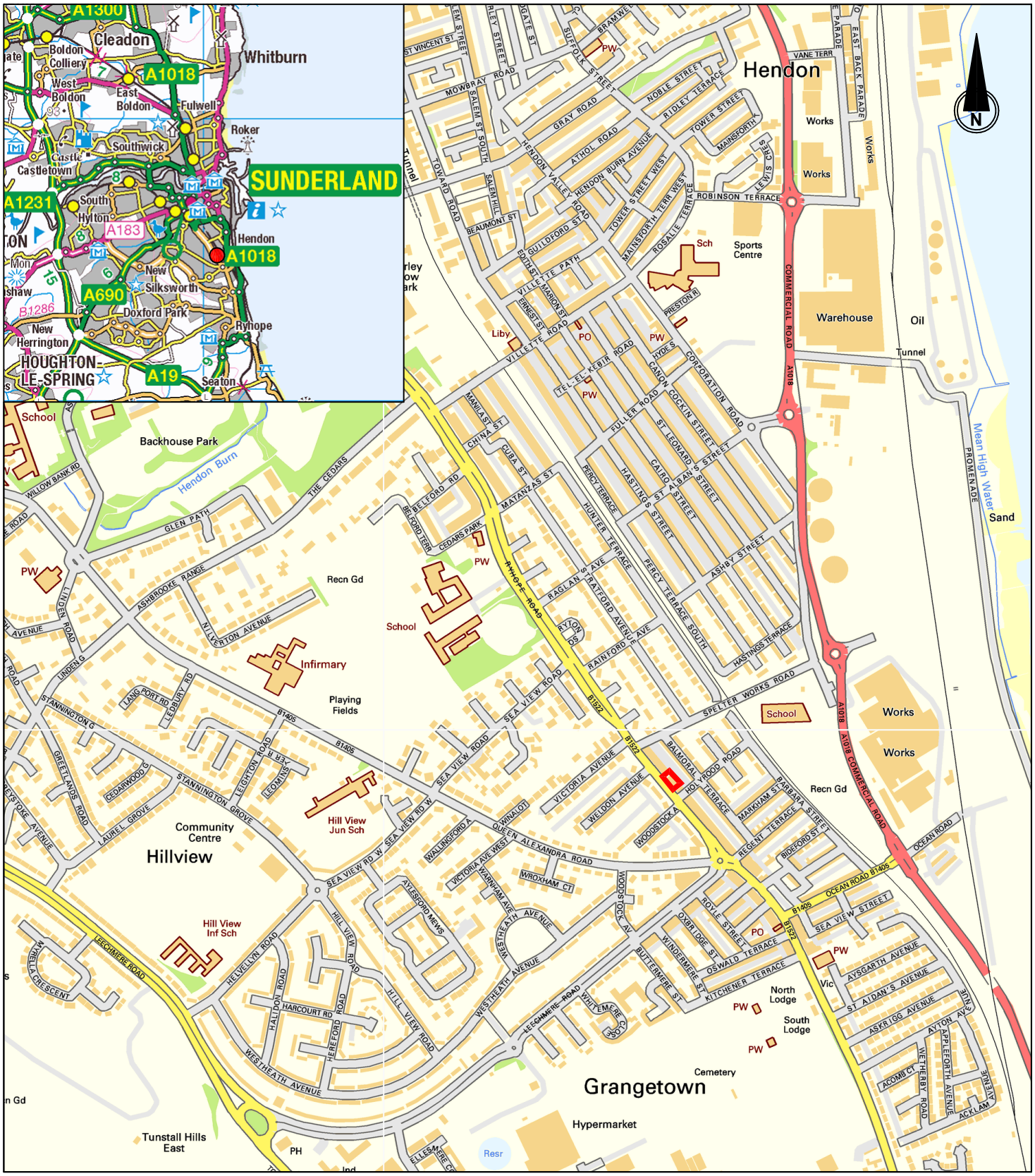
The demolition of the above ground forecourt canopy and the removal of the below ground PFS infrastructure should be undertaken in accordance with detailed RAMS for the work, and in accordance with relevant guidance and controls for working on filling stations, this includes the following.

- Health & Safety Executive, ACOP L138 "Dangerous Substances and Explosive Atmospheres Regulations 2002. Approved Code of Practice and guidance" (HSE, 2013).
- BS 6187 Code of Practice for Demolition.
- APEA and Energy Institute, Design, Construction, Modification, Maintenance and Decommissioning of Filling Stations, 4th Edition 2018 – known as the "Blue Book".
- West Yorkshire Fire and Rescue Service, Petrol Stations – "Methods of Rendering Underground Storage Tanks Safe from Risk of Fire / Explosion", Ref FS- PAN704 November 2017.

A recent general guidance overview document for investigating and managing the risks of filling stations by Environmental Protection UK is also useful for reference, as follows:

Rudland, Thomas. et al. (2020) "Before You Dig, Garages & Petrol Stations, Guidance for Developers, EPUK".

Appendix A
Drawings



Legend

Site Location Area

Revision:	Date:	Description:	By:	Chk:
-	-	-	-	-
-	-	-	-	-

Client: **The Newcastle Car Wash Ltd**

Project: **South Moor Service Station, Westholme Terrace, Sunderland**

Drawing Title: Site Location Plan

Drawn By:	Checked By:	Date:	Scale:	Paper Size:
CMC	DN	24th July 2020	1:10,000	A4
Status:	**Revision:**	**Project Number:**	**Plan No:**	
FINAL	-	**1358**	**Figure 1**	

DBS environmental

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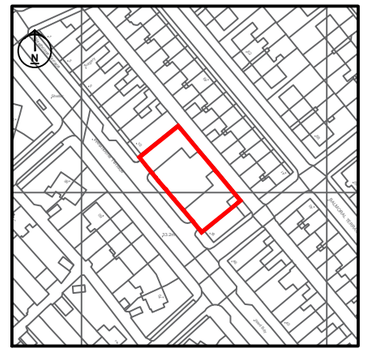
Tel.: +44 (0)191 511 8556 www.dbsenvironmental.co.uk

Proposed Site Plan

SCALE 1:200



Site Location Plan

SCALE 1:2500

NOVA CASTRIA DESIGN

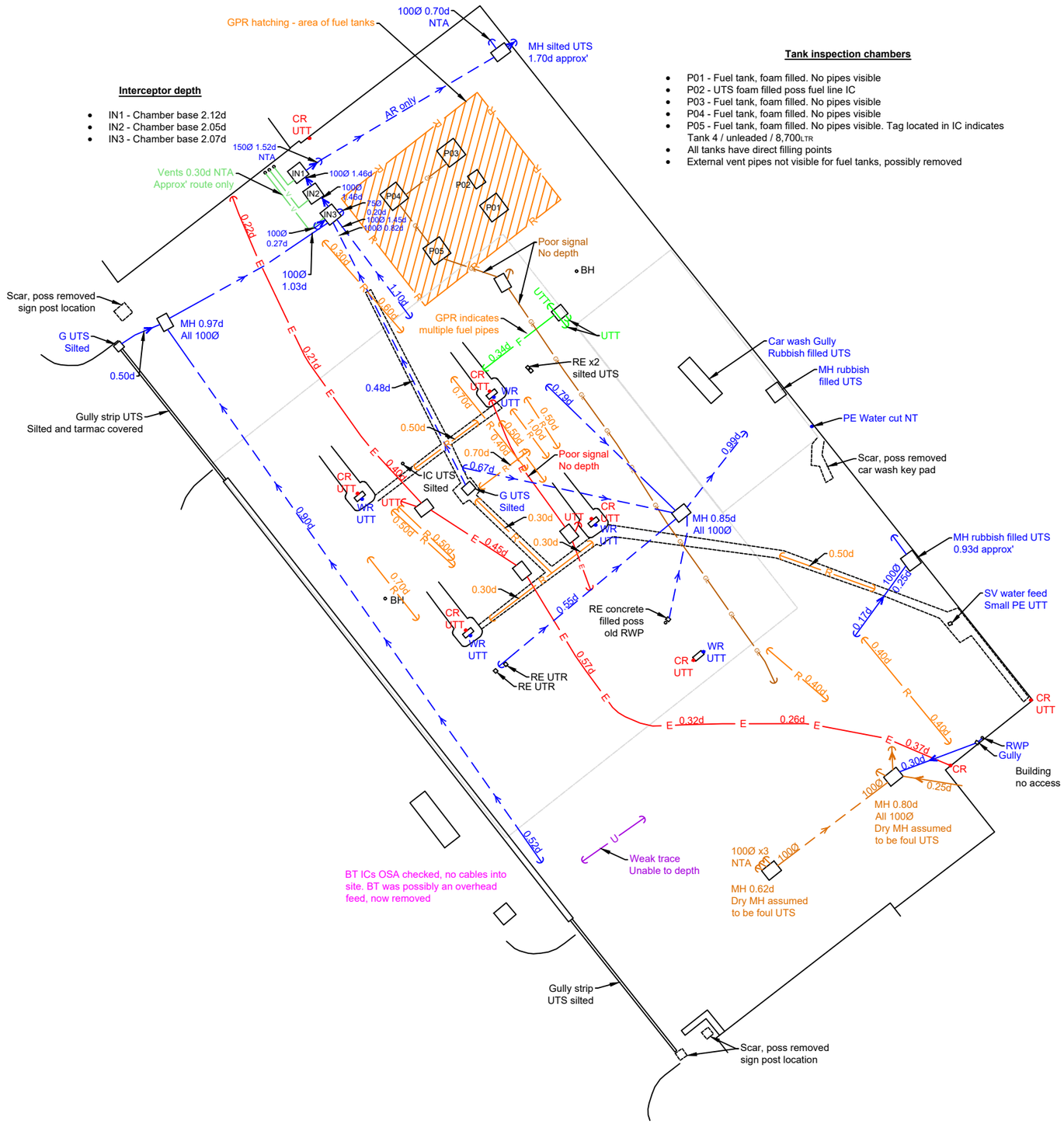
Client:
The Newcastle Car Wash Limited
Former South Moor Service Station
Westholme Terrace
Sunderland
SR2 9QA

Title:
Proposed 8no.4 Bed. Town Houses 2.5 Story on Former South Moor Service Station Site

Content:
Site Location Plan and Proposed Site Plan

Date:	Scale:	Drawn:	Checked:
Sept. 2019	**See Plan @ A3**	**LA**	**LA**

Drawing No:	Status:	Revision:
0226-P-001	**Planning Submission V1**	**-**



Interceptor depth

- IN1 - Chamber base 2.12d
- IN2 - Chamber base 2.05d
- IN3 - Chamber base 2.07d

Tank inspection chambers

- P01 - Fuel tank, foam filled. No pipes visible
- P02 - UTS foam filled poss fuel line IC
- P03 - Fuel tank, foam filled. No pipes visible
- P04 - Fuel tank, foam filled. No pipes visible
- P05 - Fuel tank, foam filled. No pipes visible. Tag located in IC indicates Tank 4 / unleaded / 8,700LTR
- All tanks have direct filling points
- External vent pipes not visible for fuel tanks, possibly removed

General Notes

- Disused petrol filling station - fuel tanks are foam filled - UTS.
- Main utility feeds undetectable, due to building been removed.
- Multiple silted MH and gullies due to debris, jetting required to survey.
- Multiple GPR targets adjacent old fuel pump islands believed to be fuel lines.
- Scar between pump islands believed to be water and electric feeds to risers on canopy supports.
- No statutory utility record information available at the time of the utility survey.

Disclaimer

ABBREVIATIONS

AR	ASSUMED ROUTE	NFI	NO FURTHER INFORMATION
BD	BACKDROP	NTA	NO TRANSMITTER ACCESS
BTIC	BRITISH TELECOM CHAMBER	OSA	OUTSIDE SURVEY AREA
CI	CAST IRON	PE	POLYETHALENE
CL	COVER LEVEL	PR	PIPE RISER
CO	CONCRETE	PVC	POLYVINYL CHLORIDE
CP	CABLE PIT	RE	RODDING EYE
CR	CABLE RISER	RWP	RAINWATER PIPE
d	DEPTH IN METRES	SV	STOP VALVE
EM	EARTH MAT	SVP	SOIL VENT PIPE
EP	ELECTRICITY POLE	TFR	TAKEN FROM RECORDS
EOT	END OF TRACE	TP	TELEGRAPH POLE
FE	FENCE EARTH POINT	UDI	UNRELIABLE DEPTH INFO'
FH	FIRE HYDRANT	UTL	UNABLE TO LOCATE
G	GULLY	UTR	UNABLE TO RAISE
GPR	TRACED BY G.P.R.	UTS	UNABLE TO SURVEY
GV	GAS VALVE	UTT	UNABLE TO TRACE
GR	GAS RISER	WL	WATER LEVEL
IC	INSPECTION CHAMBER	WR	WATER RISER
IL	INVERT LEVEL	VP	VENT PIPE
LP	LAMP POST	VR	VAPOUR RECOVERY
MH	MANHOLE	WM	WATER METER
MCW	MAINS COLD WATER	WO	WASH OUT VALVE
ND	NO DEPTH (Unable to acquire depth)	WWP	WASTE WATER PIPE

LEGEND

CATV	CABLE TELEVISION
CCTV	CLOSED CIRCUIT TELEVISION
COM	COMMUNICATIONS CABLE
A	COMPRESSED AIR
	DUCTING
E	ELECTRIC CABLE
EA	EARTH CABLE
	FOUL WATER SEWER
	COMBINED WATER SEWER
	SURFACE WATER SEWER
F	FUEL PIPE
GAS	GAS PIPE
GL	GAUGE LINE
	HEATING
O	OFFSET FILL PIPE
R	RADAR TRACE
T	TELECOMS CABLE
TL	TRAFFIC LIGHT CABLE
U	UNIDENTIFIED SERVICE
VR	VAPOUR RECOVERY
V	VENT PIPE
W	WATER PIPE
	SURVEY BOUNDARY
	END OF TRACE (Signal lost, unless stated otherwise)

N

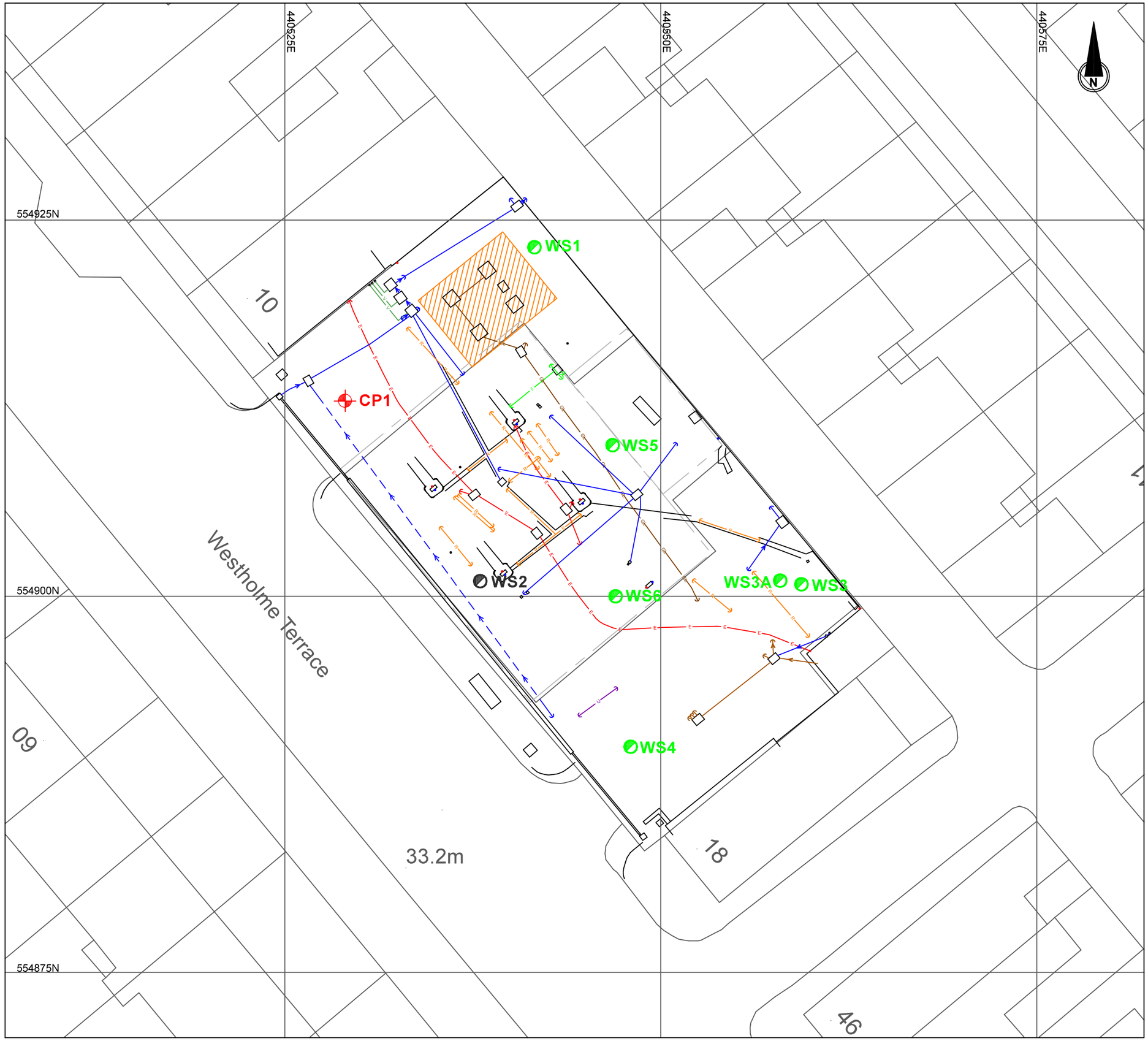
No.	Revision/Issue	By	Date
-	-	-	-

Discovery Surveys Ltd
Winning Post Centre
MoorendsThorne
Doncaster
DN8 4PB

Project Name and Address

Former Total PFS
Westholme Terrace
Sunderland
SR2 9QA

Drawing No	NCW 140520 001
Date	22-05-2020
Scale	1:200@A3
Sheet	1of1
Client	Newcastle Car Wash
Drawn	SR
Approved	JH



Legend

- Window Sample
- Cable Percussion Borehole
- Borehole Cancelled on Site

Reference File:
Base supplied by Novo Castrio Design. 0226-C-101 rev A May 2020.

DBS environmental

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Revision:	Date:	Description:	By:	Chk:
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-

Client:
The Newcastle Car Wash Ltd

Project:
South Moor Service Station, Westholme Terrace, Sunderland

Drawing Title:
Exploratory Hole Location Plan

Drawn By:	Checked By:	Date:	Scale:	Paper Size:
CMC	DN	24th July 2020	1:250	A3
Status:	**Revision:**	**Project Number:**	**Drawing No:**	
FINAL	-	**1358**	**Figure 2**	

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Creating the Environment for Business

Appendix B
Exploratory Hole Logs

DBS environmental

Site	Borehole Number
Former South Moor Service Station, Sunderland	CP1

Machine : Dando 2000 Method : Cable Percussion	Casing Diameter 150mm cased to 10.00m	Ground Level (mOD)	Client The Newcastle Car Wash Ltd	Job Number 1358
	Location	Dates 22/07/2020	Project Contractor RD Drilling	Sheet 1/1

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
						(0.30)	MADE GROUND. Concrete (forecourt).			
0.30-0.80	B1					0.30	MADE GROUND. Black ashy gravel with sand.			
1.20-1.65 1.20-1.65 1.20-1.70	SPT N=6 S2 B3			2,1/2,2,1,1		(2.40)				
2.50-2.95 2.50 2.50-2.95 2.50-3.00	SPT N=9 E S4 B5			1,1/1,2,3,3		2.70	Soft to firm brown slightly silty slightly sandy CLAY with occasional fine to coarse gravel. Gravel is fine to coarse, subangular to subrounded of sandstone and coal.			
3.50-3.95	U6			40 blows		(0.90) 3.60	Firm to stiff light brown silty sandy CLAY with occasional coarse gravel of sandstone. Gravel is fine to coarse and subrounded.			
4.00 4.00	D7 E					(0.90)				
4.50-4.95 4.50-4.95 4.50-5.00	SPT N=12 S8 B9			2,2/3,3,3,3		4.50	Loose to medium dense brown silty clayey SAND. Sand is wet, becoming saturated at 6.0m.		▼1	
6.00-6.45 6.00-6.80 6.00-6.95	SPT N=21 B11 S10			3,9/4,5,6,6 Water strike(1) at 6.50m, rose to 5.35m in 20 mins.		(2.70)			▽1	
7.50-7.95 7.50-7.95	SPT N=35 S12			5,6/7,8,9,11		7.20	Stiff to very stiff dark brown sandy gravelly CLAY. Gravel is fine to coarse, subangular to subrounded of mudstone, sandstone and coal.			
8.50-8.00	B13					(2.80)				
9.50-9.95	U14			85 blows						
10.00	D15					10.00				

Remarks

Scale (approx)	Logged By
1:50	DN

Figure No. 1358.CP1

DBS environmental

Site Former South Moor Service Station, Sunderland			**Number** WS1
Machine : Premier 110 **Method :** Drive-in Windowless Sampler	**Dimensions** 108mm to 5.45m	**Ground Level (mOD)**	**Client** The Newcastle Car Wash Ltd	**Job Number** 1358
	Location	**Dates** 22/07/2020	**Project Contractor** RD Drilling	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
					(0.20) 0.20	MADE GROUND. Concrete (forecourt surfacing).			
					(0.60) 0.80	MADE GROUND. Crushed concrete in a sandy soil matrix (sub-base).			
					(0.60) 1.40	MADE GROUND. Yellow limestone with brick.			
1.20-120.45 1.50	SPT 2*/0 N=7 E1		2/1,2,2,2			MADE GROUND. Black ashy sandy gravel, from 2.0m bgl becoming black gravelly clay.			
2.00-2.45	SPT N=27		2/2,2,10,13		(1.30) 2.70				
3.00-3.45	SPT N=11		4/2,3,3,3			Soft light brown orange silty sandy CLAY with occasional fine to coarse gravel of sandstone and coal. Gravel is subangular to subrounded. From 2.9m bgl clay becoming firm to stiff, slightly silty sandy with occasional coarse gravel of sandstone and grey dusting of silt on partings. Clay becoming very stiff and dark brown with frequent fine to coarse gravel of mudstone, sandstone and coal with depth.			
4.00-4.45 4.50	SPT N=24 E1		7/4,5,7,8		(2.75) 5.45				
5.00-5.45	SPT N=50		10/10,13,13,14			Complete at 5.45m			

Remarks
Made Ground causing black smear on gloves when sampling Made Ground at 1.5m bgl, no hydrocarbon odour.
No volatiles detected during drilling, PID reading zero ppm throughout.

Scale (approx)	Logged By
1:50	DN

Figure No. 1358.WS1

DBS environmental

Site Former South Moor Service Station, Sunderland			**Number** WS3
Machine : Premier 110 **Method :** Drive-in Windowless Sampler	**Dimensions** 108mm to 1.30m	**Ground Level (mOD)**	**Client** The Newcastle Car Wash Ltd	**Job Number** 1358
	Location	**Dates** 22/07/2020	**Project Contractor** RD Drilling	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.90)	MADE GROUND. Yellow dolomite (sub-base)		
0.50	E1				0.90			
1.00	E2				(0.25)	MADE GROUND. Asphalt		
1.20-1.20	SPT 50*/0		50/		1.15 (0.15)	MADE GROUND. black ashy gravel. Concrete obstruction at 1.3m bgl.		
					1.30	Complete at 1.30m		

Remarks
Refusal at 1.3m bgl due to buried concrete obstruction. Asphalt patched in at surface indicating possible removal of above ground structure, refusal possibly due to old foundation.

Scale (approx)	Logged By
1:50	DN

Figure No. 1358.WS3

DBS environmental

Site Former South Moor Service Station, Sunderland			**Number** WS3A
Machine : Premier 110 **Method :** Drive-in Windowless Sampler	**Dimensions** 108mm to 1.30m	**Ground Level (mOD)**	**Client** The Newcastle Car Wash Ltd	**Job Number** 1358
	Location	**Dates** 22/07/2020	**Project Contractor** RD Drilling	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.90)	MADE GROUND. Yellow dolomite (sub-base)		
					0.90 (0.25)	MADE GROUND. Asphalt		
					1.15 (0.15)	MADE GROUND. black ashy gravel. Concrete obstruction at 1.3m bgl.		
					1.30	Complete at 1.30m		

Remarks
Borehole moved away from WS3 to see if borehole could be advanced deeper. Concrete obstruction encountered again at 1.3m bgl, possible relic foundation in this area.

Scale (approx)	Logged By
1:50	DN

Figure No. 1358.WS3A

DBS environmental

Site Former South Moor Service Station, Sunderland			**Number** WS4
Machine : Premier 110 **Method :** Drive-in Windowless Sampler	**Dimensions** 108mm to 5.00m	**Ground Level (mOD)**	**Client** The Newcastle Car Wash Ltd	**Job Number** 1358
	Location	**Dates** 22/07/2020	**Project Contractor** RD Drilling	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
					(0.17) 0.17	MADE GROUND. Concrete (forecourt)			
					(0.23) 0.40	MADE GROUND. Brown gravel (sub-base)			
0.60	E1					MADE GROUND. Black ashy gravel with brick, sand and some clinker.			
1.00-1.15	SPT		6/2,3,3,3		(1.50)				
					1.90				
2.00-2.15	SPT		8/4,4,4,4			MADE GROUND. Brown black gravelly clay. Gravel includes brick and coal.			
2.50	E2				(0.80)				
					2.70				
3.00-3.15	SPT		10/8,8,6,6			Firm to stiff brown orange gravelly slightly silty slightly sandy CLAY. Gravel is fine to coarse, subangular to subrounded of mudstone, sandstone and coal. Grey dusting of silt on partings.			
					(1.00)				
					3.70				
4.00-4.15	SPT		12/5,6,7,7			Moderately compact green brown clayey silty SAND with occasional fine to medium gravel of coal.			
4.50	E3				(1.30)				
5.00-5.45	SPT N=25		10/5,6,7,7		5.00	Complete at 5.00m			

Remarks
Feint hydrocarbon odour on clay core at 1.9m bgl.
No vapours detected throughout drilling, PID reading zero.

Scale (approx)	Logged By
1:50	DN

Figure No. 1358.WS4

DBS environmental

Site Former South Moor Service Station, Sunderland			**Number** WS5
Machine : Premier 110 **Method :** Drive-in Windowless Sampler	**Dimensions** 108mm to 1.90m	**Ground Level (mOD)**	**Client** The Newcastle Car Wash Ltd	**Job Number** 1358
	Location	**Dates** 22/07/2020	**Project Contractor** RD Drilling	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.20) 0.20	MADE GROUND. Concrete (forecourt).		
					(0.80) 1.00	MADE GROUND. Yellow dolomite with a pocket of dark brown black clayey gravel (sub-base).		
					(0.20) 1.20	MADE GROUND. Concrete.		
1.20-1.65	SPT N=30		10/5,8,8,9					
1.50	E1				(0.70) 1.90	MADE GROUND. Black ashy gravel with pockets of dark brown clay between 1.6m and 1.8m.		
						Complete at 1.90m		

Remarks
Borehole terminated at 1.9m bgl due to refusal.

Scale (approx)	Logged By
1:50	DN

Figure No. 1358.WS5

DBS environmental

Site Former South Moor Service Station, Sunderland			**Number** WS6
Machine : Premier 110 **Method :** Drive-in Windowless Sampler	**Dimensions** 108mm to 0.80m	**Ground Level (mOD)**	**Client** The Newcastle Car Wash Ltd	**Job Number** 1358
	Location	**Dates** 22/07/2020	**Project Contractor** RD Drilling	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.20) 0.20	MADE GROUND. Concrete (forecourt).		
0.50	E1				(0.60) 0.80	MADE GROUND. Yellow dolomite with pocket of ashy gravelly clay fill (sub-base).		
						Complete at 0.80m		

Remarks
Borehole terminated at 0.8m bgl due to obstruction.

Scale (approx)	Logged By
1:50	DN

Figure No. 1358.WS6

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Creating the Environment for Business

Appendix C
Photographic Plates

Phase 2 Ground Investigation Photographs
South Moor Service Station, Sunderland
22 July 2020

Photographic Plate 1 – The site, derelict petrol filling station.

Photographic Plate 2 – Tank farm in forecourt, four service hatches present, tanks have been decommissioned with foam.

Phase 2 Ground Investigation Photographs
South Moor Service Station, Sunderland
22 July 2020

Photographic Plate 3 – Window sampler drilling rig advancing borehole WS1 next to tank farm.

Photographic Plate 4 – Borehole WS1 being sunk.

Phase 2 Ground Investigation Photographs
South Moor Service Station, Sunderland
22 July 2020

Photographic Plate 5 – WS1 arisings, Made Ground overlying Clay.

Photographic Plate 6 – WS5 being sunk in vicinity of former petrol pump islands.

Phase 2 Ground Investigation Photographs
South Moor Service Station, Sunderland
22 July 2020

Photographic Plate 7 – WS5 arisings, Made Ground over Clay.

Photographic Plate 8 – Drilling rig coring through concrete for borehole WS4.

Phase 2 Ground Investigation Photographs
South Moor Service Station, Sunderland
22 July 2020

Photographic Plate 9 – WS4 being sunk.

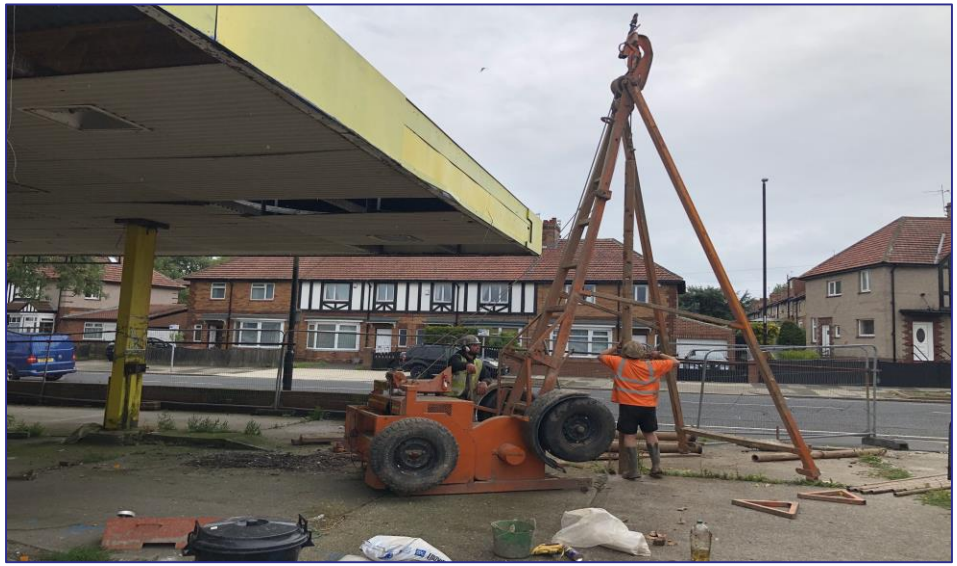
Photographic Plate 10 – WS4 with arisings.

Phase 2 Ground Investigation Photographs
South Moor Service Station, Sunderland
22 July 2020

Photographic Plate 11 – WS4 arisings. PID being used to screen arisings during logging.

Photographic Plate 12 – WS4 arisings.

Phase 2 Ground Investigation Photographs
South Moor Service Station, Sunderland
22 July 2020



Photographic Plate 13 – Cable percussion drilling rig being set up on borehole CP1.

Photographic Plate 14 – CP1 being sunk.

DBS environmental

Creating the Environment for Business

Appendix D
Laboratory Testing Certificates

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Analytical Report Number : 20-21378

Replaces Analytical Report Number: 20-21378, issue no. 2

Client sampling date amended.

Project / Site name:	South Moor Service Station, Sunderland	**Samples received on:**	24/07/2020
Your job number:	1358	**Samples instructed on/ Analysis started on:**	25/07/2020
Your order number:		**Analysis completed by:**	26/08/2020
Report Issue Number:	2	**Report issued on:**	26/08/2020
Samples Analysed:	11 soil samples		

Signed:

Will Fardon
Technical Reviewer (CS Team)
For & on behalf of i2 Analytical Ltd.

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

soils - 4 weeks from reporting
leachates - 2 weeks from reporting
waters - 2 weeks from reporting
asbestos - 6 months from reporting

Excel copies of reports are only valid when accompanied by this PDF certificate.

Any assessments of compliance with specifications are based on actual analytical results with no contribution from uncertainty of measurement.
Application of uncertainty of measurement would provide a range within which the true result lies.
An estimate of measurement uncertainty can be provided on request.

 Iss No 20-21378-2 South Moor Service Station, Sunderland 1358.XLSM
The results included within the report are representative of the samples submitted for analysis.

Analytical Report Number: 20-21378
Project / Site name: South Moor Service Station, Sunderland

Lab Sample Number				1573133	1573134	1573135	1573136	1573137
Sample Reference				WS1	WS1	WS3	WS3	WS4
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				1.50	4.50	0.50	1.00	0.60
Date Sampled				22/07/2020	22/07/2020	22/07/2020	22/07/2020	22/07/2020
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Moisture Content	%	N/A	NONE	23	11	7.9	14	11
Total mass of sample received	kg	0.001	NONE	0.7	0.89	1.1	0.6	0.76
Asbestos in Soil	Type	N/A	ISO 17025	Not-detected	-	Not-detected	Not-detected	Not-detected
General Inorganics								
pH - Automated	pH Units	N/A	MCERTS	8.1	8.1	9.1	8.2	8.3
Water Soluble Sulphate as SO4 16hr extraction (2:1)	mg/kg	2.5	MCERTS	1100	-	-	1300	1600
Water Soluble SO4 16hr extraction (2:1 Leachate Equivale	g/l	0.00125	MCERTS	0.54	-	-	0.64	0.8
Water Soluble SO4 16hr extraction (2:1 Leachate Equivale	mg/l	1.25	MCERTS	543	-	-	636	801
Organic Matter	%	0.1	MCERTS	6.1	-	0.4	4.7	6.7
Speciated PAHs								
Naphthalene	mg/kg	0.05	MCERTS	1.3	-	-	3.9	4.2
Acenaphthylene	mg/kg	0.05	MCERTS	0.38	-	-	0.96	0.86
Acenaphthene	mg/kg	0.05	MCERTS	0.86	-	-	5.9	6.2
Fluorene	mg/kg	0.05	MCERTS	0.63	-	-	5.3	5.2
Phenanthrene	mg/kg	0.05	MCERTS	12	-	-	45	42
Anthracene	mg/kg	0.05	MCERTS	3.1	-	-	9.2	7.9
Fluoranthene	mg/kg	0.05	MCERTS	20	-	-	59	61
Pyrene	mg/kg	0.05	MCERTS	19	-	-	54	55
Benzo(a)anthracene	mg/kg	0.05	MCERTS	18	-	-	45	34
Chrysene	mg/kg	0.05	MCERTS	13	-	-	24	25
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	21	-	-	46	54
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	16	-	-	17	47
Benzo(a)pyrene	mg/kg	0.05	MCERTS	24	-	-	36	29
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	15	-	-	18	16
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	4.1	-	-	5.3	4.9
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	15	-	-	18	17
Total PAH								
Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	184	-	-	392	409
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	16	6.2	2.3	15	20
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	0.3	< 0.2	< 0.2	0.8	1.3
Chromium (hexavalent)	mg/kg	4	MCERTS	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0
Chromium (III)	mg/kg	1	NONE	28	33	7.1	24	29
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	28	33	7.2	24	29
Copper (aqua regia extractable)	mg/kg	1	MCERTS	130	22	16	90	100
Lead (aqua regia extractable)	mg/kg	1	MCERTS	29	21	51	200	620
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	0.4	0.4
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	57	37	7.6	42	38
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	2
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	130	65	70	770	1200
Monoaromatics & Oxygenates								
Benzene	µg/kg	1	MCERTS	< 1.0	-	-	< 1.0	< 1.0
Toluene	µg/kg	1	MCERTS	< 1.0	-	-	< 1.0	< 1.0
Ethylbenzene	µg/kg	1	MCERTS	< 1.0	-	-	< 1.0	< 1.0

Analytical Report Number: 20-21378
Project / Site name: South Moor Service Station, Sunderland

Lab Sample Number				1573133	1573134	1573135	1573136	1573137
Sample Reference				WS1	WS1	WS3	WS3	WS4
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				1.50	4.50	0.50	1.00	0.60
Date Sampled				22/07/2020	22/07/2020	22/07/2020	22/07/2020	22/07/2020
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
p & m-xylene	µg/kg	1	MCERTS	< 1.0	-	-	< 1.0	< 1.0
o-xylene	µg/kg	1	MCERTS	< 1.0	-	-	< 1.0	< 1.0
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	< 1.0	-	-	< 1.0	< 1.0
Petroleum Hydrocarbons								
TPH-CWG - Aliphatic >EC5 - EC6	mg/kg	0.001	MCERTS	< 0.001	-	-	< 0.001	< 0.001
TPH-CWG - Aliphatic >EC6 - EC8	mg/kg	0.001	MCERTS	< 0.001	-	-	< 0.001	< 0.001
TPH-CWG - Aliphatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001	-	-	< 0.001	< 0.001
TPH-CWG - Aliphatic >EC10 - EC12	mg/kg	1	MCERTS	< 1.0	-	-	< 1.0	6.7
TPH-CWG - Aliphatic >EC12 - EC16	mg/kg	2	MCERTS	< 2.0	-	-	2.9	42
TPH-CWG - Aliphatic >EC16 - EC21	mg/kg	8	MCERTS	< 8.0	-	-	12	87
TPH-CWG - Aliphatic >EC21 - EC35	mg/kg	8	MCERTS	< 8.0	-	-	100	260
TPH-CWG - Aliphatic (EC5 - EC35)	mg/kg	10	MCERTS	< 10	-	-	120	390
TPH-CWG - Aromatic >EC5 - EC7	mg/kg	0.001	MCERTS	< 0.001	-	-	< 0.001	< 0.001
TPH-CWG - Aromatic >EC7 - EC8	mg/kg	0.001	MCERTS	< 0.001	-	-	< 0.001	< 0.001
TPH-CWG - Aromatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001	-	-	< 0.001	< 0.001
TPH-CWG - Aromatic >EC10 - EC12	mg/kg	1	MCERTS	< 1.0	-	-	8.1	< 1.0
TPH-CWG - Aromatic >EC12 - EC16	mg/kg	2	MCERTS	< 2.0	-	-	33	110
TPH-CWG - Aromatic >EC16 - EC21	mg/kg	10	MCERTS	52	-	-	240	800
TPH-CWG - Aromatic >EC21 - EC35	mg/kg	10	MCERTS	230	-	-	520	2100
TPH-CWG - Aromatic (EC5 - EC35)	mg/kg	10	MCERTS	280	-	-	800	3000

U/S = Unsuitable Sample I/S = Insufficient Sample

Analytical Report Number: 20-21378
Project / Site name: South Moor Service Station, Sunderland

Lab Sample Number				1573138	1573139	1573140	1573141	1573142
Sample Reference				WS4	WS4	WS5	WS6	CP1
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				2.50	4.50	1.50	0.50	2.50
Date Sampled				22/07/2020	22/07/2020	22/07/2020	22/07/2020	22/07/2020
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Moisture Content	%	N/A	NONE	12	16	11	11	16
Total mass of sample received	kg	0.001	NONE	0.75	1	0.74	0.98	0.71
Asbestos in Soil	Type	N/A	ISO 17025	Not-detected	-	Not-detected	Not-detected	Not-detected
General Inorganics								
pH - Automated	pH Units	N/A	MCERTS	7.6	8.2	8.6	9.7	7.6
Water Soluble Sulphate as SO4 16hr extraction (2:1)	mg/kg	2.5	MCERTS	760	60	-	-	880
Water Soluble SO4 16hr extraction (2:1 Leachate Equivale	g/l	0.00125	MCERTS	0.38	0.03	-	-	0.44
Water Soluble SO4 16hr extraction (2:1 Leachate Equivale	mg/l	1.25	MCERTS	380	30.2	-	-	439
Organic Matter	%	0.1	MCERTS	1.5	-	5.8	3.7	3
Speciated PAHs								
Naphthalene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	6.9	0.82	< 0.05
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	2.1	0.41	< 0.05
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	8.8	1.7	< 0.05
Fluorene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	6.9	1.5	< 0.05
Phenanthrene	mg/kg	0.05	MCERTS	1.1	< 0.05	71	14	3.3
Anthracene	mg/kg	0.05	MCERTS	0.18	< 0.05	13	2.7	0.82
Fluoranthene	mg/kg	0.05	MCERTS	1.4	< 0.05	87	20	5
Pyrene	mg/kg	0.05	MCERTS	1.4	< 0.05	77	18	4.2
Benzo(a)anthracene	mg/kg	0.05	MCERTS	0.82	< 0.05	43	10	2.5
Chrysene	mg/kg	0.05	MCERTS	0.65	< 0.05	26	7.7	1.8
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	0.64	< 0.05	45	11	2.7
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	0.53	< 0.05	16	3.7	0.92
Benzo(a)pyrene	mg/kg	0.05	MCERTS	0.65	< 0.05	33	8	1.9
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	0.36	< 0.05	16	4.2	1.3
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	4.3	1.2	< 0.05
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	0.36	< 0.05	16	4.6	1.2
Total PAH								
Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	8.03	< 0.80	472	109	25.5
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	6.2	3.2	15	14	10
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	0.2	< 0.2	0.3	0.6	0.3
Chromium (hexavalent)	mg/kg	4	MCERTS	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0
Chromium (III)	mg/kg	1	NONE	23	9.5	19	19	19
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	23	9.6	19	20	19
Copper (aqua regia extractable)	mg/kg	1	MCERTS	16	9.2	90	71	35
Lead (aqua regia extractable)	mg/kg	1	MCERTS	27	21	120	210	110
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	0.4	0.4
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	22	11	33	29	21
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	59	57	150	250	160
Monoaromatics & Oxygenates								
Benzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Toluene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Ethylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0

Analytical Report Number: 20-21378
Project / Site name: South Moor Service Station, Sunderland

Lab Sample Number				1573138	1573139	1573140	1573141	1573142
Sample Reference				WS4	WS4	WS5	WS6	CP1
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				2.50	4.50	1.50	0.50	2.50
Date Sampled				22/07/2020	22/07/2020	22/07/2020	22/07/2020	22/07/2020
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
p & m-xylene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
o-xylene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Petroleum Hydrocarbons								
TPH-CWG - Aliphatic >EC5 - EC6	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aliphatic >EC6 - EC8	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aliphatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aliphatic >EC10 - EC12	mg/kg	1	MCERTS	< 1.0	< 1.0	7.4	< 1.0	< 1.0
TPH-CWG - Aliphatic >EC12 - EC16	mg/kg	2	MCERTS	< 2.0	< 2.0	25	6.3	< 2.0
TPH-CWG - Aliphatic >EC16 - EC21	mg/kg	8	MCERTS	< 8.0	< 8.0	49	21	< 8.0
TPH-CWG - Aliphatic >EC21 - EC35	mg/kg	8	MCERTS	< 8.0	< 8.0	160	90	< 8.0
TPH-CWG - Aliphatic (EC5 - EC35)	mg/kg	10	MCERTS	< 10	< 10	240	120	< 10
TPH-CWG - Aromatic >EC5 - EC7	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aromatic >EC7 - EC8	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aromatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aromatic >EC10 - EC12	mg/kg	1	MCERTS	< 1.0	< 1.0	9.2	13	< 1.0
TPH-CWG - Aromatic >EC12 - EC16	mg/kg	2	MCERTS	< 2.0	< 2.0	41	30	3.5
TPH-CWG - Aromatic >EC16 - EC21	mg/kg	10	MCERTS	< 10	< 10	260	210	15
TPH-CWG - Aromatic >EC21 - EC35	mg/kg	10	MCERTS	13	< 10	510	460	17
TPH-CWG - Aromatic (EC5 - EC35)	mg/kg	10	MCERTS	17	< 10	830	720	36

U/S = Unsuitable Sample I/S = Insufficient Sample

Analytical Report Number: 20-21378
Project / Site name: South Moor Service Station, Sunderland

Lab Sample Number				1573143
Sample Reference				CP1
Sample Number				None Supplied
Depth (m)				4.00
Date Sampled				22/07/2020
Time Taken				None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**	
Stone Content	%	0.1	NONE	< 0.1
Moisture Content	%	N/A	NONE	17
Total mass of sample received	kg	0.001	NONE	0.75
Asbestos in Soil	Type	N/A	ISO 17025	-
General Inorganics				
pH - Automated	pH Units	N/A	MCERTS	8.6
Water Soluble Sulphate as SO4 16hr extraction (2:1)	mg/kg	2.5	MCERTS	-
Water Soluble SO4 16hr extraction (2:1 Leachate Equivale	g/l	0.00125	MCERTS	-
Water Soluble SO4 16hr extraction (2:1 Leachate Equivale	mg/l	1.25	MCERTS	-
Organic Matter	%	0.1	MCERTS	-
Speciated PAHs				
Naphthalene	mg/kg	0.05	MCERTS	-
Acenaphthylene	mg/kg	0.05	MCERTS	-
Acenaphthene	mg/kg	0.05	MCERTS	-
Fluorene	mg/kg	0.05	MCERTS	-
Phenanthrene	mg/kg	0.05	MCERTS	-
Anthracene	mg/kg	0.05	MCERTS	-
Fluoranthene	mg/kg	0.05	MCERTS	-
Pyrene	mg/kg	0.05	MCERTS	-
Benzo(a)anthracene	mg/kg	0.05	MCERTS	-
Chrysene	mg/kg	0.05	MCERTS	-
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	-
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	-
Benzo(a)pyrene	mg/kg	0.05	MCERTS	-
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	-
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	-
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	-
Total PAH				
Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	-
Heavy Metals / Metalloids				
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	3.4
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2
Chromium (hexavalent)	mg/kg	4	MCERTS	< 4.0
Chromium (III)	mg/kg	1	NONE	9.7
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	9.8
Copper (aqua regia extractable)	mg/kg	1	MCERTS	13
Lead (aqua regia extractable)	mg/kg	1	MCERTS	15
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	11
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	45
Monoaromatics & Oxygenates				
Benzene	µg/kg	1	MCERTS	-
Toluene	µg/kg	1	MCERTS	-
Ethylbenzene	µg/kg	1	MCERTS	-

Analytical Report Number: 20-21378
Project / Site name: South Moor Service Station, Sunderland

Lab Sample Number				1573143
Sample Reference				CP1
Sample Number				None Supplied
Depth (m)				4.00
Date Sampled				22/07/2020
Time Taken				None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**	
p & m-xylene	µg/kg	1	MCERTS	-
o-xylene	µg/kg	1	MCERTS	-
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	-
Petroleum Hydrocarbons				
TPH-CWG - Aliphatic >EC5 - EC6	mg/kg	0.001	MCERTS	-
TPH-CWG - Aliphatic >EC6 - EC8	mg/kg	0.001	MCERTS	-
TPH-CWG - Aliphatic >EC8 - EC10	mg/kg	0.001	MCERTS	-
TPH-CWG - Aliphatic >EC10 - EC12	mg/kg	1	MCERTS	-
TPH-CWG - Aliphatic >EC12 - EC16	mg/kg	2	MCERTS	-
TPH-CWG - Aliphatic >EC16 - EC21	mg/kg	8	MCERTS	-
TPH-CWG - Aliphatic >EC21 - EC35	mg/kg	8	MCERTS	-
TPH-CWG - Aliphatic (EC5 - EC35)	mg/kg	10	MCERTS	-
TPH-CWG - Aromatic >EC5 - EC7	mg/kg	0.001	MCERTS	-
TPH-CWG - Aromatic >EC7 - EC8	mg/kg	0.001	MCERTS	-
TPH-CWG - Aromatic >EC8 - EC10	mg/kg	0.001	MCERTS	-
TPH-CWG - Aromatic >EC10 - EC12	mg/kg	1	MCERTS	-
TPH-CWG - Aromatic >EC12 - EC16	mg/kg	2	MCERTS	-
TPH-CWG - Aromatic >EC16 - EC21	mg/kg	10	MCERTS	-
TPH-CWG - Aromatic >EC21 - EC35	mg/kg	10	MCERTS	-
TPH-CWG - Aromatic (EC5 - EC35)	mg/kg	10	MCERTS	-

U/S = Unsuitable Sample I/S = Insufficient Sample

Analytical Report Number : 20-21378
Project / Site name: South Moor Service Station, Sunderland

* These descriptions are only intended to act as a cross check if sample identities are questioned. The major constituent of the sample is intended to act with respect to MCERTS validation. The laboratory is accredited for sand, clay and loam (MCERTS) soil types. Data for unaccredited types of solid should be interpreted with care.

Stone content of a sample is calculated as the % weight of the stones not passing a 10 mm sieve. Results are not corrected for stone content.

Lab Sample Number	Sample Reference	Sample Number	Depth (m)	Sample Description *
1573133	WS1	None Supplied	1.5	Black clay and sand with gravel and clinker
1573134	WS1	None Supplied	4.5	Brown clay.
1573135	WS3	None Supplied	0.5	Light brown sand with gravel.
1573136	WS3	None Supplied	1	Brown clay and sand with gravel.
1573137	WS4	None Supplied	0.6	Brown clay and sand with gravel and clinker.
1573138	WS4	None Supplied	2.5	Brown clay.
1573139	WS4	None Supplied	4.5	Brown sand.
1573140	WS5	None Supplied	1.5	Brown clay and sand with gravel and clinker.
1573141	WS6	None Supplied	0.5	Brown clay and sand with gravel.
1573142	CP1	None Supplied	2.5	Brown clay and sand with gravel.
1573143	CP1	None Supplied	4	Brown sand.

Analytical Report Number : 20-21378
Project / Site name: South Moor Service Station, Sunderland

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Metals in soil by ICP-OES	Determination of metals in soil by aqua-regia digestion followed by ICP-OES.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L038-PL	D	MCERTS
Sulphate, water soluble, in soil (16hr extraction)	Determination of water soluble sulphate by ICP-OES. Results reported directly (leachate equivalent) and corrected for extraction ratio (soil equivalent).	In house method.	L038-PL	D	MCERTS
Asbestos identification in soil	Asbestos Identification with the use of polarised light microscopy in conjunction with disperion staining techniques.	In house method based on HSG 248	A001-PL	D	ISO 17025
Hexavalent chromium in soil	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry.	In-house method	L080-PL	W	MCERTS
Moisture Content	Moisture content, determined gravimetrically. (30 oC)	In house method.	L019-UK/PL	W	NONE
Organic matter (Automated) in soil	Determination of organic matter in soil by oxidising with potassium dichromate followed by titration with iron (II) sulphate.	In house method.	L009-PL	D	MCERTS
Speciated EPA-16 PAHs in soil	Determination of PAH compounds in soil by extraction in dichloromethane and hexane followed by GC-MS with the use of surrogate and internal standards.	In-house method based on USEPA 8270	L064-PL	D	MCERTS
pH in soil (automated)	Determination of pH in soil by addition of water followed by automated electrometric measurement.	In house method.	L099-PL	D	MCERTS
BTEX and MTBE in soil (Monoaromatics)	Determination of BTEX in soil by headspace GC-MS.	In-house method based on USEPA8260	L073B-PL	W	MCERTS
Cr (III) in soil	In-house method by calculation from total Cr and Cr VI.	In-house method by calculation	L080-PL	W	NONE
TPHCWG (Soil)	Determination of hexane extractable hydrocarbons in soil by GC-MS/GC-FID.	In-house method with silica gel split/clean up.	L088/76-PL	W	MCERTS
Sulphate, water soluble, in soil	Determination of water soluble sulphate by ICP-OES. Results reported directly (leachate equivalent) and corrected for extraction ratio (soil equivalent).	In house method.	L038-PL	D	MCERTS

For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.
For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.
Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.

UKAS accredited testing laboratory No. 0744 Report/Sample ID No: **S 842/01 -PSD**

Northumberland
County Council

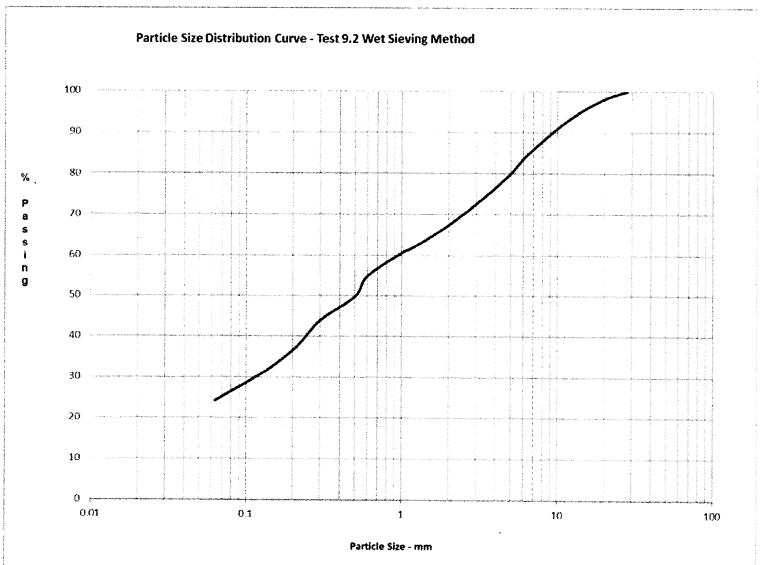
Highways Laboratory
Bassington Drive • Cramlington • Northumberland • NE23 8AJ
Tel (01670) 737575 • Email highwayslaboratory@northumberland.gov.uk

CLASSIFICATION OF SOILS

Tests according to B.S. 1377 : Part 2 Clause 9 :1990

Client: **DBS Environmental Limited, 12 Pickersgill Court, Sunderland, SR5 2AQ**
Engineer: **Dave Nanson**
Project: **South Moor Service Station, Sunderland**
Location: **CP1 at 1.2m**
Material Type: **Brown, grey, yellow, mottled, very sandy CLAY AND GRAVEL**
Sample Spec: **Sampled by Site Staff/Client**
Source: **Site**
Date Sampled: Date Received: **18/08/2020** Sampled By: **Clients Staff**
Natural Moisture Content (%): **17.5** Part 2 Clause 3.2

The liquid and Plastic Limits are prepared in accordance with BS1377: Part 2: Clause 4.2.4 due to the nature of most materials in the surrounding area (Sandy CLAY with gravel cobbles and boulders)



If Sedimentation test by Hydrometer (Test Method 9.5), was used, then no pretreatment was carried out.

Remarks: **None**

Certificate of sampling received: ☐

Signed: _____

[✓] M. Newton, Laboratory Manager
[ ] P. Fletcher. Technician

Start of Test Date: **18/08/2020** End of Test Date: **25/08/2020** Report Date: **25/08/2020**

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PARTICLE SIZE DISTRIBUTION OF SOILS

Tests according to B.S. 1377 :Part 2 :1990 Clause 9.2

Client: **DBS Environmental Limited, 12 Pickersgill Court, Sunderland, SR5 2AQ**
Engineer: **Dave Nanson**
Project: **South Moor Service Station, Sunderland**
Location: **CP1 at 1.2m**
Material Type: **Brown, grey, yellow, mottled, very sandy CLAY AND GRAVEL**
Sample Spec: **Sampled by Site Staff/Client**
Source: **Site**
Date Sampled: Date Received: **18/08/2020** Sampled By: **Clients Staff**

	Test Results	Specification
Natural Water Content (%):	**17.5**	BS EN ISO 17892-1;2014
Material Classification:	**2C**	Specification for Highway Works, Series 600, Tables 6/1,6/2

Sieve	% Passing	Specification
125mm	**100**	100
75mm	**100**	
37.5mm	**100**	
20mm	**98**	
10mm	**91**	
5mm	**80**	
2mm	**67**	15 - 80
63mic	**24**	15 - 80

Remarks: **None**

Certificate of sampling received: ☐

Signed: M. Newton

[✓] M. Newton, Laboratory Manager
[ ] P. Fletcher, Senior Technician

Start of Test Date: **18/08/2020** End of Test Date: **25/08/2020** Report Date: **25/08/2020**

UKAS accredited testing laboratory No. 0744 Report/Sample ID No: **S 842/02 -TRIM**

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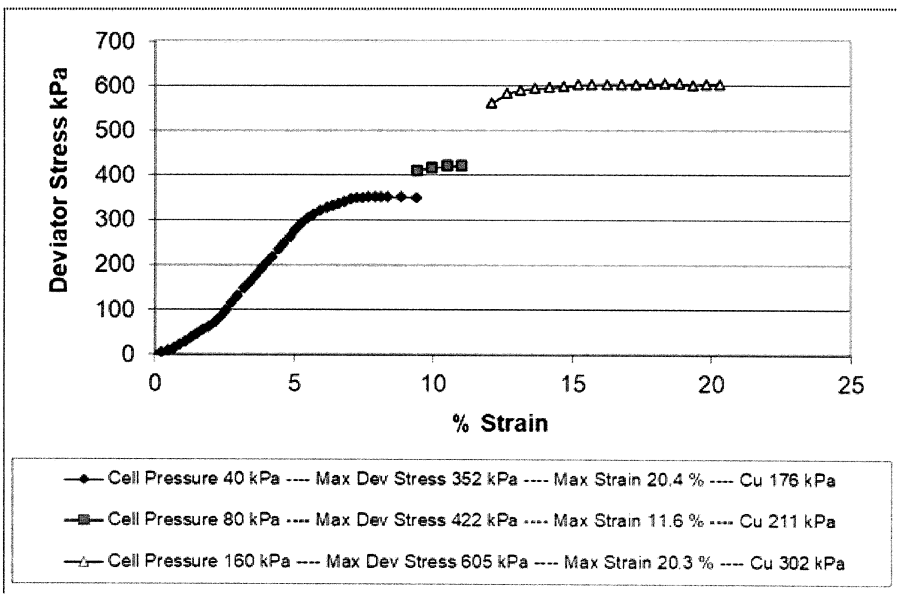
Undrained Shear Strength in Triaxial Compression - Multi Stage on a Single Specimen
Tests according to B.S. 1377 : Part 7 : 1990 - Clause 9*

Client: **DBS Environmental Limited, 12 Pickersgill Court, Sunderland, SR5 2AQ**
Engineer: **Dave Nanson**
Project: **South Moor Service Station, Sunderland**
Location: **CP1 at 3.5m**
Material Type: **Brown, yellow, very sandy CLAY / clayey SAND with coals**
Sample Spec: **Sampled by Site Staff/Client**
Date Sampled: Date Received: **18/08/2020** Sampled By: **Clients Staff**
Initial Length (mm): **198** Initial Diameter (mm): **101** Sample Type: **Undisturbed**
Rate of Strain: **2%/min**



Natural WC (%): **24.9** Test WC (%): **22.9**
Bulk Density (Mg/m³): **2.10** Dry Density (Mg/cu m): **1.71**

Cell Pressures (kPa): **40, 80, 160** Shear Strength (kPa): **460** Strain at Failure (Multi Stage): **20**

Mode of Failure: **Plastic Deformation/Shear Angle (65°)**

Remarks: **None**

*This test could not be carried out to Clause 8 (Definitive Method) due to limitations in sample size.

Certificate of sampling received: ☐ [✓] M. Newton, Laboratory Manager
Signed: [ ] P. Fletcher. Senior Technician

Start of Test Date: **18/08/2020** End of Test Date: **25/08/2020** Report Date: **25/08/2020**

UKAS accredited testing laboratory No. 0744 Report/Sample ID No: **S 842/02-CLS**

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CLASSIFICATION OF SOILS

Tests according to B.S. 1377 : 1990

Client: **DBS Environmental Limited, 12 Pickersgill Court, Sunderland, SR5 2AQ**
Engineer: **Dave Nanson**
Project: **South Moor Service Station, Sunderland**
Location: **CP1 at 3.5m**
Material Type: **Brown, yellow, very sandy CLAY / clayey SAND with coals**

Sample Specification: **Sampled by Site Staff/Client**
Source: **Site**
Date Sampled: Date Received: **18/08/2020** Sampled By: **Clients Staff**

	Test Results	Specification
Water Content (%):	**24.9**	BS EN ISO 17892-1;2014

The liquid and Plastic Limits are prepared in accordance with BS1377: Part 2: Clause 4.2.4 due to the nature of most materials in the surrounding area (Sandy CLAY with gravel cobbles and boulders)

Liquid Limit (%):	**28**	Part 2 Clause 4.4 (One point method)
Plastic Limit (%):	**20**	Part 2 Clause 5.3
Plasticity Index (%):	**8**	Part 2 Clause 5.4
Passing 425mic (%):	**93**	
Soil Classification:	**CL**	

Remarks: **None**

Certificate of sampling received: ☐

Signed: M. Newton

[✓] M. Newton, Laboratory Manager
[ ] P. Fletcher, Senior Technician

Start of Test Date: **18/08/2020** End of Test Date: **25/08/2020** Report Date: **25/08/2020**

UKAS accredited testing laboratory No. 0744 Report/Sample ID No: **S 842/03-CLS**

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CLASSIFICATION OF SOILS

Tests according to B.S. 1377 : 1990

Client: **DBS Environmental Limited, 12 Pickersgill Court, Sunderland, SR5 2AQ**
Engineer: **Dave Nanson**
Project: **South Moor Service Station, Sunderland**
Location: **CP1 at 6.0m**
Material Type: **Brown, grey, silty CLAY / clayey SILT**

Sample Specification: **Sampled by Site Staff/Client**
Source: **Site**
Date Sampled: Date Received: **18/08/2020** Sampled By: **Clients Staff**

	Test Results	Specification
Water Content (%):	**25.4**	BS EN ISO 17892-1;2014

The liquid and Plastic Limits are prepared in accordance with BS1377: Part 2: Clause 4.2.4 due to the nature of most materials in the surrounding area (Sandy CLAY with gravel cobbles and boulders)

Liquid Limit (%):	**36**	Part 2 Clause 4.4 (One point method)
Plastic Limit (%):	**24**	Part 2 Clause 5.3
Plasticity Index (%):	**12**	Part 2 Clause 5.4
Passing 425mic (%):	**97**	
Soil Classification:	**MI/CI**	

Remarks: **None**

Certificate of sampling received: ☐

Signed: _____ [✓] M. Newton, Laboratory Manager
[ ] P. Fletcher, Senior Technician

Start of Test Date: **18/08/2020** End of Test Date: **25/08/2020** Report Date: **25/08/2020**

Dave Nanson
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t: 01923 225404
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e: reception@i2analytical.com

Analytical Report Number : 20-29393

Project / Site name:	Southmoor Service Station, Sunderland	**Samples received on:**	11/09/2020
Your job number:	SOUTHMOOR SERVICE STATION, SUN	**Samples instructed on/ Analysis started on:**	11/09/2020
Your order number:		**Analysis completed by:**	17/09/2020
Report Issue Number:	1	**Report issued on:**	17/09/2020
Samples Analysed:	2 water samples		

Signed: Karolina Marek

Karolina Marek
PL Head of Reporting Team
For & on behalf of i2 Analytical Ltd.

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

soils - 4 weeks from reporting
leachates - 2 weeks from reporting
waters - 2 weeks from reporting
asbestos - 6 months from reporting

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Any assessments of compliance with specifications are based on actual analytical results with no contribution from uncertainty of measurement.
Application of uncertainty of measurement would provide a range within which the true result lies.
An estimate of measurement uncertainty can be provided on request.

Analytical Report Number: 20-29393
Project / Site name: Southmoor Service Station, Sunderland

Lab Sample Number				1617236	1617237
Sample Reference				CP1	WS4
Sample Number				None Supplied	None Supplied
Depth (m)				2.82	2.80
Date Sampled				10/09/2020	10/09/2020
Time Taken				None Supplied	None Supplied
Analytical Parameter (Water Analysis)	**Units**	**Limit of detection**	**Accreditation Status**		
General Inorganics					
Electrical Conductivity at 20 °C	µS/cm	10	ISO 17025	1300	1200
Alkalinity	mgCaCO3/l	3	ISO 17025	240	540
Chemical Oxygen Demand (Total)	mg/l	2	ISO 17025	230	150
Dissolved Oxygen	mg/l	1	NONE	2.2	2.5
Speciated PAHs					
Naphthalene	µg/l	0.01	ISO 17025	< 0.01	9.48
Acenaphthylene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Acenaphthene	µg/l	0.01	ISO 17025	< 0.01	0.41
Fluorene	µg/l	0.01	ISO 17025	< 0.01	0.21
Phenanthrene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Anthracene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Fluoranthene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Pyrene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Benzo(a)anthracene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Chrysene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Benzo(b)fluoranthene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Benzo(k)fluoranthene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Benzo(a)pyrene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Indeno(1,2,3-cd)pyrene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Dibenz(a,h)anthracene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Benzo(ghi)perylene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Total PAH					
Total EPA-16 PAHs	µg/l	0.16	ISO 17025	< 0.16	10.1
Heavy Metals / Metalloids					
Chromium (hexavalent)	µg/l	5	ISO 17025	< 5.0	< 5.0
Chromium (III)	µg/l	1	NONE	3.6	140
Arsenic (total)	µg/l	0.15	ISO 17025	3.65	22.1
Cadmium (total)	µg/l	0.02	ISO 17025	0.45	4.7
Chromium (total)	µg/l	0.2	ISO 17025	12.4	183
Lead (total)	µg/l	0.2	ISO 17025	1800	2700
Mercury (total)	µg/l	0.05	ISO 17025	0.08	< 0.05
Selenium (total)	µg/l	0.6	ISO 17025	2.4	13
Zinc (total)	µg/l	0.5	ISO 17025	470	2000
Chromium (dissolved)	µg/l	0.2	ISO 17025	3.6	140
Copper (total)	µg/l	0.5	ISO 17025	11	130

Analytical Report Number: 20-29393
Project / Site name: Southmoor Service Station, Sunderland

Lab Sample Number				1617236	1617237
Sample Reference				CP1	WS4
Sample Number				None Supplied	None Supplied
Depth (m)				2.82	2.80
Date Sampled				10/09/2020	10/09/2020
Time Taken				None Supplied	None Supplied
Analytical Parameter (Water Analysis)	**Units**	**Limit of detection**	**Accreditation Status**		
Monoaromatics & Oxygenates					
Benzene	µg/l	1	ISO 17025	< 1.0	< 1.0
Toluene	µg/l	1	ISO 17025	< 1.0	< 1.0
Ethylbenzene	µg/l	1	ISO 17025	< 1.0	< 1.0
p & m-xylene	µg/l	1	ISO 17025	< 1.0	< 1.0
o-xylene	µg/l	1	ISO 17025	< 1.0	< 1.0
MTBE (Methyl Tertiary Butyl Ether)	µg/l	1	ISO 17025	< 1.0	< 1.0
Petroleum Hydrocarbons					
TPH-CWG - Aliphatic >C5 - C6	µg/l	1	ISO 17025	< 1.0	< 1.0
TPH-CWG - Aliphatic >C6 - C8	µg/l	1	ISO 17025	< 1.0	< 1.0
TPH-CWG - Aliphatic >C8 - C10	µg/l	1	ISO 17025	< 1.0	< 1.0
TPH-CWG - Aliphatic >C10 - C12	µg/l	10	NONE	< 10	150
TPH-CWG - Aliphatic >C12 - C16	µg/l	10	NONE	< 10	210
TPH-CWG - Aliphatic >C16 - C21	µg/l	10	NONE	< 10	110
TPH-CWG - Aliphatic >C21 - C35	µg/l	10	NONE	< 10	850
TPH-CWG - Aliphatic (C5 - C35)	µg/l	10	NONE	< 10	1300
TPH-CWG - Aromatic >C5 - C7	µg/l	1	ISO 17025	< 1.0	< 1.0
TPH-CWG - Aromatic >C7 - C8	µg/l	1	ISO 17025	< 1.0	< 1.0
TPH-CWG - Aromatic >C8 - C10	µg/l	1	ISO 17025	< 1.0	< 1.0
TPH-CWG - Aromatic >C10 - C12	µg/l	10	NONE	< 10	780
TPH-CWG - Aromatic >C12 - C16	µg/l	10	NONE	< 10	< 10
TPH-CWG - Aromatic >C16 - C21	µg/l	10	NONE	< 10	< 10
TPH-CWG - Aromatic >C21 - C35	µg/l	10	NONE	< 10	< 10
TPH-CWG - Aromatic (C5 - C35)	µg/l	10	NONE	< 10	780

U/S = Unsuitable Sample I/S = Insufficient Sample

Analytical Report Number : 20-29393
Project / Site name: Southmoor Service Station, Sunderland

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Metals in water by ICP-MS (dissolved)	Determination of metals in water by acidification followed by ICP-MS. Accredited Matrices: SW, GW, PW except B=SW,GW, Hg=SW,PW, Al=SW,PW.	In-house method based on USEPA Method 6020 & 200.8 "for the determination of trace elements in water by ICP-MS.	L012-PL	W	ISO 17025
Metals in water by ICP-MS (total)	Determination of metals in water by acidification followed by ICP-MS. Accredited Matrices: SW, GW, PW except B=SW,GW, Hg=SW,PW, Al=SW,PW.	In-house method based on USEPA Method 6020 & 200.8 "for the determination of trace elements in water by ICP-MS.	L012-PL	W	ISO 17025
Hexavalent chromium in water	Determination of hexavalent chromium in water by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry.	In-house method by continuous flow analyser. Accredited Matrices SW, GW, PW.	L080-PL	W	ISO 17025
Electrical conductivity at 20oC of water	Determination of electrical conductivity in water by electrometric measurement. Accredited Matrices SW, GW, PW	In-house method	L031-PL	W	ISO 17025
Dissolved Oxygen in water	Determination of dissolved oxygen.	In-house method	L086-PL	W	NONE
Speciated EPA-16 PAHs in water	Determination of PAH compounds in water by extraction in dichloromethane followed by GC-MS with the use of surrogate and internal standards. Accredited matrices: SW PW GW	In-house method based on USEPA 8270	L102B-PL	W	ISO 17025
TPHCWG (Waters)	Determination of dichloromethane extractable hydrocarbons in water by GC-MS, speciation by interpretation.	In-house method	L070-PL	W	NONE
BTEX and MTBE in water (Monoaromatics)	Determination of BTEX and MTBE in water by headspace GC-MS. Accredited matrices: SW PW GW	In-house method based on USEPA8260	L073B-PL	W	ISO 17025
Cr (III) in water	In-house method by calculation from total Cr and Cr VI.	In-house method by calculation	L080-PL	W	NONE
Chemical Oxygen Demand in Water (Total)	Determination of total COD in water by reflux oxidation with acidified K2Cr2O7 followed by colorimetry. Accredited matrices: SW, PW, GW.	HACH DR/890 Colorimeter Procedures Manual (48470-22) (Ref 0170.2)	L065-PL	W	ISO 17025
Alkalinity in Water (by discreet analyser)	Determination of Alkalinity by discreet analyser (colorimetry). Accredited matrices: SW, PW, GW.	In house method based on MEWAM & USEPA Method 310.2.	L082-PL	W	ISO 17025

For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.
For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.
Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.

Creating the Environment for Business

Appendix E
Tabulated Chemistry Data and Statistical Data Sheets

Data Summary Statistics

Site:	South Moor Service Station	**Project No:**	1358
Data Description:	Made Ground & Natural Ground	**SOM (%):**	2.5%
Land Use:	Residential with Gardens	**Completed By:**	DN
Receptor:	Human Health	**Checked By:**	DN

Assessment Criteria Key

a) 2009 SGV (Res with Plant)
b) 2009 SGV (Allotment)
c) 2009 SGV (Commercial/Industrial)
d) EIC GAC (Res with Plant)
e) EIC GAC (Res without Plant)
f) EIC GAC (Allotment)
g) EIC GAC (Commercial/Ind)
l) LQM CIEH S4UL (Res with Plant)
m) LQM CIEH S4UL (Res without Plant)
n) LQM CIEH S4UL (Commercial/Ind)
o) BRE Special Digest
p) Other Generic Criteria
q) Site Specific Assessment Criteria
p) Laboratory Limit of Detection
r) C4SL for Lead (2014)
s) Atrisk SSV Resi with homegrown produce

Contaminant	Units	Method Detection Limit	Assess-ment Criteria (AC)	Source (see key)	Summary Statistics							Sample Identifiers and Analytical Data												
					Total Number of Samples	Results Above Detection Limit	Minimum	Maximum	Arithmetic Mean	Standard Deviation	Number of results >AC	WS1	WS1	WS3	WS3	WS4	WS4	WS4	WS5	WS6	CP1	CP1			
												1.50	4.50	0.50	1.00	0.60	2.50	4.50	1.50	0.50	2.50	4.00			
												22/07/2020	22/07/2020	22/07/2020	22/07/2020	22/07/2020	22/07/2020	22/07/2020	22/07/2020	22/07/2020	22/07/2020	22/07/2020			
												MG	NAT	MG	MG	MG	MG	NAT	MG	MG	MG	NAT			
Metals					0	0	0	0	-	-	0														
Arsenic	mg/kg	1	37	l	11	11	2.3	20	10.1181818	6.16292434	0	16	6.2	2.3	15	20	6.2	3.2	15	14	10	3.4			
Cadmium	mg/kg	0.2	11	l	11	7	0.2	1.3	0.41818182	0.35161963	0	0.3	< 0.2	< 0.2	0.8	1.3	0.2	< 0.2	0.3	0.6	0.3	< 0.2			
Chromium (hexavalent)	mg/kg	4	6	l	11	0	4	4	-	-	0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0			
Chromium (III)	mg/kg	1	910	l	11	11	7.1	33	20.0272727	8.51317695	0	28	33	7.1	24	29	23	9.5	19	19	19	9.7			
Chromium	mg/kg	1	910	l	11	11	7.2	33	20.1454545	8.46644715	0	28	33	7.2	24	29	23	9.6	19	20	19	9.8			
Copper	mg/kg	1	2400	l	11	11	9.2	130	53.8363636	43.282497	0	130	22	16	90	100	16	9.2	90	71	35	13			
Lead	mg/kg	1	200	r	11	11	15	620	129.454545	177.745528	2	29	21	51	200	620	27	21	120	210	110	15			
Mercury	mg/kg	0.3	40	l	11	4	0.3	0.4	0.33636364	0.0504525	0	< 0.3	< 0.3	< 0.3	0.4	0.4	< 0.3	< 0.3	< 0.3	0.4	0.4	< 0.3			
Nickel	mg/kg	1	180	l	11	11	7.6	57	28.0545455	15.2418085	0	57	37	7.6	42	38	22	11	33	29	21	11			
Selenium	mg/kg	1	250	l	11	1	1	2	1.09090909	-	0	< 1.0	< 1.0	< 1.0	< 1.0	2	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0			
Zinc	mg/kg	1	3700	l	11	11	45	1200	268.727273	372.011046	0	130	65	70	770	1200	59	57	150	250	160	45			
Inorganics					0	0	0	0	-	-	0														
pH - Automated	pH Units	N/A			11	11	7.6	9.7	8.37272727	0.61658886	0	8.1	8.1	9.1	8.2	8.3	7.6	8.2	8.6	9.7	7.6	8.6			
Water Soluble SO4	g/l	0.00125		o	6	6	0.03	0.8	0.47166667	0.26278635	0	0.54	-	-	0.64	0.8	0.38	0.03	-	-	0.44	-			
Organic Matter	%	0.1			8	8	0.4	6.7	3.9875	2.25922711	0	6.1	-	0.4	4.7	6.7	1.5	-	5.8	3.7	3	-			
Organics					0	0	0	0	-	-	0														
Speciated PAH					0	0	0	0	-	-	0														
Naphthalene	mg/kg	0.05	506	l	8	5	0.05	6.9	2.15875	2.55086225	0	1.3	-	-	3.9	4.2	< 0.05	< 0.05	6.9	0.82	< 0.05	-			
Acenaphthylene	mg/kg	0.05	420	l	8	5	0.05	2.1	0.6075	0.70089229	0	0.38	-	-	0.96	0.86	< 0.05	< 0.05	2.1	0.41	< 0.05	-			
Acenaphthene	mg/kg	0.05	510	l	8	5	0.05	8.8	2.95125	3.47743928	0	0.86	-	-	5.9	6.2	< 0.05	< 0.05	8.8	1.7	< 0.05	-			
Fluorene	mg/kg	0.05	400	l	8	5	0.05	6.9	2.46	2.85310858	0	0.63	-	-	5.3	5.2	< 0.05	< 0.05	6.9	1.5	< 0.05	-			
Phenanthrene	mg/kg	0.05	220	l	8	7	0.05	71	23.55625	26.0300024	0	12	-	-	45	42	1.1	< 0.05	71	14	3.3	-			
Anthracene	mg/kg	0.05	5400	l	8	7	0.05	13	4.61875	4.82544576	0	3.1	-	-	9.2	7.9	0.18	< 0.05	13	2.7	0.82	-			
Fluoranthene	mg/kg	0.05	560	l	8	7	0.05	87	31.68125	32.8814965	0	20	-	-	59	61	1.4	< 0.05	87	20	5	-			
Pyrene	mg/kg	0.05	1200	l	8	7	0.05	77	28.58125	29.3732135	0	19	-	-	54	55	1.4	< 0.05	77	18	4.2	-			
Benzo(a)anthracene	mg/kg	0.05	11	l	8	7	0.05	45	19.17125	18.9760386	4	18	-	-	45	34	0.82	< 0.05	43	10	2.5	-			
Chrysene	mg/kg	0.05	22	l	8	7	0.05	26	12.275	11.3612751	3	13	-	-	24	25	0.65	< 0.05	26	7.7	1.8	-			
Benzo(b)fluoranthene	mg/kg	0.05	3.3	l	8	7	0.05	54	22.54875	22.5487823	5	21	-	-	46	54	0.64	< 0.05	45	11	2.7	-			
Benzo(k)fluoranthene	mg/kg	0.05	93	l	8	7	0.05	47	12.65	15.7871548	0	16	-	-	17	47	0.53	< 0.05	16	3.7	0.92	-			
Benzo(a)pyrene	mg/kg	0.05	2.7	l	8	7	0.05	36	16.575	15.4558819	5	24	-	-	36	29	0.65	< 0.05	33	8	1.9	-			
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	36	l	8	7	0.05	18	8.86375	8.03504456	0	15	-	-	18	16	0.36	< 0.05	16	4.2	1.3	-			
Dibenz(a,h)anthracene	mg/kg	0.05	0.28	l	8	5	0.05	5.3	2.49375	2.36332657	5	4.1	-	-	5.3	4.9	< 0.05	< 0.05	4.3	1.2	< 0.05	-			
Benzo(ghi)perylene	mg/kg	0.05	340	l	8	7	0.05	18	9.02625	8.14990436	0	15	-	-	18	17	0.36	< 0.05	16	4.6	1.2	-			
Speciated Total EPA-16 PAHs	mg/kg	0.8	**500**		8	7	0.8	472	200.04125	196.414051	0	184	-	-	392	409	8.03	< 0.80	472	109	25.5	-			
Petroleum Hydrocarbons					0	0	0	0	-	-	0														
TPH-CWG - Aliphatic >EC5 - EC6	mg/kg	0.001	78	l	8	0	0.001	0.001	-	-	0	< 0.001	-	-	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	-			
TPH-CWG - Aliphatic >EC6 - EC8	mg/kg	0.001	230	l	8	0	0.001	0.001	-	-	0	< 0.001	-	-	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	-			
TPH-CWG - Aliphatic >EC8 - EC10	mg/kg	0.001	65	l	8	0	0.001	0.001	-	-	0	< 0.001	-	-	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	-			
TPH-CWG - Aliphatic >EC10 - EC12	mg/kg	1	330	l	8	2	1	7.4	2.5125	2.80684749	0	< 1.0	-	-	< 1.0	6.7	< 1.0	< 1.0	7.4	< 1.0	< 1.0	-			
TPH-CWG - Aliphatic >EC12 - EC16	mg/kg	2	2400	l	8	4	2	42	10.525	14.961355	0	< 2.0	-	-	2.9	42	< 2.0	< 2.0	25	6.3	< 2.0	-			
TPH-CWG - Aliphatic >EC16 - EC21	mg/kg	8	92000	l	8	4	8	87	25.125	28.6876653	0	< 8.0	-	-	12	87	< 8.0	< 8.0	49	21	< 8.0	-			
TPH-CWG - Aliphatic >EC21 - EC35	mg/kg	8	92000	l	8	4	8	260	80.25	92.6093948	0	< 8.0	-	-	100	260	< 8.0	< 8.0	160	90	< 8.0	-			
TPH-CWG - Aliphatic (EC5 - EC35)	mg/kg	10	**5000**	N/A	8	4	10	390	113.75	139.072181	0	< 10	-	-	120	390	< 10	< 10	240	120	< 10	-			
TPH-CWG - Aromatic >EC5 - EC7	mg/kg	0.001	140	l	8	0	0.001	0.001	-	-	0	< 0.001	-	-	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	-			
TPH-CWG - Aromatic >EC7 - EC8	mg/kg	0.001	290	l	8	0	0.001	0.001	-	-	0	< 0.001	-	-	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	-			
TPH-CWG - Aromatic >EC8 - EC10	mg/kg	0.001	83	l	8	0	0.001	0.001	-	-	0	< 0.001	-	-	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	-			
TPH-CWG - Aromatic >EC10 - EC12	mg/kg	1	180	l	8	3	1	13	4.4125	4.90610043	0	< 1.0	-	-	8.1	< 1.0	< 1.0	< 1.0	9.2	13	< 1.0	-			
TPH-CWG - Aromatic >EC12 - EC16	mg/kg	2	330	l	8	5	2	110	27.9375	36.9366615	0	< 2.0	-	-	33	110	< 2.0	< 2.0	41	30	3.5	-			
TPH-CWG - Aromatic >EC16 - EC21	mg/kg	10	540	l	8	6	10	800	199.625	265.552759	1	52	-	-	240	800	< 10	< 10	260	210	15	-			
TPH-CWG - Aromatic >EC21 - EC35	mg/kg	10	1500	l	8	7	10	2100	482.5	691.076593	1	230	-	-	520	2100	13	< 10	510	460	17	-			
TPH-CWG - Aromatic (EC5 - EC35)	mg/kg	10	**5000**	N/A	8	7	10	3000	711.625	991.110768	0	280	-	-	800	3000	17	< 10	830	720	36	-			
BTEX					0	0	0	0	-	-	0														
Benzene	µg/kg	1	1	p	8	0	1	1	-	-	0	< 1.0	-	-	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	-			
Toluene	µg/kg	1	290	l	8	0	1	1	-	-	0	< 1.0	-	-	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	-			
Ethylbenzene	µg/kg	1	110	l	8	0	1	1	-	-	0	< 1.0	-	-	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	-			
p & m-xylene	µg/kg	1	130	l	8	0	1	1	-	-	0	< 1.0	-	-	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	-			
o-xylene	µg/kg	1	130	l	8	0	1	1	-	-	0	< 1.0	-	-	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	-			
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	1	p	8	0	1	1	-	-	0	< 1.0	-	-	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	-			
Asbestos	Type	N/A										ND	-	ND	ND	ND	ND	-	ND	ND	ND	-			

Data Summary Statistics

Site:	South Moor Service Station	**Project No:**	1358
Data Description:	Made Ground	**SOM (%):**	2.5%
Land Use:	Residential with Gardens	**Completed By:**	DN
Receptor:	Human Health	**Checked By:**	DN

e) EIC GAC (Res without Pl; m) LQM CIEH S4UL (Res without Plant)
f) EIC GAC (Allotment) n) LQM CIEH S4UL (Commercial/Ind)
g) EIC GAC (Commercial/Ir o) BRE Special Digest
l) LQM CIEH S4UL (Res wit| p) Other Generic Criteria

Contaminant	Units	Method Detection Limit	Assess-ment Criteria (AC)	Source (see key)	Summary Statistics							Sample Identifiers and Analytical Data							
					Total Number of Samples	Results Above Detection Limit	Minimum	Maximum	Arithmetic Mean	Standard Deviation	Number of results >AC	WS1	WS3	WS3	WS4	WS4	WS5	WS6	CP1
												1.50	0.50	1.00	0.60	2.50	1.50	0.50	2.50
												22/07/2020	22/07/2020	22/07/2020	22/07/2020	22/07/2020	22/07/2020	22/07/2020	22/07/2020
												MG	MG	MG	MG	MG	MG	MG	MG
Metals					0	0	0	0	-	-	0								
Arsenic	mg/kg	1	37	l	8	8	2.3	20	12.3125	5.76874274	0	16	2.3	15	20	6.2	15	14	10
Cadmium	mg/kg	0.2	11	l	8	7	0.2	1.3	0.5	0.38544964	0	0.3	< 0.2	0.8	1.3	0.2	0.3	0.6	0.3
Chromium (hexavalent)	mg/kg	4	6	l	8	0	4	4	-	-	0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0
Chromium (III)	mg/kg	1	910	l	8	8	7.1	29	21.0125	6.87862891	0	28	7.1	24	29	23	19	19	19
Chromium	mg/kg	1	910	l	8	8	7.2	29	21.15	6.81657643	0	28	7.2	24	29	23	19	20	19
Copper	mg/kg	1	2400	l	8	8	16	130	68.5	41.9863924	0	130	16	90	100	16	90	71	35
Lead	mg/kg	1	200	r	8	8	27	620	170.875	194.783717	2	29	51	200	620	27	120	210	110
Mercury	mg/kg	0.3	40	l	8	4	0.3	0.4	0.35	0.05345225	0	< 0.3	< 0.3	0.4	0.4	< 0.3	< 0.3	0.4	0.4
Nickel	mg/kg	1	180	l	8	8	7.6	57	31.2	15.0344367	0	57	7.6	42	38	22	33	29	21
Selenium	mg/kg	1	250	l	8	1	1	2	1.125	-	0	< 1.0	< 1.0	< 1.0	2	< 1.0	< 1.0	< 1.0	< 1.0
Zinc	mg/kg	1	3700	l	8	8	59	1200	348.625	413.429192	0	130	70	770	1200	59	150	250	160
Inorganics					0	0	0	0	-	-	0								
pH - Automated	pH Units	N/A			8	8	7.6	9.7	8.4	0.72111026	0	8.1	9.1	8.2	8.3	7.6	8.6	9.7	7.6
Water Soluble SO4	g/l	0.00125		o	5	5	0.38	0.8	0.56	0.16673332	0	0.54	-	0.64	0.8	0.38	-	-	0.44
Organic Matter	%	0.1			8	8	0.4	6.7	3.9875	2.25922711	0	6.1	0.4	4.7	6.7	1.5	5.8	3.7	3
Organics					0	0	0	0	-	-	0								
Speciated PAH					0	0	0	0	-	-	0								
Naphthalene	mg/kg	0.05	506	l	7	5	0.05	6.9	2.46	2.59699185	0	1.3	-	3.9	4.2	< 0.05	6.9	0.82	< 0.05
Acenaphthylene	mg/kg	0.05	420	l	7	5	0.05	2.1	0.68714286	0.7168848	0	0.38	-	0.96	0.86	< 0.05	2.1	0.41	< 0.05
Acenaphthene	mg/kg	0.05	510	l	7	5	0.05	8.8	3.36571429	3.53620256	0	0.86	-	5.9	6.2	< 0.05	8.8	1.7	< 0.05
Fluorene	mg/kg	0.05	400	l	7	5	0.05	6.9	2.80428571	2.89665817	0	0.63	-	5.3	5.2	< 0.05	6.9	1.5	< 0.05
Phenanthrene	mg/kg	0.05	220	l	7	7	1.1	71	26.9142857	26.1771165	0	12	-	45	42	1.1	71	14	3.3
Anthracene	mg/kg	0.05	5400	l	7	7	0.18	13	5.27142857	4.81558383	0	3.1	-	9.2	7.9	0.18	13	2.7	0.82
Fluoranthene	mg/kg	0.05	560	l	7	7	1.4	87	36.2	32.7232843	0	20	-	59	61	1.4	87	20	5
Pyrene	mg/kg	0.05	1200	l	7	7	1.4	77	32.6571429	29.1809788	0	19	-	54	55	1.4	77	18	4.2
Benzo(a)anthracene	mg/kg	0.05	11	l	7	7	0.82	45	21.9028571	18.7206497	4	18	-	45	34	0.82	43	10	2.5
Chrysene	mg/kg	0.05	22	l	7	7	0.65	26	14.0214286	11.0510127	3	13	-	24	25	0.65	26	7.7	1.8
Benzo(b)fluoranthene	mg/kg	0.05	3.3	l	7	7	0.64	54	25.7628571	22.28836	5	21	-	46	54	0.64	45	11	2.7
Benzo(k)fluoranthene	mg/kg	0.05	93	l	7	7	0.53	47	14.45	16.141044	0	16	-	17	47	0.53	16	3.7	0.92
Benzo(a)pyrene	mg/kg	0.05	2.7	l	7	7	0.65	36	18.9357143	15.0560263	5	24	-	36	29	0.65	33	8	1.9
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	36	l	7	7	0.36	18	10.1228571	7.77982372	0	15	-	18	16	0.36	16	4.2	1.3
Dibenz(a,h)anthracene	mg/kg	0.05	0.28	l	7	5	0.05	5.3	2.84285714	2.3192004	5	4.1	-	5.3	4.9	< 0.05	4.3	1.2	< 0.05
Benzo(ghi)perylene	mg/kg	0.05	340	l	7	7	0.36	18	10.3085714	7.88313691	0	15	-	18	17	0.36	16	4.6	1.2
Speciated Total EPA-16 PAHs	mg/kg	0.8	500		7	7	8.03	472	228.504286	193.511959	0	184	-	392	409	8.03	472	109	25.5
Petroleum Hydrocarbons					0	0	0	0	-	-	0								
TPH-CWG - Aliphatic >EC5 - EC6	mg/kg	0.001	78	l	7	0	0.001	0.001	-	-	0	< 0.001	-	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aliphatic >EC6 - EC8	mg/kg	0.001	230	l	7	0	0.001	0.001	-	-	0	< 0.001	-	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aliphatic >EC8 - EC10	mg/kg	0.001	65	l	7	0	0.001	0.001	-	-	0	< 0.001	-	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aliphatic >EC10 - EC12	mg/kg	1	330	l	7	2	1	7.4	2.72857143	2.95900562	0	< 1.0	-	< 1.0	6.7	< 1.0	7.4	< 1.0	< 1.0
TPH-CWG - Aliphatic >EC12 - EC16	mg/kg	2	2400	l	7	4	2	42	11.7428571	15.7259718	0	< 2.0	-	2.9	42	< 2.0	25	6.3	< 2.0
TPH-CWG - Aliphatic >EC16 - EC21	mg/kg	8	92000	l	7	4	8	87	27.5714286	30.0713437	0	< 8.0	-	12	87	< 8.0	49	21	< 8.0
TPH-CWG - Aliphatic >EC21 - EC35	mg/kg	8	92000	l	7	4	8	260	90.5714286	94.9295478	0	< 8.0	-	100	260	< 8.0	160	90	< 8.0
TPH-CWG - Aliphatic (EC5 - EC35)	mg/kg	10	5000		7	4	10	390	128.571429	143.22809	0	< 10	-	120	390	< 10	240	120	< 10
TPH-CWG - Aromatic >EC5 - EC7	mg/kg	0.001	140	l	7	0	0.001	0.001	-	-	0	< 0.001	-	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aromatic >EC7 - EC8	mg/kg	0.001	290	l	7	0	0.001	0.001	-	-	0	< 0.001	-	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aromatic >EC8 - EC10	mg/kg	0.001	83	l	7	0	0.001	0.001	-	-	0	< 0.001	-	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aromatic >EC10 - EC12	mg/kg	1	180	l	7	3	1	13	4.9	5.08560059	0	< 1.0	-	8.1	< 1.0	< 1.0	9.2	13	< 1.0
TPH-CWG - Aromatic >EC12 - EC16	mg/kg	2	330	l	7	5	2	110	31.6428571	38.2564965	0	< 2.0	-	33	110	< 2.0	41	30	3.5
TPH-CWG - Aromatic >EC16 - EC21	mg/kg	10	540	l	7	6	10	800	226.714286	274.631095	1	52	-	240	800	< 10	260	210	15
TPH-CWG - Aromatic >EC21 - EC35	mg/kg	10	1500	l	7	7	13	2100	550	717.397844	1	230	-	520	2100	13	510	460	17
TPH-CWG - Aromatic (EC5 - EC35)	mg/kg	10	5000		7	7	17	3000	811.857143	1025.79245	0	280	-	800	3000	17	830	720	36
BTEX					0	0	0	0	-	-	0								
Benzene	µg/kg	1	1	p	7	0	1	1	-	-	0	< 1.0	-	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Toluene	µg/kg	1	290	l	7	0	1	1	-	-	0	< 1.0	-	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Ethylbenzene	µg/kg	1	110	l	7	0	1	1	-	-	0	< 1.0	-	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
p & m-xylene	µg/kg	1	130	l	7	0	1	1	-	-	0	< 1.0	-	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
o-xylene	µg/kg	1	130	l	7	0	1	1	-	-	0	< 1.0	-	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	1	p	7	0	1	1	-	-	0	< 1.0	-	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Asbestos	Type	N/A										ND	ND	ND	ND	ND	ND	ND	ND

Data Summary Statistics

Site:	South Moor Service Station	**Project No:**	1358
Data Description:	Natural Ground	**SOM (%):**	2.5%
Land Use:	Residential with Gardens	**Completed By:**	DN
Receptor:	Human Health	**Checked By:**	DN

Assessment Criteria Key

a) 2009 SGV (Res with Plan
b) 2009 SGV (Allotment)
c) 2009 SGV (Commercial/Ir
d) EIC GAC (Res with Plant
q) Site Specific Assessment Criteria
p) Laboratory Limit of Detection
r) C4SL for Lead (2014)
s) Atrisk SSV Resi with homegrown produce

Contaminant	Units	Method Detection Limit	Assess-ment Criteria (AC)	Source (see key)	Summary Statistics							WS1	WS4	CP1			
					Total Number of Samples	Results Above Detection Limit	Minimum	Maximum	Arithmetic Mean	Standard Deviation	Number of results >AC	4.50	4.50	4.00			
												22/07/2020	22/07/2020	22/07/2020			
												NAT	NAT	NAT			
Metals					0	0	0	0	-	-	0						
Arsenic	mg/kg	1	37	l	3	3	3.2	6.2	4.26666667	1.67729942	0	6.2	3.2	3.4			
Cadmium	mg/kg	0.2	11	l	3	0	0.2	0.2	-	-	0	< 0.2	< 0.2	< 0.2			
Chromium (hexavalent)	mg/kg	4	6	l	3	0	4	4	-	-	0	< 4.0	< 4.0	< 4.0			
Chromium (III)	mg/kg	1	910	l	3	3	9.5	33	17.4	13.5103664	0	33	9.5	9.7			
Chromium	mg/kg	1	910	l	3	3	9.6	33	17.4666667	13.452633	0	33	9.6	9.8			
Copper	mg/kg	1	2400	l	3	3	9.2	22	14.7333333	6.57368491	0	22	9.2	13			
Lead	mg/kg	1	200	r	3	3	15	21	19	3.46410162	0	21	21	15			
Mercury	mg/kg	0.3	40	l	3	0	0.3	0.3	-	-	0	< 0.3	< 0.3	< 0.3			
Nickel	mg/kg	1	180	l	3	3	11	37	19.6666667	15.011107	0	37	11	11			
Selenium	mg/kg	1	250	l	3	0	1	1	-	-	0	< 1.0	< 1.0	< 1.0			
Zinc	mg/kg	1	3700	l	3	3	45	65	55.6666667	10.0664459	0	65	57	45			
Inorganics					0	0	0	0	-	-	0						
pH - Automated	pH Units	N/A			3	3	8.1	8.6	8.3	0.26457513	0	8.1	8.2	8.6			
Water Soluble SO4	g/l	0.00125		o	1	1	0.03	0.03	0.03	-	0	-	0.03	-			
Organic Matter	%	0.1			0	0	0	0	-	-	0	-	-	-			
Organics					0	0	0	0	-	-	0						
Speciated PAH					0	0	0	0	-	-	0						
Naphthalene	mg/kg	0.05	506	l	1	0	0.05	0.05	-	-	0	-	< 0.05	-			
Acenaphthylene	mg/kg	0.05	420	l	1	0	0.05	0.05	-	-	0	-	< 0.05	-			
Acenaphthene	mg/kg	0.05	510	l	1	0	0.05	0.05	-	-	0	-	< 0.05	-			
Fluorene	mg/kg	0.05	400	l	1	0	0.05	0.05	-	-	0	-	< 0.05	-			
Phenanthrene	mg/kg	0.05	220	l	1	0	0.05	0.05	-	-	0	-	< 0.05	-			
Anthracene	mg/kg	0.05	5400	l	1	0	0.05	0.05	-	-	0	-	< 0.05	-			
Fluoranthene	mg/kg	0.05	560	l	1	0	0.05	0.05	-	-	0	-	< 0.05	-			
Pyrene	mg/kg	0.05	1200	l	1	0	0.05	0.05	-	-	0	-	< 0.05	-			
Benzo(a)anthracene	mg/kg	0.05	11	l	1	0	0.05	0.05	-	-	0	-	< 0.05	-			
Chrysene	mg/kg	0.05	22	l	1	0	0.05	0.05	-	-	0	-	< 0.05	-			
Benzo(b)fluoranthene	mg/kg	0.05	3.3	l	1	0	0.05	0.05	-	-	0	-	< 0.05	-			
Benzo(k)fluoranthene	mg/kg	0.05	93	l	1	0	0.05	0.05	-	-	0	-	< 0.05	-			
Benzo(a)pyrene	mg/kg	0.05	2.7	l	1	0	0.05	0.05	-	-	0	-	< 0.05	-			
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	36	l	1	0	0.05	0.05	-	-	0	-	< 0.05	-			
Dibenz(a,h)anthracene	mg/kg	0.05	0.28	l	1	0	0.05	0.05	-	-	0	-	< 0.05	-			
Benzo(ghi)perylene	mg/kg	0.05	340	l	1	0	0.05	0.05	-	-	0	-	< 0.05	-			
Speciated Total EPA-16 PAHs	mg/kg	0.8	**500**		1	0	0.8	0.8	-	-	0	-	< 0.80	-			
Petroleum Hydrocarbons					0	0	0	0	-	-	0						
TPH-CWG - Aliphatic >EC5 - EC6	mg/kg	0.001	78	l	1	0	0.001	0.001	-	-	0	-	< 0.001	-			
TPH-CWG - Aliphatic >EC6 - EC8	mg/kg	0.001	230	l	1	0	0.001	0.001	-	-	0	-	< 0.001	-			
TPH-CWG - Aliphatic >EC8 - EC10	mg/kg	0.001	65	l	1	0	0.001	0.001	-	-	0	-	< 0.001	-			
TPH-CWG - Aliphatic >EC10 - EC12	mg/kg	1	330	l	1	0	1	1	-	-	0	-	< 1.0	-			
TPH-CWG - Aliphatic >EC12 - EC16	mg/kg	2	2400	l	1	0	2	2	-	-	0	-	< 2.0	-			
TPH-CWG - Aliphatic >EC16 - EC21	mg/kg	8	92000	l	1	0	8	8	-	-	0	-	< 8.0	-			
TPH-CWG - Aliphatic >EC21 - EC35	mg/kg	8	92000	l	1	0	8	8	-	-	0	-	< 8.0	-			
TPH-CWG - Aliphatic (EC5 - EC35)	mg/kg	10	**5000**		1	0	10	10	-	-	0	-	< 10	-			
TPH-CWG - Aromatic >EC5 - EC7	mg/kg	0.001	140	l	1	0	0.001	0.001	-	-	0	-	< 0.001	-			
TPH-CWG - Aromatic >EC7 - EC8	mg/kg	0.001	290	l	1	0	0.001	0.001	-	-	0	-	< 0.001	-			
TPH-CWG - Aromatic >EC8 - EC10	mg/kg	0.001	83	l	1	0	0.001	0.001	-	-	0	-	< 0.001	-			
TPH-CWG - Aromatic >EC10 - EC12	mg/kg	1	180	l	1	0	1	1	-	-	0	-	< 1.0	-			
TPH-CWG - Aromatic >EC12 - EC16	mg/kg	2	330	l	1	0	2	2	-	-	0	-	< 2.0	-			
TPH-CWG - Aromatic >EC16 - EC21	mg/kg	10	540	l	1	0	10	10	-	-	0	-	< 10	-			
TPH-CWG - Aromatic >EC21 - EC35	mg/kg	10	1500	l	1	0	10	10	-	-	0	-	< 10	-			
TPH-CWG - Aromatic (EC5 - EC35)	mg/kg	10	**5000**		1	0	10	10	-	-	0	-	< 10	-			
BTEX					0	0	0	0	-	-	0						
Benzene	µg/kg	1	1	p	1	0	1	1	-	-	0	-	< 1.0	-			
Toluene	µg/kg	1	290	l	1	0	1	1	-	-	0	-	< 1.0	-			
Ethylbenzene	µg/kg	1	110	l	1	0	1	1	-	-	0	-	< 1.0	-			
p & m-xylene	µg/kg	1	130	l	1	0	1	1	-	-	0	-	< 1.0	-			
o-xylene	µg/kg	1	130	l	1	0	1	1	-	-	0	-	< 1.0	-			
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	1	p	1	0	1	1	-	-	0	-	< 1.0	-			
Asbestos	Type	N/A										-	-	-			

Data Summary Statistics

Site:	South Moor Service Station	**Project No:**	1358
Data Description:	Shallow Groundater	**SOM (%):**	N/A
Land Use:	Residential	**Completed By:**	DN
Receptor:	Groundwater (Principal Aquifer)	**Checked By:**	DN

Assessment Criteria Key

- a) The Water Supply (Water Quality) Regulations 2010 (UKDWS)
- b) WHO Guidelines fo Drinking Water Quality 4th Edition 2011
- c) WHO Petroleum Products in Drinking Water 2008
- d) Water Framework Directive (Standards & Classification) Directions (England & Wales) 2015 (EQS)
- e) - No standard available
- Breach of Assessment Criteria

Contaminant	Substance Classification Groundwater Receptor	Substance Classification Surface Water Receptor	Units	Method Detection Limit	Assess-ment Criteria (AC)	Source (see key)	Summary Statistics							Sample Identifiers and Analytical Data	
							Total Number of Samples	Results Above Detection Limit	Minimum	Maximum	Arithmetic Mean	Standard Deviation	Number of results >AC	CP1	WS4
														2.82	2.8
														10.09.20	10.09.20
														GW	GW
General Inorganics	-	-													
Electrical Conductivity at 20 °C	-	-	µS/cm	10	-	e	2	2	1200	1300	1250	70.7106781	-	1300	1200
Alkalinity	-	-	mgCaCO3/l	3	-	e	2	2	240	540	390	212.132034	-	240	540
Chemical Oxygen Demand (Total)	-	-	mg/l	2	-	e	2	2	150	230	190	56.5685425	-	230	150
Dissolved Oxygen	-	-	mg/l	1	-	e	0	0	0	0	-	-	-		
Metals / Metalloids															
Chromium (hexavalent)	-	Specific Pollutant (SP)	µg/l	5	50	a (2)	2	0	5	5	-	-	0	< 5.0	< 5.0
Chromium (III)	-	Specific Pollutant (SP)	µg/l	1	50	a (2)	2	2	3.6	140	71.8	96.449365	0	3.6	140
Arsenic (total)	-	Specific Pollutant (SP)	µg/l	0.15	10	a	2	2	3.65	22.1	12.875	13.0461201	0	3.65	22.1
Cadmium (total)	**Hazardous Substance**		µg/l	0.02	5	a	2	2	0.45	4.7	2.575	3.00520382	0	0.45	4.7
Chromium (total)	-	-	µg/l	0.2	50	a	2	2	12.4	183	97.7	120.632417	0	12.4	183
Lead (total)			µg/l	0.2	25	a	2	2	1800	2700	2250	636.396103	0	1800	2700
Mercury (total)	**Hazardous Substance**	**Priority Hazardous Substance (PHS)**	µg/l	0.05	0.07	d (1)	2	1	0.05	0.08	0.065	-	0	0.08	< 0.05
Selenium (total)	-	-	µg/l	0.6	10	a	2	2	2.4	13	7.7	7.49533188	0	2.4	13
Zinc (total)		Specific Pollutant (SP)	µg/l	0.5	10.9	d	2	2	470	2000	1235	1081.87338	0	470	2000
Chromium (dissolved)	-	-	µg/l	0.2	50	a (2)	2	2	3.6	140	71.8	96.449365	0	3.6	140
Copper (total)		Specific Pollutant (SP)	µg/l	0.5	1	d	2	2	11	130	70.5	84.145707	0	11	130
Speciated PAHs	-	-													
Naphthalene	**Hazardous Substance**	Priority Substance	µg/l	0.01	2	d	2	1	0.01	9.48	4.745	-	0	< 0.01	9.48
Acenaphthylene	**Hazardous Substance**	-	µg/l	0.01	-	e	2	0	0.01	0.01	-	-	-	< 0.01	< 0.01
Acenaphthene	-	-	µg/l	0.01	-	e	2	1	0.01	0.41	0.21	-	-	< 0.01	0.41
Fluorene	-	-	µg/l	0.01	-	e	2	1	0.01	0.21	0.11	-	-	< 0.01	0.21
Phenanthrene	-	-	µg/l	0.01	-	e	2	0	0.01	0.01	-	-	-	< 0.01	< 0.01
Anthracene	**Hazardous Substance**	**Priority Hazardous Substance (PHS)**	µg/l	0.01	-	e	2	0	0.01	0.01	-	-	-	< 0.01	< 0.01
Fluoranthene	**Hazardous Substance**	-	µg/l	0.01	-	e	2	0	0.01	0.01	-	-	-	< 0.01	< 0.01
Pyrene	-	-	µg/l	0.01	-	e	2	0	0.01	0.01	-	-	-	< 0.01	< 0.01
Benzo(a)anthracene	-	-	µg/l	0.01	-	e	2	0	0.01	0.01	-	-	-	< 0.01	< 0.01
Chrysene	-	-	µg/l	0.01	-	e	2	0	0.01	0.01	-	-	-	< 0.01	< 0.01
Benzo(b)fluoranthene	**Hazardous Substance**	**Priority Hazardous Substance (PHS)**	µg/l	0.01	0.1	a	2	0	0.01	0.01	-	-	0	< 0.01	< 0.01
Benzo(k)fluoranthene	**Hazardous Substance**	**Priority Hazardous Substance (PHS)**	µg/l	0.01	0.1	a	2	0	0.01	0.01	-	-	0	< 0.01	< 0.01
Benzo(a)pyrene	**Hazardous Substance**	**Priority Hazardous Substance (PHS)**	µg/l	0.01	0.01	a	2	0	0.01	0.01	-	-	0	< 0.01	< 0.01
Indeno(1,2,3-cd)pyrene	**Hazardous Substance**	**Priority Hazardous Substance (PHS)**	µg/l	0.01	0.1	a	2	0	0.01	0.01	-	-	0	< 0.01	< 0.01
Dibenz(a,h)anthracene			µg/l	0.01	-	e	2	0	0.01	0.01	-	-	-	< 0.01	< 0.01
Benzo(ghi)perylene	**Hazardous Substance**	**Priority Hazardous Substance (PHS)**	µg/l	0.01	0.1	a	2	0	0.01	0.01	-	-	0	< 0.01	< 0.01
Total PAH	-	-			-	e	2	1	0.16	10.1	5.13	-	-	< 0.16	10.1
BTEX															
Benzene	**Hazardous Substance**	Priority Substance	µg/l	1	1	a	2	0	1	1	-	-	0	< 1.0	< 1.0
Toluene	**Hazardous Substance**	Specific Pollutant (SP)	µg/l	1	700	c	2	0	1	1	-	-	0	< 1.0	< 1.0
Ethylbenzene	**Hazardous Substance**	-	µg/l	1	300	c	2	0	1	1	-	-	0	< 1.0	< 1.0
p & m-xylene	**Hazardous Substance**	-	µg/l	1	500	c	2	0	1	1	-	-	0	< 1.0	< 1.0
o-xylene	**Hazardous Substance**	-	µg/l	1	500	c	2	0	1	1	-	-	0	< 1.0	< 1.0
MTBE (Methyl Tertiary Butyl Ether)	-	-	µg/l	1	15	c								< 1.0	< 1.0
Petroleum Hydrocarbons	**Hazardous Substance**	-													
TPH-CWG - Aliphatic >C5 - C6			µg/l	1	15000	c	2	0	1	1	-	-	0	< 1.0	< 1.0
TPH-CWG - Aliphatic >C6 - C8			µg/l	1	15000	c	2	0	1	1	-	-	0	< 1.0	< 1.0
TPH-CWG - Aliphatic >C8 - C10			µg/l	1	300	c	2	0	1	1	-	-	0	< 1.0	< 1.0
TPH-CWG - Aliphatic >C10 - C12			µg/l	10	300	c	2	1	10	150	80	-	0	< 10	150
TPH-CWG - Aliphatic >C12 - C16			µg/l	10	300	c	2	1	10	210	110	-	0	< 10	210
TPH-CWG - Aliphatic >C16 - C21			µg/l	10	-	e	2	1	10	110	60	-	-	< 10	110
TPH-CWG - Aliphatic >C21 - C35			µg/l	10	-	e	2	1	10	850	430	-	-	< 10	850
TPH-CWG - Aliphatic (C5 - C35)			µg/l	10	-	e	2	1	10	1300	655	-	-	< 10	1300
TPH-CWG - Aromatic >C5 - C7			µg/l	1	10	c	2	0	1	1	-	-	0	< 1.0	< 1.0
TPH-CWG - Aromatic >C7 - C8			µg/l	1	700	c	2	0	1	1	-	-	0	< 1.0	< 1.0
TPH-CWG - Aromatic >C8 - C10			µg/l	1	300	c	2	0	1	1	-	-	0	< 1.0	< 1.0
TPH-CWG - Aromatic >C10 - C12			µg/l	10	90	c	2	1	10	780	395	-	0	< 10	780
TPH-CWG - Aromatic >C12 - C16			µg/l	10	90	c	2	0	10	10	-	-	0	< 10	< 10
TPH-CWG - Aromatic >C16 - C21			µg/l	10	90	c	2	0	10	10	-	-	0	< 10	< 10
TPH-CWG - Aromatic >C21 - C35			µg/l	10	90	c	2	0	10	10	-	-	0	< 10	< 10
TPH-CWG - Aromatic (C5 - C35)			µg/l	10	-	e	2	1	10	780	395	-	-	< 10	780
Notes															
1. Assessment Criteria for Mercury based on MAC in absence of AA															
2. Assessment Criteria for Chroimum (VI, III and dissolved) based on Total Chromium Value															

Data Summary Statistics

Site:	South Moor Service Station	**Project No:**	1358
Data Description:	Vapours and Shallow Groundater	**SOM (%):**	N/A
Land Use:	Residential	**Completed By:**	DN
Receptor:	Human Health	**Checked By:**	DN

Assessment Criteria Key

a) ATRISK WSV

Breach of assessment Criteria

Contaminant	Units	Method Detection Limit	Assess-ment Criteria (AC)	Source (see key)	Summary Statistics							Sample Identifiers and Analytical Data						
					Total Number of Samples	Results Above Detection Limit	Minimum	Maximum	Arithmetic Mean	Standard Deviation	Number of results >AC	CP1	WS4					
												2.82	2.8					
												10.09.20	10.09.20					
												GW	GW					
Volatile Contaminants					0	0	0	0	-	-	0							
TPH-CWG - Aliphatic >C5 - C6	µg/l	1	1930	a	2	0	1	1	-	-	0	< 1.0	< 1.0					
TPH-CWG - Aliphatic >C6 - C8	µg/l	1	1400	a	2	0	1	1	-	-	0	< 1.0	< 1.0					
TPH-CWG - Aliphatic >C8 - C10	µg/l	1	29.6	a	2	0	1	1	-	-	0	< 1.0	< 1.0					
TPH-CWG - Aliphatic >C10 - C12	µg/l	10	22.8	a	2	1	10	150	80	-	1	< 10	150					
TPH-CWG - Aliphatic >C12 - C16	µg/l	10	5.47	a	2	1	10	210	110	-	2	< 10	210					
TPH-CWG - Aromatic >C5 - C7	µg/l	1	88.8	a	2	0	1	1	-	-	0	< 1.0	< 1.0					
TPH-CWG - Aromatic >C7 - C8	µg/l	1	96400	a	2	0	1	1	-	-	0	< 1.0	< 1.0					
TPH-CWG - Aromatic >C8 - C10	µg/l	1	985	a	2	0	1	1	-	-	0	< 1.0	< 1.0					
TPH-CWG - Aromatic >C10 - C12	µg/l	10	3870	a	2	1	10	780	395	-	0	< 10	780					
TPH-CWG - Aromatic >C12 - C16	µg/l	10	10500	a	2	0	10	10	-	-	0	< 10	< 10					
Acenaphthene	ug/l	0.01	375000	a	2	1	0.01	0.41	0.21	-	0	< 0.01	0.41					
Mercury	ug/l	0.05	4.68	a	2	1	0.05	0.08	0.065	-	0	0.08	< 0.05					
Naphthalene	ug/l	0.01	952	a	2	1	0.01	9.48	4.745	-	0	< 0.01	9.48					
Note																		
TPH >C16 are not considered volatile																		
according to TPHCWG.																		

Creating the Environment for Business

Appendix F
Gas and Groundwater Monitoring Results

Ground Gas Monitoring Results - South Moor Service Station, Grangetown, Sunderland
July 2020 to October 2020
Project Number - 1358

Date - Time	ID	CH4(%)	LEL(%)	CO2(%)	O2(%)	H2S(ppm)	CO(ppm)	Hex(%)	PIDCf()	Flw(lh)	PkFlw(lh)	DP(Pa)	AP(mbar)	SP(mbar)	DIP1(m)	Bal(%)	PID Peak	PID Steady
28/07/2020 09:07	WS1	0	<<<.<	0	17.2	0	0	0	1	0	0	0	1002	_____	3	82.8	0	0
11/08/2020 09:33	WS1	0	0	0	20.9	0	0	0	1	0	0	0	998	_____	2.9	80.1	0	0
24/08/2020 11:19	WS1	0	0	0	20.8	0	0	0.029	1	0	0	0	1003	_____	2.88	79.2	0.1	0
07/09/2020 08:05	WS1	0	0	0.1	20.8	0	0	0.009	1	0	0	0	1001	_____	2.84	79.5	0	0
28/09/2020 12:05	WS1	0	0	0.1	20.6	0	0	0.017	1	0	0	0	1002	_____	2.83	79.3	0	0
13/10/2020 16:12	WS1	0	0	0.1	20.4	0	0	0.047	1	0	0	0	1011	_____	2.71	79.5	0	0
28/07/2020 09:18	WS4	0	<<<.<	1.5	15.4	0	0	0	1	0	0	0	1002	_____	2.73	83.1	8.2	7.4
11/08/2020 09:48	WS4	0	0	0.8	19.8	0	0	0	1	0	0	0	998	_____	2.71	79.9	6.1	5.2
24/08/2020 11:33	WS4	0	0	0.4	20.4	0	0	0.02	1	0	0	0	1002	_____	2.62	79.2	22.3	9.1
07/09/2020 08:21	WS4	0	0	1.3	16.2	0	0	0.041	1	0	0	0	1001	_____	2.6	79.7	4.1	4.1
28/09/2020 12:14	WS4	0.1	3	3	15.8	0	0	0.035	1	-0.7	-0.7	-4	1001	_____	2.55	81.1	2.9	2.9
13/10/2020 16:23	WS4	0	0	0.8	19.3	0	0	0.056	1	0	14.1	0	1010	_____	2.58	79.9	2.2	2.2
28/07/2020 09:27	CP1	0	<<<.<	0.8	15.2	0	0	0	1	0	0	0	1002	1002	2.88	84	1.3	0
11/08/2020 09:43	CP1	0	0	1.4	15.9	0	0	0	1	0	0	0	998	_____	2.91	81.1	0.1	0
24/08/2020 11:29	CP1	0	0	6.3	8.9	0	0	0.027	1	0	4.9	0	1002	_____	2.88	84.8	0.3	0
07/09/2020 08:16	CP1	0	0	4.5	11.2	0	0	0.013	1	0	0	0	1001	_____	2.85	84.3	0	0
28/09/2020 12:11	CP1	0	0	4.6	11	0	0	0.014	1	-4	-3.3	-26	1001	_____	2.8	84.4	0	0
13/10/2020 16:17	CP1	0	0	4.9	10.7	0	0	0.044	1	2.4	2.4	16	1010	_____	2.7	84.4	0	0

Weather Conditions During Monitoring (source bbc.co.uk/weather - Newcastle Observation Station)

28 July 2020	17 degrees, sunny, breezy, 1004mb rising atmospheric pressure
11 August 2020	20 degrees, sunshine, breezy, 998mb steady atmospheric pressure
24 August 2020	22 degrees, sunny, breezy, 1014mb rising atmospheric pressure
07 September 2020	18 degrees, slightly overcast with sunny spells, 1000mb steady atmospheric pressure
28 September 2020	14 degrees, overcast, still, 1011mb steady
13 October 2020	11 degrees, overcast, showers, 1013mb steady