

**REPORT C1634
JUNE 2008**

**GEOENVIRONMENTAL APPRAISAL
AND REMEDIATION STRATEGY**

**for land off
SHEFFIELD ROAD, BIRDWELL**

**prepared for
HARTWOOD ESTATES LTD**



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EXECUTIVE SUMMARY

Sirius Geotechnical and Environmental Ltd (Sirius) were commissioned by Hartwood Estates Ltd (Hartwood), to undertake a geoenvironmental appraisal of land off Sheffield Road, Birdwell.

It is understood that Hartwood are proposing to redevelop the site with low rise commercial/industrial units, with associated car parking, access roads and areas of soft landscaping. It is understood that the proposed development will involve the demolition of the existing office building and disused workshop located on site.

A preliminary investigation (desk study) for the site was undertaken by Wardell Armstrong Engineering and Environmental Solutions (Wardell Armstrong) in November 2006 (Report ref: SD06-00179a). Based on the results of the Wardell Armstrong preliminary investigation an intrusive investigation was designed by Sirius.

This report details the results of the intrusive investigation and makes recommendations relating to the proposed redevelopment and should be read in conjunction with the desk study undertaken by Wardell Armstrong, which contains the environmental setting and preliminary conceptual site model.

The site is a roughly rectangular plot of land, and comprises a single storey office building, which at the time of the investigation was occupied by Hartwood Estates Ltd, and a derelict double height workshop, which are located within the northern and central areas of the site, respectively. A concrete bund is located adjacent to the north eastern edge of the office building, and is believed to have previously housed an electricity substation.

To the north of the derelict workshop, a number of relict concrete floor slabs/foundations and brick walls of former buildings are evident. The far northern part of the site was inaccessible at the time of the investigation due to a brick wall approximately 2.00m high. Beyond the brick wall is an area of rough overgrown grassland with evidence of fly tipping.

The southern part of the site is comprised of rough grassland and is separated from the remainder of the site by a concrete block wall which has been partly demolished. Centrally within the southern area of the site, are two stockpiles of earth, which are approximately 2m high.

Review of the available historical Ordnance Survey (OS) plans, included as part of the Wardell Armstrong desk study, revealed that the site was largely undeveloped from at least 1855 with the exception of a railway, set in a cutting, within the southern area of the site. By 1893, the far northern area of the site had been developed with terraced properties annotated as "Rockingham Row", which were later demolished sometime between 1978 and 1991. The remainder of the site comprised part of "Rockingham Gas Works", with associated gas holder, tanks and buildings within the northern and central areas, which by 1956 had been demolished/removed, and only three buildings/units remained on site.

On the 1974 OS plan the railway within the southern area of site is shown to be disused and partly dismantled, and by 1991 had been completely removed and the cutting is annotated as a "Tip". It is believed that the site was most recently used for vehicle dismantling and recycling.

Significant features recorded on the historical OS plans, nearby the site, include the M1 motorway, located 150m west of the site, a Highways Agency depot located immediately south of the site and a number of former sandstone quarries, the nearest of which is located 10m west of the site (annotated as Birdwell Quarry) and was subsequently infilled between 1938 and the present day.

The 1:50,000 and 1:10,000 scale geological plans for the area indicate the site to be directly underlain by the Haigh Moor/Birdwell Rock (sandstone) of the Carboniferous Middle Coal Measures strata. The Haigh Moor Coal is shown to outcrop approximately 130m south west of site, dipping to the north east beneath the site. No drift deposits are shown to overlie the site, however the southern part of the site is indicated as landfill, assumed to be associated with the infilled railway cutting.

According to the Coal Authority Report the property lies in the likely zone of influence from workings in 7 seams of coal at 120m to 340m bgl and last worked in 1960. Inspection of historical OS plans reviewed as part of this investigation do not reveal any quarries on the site, however a number of old quarries are shown surrounding the site, the closest of which is located approximately 10m west of site (Birdwell Quarry).

According to the Wardell Armstrong desk study, there is one licensed landfill site located within the property. It is assumed that this is associated with the infilling of the railway cutting, located in the southern part of the site.

The site is considered to lie within a setting of low environmental sensitivity.

Fieldwork comprised the excavation of sixteen trial pits to depths of between 1.30m and 4.00m bgl and four rotary probeholes to depths of 2.20m and 30.00m bgl.

This investigation has revealed the shallow soils to comprise a variable thickness of made ground, over weathered mantle material, over Middle Coal Measures strata, comprising sandstone, overlying mudstone at depth, and locally coal.

The made ground was typically encountered to depths of between 0.50m and a maximum proven depth of 2.70m bgl. An area of deep granular made ground was encountered to a depth of 3.30m bgl within TP11. This is assumed to be located within the former gas holder indicated on the historical OS plans.

A number of the exploratory holes, undertaken across the site encountered obstructions and were subsequently terminated within the made ground; as such the true thickness of this material was not proven.

Underlying the made ground, stiff to very stiff, locally soft and firm, low to high strength clay, was encountered to depths ranging between 1.20m and 4.00m bgl, which in turn was underlain by Middle Coal Measures strata, comprising sandstone and mudstone. Coal was encountered within BHR2 at a depth of 21.50m bgl and was noted to be 0.50m thick.

Based on CIRIA Special Publication 32 'Construction over Abandoned Mine Workings', it is considered there is sufficient competent rock cover above the coal seam encountered beneath the site, to mitigate against any surface instability.

Noticeable olfactory odours and visual evidence of organic contamination was recorded during the fieldwork which were noted predominantly in the made ground, however, some isolated contamination was also observed in natural strata in a number of exploratory holes across the site.

The made ground present is considered unsuitable to support foundations in their present condition due to its inherent variability and lack of consistency. Foundations for any proposed development should therefore be extended through these soils to bear onto/into underlying competent/solid strata, or materials re-engineered to provide a suitable bearing medium.

The following foundation options should be considered:

- *Raft foundations: This will require excavation, screening and re-engineering of the full thickness of made ground beneath the development areas. Based on the material types encountered in the trial pits, it is considered likely that the re-engineered soils could provide an allowable bearing capacity of 50kPa, subject to confirmatory testing.*
- *Shallow spread foundations: Pad or strip/trench foundations may be appropriate where made ground thicknesses are not excessive. These foundations should be taken down to bear on natural clay (at least firm, medium strength clay) or bedrock. The natural clays can be assumed to have an allowable net bearing capacity of 80kN/m² increasing to 150kN/m² within the underlying sandstone bedrock.*
- *Where the proposed development spans the backfilled railway cutting (Unit H on the provisional layout), foundations depths will be shallow in the north west and deeper in the south east towards the centre of the cutting. Pad and Stem foundations eg. concrete filled manhole rings, could be founded on the underlying bedrock in the deeper areas of fill and prove a more cost effective solution than piles or vibro replacement. As with piled foundations, ground beams will be required for this solution.*
- *Piles or Vibro-replacement methods could be considered if localised fill depths are excessive in some locations, or if this is the preferred option by the structural engineer based on the proposed building design. Allowance should be made for potential obstructions in the fill where the full thickness of made ground is not re-engineered. The design of the piles or vibro stone columns should be undertaken by a specialist contractor, using information obtained during this site investigation.*

Sub-surface concrete, within the infilled railway cutting, should be Design Sulphate Class DS-2, with an ACEC Classification of AC-2 based on brownfield site designation and mobile groundwater conditions. Within the former

gas works/vehicle dismantling and recycling yard, chemical results indicate a design sulphate class of DS-3, with an ACEC Classification of AC-3 based on brownfield site designation and mobile groundwater conditions.

Based on the chemical results obtained as part of this investigation, it is considered that the made ground poses a low/moderate risk to proposed end users/landscaping, based on elevated concentrations of benzo(a)pyrene. However, it is considered that the soils in the vicinity of the identified hydrocarbon “hotspot” (TP3) pose a moderate/high risk to proposed end users/landscaping.

It is recommended that to deal with the identified areas of contamination, the extent of TPH contamination encountered within the vicinity of TP3 be confirmed and hydrocarbon impacted soils be excavated and treated (either through bioremediation or removal to a suitably licensed landfill facility).

Based on the assumption that the majority of the site is to be hardsurfaced (buildings, roadways and car park), it is considered any remaining made ground will pose a low risk to the proposed end users as this will break/remove the pathway between the made ground and the end users and hence the risk associated with direct contact.

A subsoil/topsoil “cap” will be required in areas of proposed landscaping where made ground or reworked/engineered made ground underlies the development. At this stage it is recommended that 450mm of “clean” topsoil/subsoil be assumed in areas proposed for landscaping. This thickness is subject to regulatory approval. The capping layer will remove the direct pollutant linkage and therefore the potential risk to end users, and in addition provide a suitable growing medium for shallow rooted plants. Deep rooted plants will need to be potted in a suitable depth of clean inert fill.

No remedial action is considered necessary to be protective of controlled waters.

The results of this investigation have revealed slightly elevated concentrations of carbon dioxide, coupled with elevated VOC concentrations. Based upon the gas monitoring results to date, the site falls into Characteristic Situation (CS) 1. However, elevated VOC concentrations were detected within the majority of the gas monitoring wells, subsequently this necessitates a gas proof hydrocarbon resistant membrane and all joints and penetrations to be sealed, in proposed developments on site. It should be noted that these are provisional recommendations and are based on two monitoring visits. A further four monitoring visits are programmed prior to finalising recommendations for gas protective measures.

According to the BGS, basic radon protective measures will be required for any envisaged future development on this site. The above measures are adequate to address this risk

1.0 INTRODUCTION

Sirius Geotechnical and Environmental Ltd (Sirius) were commissioned by Hartwood Estates Ltd (Hartwood), to undertake a geoenvironmental appraisal of land off Sheffield Road, Birdwell.

It is understood that Hartwood are proposing to redevelop the site with low rise commercial/industrial units within the south eastern and north western areas of site, with associated car parking, access roads and areas of soft landscaping. It is understood that the proposed development will involve the demolition of the existing office block and disused workshop located on site. A proposed layout plan is presented as Drawing No. C1634/3, in Appendix A to this report.

A preliminary investigation (desk study) for the site was undertaken by Wardell Armstrong Engineering and Environmental Solutions (Wardell Armstrong) in November 2006 (Report ref: SD06-00179a). Based on the results of the Wardell Armstrong preliminary investigation an intrusive investigation was designed by Sirius.

This report details the results of the intrusive investigation and makes recommendations relating to the proposed redevelopment and should be read in conjunction with the desk study undertaken by Wardell Armstrong, which contains the environmental setting and preliminary conceptual site model.

The objectives of this intrusive investigation were as follows:

- To determine the risk to surface stability from past coal mining/quarrying.
- To determine the near surface ground conditions.
- To determine the nature and degree of shallow soils contamination.
- To provide foundation recommendations, guidance on ground conditions for pavement design and advice on measures to deal with any proven contamination.
- To investigate the potential risk to the site from hazardous gas, including radon; and
- To provide a preliminary remediation strategy.

The fieldwork was undertaken by Sirius on the 28th and 29th April 2008. The fieldwork comprised the drilling of four rotary probeholes and the excavation of sixteen machine excavated trial pits. Following completion of the fieldwork selected soil and groundwater samples were scheduled for geotechnical and chemical analysis.

This report presents the factual information derived during this investigation, followed by an interpretation of this data and recommendations relating to the proposed end use of the site.

It is assumed in the production of this report that the site is to be redeveloped with a number of low rise commercial/industrial units in the south eastern and north western areas of site with associated car parking, access roads and areas of soft landscaping. For the purpose of this report, it is assumed that levels will remain broadly as existed at the time of the investigation. If these assumptions are incorrect, the conclusions and recommendations presented in this report may need to be revised.

The comments and opinions presented in this report are based on the ground conditions encountered during this intrusive investigation work and on the results of tests carried out in the

laboratory. There may be other conditions prevailing on the site which have not been disclosed by this investigation and which have not been taken into account by this report. Responsibility cannot be accepted for conditions not revealed by the investigation. Any diagram or opinion of the possible configuration of ground conditions between exploratory positions is conjectural and given for guidance only and confirmation of intermediate ground conditions should be considered if deemed necessary.

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2.0 SITE DESCRIPTION

National Grid Ref:	SE 347 005.
Site Location	The site is located off Sheffield Road, in the village of Birdwell, approximately 16km north of Sheffield City Centre. The location of the site is shown on Drawing No. C1634/1, presented in Appendix A to this report.
Approximate Site Area – Acres	0.71 hectares.
Site Description	The site is a roughly rectangular plot of land, which slopes gently downwards from south to north with an elevation difference of approximately 3.00m. The site contains a single storey office building, which at the time of the investigation was occupied by Hartwood Estates Ltd, and a derelict double height workshop, which are located within the northern and central areas of the site, respectively. The office building is brick built with a flat roof and is orientated approximately east/west. A concrete bund is located adjacent to the south eastern edge of the office building and is reported within the Wardell Armstrong report to have previously housed an electricity substation, which was decommissioned sometime between 1990 and 2006. The derelict workshop is divided into two sections, with a large room within the southern part of the building and a smaller room within the northern part. Access into the derelict workshop is gained through a double height steel shutter door within the southern part of the building and a single wooden door within the northern part. The southern part of the building comprises a concrete floor, which had been partly broken out and evidence of previous excavated trial pits were visible. In addition, redundant machinery is located around the edges of the room. The smaller room was empty at the time of investigation with the exception of an overhead railed crane. Access into the smaller rooms was restricted at the time of the investigation. A disused concrete bunded area is located adjacent to the derelict workshop, which is approximately 1.00m higher than the surrounding land. A ramp leads from the bunded area to a loading bay to the north of the derelict workshop. It is reported within the desk study undertaken by Wardell Armstrong that this bunded area was previously used for draining fluid and oil out of engines. To the north of the derelict workshop, a number of relict concrete floor slabs/foundations and brick walls of former buildings are evident. The far northern part of the site was inaccessible at the time of the investigation due to a brick wall approximately 2.00m high. Beyond the brick wall is an area of rough overgrown

	grassland with evidence of fly tipping. The southern part of the site is comprised of rough grassland which is separated from the remainder of the site by a concrete block wall which has been partly demolished. Centrally within the southern area of the site, are two stockpiles of earth, which are approximately 2.00m high.
Possible contamination sources	Other than the unknown nature of any made ground, evidence of fly tipping within the northern part of the site and the contaminants/chemicals associated with the commercial/industrial units, electricity substation and the former workshop, no other significant sources of contamination were identified. However, it was reported within the Wardell Armstrong desk study that a small diesel tank and oil heating tank were located within the derelict workshop, in addition to a bunded diesel tank located adjacent to the site entrance. None of these tanks were evident during the Sirius site investigation. It should be noted that possible asbestos products may exist within the derelict buildings.
Adjacent Land Uses	The site is bounded to the west by Sheffield Road, beyond which is the site of the former Birdwell Quarry, which is currently occupied by a theatre school and a garage. To the south the site is bounded by a depot and residential properties, to the east by an industrial estate, containing light industrial and commercial units, and to the north by an access road, beyond which are residential properties.

The main site features are shown on Drawing No. C1634/2 presented in Appendix A of this report.

3.0 PREVIOUS INVESTIGATION.

3.1 General

A previous desk study was completed by Wardell Armstrong in November 2006 (Report ref SD06-00179a). Salient points of the report are summarised below.

3.2 Site History

Review of available historical Ordnance Survey (OS) plans, included as part of the Wardell Armstrong desk study, revealed that the site was largely undeveloped from at least 1855 with the exception of a railway, set in a cutting aligned approximately south west/north east, within the southern area of the site. By 1893, the far northern area of the site had been developed with terraced properties annotated as “Rockingham Row”. The remainder of the site comprised part of “Rockingham Gas Works”, with an associated gas holder located within the eastern area of the site and a number of tanks and buildings within the northern and central areas. The remainder of the gas works extended in to the adjoining land to the east. Between 1893 and 1937 the gas works was shown to be developed further with a number of additional buildings, tanks and travelling cranes, shown.

By 1956, the gas works and associated gas holder and tanks had been demolished/removed, and only three buildings/units (later reported as an engineering works, “Worsely View” and an electricity substation), in addition to a weighbridge, possibly associated with the “NCB Central Workshops” located with the adjacent land to the east, are annotated within the site boundary.

On the 1974 OS plan the railway within the southern area of site is shown to be disused and partly dismantled, and by 1991 had been completely removed and the cutting is annotated as a “Tip”.

At some point between 1978 and 1991, the residential properties on Rockingham Row were demolished.

By 1993 the building reported as “Worsely View” had been demolished and only the engineering works (shown to cover the footprint of the buildings as exist at present) and the electricity substation remain. Anecdotal information contained within the Wardell Armstrong desk study indicates that the substation was removed sometime between 1990 and 2006 and it is believed that the site was most recently used as a vehicle dismantling and recycling yard.

Significant features recorded on the historical OS plans, nearby the site, include the M1 motorway, located 150m west of the site, a Highways Agency depot located immediately south of the site and a number of former sandstone quarries, the nearest of which is located 10m west of the site (annotated as Birdwell Quarry) and was subsequently infilled between 1938 and the present day.

In addition “Rockingham Colliery” and “Wharncliffe Silkstone Colliery” are annotated approximately 600m north east and 800m south west of the site, respectively, and are later reported on the 1978 to 1982 OS Plans as being “refuse or slag heaps” and “Tip (disused)”.

3.3 Geology

Maps/ Publications Referenced	BGS 1:50,000 scale, sheet 87 (Solid and Drift Edition), Barnsley. BGS 1:10,000 scale, sheet SE 30 SW.
Made Ground/ Drift Geology	No drift deposits are shown to overlie the site. The southern part of the site is indicated as a “Landfill Site”, assumed to be associated with the infilled railway cutting. Given that the northern and central area of the site was formerly occupied by a gas works and later a vehicle dismantling and recycling yard, made ground is envisaged beneath the site. Two areas of made/worked ground are identified on the geological map within close vicinity of the site. The closest is located approximately 10m west of site, associated with the former Birdwell Quarry, and is reported as being “worked out open cast, coal seam area (backfilled) or backfilled quarry”. A larger area of made ground is also located approximately 150m north east of site. No further information is given on the geological map regarding the type or composition of the latter.
Solid Geology	The site is shown to be directly underlain by the Haigh Moor/Birdwell Rock (sandstone) of the Carboniferous Middle Coal Measures. The Haigh Moor coal seam is shown to outcrop approximately 130m south west of the site, dipping to the north east beneath the site. The coal seam is reported to be between 1.00m and 2.15m thick on the generalised vertical section provided on the 1:10,000 geological map.
Dip of Solid Strata	The solid geology is shown to dip to the north east.
Faults	No faults are shown to cross or lie in the immediate vicinity of the site.

3.4 Quarrying and mining

A mining report was commissioned from the Coal Authority (CA) as part of the Wardell Armstrong report. Salient points are summarised below.

- *“The property is in the likely zone of influence from workings in 7 seams of coal at 120m to 340m bgl and last worked in 1960”.*
- *“The property is not in the likely zone of influence of any present underground workings”.*
- *“The property is not within an area for which the CA is determining whether to grant a licence/a licence has been granted to remove coal using underground methods”.*
- *“Reserves of coal exist in the local area which could be worked at some time in the future”.*
- *“There are no known coal mine entries within, or within 20m of, the boundary of the property”.*
- *“The property does not lie within 200m of the boundary of an opencast site from which coal is being removed by opencast methods”.*

Review of the 1:10,000 scale geological plan, indicates that the Haigh Moor coal seam lies at shallow depth below the site. To investigate the risk to surface stability from unrecorded coal mining within this seam rotary probeholes have been drilled as part of this investigation.

Inspection of the Historical OS plans, obtained as part of the Wardell Armstrong investigation do not reveal any quarries on site, however a number of old quarries are shown surrounding the site, the closest of which is located approximately 10m west of site (Birdwell Quarry).

3.5 Hydrology and Hydrogeology

The site is shown to be underlain by sandstone of the Middle Coal Measures strata, which are classified as a minor aquifer. The soils which underlie the site are seen to have a high leaching potential, due to the sites urban location and hence variability.

It is reported within the Wardell Armstrong desk study that the nearest known surface water feature is Warren Dyke located approximately 300m west of the site. Warren Dyke is classified under the Environment Agency's (EA) General Quality Assessment (GQA) scheme for inland waters and canals as River Quality D (fair).

There are no known surface of groundwater abstraction wells within 1km of the site.

3.6 Landfilling

According to the Wardell Armstrong desk study, there is one licensed landfill site located within the site. It is assumed that this is associated with the infilling of the railway cutting, located in the southern part of the site.

In addition, it is reported within the Wardell Armstrong desk study that there are two waste management licences held at the site, one of which refers to the infilling of the railway cutting.

The licence authorised the tipping of clay, subsoil, topsoil, construction and demolition waste, foundry sand and slag, hardcore and waste excluding coal processing. Prohibited waste included asbestos, liquids and slurry in containers over 4 litres capacity. The status of the licence is reported to be lapsed/cancelled/defunct/not applicable/surrendered.

The second waste management licence refers to metal recycling (vehicle dismantling and recycling) which was issued in November 1996, this licence authorised the disposal of scrap motor vehicles and scrap tyres. Liquid wastes were prohibited. It is reported that at the time of writing of the Wardell Armstrong report the waste management licence was in the process of being surrendered.

Inspection of historical OS plans, contained within the Wardell Armstrong desk study, reveals a number of old quarries within the immediate vicinity of the site, the closest of which is annotated as Birdwell Quarry and is located approximately 10m west of site. The aforementioned quarry was infilled between 1938 and the present day. No information is available with regards to the nature of the infill/waste accepted.

In addition, review of the 1:10,000 scale geological plan reports the southern area of the site as a “Landfill Site”, assumed to be associated with the infilled railway cutting.

3.7 Radon

To determine whether the site is at risk from Radon Gas the BRE document “Radon: guidance on protective measures for new dwellings” was referenced by Wardell Armstrong. This document shows the site to lie within an area where basic radon protective measures are required.

3.8 Previous investigation

It is reported within the Wardell Armstrong desk study that remedial works have been undertaken at the site. As part of the works, contaminated soil was removed from the north eastern boundary where engines were formerly stored prior to export. It is reported by Wardell Armstrong that the removed soil was taken to a landfill facility following chemical analysis.

Chemical tests undertaken as part of the remedial works indicate the following levels of determinands:

PAH	2200mg/kg
TPH	8900mg/kg
Arsenic	17mg/kg
Cadmium	2.3mg/kg
Copper	160mg/kg
Lead	140mg/kg
Mercury	1.6mg/kg
Selenium	0.79mg/kg
Phenol	<0.5mg/kg

The total volume of soil removed from the site is not known.

4.0 PROPOSED DEVELOPMENT

It is understood that consideration is being given to the redevelopment of the site with low rise commercial/industrial units within the north western and south eastern areas of the site, with associated car parking, roadways and areas of soft landscaping. It is understood that the proposed development will include the demolition of the existing office building and disused workshop on site.

A plan showing the envisaged development scheme is presented in Appendix A as drawing C1634/3.

For the purpose of this report, it is assumed that levels will remain broadly as existed at the time of the investigation. The anticipated building loads were not known at the time of writing.

5.0 FIELDWORKS

5.1 Introduction

Fieldwork was undertaken on the 28th and 29th April 2008 and comprised four rotary probeholes (BHR1 to BHR3 including BHR1A) and the excavation of sixteen machine excavated trial pits (TP1 to TP16).

The trial pits were excavated to depths of between 1.30m and 4.00m bgl using a rubber tyred excavator equipped with a 0.60m wide toothed backhoe bucket. On completion of testing, logging and sampling the trial pits were backfilled with the excavated materials, placed in approximately the reverse order and lightly compacted with the backhoe bucket.

The rotary drilling was carried out using a top drive track mounted rotary rig with a down the hole pneumatic hammer and air flush. The probeholes were drilled to depths of 2.20m and 30.00m bgl.

Combined 50mm diameter gas/groundwater monitoring wells were installed within each of the rotary probeholes. Two of the wells were sealed into the made ground (BHR1 and BHR2) and two were sealed into the natural ground (BHR1A and BHR3). Details of the installations are shown on the respective borehole records in Appendix B.

The fieldwork was carried out under the supervision of a Sirius geoenvironmental engineer.

5.2 Strata Description

Depths and descriptions of strata and groundwater encountered, together with details of the samples recovered are presented on the exploratory hole record sheets within Appendix B of this report.

Strata descriptions are based on an examination of the strata encountered, together with consideration of the in situ and laboratory test data. Procedures and principles contained in BS5930 (1999), BS10175 (2001), BS1377 (1990), BS EN ISO 14688 (2004), BS EN ISO 14689 (2003) and BS EN ISO 1997 (Eurocode 7) have been followed.

The depths of strata on the record sheets are related to current ground levels at each location. The information contained in this report is limited to land within the site boundary, as indicated on the site plan shown within Appendix A, and the areas accessible during the ground investigation.

It must be noted that the rotary open hole drilling techniques only recover small chip samples, brought to the surface by the flush returns. Subsequently the strata descriptions and depth to strata boundaries recorded on the rotary logs, are based on the driller's descriptions/observations and are therefore limited and should only be used as a guide to the ground conditions. As such the descriptions and depths of strata boundaries are based on the engineers observations made during the excavation of the trial pits.

5.3 Sampling

Disturbed samples of all strata encountered were selected from the trial pits by a representative of Sirius during the site investigation works. Samples for geotechnical analysis were contained within 1 litre air tight plastic tubs.

Samples of soil for chemical analysis were placed into 1 litre plastic and glass containers and dispatched to a UKAS/MCERTs accredited laboratory under appropriate Duty of Care. Samples were stored at approximately 4°C using cool boxes until delivery to the laboratory to maintain sample integrity.

Groundwater samples were taken on a return visit to the site. Groundwater samples were taken after first purging three times the well volume using a dedicated bailer for each well and collected in 1 litre amber glass bottles.

5.4 In Situ Testing

The undrained shear strength of cohesive soils was measured in the trial pits using a Pilcon hand held shear vane. The results are shown on the trial pit logs in Appendix B.

At shallow depth the tests were carried out in situ, at depth the tests were carried out at the surface on excavated blocks.

5.5 Exploratory Hole Locations

Exploratory hole locations were determined by Sirius, in order to produce a representative over view of shallow ground conditions across the site.

Restrictions were imposed by the operational nature of the existing office building, in addition to access restrictions in the former workshop and the northern part of the site.

The locations of the exploratory holes are shown on Drawing No C1634/2, in Appendix A.

6.0 LABORATORY TESTING

6.1 Geotechnical

Geotechnical laboratory testing, as scheduled by Sirius, was carried out on selected samples in accordance with the methods detailed in BS1377 "Methods of test for soils for civil engineering purposes" at external laboratories. The tests include:

- Five moisture contents.
- Determination of Atterberg limits on five samples.

Water soluble sulphate content and pH values were determined as part of the contamination testing.

The results of the tests are included in Appendix C and discussed in Section 7 of this report.

6.2 Chemical

Selected soil and groundwater samples were tested for a range of potential contaminants, under a sub-contract with Derwentside Environmental Testing Services Ltd (DETS), a UKAS/MCERTS accredited laboratory. The analytes tested are listed in Section 8.1 of this report. In assessing the type of contaminants that may be present on site, DEFRA R & D Publication CLR8 was referenced. The results of the tests, as received from the laboratory, are presented in Appendix C and are discussed in Section 8.3 of this report.

7.0 GROUND CONDITIONS AND MATERIAL PROPERTIES

A complete record of all the strata encountered is given on the exploratory hole logs presented in Appendix B to this report. These show the site to be underlain by a variable thickness of made ground, overlying weathered mantle material, over solid geology of the Middle Coal Measures strata.

7.1 Made Ground

Made ground was encountered across the site to depths of between 0.50m and 3.30m bgl. The thicker made ground encountered within the trial pits is assumed to be associated with historical features (i.e. former gas holder and infilled railway cutting).

Within the northern and central area of the site, within the former gas works and vehicle dismantling and recycling yard, a granular made ground was generally encountered to depths of between 0.50m and a maximum proven depth of 2.70m bgl. The made ground typically comprises a surface cover of tarmac, concrete or limestone hardcore over a granular fill of sand and gravel with occasional cobbles of sandstone, ash, timber, brick, concrete and slate. Locally occasional fragments of fabric, pottery, wire and metal were encountered.

An area of deep granular made ground was encountered to a depth of 3.30m bgl within TP11. This is assumed to be located within the former gas holder indicated on the historical OS plans.

To the south of the site, within the former railway cutting, topsoil was seen to overlay a granular made ground to depths of between 0.60m and a maximum proven depth of 2.10m bgl. The made ground typically comprises sand and gravel with cobbles and boulders of sandstone, brick, timber, limestone, concrete, ash and wire. Locally fragments of plastic, fabric and timber were encountered. The boulders encountered during the excavation of the trial pits were up to 1.00m long by 0.50m wide and are of dressed sandstone and reinforced concrete.

Trial pits TP2, TP4 - TP6 and TP8 excavated within the former gas works, together with TP14 and BHR1 located within the infilled railway cutting, were terminated within the made ground and consequently did not prove the true thickness of this material.

Water soluble sulphate (SO_4) concentrations, recorded as part of the chemical testing, from the ten samples taken of made ground collected from the former gas works site and vehicle dismantling and recycling yard recorded water soluble sulphate (SO_4) concentrations of 0.09 to 1.7g/l, together with pH conditions of between 7.3 to 10.3.

Three samples of made ground obtained from the infilled railway cutting were tested for water soluble sulphate (SO_4) concentrations and pH as part of the contamination testing. These recorded water soluble sulphate (SO_4) contents in the range of 0.39 to 0.55g/l with pH values in the range of 10.8 to 11.7.

7.2 Weathered Mantle Material

Underlying the made ground, stiff to very stiff, locally soft and firm, slightly sandy clay with occasional gravel and cobbles of sandstone, was encountered to depths ranging between 1.20m and 4.00m bgl. It is assumed that the clay is weathered mantle material derived in situ by weathering of the underlying bedrock.

In situ hand vane tests undertaken within the weathered mantle material returned shear strength values of between 38 and 110kN/m², indicating low to high strength clay.

The results of five Atterberg Limit Tests undertaken on the weathered mantle material gave Liquid Limits of between 36% and 46% (mean 40.4%), Plastic Limits between 18% and 21% and Plasticity Indices of between 15% and 26% (mean 20.4%). The results are indicative of clay with intermediate plasticity. The modified Plasticity Index for samples of the mantle material are between 11% and 21%, indicating the clay to be of a low to medium volume change potential.

Water soluble sulphate (SO_4) concentrations in this formation were recorded to be between 0.07g/l to 0.23g/l with pH conditions of between 7.7 and 11.4 from the five samples tested.

7.3 Bedrock

Beneath the weathered mantle material, fine to medium grained sandstone, was encountered between depths of 1.20m (TP15) and 2.40m bgl (TP7).

A weathering profile was seen within the sandstone, although variable, with an upper layer of highly to moderately weathered sandstone (recovered as clayey sand and gravel).

The rotary probeholes proved sandstone to depths of 20.00m and 22.00m bgl, overlying mudstone to a proven depth of 30.00m bgl. Coal was encountered within BHR2 at 21.50m bgl and was reported to be 0.50m thick.

7.4 Groundwater

During the excavation of trial pit TP4 a seepage was noted within the made ground at a depth of 2.70m. An oily sheen was noted on the surface of the water.

Perched groundwater was encountered within the weathered mantle material in trial pits TP7 and TP11, at depths of 1.60m and 3.40m bgl, respectively.

Groundwater was encountered within the completely weathered sandstone in borehole BHR3 at a depth of 20.00m bgl, no rise was noted during the drilling of the borehole. However, due to the nature of this drilling method, it is not sensitive to picking up seepages or low flow water strikes, i.e. the compressed air used as flush pressurises the ground, which can restrict water inflow.

Groundwater levels observed during our monitoring visits, undertaken on the 9th and 23rd May 2008, revealed all the wells installed within the rotary probe holes to be dry with the exception of BHR3 where groundwater levels of 12.30m and 13.36m bgl were encountered.

It should be borne in mind that water levels are likely to fluctuate with season/rainfall and may therefore be substantially higher at wetter times of year than those found during this investigation.

7.5 Visual/Olfactory Evidence of Contamination

The made ground materials include gravel and cobbles sized fragments of sandstone, brick, limestone, ash, timber, brick, concrete and slate, and locally occasional fragments of fabric, plastic, wire and metal. These materials can produce elevated concentrations of certain contaminants, such as toxic and phytotoxic metals, sulphate and PAH.

Noticeable olfactory odours and visual evidence of organic contamination was recorded during the fieldwork which were noted predominantly in the made ground, however, some isolated contamination was also observed in natural strata in a number of exploratory holes across the site. Observations are summarised in the table below.

Visual and/or Olfactory Evidence of Organic Contamination

Exploratory Hole Ref	Depths(m bgl)	Observation
Former Gas Works/ Vehicle Dismantling and Recycling Yard		
TP1	0.26 – 0.96m	Hydrocarbon odour within granular made ground.
TP2	0.18 – 2.00m	Slight hydrocarbon odour within granular made ground.
TP3	0.05 – 1.90m	Slight diesel odour within the granular made ground.
TP3	1.90 – 2.10m	Strong diesel odour within the granular made ground.
TP4	0.05 – 2.70m	Slight diesel odour within the granular made ground.
TP4	2.70m	Oily sheen noted on the groundwater encountered within the made ground.
TP6	1.50m	Slight diesel odour within the granular made ground.
TP7	1.60m	Strong hydrocarbon odour within the groundwater encountered within the made ground.
TP7	2.00 – 2.40m	Hydrocarbon odour within weathered mantle material.
TP10	1.70 – 1.80m	Hydrocarbon odour noted within the weathered mantle material.
TP11	1.40 – 3.30m	Strong diesel odour and a sulphur odour within the granular made ground.
TP11	2.20 – 4.00m	Hydrocarbon odour and a slight sheen within the groundwater encountered within the weathered mantle material.

No visual/olfactory evidence of organic contamination was encountered within the exploratory holes undertaken within the former railway cutting as part of this investigation.

During the return water monitoring/sampling visit a hydrocarbon odour was detected within the groundwater purged/sampled from BHR3.

7.6 Obstructions

Based on the historical information available for the site it is anticipated that structures (including foundations, underground services, etc) will exist.

Trial pits TP4 to TP6 and TP8 encountered obstructions within the made ground, and consequently did not prove the full thickness of the material. The obstructions generally comprised a brick or concrete floor at depths of between 1.50m and 2.70m bgl. These are thought to be relict structures associated with the former gas works/vehicle dismantling and recycling yard.

Concrete obstructions were encountered within the infilled railway cutting at a depth of 2.20m and 2.10m bgl in BHR1 and TP14, respectively. Subsequently BHR1 and TP14 were terminated within the made ground did not prove the true thickness of the material.

Similarly trial pits TP2, TP9 and TP10 were terminated at depths of between 1.30m and 2.00m bgl due to the presence of buried utility services (consisting of randomly orientated cast iron pipes), which prevented the safe excavation of the trial pits.

8.0 CHEMICAL CONTAMINATION

8.1 General / Conceptual Model

Review of the available historical *Ordnance Survey (OS) plans*, included as part of the Wardell Armstrong desk study, revealed that the site was largely undeveloped from at least 1855 with the exception of a railway, set in a cutting, within the southern area of the site. By 1893, the far northern area of the site had been developed with terraced properties annotated as “Rockingham Row”, which were later demolished sometime between 1978 and 1991. The remainder of the site comprised part of “Rockingham Gas Works”, with associated gas holder, tanks and buildings within the northern and central areas, which by 1956 had been demolished/removed, and only three buildings/units remained on site.

On the 1974 OS plan the railway within the southern area of site is shown to be disused and partly dismantled, and by 1991 had been completely removed and the cutting is annotated as a “Tip”. It is believed that the site was most recently used for vehicle dismantling and recycling.

In assessing the type of contaminants that may be present on the site, DEFRA R&D Publication CLR8 has been referenced.

The types of contaminants that could be found on this site include, but are not necessarily limited to:

- Toxic and phytotoxic metals
- Polyaromatic Hydrocarbons
- TPH
- Sulphate
- Phenols
- Cyanide
- Asbestos
- PCBs

The site is considered to lie within a setting of **low** environmental sensitivity. Factors which are considered pertinent to this conclusion are:

- The site is underlain by a minor aquifer.
- The nearest surface water feature is Birdwell Dyke, located 300m west of the site.
- No groundwater or surface water abstractions are known to exist within 1km of the site.
- There are no source protection zones within 1km of the site.

It is understood that consideration is being given to the redevelopment of the site with a number of low rise commercial/industrial units, with associated car parking and access roads together with localised soft landscaped areas. This is considered a **low** sensitivity end use.

A Conceptual Site Model is presented as Drawing No. C1634/4, in Appendix A.

To ascertain the nature and degree of a number of potential contaminants in the shallow soil/water below the site (and any implications it may have on redevelopment), selected soil and groundwater samples were chosen for chemical analysis.

Fifteen samples of soil (twelve of made ground and three of natural soil) recovered from across the site were analysed for the following determinands:

arsenic, cadmium, chromium, copper, lead, mercury, selenium, nickel, zinc, pH, water soluble and total sulphate, total phenols (monohydric), total organic carbon, total and speciated polycyclic aromatic hydrocarbons (PAH).

Two samples of made ground containing ash were tested to determine their calorific value.

One sample of made ground and a sample of natural ground obtained from trial pit TP11, excavated within the vicinity of the former gas holder, were tested for free and total cyanide.

Seven samples of made ground and a sample of natural ground collected from across the site were tested for total and speciated TPH analysis (including aliphatic/aromatic split). Six of the samples tested (TP1 at 0.30m, TP3 at 0.20m and 2.00m, TP7 at 1.60m and TP11 at 1.50m) contained olfactory evidence of hydrocarbon contamination.

One sample of made ground taken from the vicinity of the electricity substation was tested for PCBs.

Three samples of made ground, containing evidence of demolition rubble were tested for asbestos.

In addition to the fifteen soil samples tested for pH and water soluble sulphate (SO₄), as part of the Sirius Soil Suite, two additional samples of natural ground were also tested for pH and water soluble sulphate (SO₄), for the use in concrete design

Four samples of made ground were analysed for the leachable fraction of the following analytes:

pH, arsenic, cadmium, chromium, copper, lead, mercury, selenium, nickel, zinc, phenol and total and speciated PAH.

One sample of groundwater, recovered from BHR3, was analysed for the following:

arsenic, cadmium, chromium, mercury, lead, selenium, copper, nickel, zinc, sulphate, pH, phenol, total and free cyanide, total and speciated PAH, hardness, electrical conductivity, ammonia and total and speciated TPH.

The results, as provided by the laboratory, are presented in Appendix C to this report.

8.2 Current Guidance and the Interpretation of Analytical Data

Contaminated land is defined under law through Part IIA of the Environmental Protection Act 1990, implemented through Section 57 of the Environment Act 1995. This supports a 'suitable for use' based approach to the risk assessment of contaminated land. The site specific risk assessment is based upon an assessment of plausible pollutant linkages, referred to as the contaminant → pathway → receptor model, based upon the current or proposed use of the site.

The first stage comprises the development of a preliminary conceptual site model (CSM), usually based on desk top study data. This is undertaken in order to identify potential contaminants, pathways and targets. This initial model can then be used to scope an effective/targeted intrusive ground investigation.

Following completion of the investigation, the findings are used to refine the preliminary CSM, in order that a suitable cost effective remediation strategy can be devised or further investigation and risk assessment undertaken.

The process of refining the preliminary CSM, involves semi quantitative risk assessment, which is split into two parts:

- The comparison of the soil analysis results against generic soil screening values, to establish sources of contamination (Generic Quantitative Risk Assessment); and,
- A qualitative risk assessment to identify any plausible pollutant linkages from contaminant through to receptor.

If the screening levels are exceeded and the qualitative risk assessment identifies a plausible pollutant linkage, then assessment could move onto another stage, which includes more sophisticated Detailed Quantitative Risk Assessment (DQRA), or remedial action taken to break the pollutant linkages. The benefits of undertaking a DQRA must be weighed against the likelihood that it will bring about cost savings in the proposed remediation.

The initial screening levels currently used by Sirius are as follows:

CLEA (2002)/ CLEA UK

For general human health risk assessment purposes, the current best practice soil screening values for use in UK were derived using the DEFRA Contaminated Land Exposure and Assessment (CLEA 2002) model. A number of land use scenarios are defined within CLEA from which generic soil guideline values (SGVs) were then derived. CLEA 2002 has now been withdrawn and replaced by CLEA UK, although the published SGVs remain valid. At the time of writing, however, published SGVs are only available for a limited number of parameters, although toxicological data is also available for a range of other compounds.

Due to the nature of the proposed redevelopment (commercial/industrial end use), the results of chemical analysis have been compared against the SGVs for a commercial/industrial end use.

Land Quality Management and Chartered Institute for Environmental Health, Generic Assessment Criteria for Human Health Risk Assessment (2007)

LQM and CIEH have derived a set of Generic Assessment Criteria (GAC) for soil contaminants, for which there are no Defra or Environment Agency published SGVs. In the absence of published SGVs for hydrocarbon fractions, copper and zinc, it is considered that these GAC are appropriate for use for human health purposes.

PAHs

Based upon current UK practice, in the case of PAHs, which contain thousands of individual compounds, for which only 16 are routinely analysed for, two indicator compounds are selected for initial assessment to determine the significance of the result obtained. It is considered that the two compounds from the 16 routinely analysed for, which are representative of the extremes of the PAH species in terms of toxicity and mobility, are Benzo(a)pyrene and Naphthalene. These compounds are therefore considered to be the most appropriate for adoption as indicator compounds in relation to assessment of the potential risks.

Benzo(a)pyrene (B(a)P) is selected due to its carcinogenicity. It is acknowledged that other PAH species are also carcinogenic, and these are also considered in an assessment relating to PAH contamination, but are considered in relation to their relative toxicity to B(a)P.

Naphthalene has also been adopted as an indicator compound, due to its mobility through solubility and volatility. Naphthalene is considered to be the most soluble and volatile of the organic species routinely analysed for, by virtue of its physiochemical properties.

In the absence of a suitable published screening value, in-house screening values SSVs for B(a)P and naphthalene have been derived using in-house methods, details of which can be provided on request.

Sirius in House SSVs (Soils Screening Values)

In the absence of published SGVs, Tier 1 generic Soil Screening Values (SSVs) have been derived by Sirius for selected contaminants of concern. SSVs have been calculated for standard land uses in accordance with the current UK best practice guidelines set out within DEFRA 'CLEA' publication CLR10 and the subsequent supporting briefing notes using an appropriate risk assessment model.

BRE (2005) Special Digest 1

The upper limits for DS-1 Design Sulphate Class concrete provided in the BRE (2005) Special Digest 1 (3rd Edition, Concrete in aggressive ground) document have been used for comparison with total sulphate and water soluble sulphate concentrations encountered at the site.

Environment Agency Environmental Quality Standards

For the purposes of this report, a Tier I (R&D P20) assessment using leachability analytical concentrations from the site soils and concentrations within groundwater samples has been carried out to assess potential risks to local controlled waters. The results of the leachability and groundwater analysis have been compared directly with the Environmental Quality

Standards (EQS) for Fresh Waters and the Water Supply (Water Quality) Regulations (2001) for screening purposes.

The qualitative risk assessment carried out as part of this report assumes a commercial/industrial end use.

8.3 Results

Total concentrations in soils

The results of the soils analysis are presented in Appendix C of this report and are summarised below.

Summary of Total Soil Concentrations and Generic Semi-Quantitative Risk Assessment for a Commercial/Industrial End Use.

Parameter	Screening value (mg/kg, unless otherwise stated)	No. of samples above screening value	No. of samples tested	Maximum concentration above screening value (mg/kg, unless otherwise stated)
Metals/Metalloids				
Arsenic	500 ^(a)	0	15	
Cadmium	1400 ^(a)	0	15	
Chromium (Total)	5000 ^(a)	0	15	
Lead	750 ^(a)	2	15	1000 TP5 @ 0.30m
Mercury	480 ^(a)	0	15	
Selenium	8000 ^(a)	0	15	
Copper	45700 ^(b)	0	15	
Nickel	5000 ^(a)	0	15	
Zinc	188000 ^(b)	0	15	
Inorganics				
pH	<5	0	17	
Total Sulphate	2,400 ^(c)	3	15	7,400 TP5 @ 0.30m
Water Soluble Sulphate	0.5 g/l ^(c)	4	17	1.7g/l TP5 @ 0.30m
Organics				
Monohydric Phenol	21,900 (1% SOM) ^(a) 43,000 (2.5% SOM) 78,100 (5% SOM)	0	15	
*Benzo(a)pyrene	29.7 ^(b)	4	15	190 TP1 @ 0.30m
**Naphthalene	290 (1% SOM) ^(d) 720 (2.5% SOM) 1,440 (5% SOM)	1	15	330 TP3 @ 2.00m
TOC	3 w/w% ^(b)	11	15	36 w/w% TP11 @ 3.50m
Free Cyanide	1170 ^(f)	0	2	
TPH - Aliphatics				
>C5-C6	95.3 ^(b)	0	8	
>C6-C8	242 ^(b)	0	8	
>C8-C10	65.9 ^(b)	0	8	
>C10-C12	29,900 ^(b)	0	8	
>C12-C16	29,900 ^(b)	0	8	
>C16-C35	617,000 ^(b)	0	8	
TPH - Aromatics				
>C5-C7	26.9 ^(b)	0	8	
>C7-C8	30.40 ^(b)	0	8	
>C8-C10	107 ^(b)	0	8	

>C10-C12	625 ^(b)	0	8	
>C12-C16	12,200 ^(b)	1	8	17000 TP3 @ 2.00m
>C16-C21	9,190 ^(b)	1	8	16000 TP3 @ 2.00m
>C21-C35	9,250 ^(b)	1	8	20000 TP3 @ 2.00m
Others				
Calorific Value	2 MJ/kg ^(e)	0	2	
Asbestos	Fibres detected	0	3	

(a) DEFRA soil guideline values for 'commercial/industrial end-use'.

(b) LQM/CIEH (2007) Generic Assessment Criteria for Human Health Risk Assessment (for a sandy soil with 1% SOM and pH 7.0)

(c) BRE (2005) Special Digest 1, 3rd Edition, Concrete in aggressive ground. Upper limits for DS-1 Design Sulphate Class concrete.

(d) The Hazardous Waste (England and Wales) Regulations 2005. 'Inert' waste threshold.

(e) ICRL (1986) Guidance Note 61/84, 2nd Edition.

(f) Sirius' in-house soil screening values (risk assessment methodology can be provided on request)

SOM Soil Organic Matter

Two samples of made ground contained elevated concentrations of lead, with a maximum reported value of 1000mg/kg against a threshold of 750mg/kg.

In accordance with CLR7, statistical analysis was undertaken for lead concentrations in excess of the adopted threshold recorded within the top 1.00m of made ground. The statistical analysis indicates that the Upper 95th percentile bound value (US₉₅) for lead is 297.32mg/kg, below the relevant SGV of 750mg/kg for a commercial/industrial end use.

Application of the T (Maximum Value) test to this data indicates that the maximum recorded concentration of lead is shown to be within the normal distribution and the US₉₅ is considered as being representative of the general characteristics of existing made ground soils within the site.

Elevated concentrations of benzo(a)pyrene was reported within four samples of made ground, with a maximum concentration of 190mg/kg within TP1 at 0.30m bgl, in comparison to a threshold value of 29.7mg/kg. The statistical US₉₅ calculated for the samples within the top 1.00m of the made ground is 54.86mg/kg compared to an SGV of 29.7mg/kg.

Application of the T (Maximum Value) test to this data, indicates that the elevated concentrations of benzo(a)pyrene recorded are shown to be within the normal distribution and therefore as the determined US₉₅ lies in excess of the adopted threshold, it is recommended that existing made ground soils across the site should be considered to be contaminated, with respect to this determinand.

An elevated concentration of naphthalene was reported within one sample of made ground obtained from TP3 at 2.00m bgl. A concentration of 330mg/kg, in comparison to a threshold value of 290mg/kg was detected. However, in accordance with guidelines published within CLR7 and taking into consideration that this sample was recovered at a depth greater than 1.00m bgl, the elevated concentration of naphthalene is not considered to be risk to human health and does not require further consideration.

Elevated concentrations of TPH were recorded in TP3 at 2.00m bgl in the aromatic range of C12-C16, C16-21 and C21-35.

Elevated total organic carbon (TOC) levels were recorded in ten samples of made ground and one sample of natural ground with a maximum concentration of 36%w/w in TP11 at 3.50m bgl. TOC is a measure of organic carbon and is used primarily in the assessment of other organic test results, it is not a determinant that poses a risk to human health and is not considered

further. However, the values recorded will affect the waste classification of any material disposed of within a licensed landfill site.

Water soluble sulphate exceeded the tier 1 threshold concentration in four samples of made ground with a maximum reported concentration of 1.7g/l against a threshold of 0.5g/l. Within three of the aforementioned samples of made ground elevated concentrations of total sulphate were also detected, with a maximum reported concentration of 7,400mg/kg in comparison to a threshold value of 2,400g/l. These elevated concentrations would have an affect on buried concrete and are discussed in Section 8.4 of this report.

Leachability Testing

Leachability testing was conducted on four samples of made ground. The results of the leachability testing are summarised in the table below. Where EQS values are given the screening value has been derived using a hardness of 810mg/l in the receiving water (from the values reported in the groundwater sample collected from BHR3) assuming protection of cyprinid fish.

Summary of Soil Leachate Concentrations and Generic Semi-Quantitative Risk Assessment

Parameter	Screening value (units µg/l unless otherwise stated)	No. of samples above screening value	No. of samples tested	Maximum concentration (units µg/l unless otherwise stated)
Metals/Metalloids				
Arsenic	10 ^(b) (50) ^(a)	0	4	
Cadmium	5 ^(a, b)	0	4	
Chromium +	250 ^(a) (50) ^(b)	0	4	
Lead +	250 ^(a) (25) ^(b)	0	4	
Mercury	1 ^(a, b)	0	4	
Selenium	10 ^(b)	0	4	
Copper +	28 ^(a) (2,000) ^(b)	0	4	
Nickel +	200 ^(a) (20) ^(b)	0	4	
Zinc +	500 ^(a) (5,000) ^(b)	0	4	
Organics				
Phenol	0.5 ^(b) (30 [300]) ^(a)	0	4	
Naphthalene	10 ^(a)	0	4	
Benzo(a)pyrene	0.01 ^(b)	0	4	
Benzo(b)fluoranthene *	0.1 ^(b)	0	4	
Benzo(k)fluoranthene *	0.1 ^(b)	0	4	
Benzo(ghi)perylene *	0.1 ^(b)	0	4	
Indeno(1,2,3-cd)pyrene*	0.1 ^(b)	0	4	
Sum PAH – 4 *	0.1 ^(b)	0	4	
Others				
pH	6-9 pH units ^(c)	0	4	

(a) Environment Agency (2002) Environment Agency technical advice to third parties on pollution of controlled waters for Part IIA of the EPA 1990. Freshwater EQS.

(b) The Water Supply (Water Quality) (Amendment) Regulations 2001.

(c) The Surface Waters (Fishlife) (Classification) Regulations 1997.

+ Hardness related

* Sum of all individual PAHs marked with an asterix (*)

For some organic parameters (e.g. phenol 300 [30] µg/L) two values are given, which relate to an acceptable annual average followed by the maximum admissible peak concentration.

The concentrations of the analytes tested were all below the relevant threshold levels.

Water Testing

The results of the groundwater analysis, as received from the laboratory, are presented in Appendix C to this report, and are summarised in the following table.

Where a range of freshwater EQS values are given, the most appropriate value has been determined based on the recorded hardness of 810mg/l, recorded within the groundwater sample collected from BHR3. It is assumed that the receiving surface water is cyprinid.

Summary of Groundwater Concentrations and Generic Semi-Quantitative Risk Assessment

Parameter	Screening value (units µg/l unless otherwise stated)	No. of samples above screening value	No. of samples tested	Maximum concentration above screening value (units µg/l unless otherwise stated)
Metals/Metalloids				
Arsenic	10 ^(b) (50) ^(a)	0	1	
Cadmium	5 ^(a, b)	0	1	
Chromium ⁺	250 ^(a) (50) ^(b)	0	1	
Lead ⁺	250 ^(a) (25) ^(b)	0	1	
Mercury	1 ^(a, b)	0	1	
Selenium	10 ^(b)	0	1	
Copper ⁺	28 ^(a) (2,000) ^(b)	0	1	
Nickel ⁺	200 ^(a) (20) ^(b)	0	1	
Zinc ⁺	500 ^(a) (5,000) ^(b)	0	1	
Inorganics				
Sulphate	250 mg/l ^(b) (400 mg/l) ^(a)	1	1	380mg/l BHR3
Ammonia (NH ₃ as N)	15 ^(a)	0	1	
Total Cyanide	50 ^(b)	0	1	
Organics				
Phenol	0.5 ^(b) (30 [300]) ^(a)	1	1	38 BHR3
Total TPH	10 ^(b)	1	1	37700 BHR3
PRO	10 ^(b)	1	1	34000 BHR3
Benzo(a)pyrene	0.01 ^(b)	0	1	
Benzo(b)fluoranthene*	0.1 ^(b)	0	1	
Benzo(k)fluoranthene*	0.1 ^(b)	0	1	
Benzo(ghi)perylene*	0.1 ^(b)	0	1	
Indeno(1,2,3cd)pyrene*	0.1 ^(b)	0	1	
Sum PAH-4*	0.1 ^(b)	0	1	
Naphthalene	10 ^(a)	1	1	14 BHR3
Others				
Electrical Conductivity	2,500 µS/cm @ 20°C ^(b)	0	1	
pH	6-9 pH units ^(c)	0	1	

(a) Environment Agency (2002) Environment Agency technical advice to third parties on pollution of controlled waters for Part IIA of the EPA 1990. Freshwater EQS.

(b) The Water Supply (Water Quality) (Amendment) Regulations 2001.

(c) The Surface Waters (Fishlife) (Classification) Regulations 1997.

⁺ Hardness related

* Sum of all 4 individual PAHs marked with an asterisk (*)

For some organic parameters (e.g. phenol 300 [30] µg/L) two values are given, which relate to an acceptable annual average followed by the maximum admissible peak concentration.

The concentrations of targeted contaminants within the groundwater sample obtained from BHR3 were all below the relevant threshold levels, with exception of TPH, phenol, naphthalene and sulphate.

Groundwater recovered from BHR3 contained an elevated concentration of total TPH, with a reported value of 37000µg/l, in comparison to a threshold value of 10µg/l specified in the Water Supply (Water Quality) Regulations.

Speciation of the TPH indicated it to be mainly in the petrol range of C6 – C10 with a reported value of 34,000µg/l. This coincides with the strong hydrocarbon odour encountered during the sampling of the groundwater within BHR3.

An elevated phenol concentration of 38µg/l was detected within the groundwater, in comparison to the Water Supply (Water Quality) Regulations, 2001, threshold of 0.5µg/l. However, the reported concentration did not exceed the maximum admissible peak concentration of 300µg/l, specified within the EQS.

A marginally elevated concentration of naphthalene was recorded within the groundwater sample obtained from BHR3, with a reported concentration of 14µg/l, in comparison to a threshold value of 10µg/l.

Within the groundwater sample analysed an elevated concentration of sulphate was recorded, with a reported value of 380mg/l which exceeds the threshold value specified within the Water Supply Regulations.

8.4 Qualitative Risk Assessment

As discussed in Section 8.2 risk assessment is based on source > pathway > target principles. With respect to the subject land and the analytical results these can be defined as follows:

Identified Contaminants of Concern

- Elevated concentrations of benzo(a)pyrene within the made ground.
- Locally elevated concentrations of TPH within the made ground.
- Elevated concentrations of TPH, phenol, naphthalene and sulphate within the groundwater.

Pathways

- Dermal contact.
- Direct and indirect ingestion.
- Inhalation.
- Potential plant uptake of contamination in soil.

Targets/Receptors

- End users/landscaping.
- Controlled waters (principally the underlying minor aquifer).
- Construction and maintenance workers.

- Built development.

In assessing risk, the following categorisation has been developed:

Term	Description
Very High Risk	There is a high probability that severe harm could arise to a designated receptor from an identified hazard at the site without appropriate remedial action.
High Risk	Harm is likely to arise to a designated receptor from an identified hazard at the site without appropriate remedial action.
Moderate Risk	It is possible that without appropriate remedial action harm could arise to a designated receptor. It is relatively unlikely that any such harm would be severe, and if any harm were to occur it is more likely that such harm would be relatively mild.
Low Risk	It is possible that harm could arise to a designated receptor from an identified hazard. It is likely that, at worst if any harm was realised any effects would be mild.
Negligible Risk	The presence of an identified hazard does not give rise to the potential to cause harm to a designated receptor.

The above is intended to be an aid in assessing the degree of risk. It should be noted that in terms of the Environmental Protection Act 1990, there is no differing degree of risk, it is either 'significant' or not.

The site has previously been subject to uses that are deemed to pose a **high** potential for significant contamination. Review of historical OS plans, obtained as part of the preliminary investigation undertaken by Wardell Armstrong, has reveal that the site has been occupied by a gas works, a vehicle recycling and dismantling yard, an electricity substation and a railway set in a cutting, which has subsequently been infilled.

The environmental sensitivity of the site is considered to be **low** with respect of controlled waters.

Consideration is being given to the development of the site for a commercial/industrial end use. It is assumed that the development will comprise a number of low rise commercial/industrial units within the north western and south eastern areas of the site with associated roadways, car parking and areas of soft landscaping.

A commercial/industrial end use is considered to represent a **low** sensitivity end use.

End Users / Landscaping

Based on the contaminant > pathway > receptor philosophy, and the chemical results obtained as part of this investigation, it is considered that the made ground poses a **low/moderate** risk to proposed end users/landscaping, based on elevated concentrations of benzo(a)pyrene. However, it is considered that the soils in the vicinity of the identified hydrocarbon "hotspot" (TP3) pose a moderate/high risk to proposed end users/landscaping.

Locally TPH contamination has been identified in the soils. From observations made during the fieldwork and the chemical results, the hydrocarbon contamination appears to be largely within

the shallow made ground soils within the former gas works/vehicle dismantling and recycling yard and does not appear to be significantly impacting the natural soils at depth. However, visual and olfactory evidence of hydrocarbons were noted within the natural ground encountered directly below the made ground in trial pits TP7, TP10 and TP11.

It is recommended that to deal with the identified areas of contamination, the extent of TPH contamination encountered within the vicinity of TP3 be confirmed and hydrocarbon impacted soils be excavated and treated (either through bioremediation or removal to a suitably licensed landfill facility). Given that visual and olfactory evidence of hydrocarbons were encountered throughout the site, in particular within the former gas works/vehicle dismantling and recycling yard within the northern and central areas of site, vigilance should be maintained during site clearance and construction works for any other hydrocarbon hotspots, and any occurrences reported and appropriate advice sought.

Based on the assumption that the majority of the site is to be hardsurfaced (buildings, roadways and car park), it is considered any remaining made ground will pose a **low** risk to the proposed end users as this will break/remove the pathway between the made ground and the end users and hence the risk associated with direct contact.

A subsoil/topsoil “cap” will be required in areas of proposed landscaping where made ground or reworked/engineered made ground underlies the development. At this stage it is recommended that 450mm of “clean” topsoil/subsoil be assumed in areas proposed for landscaping. This thickness is subject to regulatory approval. The capping layer will remove the direct pollutant linkage and therefore the potential risk to end users, and in addition provide a suitable growing medium for shallow rooted plants. Deep rooted plants will need to be potted in a suitable depth of clean inert fill.

Statutory service providers should be consulted to determine if service pipes require upgrading to protect against chemical attack. Protection/upgraded services should be anticipated.

Gas protective measures are discussed in Section 9 of this report.

Controlled Waters

Given the fact that none of the leachable determinands tested were found at concentrations greater than their relevant guideline thresholds and based upon the assumption that the majority of the site will be hardsurfaced, hence reducing surface water infiltration and leachate generation, it is considered the risk to controlled waters is **low/negligible**.

Groundwater recovered from BHR3 was reported to be impacted by elevated concentrations of TPH. The presence of the contaminants in the groundwater is believed to be associated with the site being formerly occupied by a gas works and a vehicle dismantling and recycling yard, with associated tanks and gas holder, within the northern and central area of the site. At this stage we believe these former structures have been removed and the observed contamination is residual in the ground from these historical features.

Contaminated groundwater poses a risk to regional groundwater quality and surface water quality in the future (principally through TPH concentrations). It is recommended that further

works be undertaken to investigate the extent of the hydrocarbon “hotspot” within the vicinity of TP3.

Based upon the results of this investigation, other than the removal/treatment of the hydrocarbon hotspot for human health purposes, it is considered that remedial action is unlikely to be required to protect controlled waters. This conclusion is subject to regulatory approval.

Construction and Maintenance Workers

In moving or excavating the made ground materials, it is considered that there are **low/moderate** risks to construction and maintenance workers associated with exposure to contamination during the redevelopment works. It is recommended that normal health and safety procedures should be adopted by groundworkers including no eating, drinking or smoking on-site, provision of washing facilities and wearing gloves and overalls. It is also recommended that procedures outlined in the HSE document “Protection of Workers and the General Public during Redevelopment of Contaminated Land” be followed.

Specific method statements would need to be derived by the Principal Contractor to address how to safely handle the hydrocarbon impacted soils during the works.

This report should be forwarded to the construction/maintenance company undertaking the groundworks in order for them to assess risk to their personnel.

If groundworks are undertaken in dry weather conditions, dust suppression will be required.

Given the presence of identified contamination on site, it is recommended that any new services within the final development should be installed within oversize trenches, backfilled within inert materials.

Built Development

Based on the samples tested, and in accordance with BRE Special Digest 1 and the results of soluble sulphate testing, a Design Sulphate Class of DS-2 and an ACEC Class of AC-2 should be used for buried concrete structures, assuming mobile groundwater within the infilled railway cutting.

Within the former gas works/vehicle dismantling and recycling yard, chemical results indicate a design sulphate class of DS-3 in accordance with BRE Special Digest 1 (2005) for the design of buried concrete. Based on brownfield site designation and mobile groundwater conditions an ACEC class of AC-3 is indicated.

Chemical results should be forwarded to the appropriate utility companies in order to determine the necessity for service protection.

9.0 HAZARDOUS GAS MONITORING

9.1 General

Hazardous concentrations of methane and carbon dioxide can be generated by the degradation of organic matter/biodegradable materials. Methane is a flammable gas and a mixture containing 5% and 15% v/v in air is explosive. Carbon dioxide is an asphyxiant and toxic.

The most recent published guidance on the assessment of hazardous soils gases is CIRIA Report C665.

The Wardell Armstrong desk study indicates that there is one landfill site, associated with the infilled railway cutting, located within the southern part of the site. It is reported that the landfill was licensed to admit clay, subsoil, topsoil, construction and demolition waste, foundry sands and slag, and hardore. This licence is now lapsed.

A second landfill, located at the site of the former Birdwell Quarry, is located approximately 10m west of the site. No further information is available in relation to the landfill.

In addition to the aforementioned possible sources of hazardous gas, mine gas associated with the underlying strata may be present.

Site investigation works have revealed deep made ground is present locally across the site and is noted to locally contain visual and olfactory evidence of hydrocarbon contamination. Due to the presence of deep made ground deposits on the site and the presence of biodegradable material recorded, it is considered that these deposits may represent potential sources of hazardous ground gases.

In light of these potential sources of gas, wells were installed in each of the rotary probeholes (BHR1 – BHR3, including BHR1A). 50mm diameter gas and groundwater monitoring wells were sealed into the made ground within BHR1 and BHR2, and sealed into the natural strata within BHR1A and BHR3.

Gas monitoring is currently ongoing. The results of the monitoring completed to date are enclosed as Appendix D to this report.

9.2 Monitoring Procedure

The gas monitoring wells were monitored for methane, carbon dioxide, oxygen and flow using a Gas Data GFM 430 gas analyser. Groundwater levels were taken using an electronic dip meter.

The gas monitoring was undertaken in accordance with the guidance given in CIRIA Report 151 'Interpreting Measurements of Gas in the Ground' (1995).

VOC concentrations were assessed using the HSE (2005) 'Occupational exposure limits, EH40/2005' which gives long term (8 hour) time weighted average exposure limits for workers to benzene of 1ppm (parts per million). Adopting a conservative approach, assuming that any VOCs detected are due to benzene, VOC levels in excess of 1ppm may be regarded as posing a potential health risk.

9.3 Results

To date, the gas/groundwater monitoring wells have been monitored on two occasions on 9th and 23rd May 2008. Four further monitoring visit have been scheduled to supplement these two gas monitoring visits.

Gas monitoring has been carried out at an atmospheric pressure of 999mb during both of the return monitoring visits.

A methane concentration of 0.4%v/v was detected within BHR3 on the 9th May 2008. Methane was not detected within any of the other gas/groundwater monitoring wells.

Slightly elevated concentrations of carbon dioxide (>1.5% v/v) have been recorded in BHR1A and BHR2, reaching a maximum steady concentration of 1.7% v/v (BHR2) on 9th May 2008.

Depleted oxygen concentrations (<18% v/v) were recorded within BHR2 on 9th May 2008, with a minimum recorded value of 13.3%v/v.

VOC's were detected in each of the exploratory holes during both of the return monitoring visits, with a maximum recorded concentration of 27.9ppm on the 9th May 2008 in BHR3.

No positive initial or constant gas emission rates have been detected.

9.4 Discussion

Gas monitoring undertaken to date has revealed localised slightly elevated concentrations of carbon dioxide and locally depleted oxygen concentrations, coupled with elevated VOC concentrations.

As no positive gas flows have been detected, therefore a value of 0.1 l/h (the minimum limit of detection of the Gas Data GFM 430 gas analyser) has been used to derive a gas screening value (GSV).

Based on the maximum recorded readings for each borehole, a worst case Gas Screening Value (GSV) of 0.0004 litres/hour and 0.0017 litres/hour for methane and carbon dioxide, respectively, has been derived. As such, it is considered that the GSVs are representative of Characteristic Situation (CS) 1 – CIRIA C665 (Table 8.5).

However, given the elevated VOC concentrations (<1ppm) detected in the majority of the monitoring wells, a gas proof hydrocarbon resistant membrane, and all joints and penetrations sealed, will be required in any future developments on the site.

Gas protection measures should be as prescribed in BRE Report 414. Membranes should always be fitted by a specialist contractor.

It should be noted that these are provisional recommendations and are based on two monitoring visits. A further four monitoring visits are programmed prior to finalising gas protective measures.

According to the BGS, basic radon protective measures will be required for any envisaged future development on this site. The above measures are adequate to address this risk.

10.0 CONCLUSIONS AND RECOMMENDATIONS

10.1 Mining and Quarrying

Based on the information contained within the preliminary investigation undertaken by Wardell Armstrong, and a review of the geological plans, a potential risk to surface stability was considered to exist at the site from unrecorded mine workings, namely in the Haigh Moor coal seam.

In order to investigate the risk posed to surface stability by former mining, four rotary probeholes were drilled in accessible areas of the site, to depths of 30.00m bgl (BHR1 was terminated on an obstruction 2.2m and redrilled as BHR1A). A thin seam of coal was encountered within rotary probehole BHR2, undertaken within the western area of the site, at a depth of 21.50m bgl and was reported to be approximately 0.50m thick. No evidence of workings was recorded in this seam, or elsewhere across the site.

Based on CIRIA Special Publication 32 'Construction over Abandoned Mine Workings', it is considered there is sufficient competent rock cover above the documented coal seam beneath the site to mitigate against any surface instability.

There are no recorded mine entries on site, however, in areas of productive Coal Measure strata there is always the possibility of unrecorded mine entries. It is recommended that all excavations are examined for evidence of mine entries. If a mine entry is suspected work should cease and the advice sought of a suitably qualified consultant. All mine entries should be stabilised in accordance with Coal Authority guidelines.

Inspection of historical OS plans reviewed as part of this investigation does not reveal any quarries on the site, however a number of old quarries are shown surrounding the site, the closest of which is Birdwell Quarry, located approximately 10m west of site. Birdwell quarry has subsequently been infilled.

10.2 Foundations

It is understood that the proposed development will comprise a commercial/industrial end use with associated access roads, car parking and areas of soft landscaping.

Column / line loads for the proposed development were not available to Sirius at the time of writing of this report. For the purpose of this report it is assumed that buildings will not exceed three storeys.

This investigation has revealed the shallow soils to comprise a variable thickness of made ground, over weathered mantle material (soft to very stiff clay), over Middle Coal Measures strata, comprising sandstone and mudstone.

The made ground was typically encountered to depths of between 0.50m and a maximum proven depth of 2.70m bgl. An area of deep granular made ground was encountered to a depth

of 3.30m bgl within TP11, assumed to be located within the former gas holder indicated on the historical OS plans.

The made ground typically comprised a surface cover of hardstand or topsoil over a granular fill of sand and gravel with occasional cobbles and boulders of sandstone, ash, timber, brick, limestone, concrete and slate. The boulders encountered during the excavation of the trial pits were up to 1.00m long by 0.50m wide and are of dressed sandstone and/or reinforced concrete. Locally occasional fragments of fabric, pottery, plastic, wire and metal were encountered.

The made ground is considered unsuitable to support foundations in its present condition due to possible variability in consistency and content. Foundations for any proposed development should therefore be extended through these soils to bear onto/into underlying competent/solid strata, or the materials re-engineered to provide a suitable bearing medium.

The following foundation options should be considered:

- Raft foundations: This will require excavation, screening and re-engineering of the full thickness of made ground beneath the development areas. Based on the material types encountered in the trial pits, it is considered likely that the re-engineered soils could provide an allowable bearing capacity of 50kPa, subject to confirmatory testing.
- Shallow spread foundations: Pad or strip/trench foundations may be appropriate where made ground thicknesses are not excessive. These foundations should be taken down to bear on natural clay (at least firm, medium strength clay) or bedrock. The natural clays can be assumed to have an allowable net bearing capacity of 80kN/m² increasing to 150kN/m² within the underlying sandstone bedrock. Greater bearing capacities may be achieved in the rock subject to confirmatory rock testing. Where foundations encounter rock, they should be placed wholly in rock and not partly in rock and partly in drift deposits. Differential settlement may occur between foundations placed in different material.
- Where the proposed development spans the backfilled railway cutting (Unit H on the provisional layout), foundations depths will be shallow in the north west and deeper in the south east towards the centre of the cutting. Pad and Stem foundations eg. concrete filled manhole rings, could be founded on the underlying bedrock in the deeper areas of fill and prove a more cost effective solution than piles or vibro replacement. As with piled foundations, ground beams will be required for this solution.
- Piles or Vibro-replacement methods could be considered if localised fill depths are excessive in some locations, or if this is the preferred option by the structural engineer based on the proposed building design. Allowance should be made for potential obstructions in the fill where the full thickness of made ground is not re-engineered. The design of the piles or vibro stone columns should be undertaken by a specialist contractor, using information obtained during this site investigation.

Shallow spread foundations terminating in cohesive strata should be a minimum of 0.90m deep below current or proposed levels, whichever is the deepest and should be deepened if necessary due to the presence of trees or where competent natural strata is not present at that depth.

Ground floor slabs may be ground bearing where fill materials are appropriately re-engineered and not subject to potential volume change. Fully suspended slabs may be required depending on the adopted foundation type as discussed above or where made ground is not re-engineered.

Strengthening of footings with reinforcement may be required to protect foundations from any differential settlements across bedrock with varying degrees of weathering. Specialist design advice should be sought from a suitably qualified structural engineer if sufficient variations are encountered.

To prevent deterioration of the founding stratum all foundation excavations should be blinded after excavation.

Foundations should be taken below a line drawn up at 45° from the base of any existing or proposed services or similar.

If any relict foundations/substructures are encountered foundations should be taken to a greater depth than the existing foundations into natural ground of adequate bearing capacity.

Much of the made ground encountered beneath the former gas works/vehicle dismantling and recycling yard comprises the fabric of the former or existing facilities on the site i.e. hardstanding, floor slabs and foundations. Several trial pits encountered obstructions and were subsequently terminated within the made ground; as such the true thickness of this material was not proven in all locations. It is recommended that as part of the remedial works, additional site investigation works be undertaken in order to prove the true depth of the made ground.

It must be ensured that piles or vibro stone columns do not introduce any preferential pathways for the migration of contaminants and the guidance given in the Environment Agency document 'Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination: Guidance on Pollution Prevention' should be followed and discussed with the Environment Agency prior to undertaking any piling operations.

Based on the samples tested, and in accordance with BRE Special Digest 1 and the results of soluble sulphate testing, a Design Sulphate Class of DS-2 and an ACEC Class of AC-2 should be used for buried concrete structures, assuming mobile groundwater within infilled railway cutting.

Within the former gas works/vehicle dismantling and recycling yard, chemical results indicate a design sulphate class of DS-3 in accordance with BRE Special Digest 1 (2005) for the design of buried concrete. Based on brownfield site designation and mobile groundwater conditions an ACEC class of AC-3 is indicated.

10.3 Excavations

Excavation should be suitable for standard plant although the use of hydraulic or pneumatic breakers would be required for excavations extending into rock and where existing foundations or other buried structures/obstructions are encountered.

Shallow excavations through the made ground should be assumed to be unstable and an allowance should be made for suitable shoring. No man entry into unsupported excavations should be allowed without an appropriate risk assessment. Reference to CIRIA 97 Trenching Practice should be made to establish suitable means of support or battering of excavation sides during construction.

Shallow excavations (<2m) are generally expected to remain dry. Seepages or minor inflows could occur locally. It should be possible to deal with these seepages through normal site pumping practises for any shallow excavations open for short periods of time.

10.4 Road Pavement Design

For preliminary design purposes a CBR value of less than 2% is suggested for areas of made ground. It is recommended that CBR values for the finished sub grade be determined by laboratory testing or on site testing once levels have been finalised. In view of the variation in thickness of made ground, consideration should be given to providing geogrid reinforcement beneath road and parking areas.

Treatment of the soils below the proposed highways should be discussed with the local highways authority.

10.5 Contamination Constraints to Development

Review of the historical maps included as part of the Wardell Armstrong desk study revealed that the site was largely undeveloped from at least 1855 with the exception of a railway, set in a cutting, aligned approximately south west/north east within the southern area of the site. By 1893, the far northern area of the site had been developed with terraced properties annotated as “Rockingham Row”. The remainder of the site comprised part of “Rockingham Gas Works”, with an associated gas holder located within the eastern area of the site and a number of tanks and buildings within the northern and central areas.

By 1956, the gas works and associated gas holder and tanks had been demolished/removed, and only three buildings/units (later reported as an engineering works, “Worsely View” and an electricity substation), are annotated within the site boundary.

On the 1974 OS plan the railway within the southern area of site is shown to be disused and partly dismantled, and by 1991 had been completely removed and the cutting is annotated as a “Tip”. Information contained within Wardell Armstrong report revealed that a landfill licence was granted for the infilling of the railway cutting; authorised waste included clay, subsoil, topsoil, construction and demolition waste, foundry sand and slag, hardcore and “waste ex. Coal processing”.

At some point between 1978 and 1991, the residential properties on Rockingham Row were demolished.

By 1993 the building reported as “Worsely View” had been demolished and only the engineering works and the electricity substation remain. Anecdotal information contained within the Wardell Armstrong desk study indicates that the substation was removed sometime between 1990 and 2006 and it is believed that the site was most recently used as a vehicle dismantling and recycling yard.

This investigation has revealed the shallow soils to comprise a variable thickness of made ground, over weathered mantle material, over Middle Coal Measures strata, comprising sandstone and mudstone.

The made ground was typically encountered to depths of between 0.50m and a maximum proven depth of 2.70m bgl. An area of deep granular made ground was encountered to a depth of 3.30m bgl within TP11. This is assumed to be located within the former gas holder indicated on the historical OS plans.

Noticeable olfactory odours and visual evidence of organic contamination was recorded during the fieldwork which were noted predominantly in the made ground, however, some isolated contamination was also observed in natural strata in a number of exploratory holes across the site.

The site is considered to lie within a low sensitivity environmental setting, as described in Section 8.1.

Based on the results of this geoenvironmental appraisal, it is considered that the made ground poses a low/moderate risk to proposed end users/landscaping, based on elevated concentrations of benzo(a)pyrene. However, it is considered that the soils in the vicinity of the identified hydrocarbon “hotspot” (TP3) pose a moderate/high risk to proposed end users/landscaping.

It is recommended that to deal with the identified area of contamination, hydrocarbon impacted soils, encountered within the vicinity of TP3, be excavated and removed to a suitably licensed landfill facility. Visual and olfactory evidence of hydrocarbons were encountered throughout the site, in particular within the historical gas works to the northern and central areas of site, vigilance should therefore be maintained during site clearance and construction works for any other hydrocarbon hotspots, and any occurrences reported and appropriate advice sought.

The vast majority of the site is to be hardsurfaced (buildings, roadways and car park). It is therefore considered that the made ground will pose a **low** risk to the proposed end users as this fabric of the development will break/remove the pathway between the made ground and the end users and hence the risk associated with direct contact.

The made ground is considered unsuitable to be reused as a topsoil material in landscaped areas and that where landscaping is proposed a minimal capping of 450mm of clean imported soil should be used to provide a suitable growing medium for shallow rooted plants, although this is subject to regulatory approval.

Given the fact that none of the leachable determinands tested were found at concentrations greater than their relevant guideline thresholds and based upon the fact that the majority of the site will be hardsurfaced, hence reducing surface water infiltration and leachate generation, it is considered the risk to controlled waters is low/negligible not warranting any remedial action.

Groundwater recovered from BHR3 was reported to be impacted by elevated concentrations of TPH. The presence of the contaminants in the groundwater is believed to be associated with the site being formerly occupied by a gas works and a vehicle dismantling and recycling yard,

with associated tanks and gas holder, within the northern and central area of the site. At this stage we believe these former structures have been removed and the observed contamination is residual in the ground from these historical features.

Contaminated groundwater poses a risk to regional groundwater quality and surface water quality in the future (principally through TPH concentrations). It is recommended that further works be undertaken to investigate the extent of the hydrocarbon “hotspot” within the vicinity of TP3. In addition, it is recommended that further groundwater samples be recovered and tested and that dialogue be initiated with the Environment Agency.

Based upon the results of this investigation, other than the removal/treatment of the hydrocarbon hotspot for human health purposes, it is considered that remedial action is unlikely to be required to protect controlled waters. This conclusion is subject to regulatory approval.

Any material removed from site should be undertaken in accordance with the Duty of Care Regulations 1991 and the Landfill Directive.

Health and safety precautions for groundworkers are discussed in Section 8.4, as are recommendations for protection to buried services/structures.

It is possible that other significant contamination will be encountered on site during redevelopment. If any areas of noxious, odorous, brightly coloured, liquid, fibrous etc contamination are identified further advice should be sought from a suitably qualified consultant.

An asbestos survey should be carried out by a suitably qualified specialist in the buildings on site prior to demolition. If asbestos bearing material is to be dismantled it should be removed by a qualified contractor to a suitably licensed facility.

Any material removed from site should be undertaken in accordance with the Duty of Care Regulations 1991 and the Landfill Directive.

10.6 Hazardous Gas

Gas monitoring undertaken to date has revealed localised slightly elevated concentrations of carbon dioxide and locally depleted oxygen concentrations, coupled with elevated VOC concentrations.

As described in Section 9.4, based on the gas monitoring results to date, the site falls into Characteristic Situation (CS) 1. However, elevated VOC concentrations (<1ppm) were detected in the majority of the monitoring wells. Subsequently, this necessitates a gas proof hydrocarbon resistant membrane and all joints and penetrations to be sealed, in proposed developments on site.

Gas protection measures should be as prescribed in BRE Report 414. Membranes should always be fitted by a specialist contractor.

It should be noted that these are provisional recommendations and are based on two monitoring visits. A further four monitoring visits are programmed prior to finalising gas protective measures.

According to the BGS, basic radon protective measures will be required for any envisaged future development on this site. The above measures are adequate to address this risk.

11.0 REMEDIATION STRATEGY

11.1 Introduction

The main aims of the remediation strategy are as follows:

- To provide a final ground surface suitable for the proposed end use of the site i.e. low rise commercial/industrial units with associated hardstanding and localised areas of soft landscaping.
- To ensure construction workers are not put at an unacceptable short term risk in reclaiming and redeveloping the site.
- To comply with the requirements of the Local Planning Authority and their Environmental Health Department to ensure future users of the site are not put at risk from any chemical contamination arising from its former use(s) or nature of materials present.

An outline remediation strategy is detailed below for works to be undertaken prior to development.

- Demolition of existing buildings (including the existing office building and disused workshop).
- Any relic foundations, basement walls, concrete slabs and obstructions should be exposed and broken out (where they would impose a constraint on development), including the safe disposal of any notifiable asbestos, that is encountered and appropriate treatment or disposal of soils contaminated with hazardous materials.
- Assessment of existing wildlife habitats located on site should be completed by others, with liaison with relevant authorities.
- General site clearance of all vegetation and removal and appropriate disposal from site of areas of tarmac hardstanding and fly tipped 'rubbish'.
- Topsoil strip and stockpiling.
- Chemical validation of the crushed and stockpiled hardstanding and demolition materials should be undertaken in accordance with criterion and frequency of testing agreed by with relevant regulators.
- Supplementary ground investigation (to be carried out during remediation works) in order to identify the ground conditions in areas where previous intrusive methods were obstructed and to determine the lateral extent of proven hydrocarbon contamination within the made ground within the vicinity of TP3.
- Excavation and off site disposal of the shallow hydrocarbon hotspot, encountered within the vicinity of TP3, with validation supervision and sampling.

- When access allows, spot samples should be recovered and tested from below potential point sources of contamination; namely the former electricity substation, gas holder and workshop.
- Where granular made ground, comprising ash, timber, brick, concrete, slate, fabric, plastic, wire and metal exists in proposed areas of landscaping, this should be either removed or covered with a minimum of 450mm of clean inert topsoil/subsoil, to act as a suitable growing medium for shallow rooted plants. The capping thickness is subject to regulatory approval. Testing would be required for any materials proposed to be imported to site to be used in areas of landscaping.
- Should any evidence of contamination which has not been encountered during the Sirius site investigations be observed during development, then the materials should be assessed by a suitably qualified consultant, in liaison with the appropriate regulators.
- Any 'hotspots' of contamination encountered during construction should be removed and disposed of to a suitably licensed landfill, and the excavated area subsequently validated by a suitably qualified consultant.
- All site works should be undertaken in accordance with relevant Health and Safety legislation.
- Production of a validation report on completion of the works to demonstrate to the regulators that the works were completed satisfactorily, and in accordance with the agreed remediation specification.

11.2 Demolition of Existing Buildings and Removal of Underground Structures

All existing buildings foundations and relict structures associated with the current and former uses of the site shall be broken out and removed where they could pose a constraint to the proposed development. Selected materials suitable for re-use or recycling shall be retained on site for use in the works.

Prior to the demolition of the existing buildings a Type III asbestos survey should be carried out by a suitably qualified specialist.

Additional precautions will apply should the demolition work include the handling of hazardous materials, which may include asbestos. If encountered, the asbestos shall be disposed of in accordance with current legislation and accepted practices. A licensed removal contractor shall be used for this work.

The RE shall inspect any buried slabs and relict foundations which are encountered during the excavations and ensure that they are completely removed where they would impose a constraint to the proposed development.

Visual/olfactory evidence of hydrocarbons was noted in exploratory holes where obstructions/relict foundations/structures were encountered. Further chemical analysis and specifically TPH analysis should be undertaken on soils immediately below the obstructions. If hydrocarbon hotspots are encountered they should be excavated and disposed off site at a suitably licensed landfill site.

All concrete slabs, foundations etc shall be stockpiled and crushed in an agreed location. Appropriate materials shall be crushed (125mm down) to generate a 6F2 type material for reuse within the works.

The RE shall inspect the crushed product and instruct the removal of any unsuitable material, including, but not limited to metal, steel reinforcement, rags, plastic timber or degradable material and schedule appropriate confirmatory testing to prove its suitability for retention on site.

The contractor shall undertake geotechnical testing at a minimum rate of one per 1000m³ of crushed product, this testing shall include:

- Moisture content;
- Particle size distribution (by sieving); and,
- pH and sulphate content (2:1 water:soil extract).

The contractor shall supply the results of the chemical and geotechnical testing within seven working days of the samples being taken.

The contractor shall survey the base of all foundations and other excavations etc prior to any backfilling commencing.

11.3 Excavation and Disposal of Hydrocarbon Contaminated Soils

11.3.1 General

The hydrocarbon hotspot in the vicinity of TP3 shall be delineated and removed from site. The exact dimensions of the excavations will depend on the extent of the observed contamination during the works but a nominal 4m by 8m to 2.00m nominal depth has been assumed to allow calculation of volumes of soil for disposal.

Disposal of contaminated soil will take place by the direct placement of the soil into a road haulage truck and subsequent disposal at a suitably licensed landfill site. On site precautions will be required to prevent the spreading of contaminated soils around the site or to adjacent land.

The removal of sufficient soil will be validated by ensuring that remedial targets have been met for the contaminants. Remediation targets levels will be based on CIEH LQM Generic Screening Values, assuming a commercial end use. Once validation of the hotspot removal has been achieved, suitable material generated site should be backfilled into the excavation.

11.3.2 Independent Validation and Supervision of the Works

The mitigation measures outlined above will require validation to ensure that it is effectively carried out.

11.3.3 Confirmation of Soil Removal

In order to ensure that all of the contaminated soil is removed from this area, supervision of the excavation will be carried out, as follows:

- A visual inspection of the soil will be undertaken. The excavation will be progressed until no visual or olfactory evidence of hydrocarbon staining is visible.
- Soil samples will be taken from the base and sides of the excavation (one from each side wall and two from the base on 10m spacing). All sample collection will be carried out by the use of the excavator bucket to take a 'scrape' from the required location – the Sirius Engineer will not enter the excavation to take a sample.
- If, in the experience of the supervising engineer, it is thought that the visual and on site screening evidence indicates that the concentrations of hydrocarbons are likely to be below the remedial targets then the samples will be submitted for confirmatory laboratory analysis (on a 5 day turnaround).
- Should the laboratory analysis results indicate that the soil samples contained hydrocarbons below the remedial targets then the excavation will be passed for backfilling.
- Should the results be greater than the remedial targets then further 'chasing out' of contamination will be necessary. The on site observation/screening exercise and confirmatory analysis will then be carried out as described above with samples only being taken from the previously 'failed' side of the excavation.

11.3.4 Validation of Soil Disposal

The soil to be disposed of off site shall be transported to a suitably licensed facility with suitable Duty of Care documentation being in place. The Special Waste Regulations (1996 and 2000) will also need to be complied with. It will be necessary to include confirmation that suitable disposal took place in the validation report, hence relevant paperwork will be required to be available from the contractor for inspection / copying.

11.3.5 Environmental Controls

To protect site workers and the general public, as well as to prevent environmental harm, a series of environmental controls will be put in place during earth works on site:

Dust

Soils will be dampened down as necessary and activity will be minimised in extremely windy conditions to prevent dust nuisance. When dusty material is being loaded onto trucks extra care will be taken to ensure the drop height is minimised.

Stockpiles of loose, fine materials should be tamped down or covered over if necessary to reduce the production of dust.

Vapours and Odours

Soils excavated for the remediation of hydrocarbon hotspots will not be stockpiled on site but will be tipped directly into a truck for off site disposal.

The Supervising Engineer will monitor the atmosphere and, in the case of excessive vapours being detected at the site boundary, will instruct the contractor to cover the excavation face releasing the vapours with soil or sand (some suitable material will be required to be kept on site in case this scenario occurs).

11.4 Cover Materials in Landscaped Areas

11.4.1 General

The remediation strategy for the site, with respect to human health impacts on site users is for the provision of a 'clean' cover capping layer to soft landscaped areas. The provision of any growing medium in landscape areas shall be the responsibility of the developer and does not form part of the remediation contract.

In accordance with the recommendations mentioned previously, a 450mm clean cover layer shall be placed in areas of soft landscaping.

11.4.2 Topsoil

Shall be placed by the Main Contractor responsible for the construction phase of the works. It shall be ensured that topsoil is of an appropriate quality and that concentrations of contaminants do not exceed the maximum concentrations stipulated.

11.4.3 Subsoil

Subsoil materials for the use in the 'clean' cover layer may fall into two main categories:

- Inert materials meeting the requirements of the engineering specification and specified guideline values; and,
- Inert material meeting the specified guideline values but possibly unsuitable for engineering purposes.

All subsoil shall either be sourced from site or imported from other site sources.

The subsoil shall be inspected during excavation to ensure that all material meets the required specification. Subsoil shall be clean and free of foreign debris, building waste materials, timber or other deleterious matter.

Clean cover materials shall be imported by the contractor into stockpiles, at locations agreed with the RE, for future placement by the Main Contractor responsible for the development works.

Materials to be imported to site shall be sampled at source and the test results made available to the RE **prior** to any material being delivered to site.

Representative samples of the subsoil material shall be taken during the stockpiling on site at a rate of 1 sample per 250m³. Each sample shall be forwarded to an UKAS and MCERTS accredited laboratory for analysis.

Granular and cohesive materials shall be stored in separate stockpiles and be clearly identified.

11.5 Contractors Responsibilities

The works shall be undertaken in accordance with all relevant legislation including, but not limited to:

- The Health and Safety at Work etc Act 1974;
- The Construction (Design and Management) Regulations 2007;
- Construction Health Safety and Welfare Regulations 1996;
- The Waste Management (Duty of Care) Regulations, 1991.
- The Waste Management Licensing Regulations, 1994.
- The Landfill Regulations, 2002.

The contractor will be responsible for waste classification. The Supervising Engineer will need access to waste transfer notes, landfill weigh bridge tickets, and any consignment notes for inclusion in the Validation Report.

11.6 Supervising Engineer

The responsibilities of the Supervising Engineer shall include, but not be limited to, the following:

- Advice on the correct handling of materials and conditions encountered.
- Location, area, and volume of any materials excavated and re-used / redeposited on site
- Soil/fill sampling as required under the specification and advising the contractor of the results in order to allow the satisfactory progress of the works.
- Photographs
- Liaison with statutory bodies as required.

11.7 Validation

The Supervising Engineer will ensure that the requirements of this Strategy are complied with. On satisfactory completion of all of the remediation works Sirius will provide a validation report. This report will comprise relevant site records and act as certification that the remedial preparation works have been carried out in accordance with the Strategy.

The validation report shall include the following:

- A description of the works undertaken.
- Progress photographs.
- Chemical validation test results.
- Waste transfer notes.

- A statement that the works have been undertaken in accordance with the agreed Strategy.

12.0 REGULATORY APPROVAL.

The conclusions and recommendations presented above are considered practical based on the findings of this investigation. The conclusions and recommendations cannot however be guaranteed to gain regulatory approval, and therefore this report should be passed to the regulators (local authority and Environment Agency) for their comment/approval prior to undertaking any works on site.

The regulatory authorities may require a Remediation Statement, and validation of the remedial works in due course.



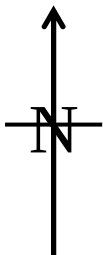
APPENDIX A

DRAWINGS



Site Location Plan

Contract Number	C1634
Contract	Sheffield Road Birdwell
Client	Hartwood Estates Ltd

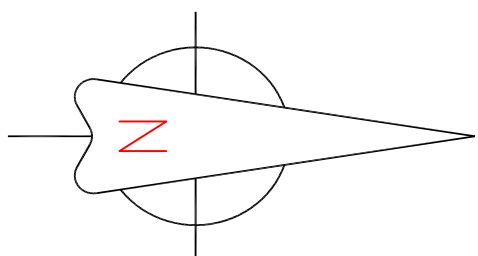


THE SITE

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Sirius Geotechnical & Environmental Ltd, Suite 2, Russel House, Mill Road, Langley moor, Durham DH7 8HJ.
Licence No. 100042005

Scale	1:50,000		
Drawn by	SA	Approved	MB
Drawing Number	C1634/1		



TP	OBH	SH	TP	OBH	SH
TP1	OBH1	SH1	TP2	OBH2	SH2
TP3	OBH3	SH3	TP4	OBH4	SH4
TP5	OBH5	SH5	TP6	OBH6	SH6
TP7	OBH7	SH7	TP8	OBH8	SH8
TP9	OBH9	SH9	TP10	OBH10	SH10
TP11	OBH11	SH11	TP12	OBH12	SH12
TP13	OBH13	SH13	TP14	OBH14	SH14
TP15	OBH15	SH15			

Key

TP14 Trial Pit

OBH3 Rotary Probehole

Approximate area of spoil heaps

Approximate area of infilled railway

Site boundary

REVISION

0	>>
A	>>
B	>>
C	>>
D	>>

SIRIUS
GEOTECHNICAL &
ENVIRONMENTAL



TEL: 0113 264 9960
FAX: 0113 264 9962

CLIENT

Hartwood Estates Ltd

SITE

Sheffield Road,
Birdwell

DRAWING TITLE

Exploratory Hole Location Plan

DRAWING NO.

C1634/2

REVISION NO.

0

DRAWN BY

SA

APPROVED BY

MB

DATE

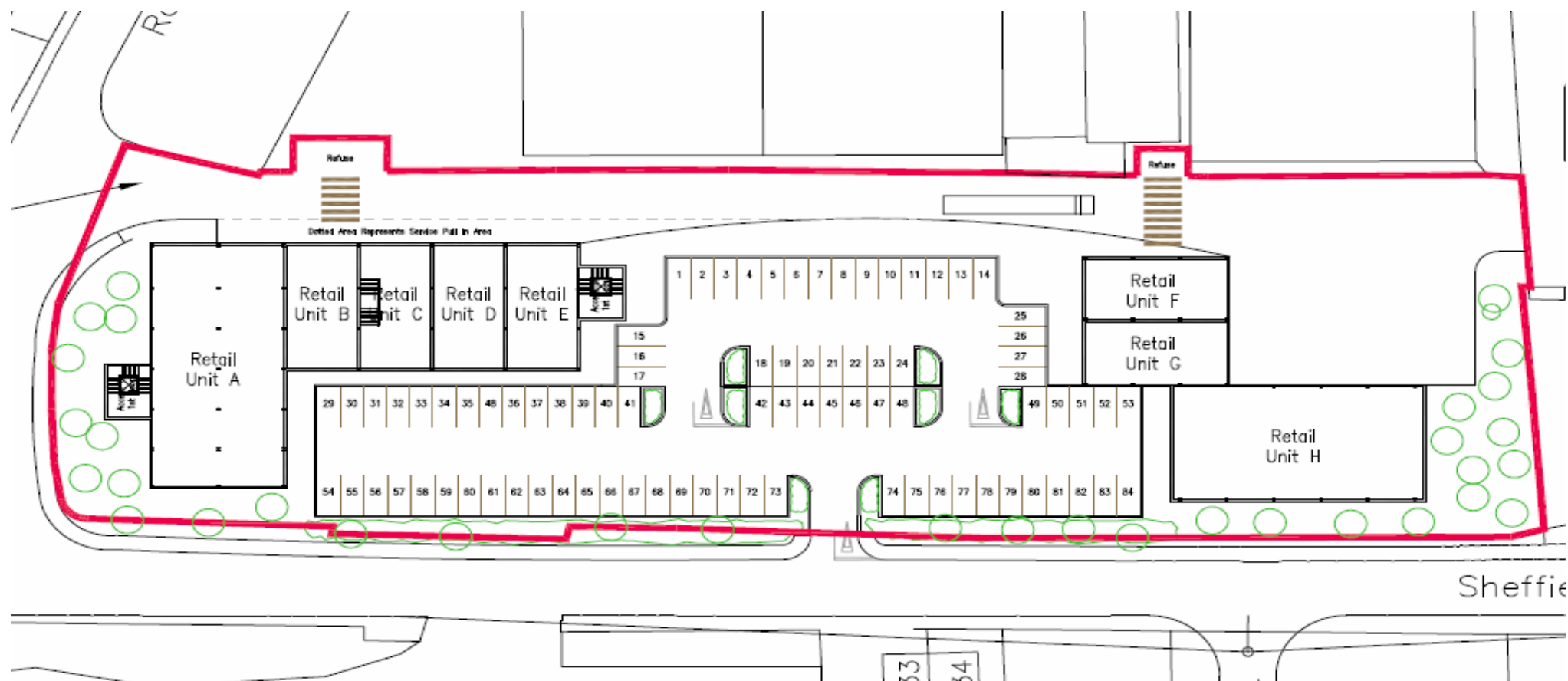
June 2008

SCALE

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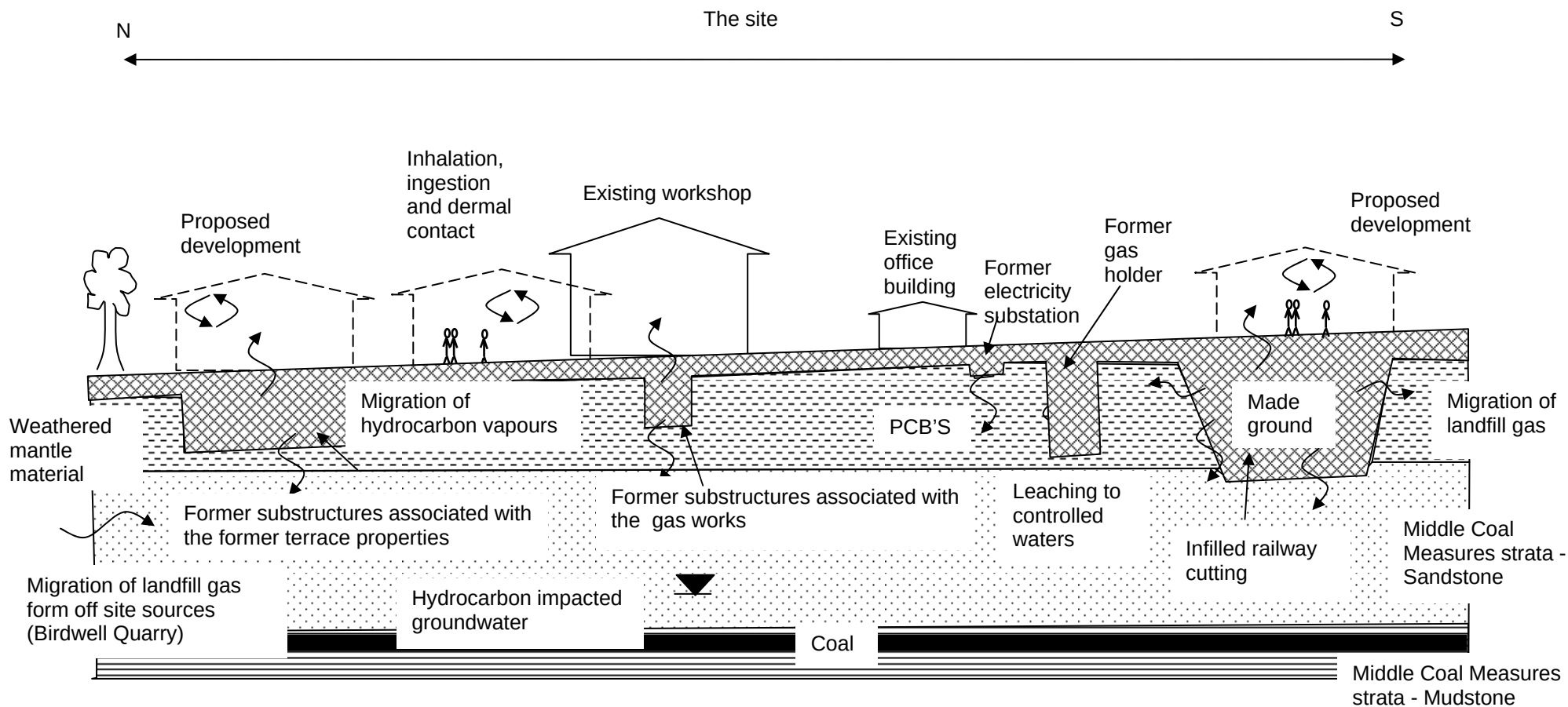
PAPER SIZE

A1



Contract Number	C1634	Scale	NTS
Contract	Sheffield Road Birdwell	Drawn by	SA
		Approved	
Client	Hartwood Estates Ltd	Drawing Number	
		C1634/3	

**Proposed Development
plan**



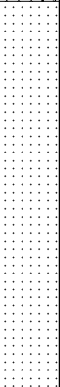
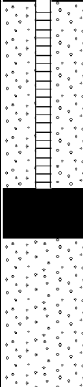
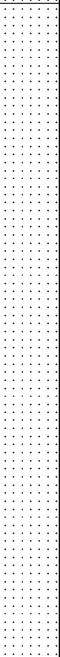
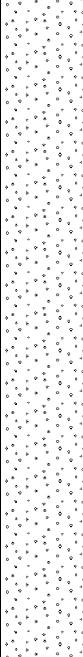
Contract Number C1634		Scale NTS	
Contract	Sheffield Road Birdwell	Drawn by SA	Approved
		Drawing Number C1634/4	
Client Hartwood Estates Ltd			

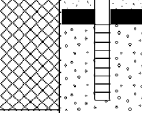
**Conceptual
Site Model**

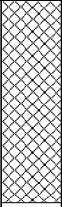
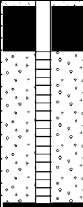


APPENDIX B

EXPLORATORY HOLE RECORDS

						BOREHOLE RECORD			BH No. BHR1A Sheet 1 of 1			
						Site: Sheffield Road, Birdwell			Contract No: C1634			
						Client: Hartwood Estates Ltd			Dates: 28/04/2008			
						Method: Rotary drilling rig with down the hole hammer.			Scale 1:150			
SAMPLE DETAILS						Groundwater (Casing)	STRATA RECORD Description	Logged By: AF		Checked By:		
Type	Depth From - To (m)	TCR (%)	SCR (%)	ROD (%)	N (Fl)			Driller: AF				
								Depth (m)	Level (mAOD)	Legend	Well	
						1	MADE GROUND. Grey SAND and GRAVEL (Drillers description).	1				
						2	Brown SANDSTONE. (Drillers description).	2	1.30			
						3			3			
						4			4			
						5			5			
						6			6			
						7			7			
						8			8			
						9			9	9.00		
						10	Grey SANDSTONE. (Drillers description).	10				
						11			11			
						12			12			
						13			13			
						14			14			
						15			15			
						16			16			
						17			17			
						18			18			
						19			19			
						20			20			
						21			21			
						22	Grey MUDSTONE. (Drillers description).	22	22.00			
						23			23			
						24			24			
						25			25			
						26			26			
						27			27			
						28			28			
						29			29			
Remarks and Water Observations 1. Service inspection pit, hand excavated to 1.20m prior to drilling. 2. No groundwater encountered. 3. Rotary openhole drilling complete at 30.00m. 4. Standpipe installed, as detailed above.							End of Borehole at 30.00 m		GL (m AOD) - Easting: - Northing: -		Fig. No. BHR1A	

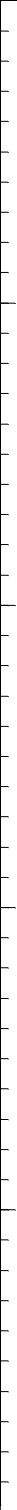
						BOREHOLE RECORD		BH No. BHR1 Sheet 1 of 1			
						Site: Sheffield Road, Birdwell		Contract No: C1634			
						Client: Hartwood Estates Ltd		Dates: 28/04/2008			
						Method: Rotary drilling rig with down the hole hammer.		Scale 1:150			
SAMPLE DETAILS						Groundwater (Casing)	STRATA RECORD Description	Logged By: AF		Checked By:	
Type	Depth From - To (m)	TCR (%)	SCR (%)	ROD (%)	N (FI)			Driller: AF			
								Depth (m)	Level (mAOD)	Legend	Well
						1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29	MADE GROUND. Brown SAND and GRAVEL with cobbles and boulders. (Drillers description). End of Borehole at 2.20 m	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29			
Remarks and Water Observations							GL (m AOD) - Easting: - Northing: -		Fig. No. BHR1		
1. No groundwater encountered. 2. Rotary openhole drilling terminated at 2.20m on a concrete obstruction. 3. Standpipe installed, as detailed above.											

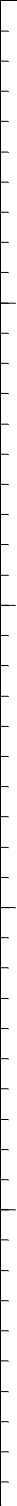
						BOREHOLE RECORD		BH No. BHR2 Sheet 1 of 1				
						Site: Sheffield Road, Birdwell		Contract No: C1634				
						Client: Hartwood Estates Ltd		Dates: 28/04/2008				
						Method: Rotary drilling rig with down the hole hammer.		Scale 1:150				
SAMPLE DETAILS						Groundwater (Casing)	STRATA RECORD Description	Logged By: AF		Checked By:		
Type	Depth From - To (m)	TCR (%)	SCR (%)	ROD (%)	N (Fl)			Driller: AF				
								Depth (m)	Level (mAOD)	Legend	Well	
						1	MADE GROUND. Grey SAND and GRAVEL. (Drillers description)	1				
						2		2				
						3		3				
						4		4	4.00			
						4	Brown CLAY. (Drillers description).	4.20				
						5	Brown SANDSTONE. (Drillers description).	5				
						6		6				
						7		7				
						8		8				
						9		9				
						10		10				
						11		11				
						12		12				
						13		13				
						14		14				
						15		15				
						16		16				
						17		17				
						18	Grey SANDSTONE. (Drillers description).	18	18.00			
						19		19				
						20		20				
						21		21				
						21		21	21.50			
						22	COAL. (Drillers description).	22	22.00			
						22	Grey MUDSTONE. (Drillers description).					
						23		23				
						24		24				
						25		25				
						26		26				
						27		27				
						28		28				
						29		29				
Remarks and Water Observations							End of Borehole at 30.00 m		GL (m AOD) - Easting: - Northing: -		Fig. No. BHR2	
1. Service inspection pit, hand excavated to 1.20m prior to drilling. 2. No groundwater encountered. 3. Rotary openhole drilling complete at 30.00m. 4. Standpipe installed, as detailed above.												

						BOREHOLE RECORD			BH No. BHR3 Sheet 1 of 1				
						Site: Sheffield Road, Birdwell			Contract No: C1634				
						Client: Hartwood Estates Ltd			Dates: 28/04/2008				
						Method: Rotary drilling rig with down the hole hammer.			Scale 1:150				
SAMPLE DETAILS						Groundwater (Casing)	STRATA RECORD Description			Logged By: SA		Checked By:	
Type	Depth From - To (m)	TCR (%)	SCR (%)	ROD (%)	N (FI)					Driller: AF			
										Depth (m)	Level (mAOD)	Legend	Well
						1							
						2							
						3							
						4							
						5							
						6							
						7							
						8							
						9							
						10							
						11							
						12							
						13							
						14							
						15							
						16							
						17							
						18							
						19							
						20							
						21							
						22							
						23							
						24							
						25							
						26							
						27							
						28							
						29							
Remarks and Water Observations							End of Borehole at 30.00 m			GL (m AOD) - Easting: - Northing: -		Fig. No. BHR3	
1. Service inspection pit, hand excavated to 1.20m, prior to drilling. 2. Groundwater encountered at 20.00m. 3. Rotary openhole drilling complete at 30.00m. 4. Standpipe installed, as detailed above.													

			TRIAL PIT RECORD			TP No. TP1			
			Site : Sheffield Road, Birdwell			Sheet 1 of 1			
			Client : Hartwood Estates Ltd			Contract No: C1634			
			Method : JCB 3CX backhoe excavator with 0.60m wide toothed bucket.			Dates: 28/04/2008			
			Scale 1:25						
SAMPLE DETAILS			Groundwater	STRATA RECORD			Logged By: SA		
							Checked By:		
Type	Depth From - To(m)	Vane Results kN/m²					Depth (m)	Level (mAOD) PID (ppm)	Legend
D	0.30m			MADE GROUND: Tarmac.	0.09				
				MADE GROUND: Light grey sandy angular to subangular fine to coarse GRAVEL of limestone.	0.26				
D	0.90m			MADE GROUND: Dark grey fine to coarse SAND and angular to subangular fine to coarse GRAVEL with occasional cobbles. Gravel is of sandstone and brick. Cobbles are angular of brick, fabric and timber. Hydrocarbon odour.					
D	1.20m			Stiff friable orange brown mottled grey slightly sandy slightly gravelly CLAY with occasional cobbles. Low plasticity. Gravel is angular to subangular fine to coarse of sandstone. Cobbles are angular of sandstone.	0.96				
D	1.80m			Very weak becoming weak orange brown fine to medium grained SANDSTONE. Highly weathered. (Recovered as gravelly clay. Gravel is angular to subangular fine to coarse).	1.60				
				End of Trial Pit at 2.00 m	2.00				
Remarks and Water Observations						GL (m AOD)		Fig. No.	
1. Trial pit stable during excavation.						-		TP1	
2. No groundwater encountered.						Easting:			
3. Trial pit refused at 2.00m on impenetrable rock.						-			
						Northing:			
						-			

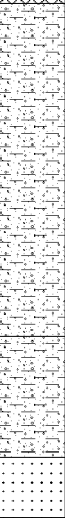
			TRIAL PIT RECORD			TP No. TP2				
			Site : Sheffield Road, Birdwell			Sheet 1 of 1				
			Client : Hartwood Estates Ltd			Contract No: C1634				
			Method : JCB 3CX backhoe excavator with 0.60m wide toothed bucket.			Dates: 28/04/2008				
						Scale 1:25				
SAMPLE DETAILS			Groundwater	STRATA RECORD			Logged By: SA			
							Checked By:			
Type	Depth From - To(m)	Vane Results kN/m²					Depth (m)	Level (mAOD) PID (ppm)	Legend	Well
D	0.30m			MADE GROUND: Tarmac.	0.09					
				MADE GROUND: Light grey sandy angular to subangular fine to coarse of GRAVEL of limestone.	0.18					
				MADE GROUND: Dark grey clayey fine to coarse SAND and angular to subangular fine to coarse GRAVEL with occasional cobbles. Gravel is of sandstone, brick and timber. Cobbles are angular of timber, pottery and sandstone. Slight diesel odour.	0.50					
D	0.80m			MADE GROUND: Dark brown fine to coarse SAND and angular to subrounded fine to coarse GRAVEL with occasional cobbles. Gravel is of ash, clinker, sandstone and brick. Cobbles are angular of wire and brick. Slight diesel odour.						
D	1.30m									
D	1.80m			--- At 2.00m 4" diameter cast iron pipe along east face.						
				End of Trial Pit at 2.00 m	2.00					
Remarks and Water Observations					GL (m AOD)		Fig. No.			
1. Trial pit stable during excavation.					-					
2. No groundwater encountered.					Easting:		TP2			
3. Trial pit terminated at 2.00m to avoid undermining an existing service.					-					
					-					

			TRIAL PIT RECORD		TP No. TP3									
			Site : Sheffield Road, Birdwell		Sheet 1 of 1									
			Client : Hartwood Estates Ltd		Contract No: C1634									
			Method : JCB 3CX backhoe excavator with 0.60m wide toothed bucket.		Dates: 28/04/2008									
					Scale 1:25									
SAMPLE DETAILS			STRATA RECORD	Logged By: SA										
<table><tr><td rowspan="2">Type</td><td rowspan="2">Depth From - To(m)</td><td rowspan="2">Vane Results kN/m²</td><td rowspan="2">Groundwater</td><td rowspan="2">Description</td><td>Checked By:</td></tr><tr><td>Depth (m)</td><td>Level (mAOD) PID (ppm)</td><td>Legend</td><td>Well</td></tr></table>				Type	Depth From - To(m)	Vane Results kN/m²	Groundwater	Description	Checked By:	Depth (m)	Level (mAOD) PID (ppm)	Legend	Well	
									Type	Depth From - To(m)	Vane Results kN/m²	Groundwater	Description	Checked By:
Depth (m)	Level (mAOD) PID (ppm)	Legend	Well											
D	0.20m			MADE GROUND: Light grey sandy angular to subangular fine to coarse GRAVEL of limestone.	0.05									
D	0.60m			MADE GROUND: Dark grey clayey fine to coarse SAND and angular to subangular fine to coarse GRAVEL with occasional cobbles. Gravel is of sandstone, concrete, brick, timber, ash and slate. Cobbles are angular of brick and sandstone. Slight diesel odour.										
D	1.20m													
D	1.60m													
D	2.20m			MADE GROUND: Red brown clayey fine to coarse SAND and angular to subangular fine to coarse GRAVEL of brick and sandstone. Strong diesel odour.	1.90									
			Soft orange brown mottled grey slightly sandy gravelly CLAY. High plasticity. Gravel is angular to subangular fine to coarse of sandstone.	2.10										
			Weak to medium strong orange brown fine to medium grained SANDSTONE. Highly to moderately weathered. (Recovered as sandy angular to subangular fine to coarse gravel).	2.20										
			End of Trial Pit at 2.30 m	2.30										
Remarks and Water Observations					GL (m AOD)		Fig. No.							
1. Trial pit stable during excavation.					-		TP3							
2. No groundwater encountered.					Easting:									
3. Trial pit refusal at 2.30m on impenetrable sandstone.					Northing:									
					-									

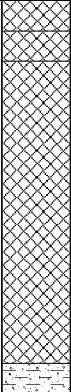
			TRIAL PIT RECORD			TP No. TP4			
			Site : Sheffield Road, Birdwell			Sheet 1 of 1			
			Client : Hartwood Estates Ltd			Contract No: C1634			
			Method : JCB 3CX backhoe excavator with 0.60m wide toothed bucket.			Dates: 28/04/2008			
			Scale 1:25						
SAMPLE DETAILS			Groundwater	STRATA RECORD			Logged By: SA		
							Checked By:		
Type	Depth From - To(m)	Vane Results kN/m²					Depth (m)	Level (mAOD) PID (ppm)	Legend
D	0.20m			MADE GROUND: Light grey sandy angular to subangular fine to coarse GRAVEL of limestone. MADE GROUND: Dark grey clayey fine to coarse SAND and angular to subangular fine to coarse GRAVEL with occasional cobbles. Gravel is of sandstone, concrete, brick, timber, ash and slate. Cobbles are angular of brick and sandstone. Slight diesel odour.			0.05		
D	0.60m								
D	1.20m								
D	2.70m								
Remarks and Water Observations				GL (m AOD)		Fig. No.			
1. Trial pit stable during excavation.				-		TP4			
2. Groundwater seepage encountered at 2.70m, oily sheen.				Easting:					
3. Trial pit refused at 2.70m on a brick floor.				-					
				Northing:					
				-					

			TRIAL PIT RECORD		TP No. TP5														
			Site : Sheffield Road, Birdwell		Sheet 1 of 1														
			Client : Hartwood Estates Ltd		Contract No: C1634														
			Method : JCB 3CX backhoe excavator with 0.60m wide toothed bucket.		Dates: 28/04/2008														
					Scale 1:25														
SAMPLE DETAILS			STRATA RECORD	Logged By: SA															
<table><tr><td rowspan="3">Type</td><td rowspan="3">Depth From - To(m)</td><td rowspan="3">Vane Results kN/m²</td><td rowspan="3">Groundwater</td><td colspan="4">Checked By:</td></tr><tr><td rowspan="2">Depth (m)</td><td rowspan="2">Level (mAOD) PID (ppm)</td><td rowspan="2">Legend</td><td rowspan="2">Well</td></tr><tr></tr></table>				Type	Depth From - To(m)	Vane Results kN/m²	Groundwater	Checked By:				Depth (m)	Level (mAOD) PID (ppm)	Legend	Well				
								Type	Depth From - To(m)	Vane Results kN/m²	Groundwater					Checked By:			
												Depth (m)	Level (mAOD) PID (ppm)	Legend	Well				
			Description																
D	0.30m			MADE GROUND: Tarmac.	0.10														
				MADE GROUND: Light grey sandy angular to subangular fine to coarse GRAVEL of limestone.					0.20										
	D	0.80m			MADE GROUND: Dark grey fine to coarse SAND and angular to subangular fine to coarse GRAVEL with occasional cobbles. Gravel is of sandstone, brick, ash and slate. Cobbles are angular of sandstone, brick and slate.														
D	1.30m																		
				--- At 1.50m brick floor	1.50														
				End of Trial Pit at 1.50 m															
Remarks and Water Observations					GL (m AOD)		Fig. No.												
1. Trial pit stable during excavation.					-		TP5												
2. No groundwater encountered.					Easting:														
3. Trial pit refused at 1.50m on a brick floor.					-														
					Northing:														
					-														

			TRIAL PIT RECORD			TP No. TP6		
			Site : Sheffield Road, Birdwell			Sheet 1 of 1		
			Client : Hartwood Estates Ltd			Contract No: C1634		
			Method : JCB 3CX backhoe excavator with 0.60m wide toothed bucket.			Dates: 29/04/2008		
			Scale 1:25					
SAMPLE DETAILS			Groundwater	STRATA RECORD			Logged By: SA	
							Checked By:	
Type	Depth From - To(m)	Vane Results kN/m²		Description	Depth (m)	Level (mAOD) PID (ppm)	Legend	Well
D	0.30m			MADE GROUND: Tarmac.	0.09			
			MADE GROUND: Light grey sandy angular to subangular fine to coarse GRAVEL of limestone.	0.16				
			MADE GROUND: Light brown fine to coarse SAND and angular to subangular fine to coarse GRAVEL with occasional cobbles. Gravel is of brick, sandstone, concrete and ash. Cobbles are angular of brick.					
D	1.00m		MADE GROUND: Dark grey clayey fine to coarse SAND and subangular to subrounded fine to coarse GRAVEL with occasional cobbles. Gravel is of brick, ash, sandstone and occasional concrete. Cobbles are angular of brick, metal and timber.	0.90				
D	1.50m		--- At 1.60m concrete floor. --- From 1.50m slight diesel odour. End of Trial Pit at 1.60 m	1.60				
Remarks and Water Observations					GL (m AOD)		Fig. No.	
1. Trial pit stable during excavation.					-		TP6	
2. No groundwater encountered.					Easting:			
3. Trial pit refused at 1.60m on a concrete floor.					-			
					Northing:			
					-			

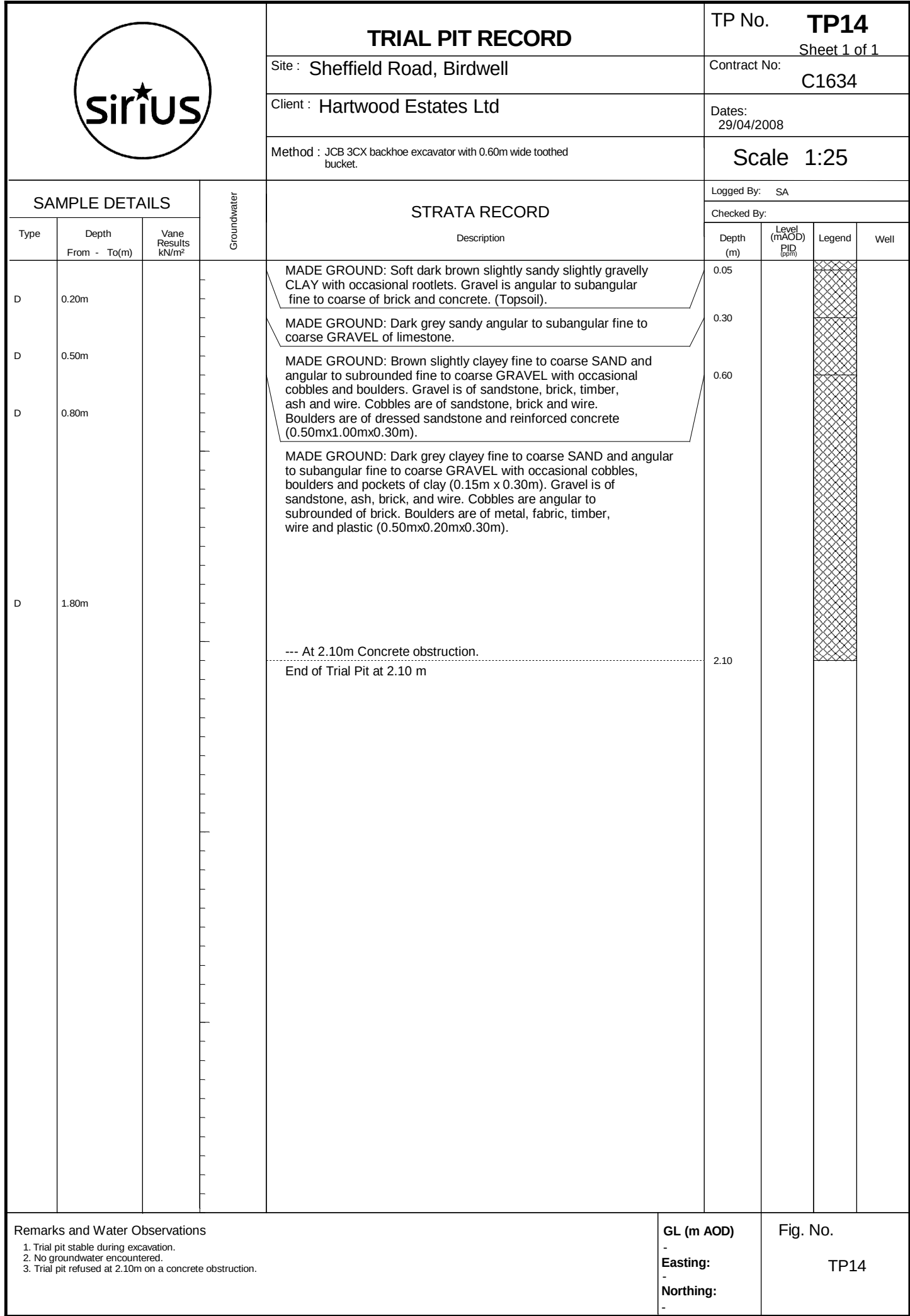
			TRIAL PIT RECORD		TP No. TP7										
			Site : Sheffield Road, Birdwell		Sheet 1 of 1										
			Client : Hartwood Estates Ltd		Contract No: C1634										
			Method : JCB 3CX backhoe excavator with 0.60m wide toothed bucket.		Dates: 28/04/2008										
					Scale 1:25										
SAMPLE DETAILS			STRATA RECORD	Logged By: SA											
<table><tr><td rowspan="2">Type</td><td rowspan="2">Depth From - To(m)</td><td rowspan="2">Vane Results kN/m²</td><td rowspan="2">Groundwater</td><td rowspan="2">Description</td><td rowspan="2">Depth (m)</td><td rowspan="2">Level (mAOD) PID (ppm)</td><td rowspan="2">Legend</td><td rowspan="2">Well</td></tr><tr></tr></table>				Type	Depth From - To(m)	Vane Results kN/m²	Groundwater	Description	Depth (m)	Level (mAOD) PID (ppm)	Legend	Well	Checked By:		
													Type	Depth From - To(m)	Vane Results kN/m²
D	0.20m	40.0		MADE GROUND: Light grey angular to subangular fine to coarse GRAVEL of limestone.	0.10										
				MADE GROUND: Dark grey fine to coarse SAND and angular to subangular fine to coarse GRAVEL with occasional cobbles. Gravel is of brick and sandstone. Cobbles are angular of sandstone.	0.50										
D	0.90m				MADE GROUND: Soft orange brown slightly sandy slightly gravelly CLAY. High plasticity. Gravel is angular to subangular fine to coarse of sandstone and brick.				0.90						
D	1.10m	38.0		Firm, low and medium strength orange brown mottled light grey slightly sandy slightly gravelly CLAY. High plasticity. Gravel is angular to subangular fine to coarse of sandstone.											
D	1.60m				--- From 1.60m Groundwater seepage with strong hydrocarbon odour.										
D	2.00m														
D	2.20m	90.0		Stiff, high strength grey mottled orange brown slightly sandy slightly gravelly CLAY. High plasticity. Gravel is angular to subangular fine to coarse of sandstone. Hydrocarbon odour.	2.00										
D	2.50m			Moderately weak grey brown SANDSTONE. Highly weathered. (Recovered as angular gravel).	2.40										
				End of Trial Pit at 2.60 m	2.60										
Remarks and Water Observations					GL (m AOD)		Fig. No.								
1. Trial pit stable during excavation.					-		TP7								
2. Groundwater seepage, encountered at 1.60m.					Easting:										
3. Trial pit refused at 2.60m on impenetrable rock.					Northing:										
					-										

			TRIAL PIT RECORD		TP No. TP8		
			Site : Sheffield Road, Birdwell		Sheet 1 of 1		
			Client : Hartwood Estates Ltd		Contract No: C1634		
			Method : JCB 3CX backhoe excavator with 0.60m wide toothed bucket.		Dates: 28/04/2008		
					Scale 1:25		
SAMPLE DETAILS			Groundwater	STRATA RECORD		Logged By: SA	
		Checked By:					
Type	Depth From - To(m)	Vane Results kN/m²				Depth (m)	Level (mAOD) PID (ppm)
D	0.50m			MADE GROUND: Concrete.	0.10		
				MADE GROUND: Light grey sandy angular to subangular fine to coarse GRAVEL of limestone.	0.30		
D	1.00m			MADE GROUND: Grey brown fine to coarse SAND and angular to subangular fine to coarse GRAVEL with occasional cobbles. Gravel is of sandstone, concrete and brick. Cobbles are angular of concrete and brick. --- From 0.30m to 2.50m on the north and east faces of the trial pit- concrete wall.			
D	1.50m						
D	2.00m						
D	2.50m			--- At 2.50m concrete obstruction.			
				End of Trial Pit at 2.50 m	2.50		
Remarks and Water Observations					GL (m AOD)		Fig. No.
1. Trial pit stable during excavation.					-		
2. No groundwater encountered.					Easting:		
3. Trial pit refused at 2.50m on a concrete obstruction.					-		
					Northing:		TP8
					-		

			TRIAL PIT RECORD			TP No. TP9		
			Site : Sheffield Road, Birdwell			Sheet 1 of 1		
			Client : Hartwood Estates Ltd			Contract No: C1634		
			Method : JCB 3CX backhoe excavator with 0.60m wide toothed bucket.			Dates: 28/04/2008		
			Scale 1:25					
SAMPLE DETAILS			Groundwater	STRATA RECORD			Logged By: SA	
							Checked By:	
Type	Depth From - To(m)	Vane Results kN/m²	Description	Depth (m)	Level (mAOD) PID (ppm)	Legend	Well	
D	0.40m		MADE GROUND: Tarmac	0.10				
			MADE GROUND: Light grey sandy angular to subangular fine to coarse GRAVEL of limestone.	0.20				
D	0.90m		MADE GROUND: Dark grey fine to coarse SAND and angular to subangular fine to coarse GRAVEL with occasional cobbles. Gravel is sandstone, brick and clinker. Cobbles are angular of sandstone and brick. --- From 0.20m to 1.20m on the north face of the trial pit, brick wall.					
D	1.20m		--- At 1.20m 3no cast iron pipes, running east-west in north and south face of pit.	1.20				
			Soft orange brown slightly sandy slightly gravelly CLAY. High plasticity. Gravel is angular to subangular fine to coarse of sandstone.	1.30				
			End of Trial Pit at 1.30 m					
Remarks and Water Observations				GL (m AOD)		Fig. No.		
1. Trial pit stable during excavation.				-		TP9		
2. No groundwater encountered.				Easting:				
3. Trial pit terminated at 1.30m to avoid undermining existing services.				-				
				Northing:				
				-				

			TRIAL PIT RECORD			TP No. TP11		
			Site : Sheffield Road, Birdwell			Sheet 1 of 1		
			Client : Hartwood Estates Ltd			Contract No: C1634		
			Method : JCB 3CX backhoe excavator with 0.60m wide toothed bucket.			Dates: 29/04/2008		
			Scale 1:25					
SAMPLE DETAILS			Groundwater	STRATA RECORD			Logged By: SA	
							Checked By:	
Type	Depth From - To(m)	Vane Results kN/m²					Depth (m)	Level (mAOD) PID (ppm)
D	0.40m			MADE GROUND: Dark grey locally slightly clayey fine to coarse SAND and angular to subangular fine to coarse GRAVEL with occasional cobbles. Gravel is of sandstone, ash and brick. Cobbles are angular of brick.	0.10 0.20			
D	1.00m			MADE GROUND: Brick floor.				
D	1.50m			MADE GROUND: Dark grey locally slightly clayey fine to coarse SAND and angular to subangular fine to coarse GRAVEL with occasional cobbles. Gravel is of sandstone, ash and brick. Cobbles are angular of brick.	1.40			
D	2.50m			MADE GROUND: Light brown and dark grey slightly gravelly, clayey fine to coarse SAND with occasional cobbles and pockets (100-500mm) of soft dark grey clay. Gravel is angular to subangular fine to coarse of brick, sandstone and timber. Cobbles are angular of brick and timber. Strong diesel odour within clay pockets and sulphur odour with depth.				
D	3.50m			Soft orange brown stained dark grey slightly sandy slightly gravelly CLAY. High plasticity. Gravel is angular to subangular fine to coarse of sandstone. --- At 3.40m slight sheen and hydrocarbon odour on water.	3.30			
				End of Trial Pit at 4.00 m	4.00			
Remarks and Water Observations					GL (m AOD)		Fig. No.	
1. Trial pit stable during excavation.					-		TP11	
2. Groundwater encountered at 3.40m, slight sheen and hydrocarbon odour.					Easting:			
3. Trial pit terminated at 4.00m at full reach of excavator.					Northing:			
					-			

				TRIAL PIT RECORD			TP No. TP13	
				Site : Sheffield Road, Birdwell			Sheet 1 of 1	
				Client : Hartwood Estates Ltd			Contract No: C1634	
				Method : JCB 3CX backhoe excavator with 0.60m wide toothed bucket.			Dates: 29/04/2008	
				Scale 1:25				
SAMPLE DETAILS			Groundwater	STRATA RECORD			Logged By: SA	
							Checked By:	
Type	Depth From - To(m)	Vane Results kN/m²					Depth (m)	Level (mAOD) PID (ppm)
D	0.30m	70.0	MADE GROUND: Soft dark brown slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is angular to subangular fine to coarse of sandstone and brick. (Topsoil).			0.05		
D	0.80m		MADE GROUND: Dark brown clayey fine to coarse SAND and angular to subangular fine to coarse GRAVEL with occasional cobbles and boulders. Gravel is of sandstone, brick, timber, ash and wire. Cobbles are angular of sandstone, brick and wire. Boulders are of dressed sandstone and reinforced concrete. (1.0mx0.5mx0.2m).					
D	1.50m							
D	2.00m		Stiff, medium strength, orange brown mottled slightly sandy slightly gravelly CLAY. High plasticity. Gravel is angular to subangular fine to coarse of sandstone. (Completely weathered sandstone).			1.70		
D	2.30m		Moderately strong orange brown fine to medium grained SANDSTONE. Moderately weathered. (Recovered as angular fine to coarse gravel).			2.30 2.35		
				End of Trial Pit at 2.35 m				
Remarks and Water Observations						GL (m AOD)		Fig. No.
1. Trial pit stable during excavation.						-		
2. No groundwater encountered.						Easting:		
3. Trial pit refused at 2.35m on impenetrable rock.						Northing:		
								TP13



			TRIAL PIT RECORD			TP No. TP15		
			Site : Sheffield Road, Birdwell			Sheet 1 of 1		
			Client : Hartwood Estates Ltd			Contract No: C1634		
			Method : JCB 3CX backhoe excavator with 0.60m wide toothed bucket.			Dates: 29/04/2008		
			Scale 1:25					
SAMPLE DETAILS			Groundwater	STRATA RECORD			Logged By: SA	
							Checked By:	
Type	Depth From - To(m)	Vane Results kN/m²					Depth (m)	Level (mAOD) PID (ppm)
D	0.10m	98.0	MADE GROUND: Soft dark brown slightly sandy slightly gravelly CLAY. High plasticity. Gravel is angular to subangular fine to coarse of sandstone and brick. (Topsoil).			0.05		
D	0.50m		MADE GROUND: Dark brown clayey fine to coarse SAND and angular to subrounded fine to coarse GRAVEL with occasional cobbles and boulders. Gravel is of sandstone, brick, and concrete. Cobbles and boulders (0.50mx0.30mx0.20m) are angular of brick and concrete.			0.60		
D	1.00m		Stiff, high strength orange brown mottled grey, slightly sandy slightly gravelly CLAY with occasional cobbles. Gravel is of sandstone. Cobbles are angular of sandstone.			1.20		
D	1.50m		Moderately strong grey discoloured orange brown fine to medium grained SANDSTONE. Moderately weathered. (Recovered as clayey angular to subangular fine to coarse gravel with cobbles and boulders (0.3mx0.3mx0.1m)).			1.70		
			End of Trial Pit at 1.70 m					
Remarks and Water Observations						GL (m AOD)		Fig. No.
1. Trial pit stable during excavation.						-		
2. No groundwater encountered.						Easting:		
3. Trial pit refused at 1.70m on impeneterable rock.						-		
						Northing:		
						-		
						TP15		

			TRIAL PIT RECORD			TP No. TP16		
			Site : Sheffield Road, Birdwell			Sheet 1 of 1		
			Client : Hartwood Estates Ltd			Contract No: C1634		
			Method : JCB 3CX backhoe excavator with 0.60m wide toothed bucket.			Dates: 29/04/2008		
			Scale 1:25					
SAMPLE DETAILS			Groundwater	STRATA RECORD			Logged By: SA	
							Checked By:	
Type	Depth From - To(m)	Vane Results kN/m²					Depth (m)	Level (mAOD) PID (ppm)
D	0.15m	60.0 102.0	MADE GROUND: Tarmac.			0.08		
D	0.50m		MADE GROUND: Light brown grey fine to coarse SAND and angular to subrounded fine to coarse GRAVEL with occasional cobbles. Gravel is of sandstone, brick and timber. Cobbles are angular of brick.			0.38		
D	0.80m		MADE GROUND: Dark grey fine to coarse SAND and angular to subangular fine to coarse GRAVEL with occasional cobbles. Gravel is of brick, ash and sandstone. Cobbles are angular of brick.			0.70		
D	1.80m		Stiff, medium to high strength orange brown mottled light grey slightly sandy gravelly CLAY. High plasticity. Gravel is angular to subangular fine to coarse of sandstone.			1.90		
D	1.95m					Moderately strong grey discoloured orange brown fine to medium grained SANDSTONE. Highly to moderately weathered. (Recovered as clayey angular to subangular fine to coarse gravel).		
			End of Trial Pit at 2.00 m					
Remarks and Water Observations						GL (m AOD)		Fig. No.
1. Trial pit stable during excavation.						-		
2. No groundwater encountered.						Easting:		
3. Trial pit refused at 2.00m on impeneterable sandstone.						Northing:		
						-		TP16



APPENDIX C

LABORATORY TEST RESULTS



LABORATORY REPORT



4043

Contract Number: PSL08/1035

Client's Reference:

Report Date: 20 May 2008

Client Name: Sirius Leeds
4245 Park Approach
Century Way
Thorpe Park
Leeds
LS15 8GB



For the attention of: Mark Brennan

Contract Title: Sheffield Road, Birdwell

Date Received: 12-May-08

Date Commenced: 12-May-08

Date Completed: 14-May-08

Notes: Observations and Interpretations are outside the UKAS Accreditation

A copy of the Laboratory Schedule of accredited tests as issued by UKAS is attached to this report. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced in full, without the prior written approval of the laboratory.

Approved Signatories:

R Gunson
(Director)

A Watkins
(Director)

A D'Rozario
(Quality Manager)

D Lambe
(Senior Technician)

SUMMARY OF LABORATORY SOIL DESCRIPTIONS

[illegible]

		SHEFFIELD ROAD, BIRDWELL.				Contract No: PSL08/1035	
Compiled by		Date	14/5/08	Checked by		Date	14/5/08
				Approved by		Date	
						Client Ref: C1634	

(B.S. 1377 : PART 2 : 1990)

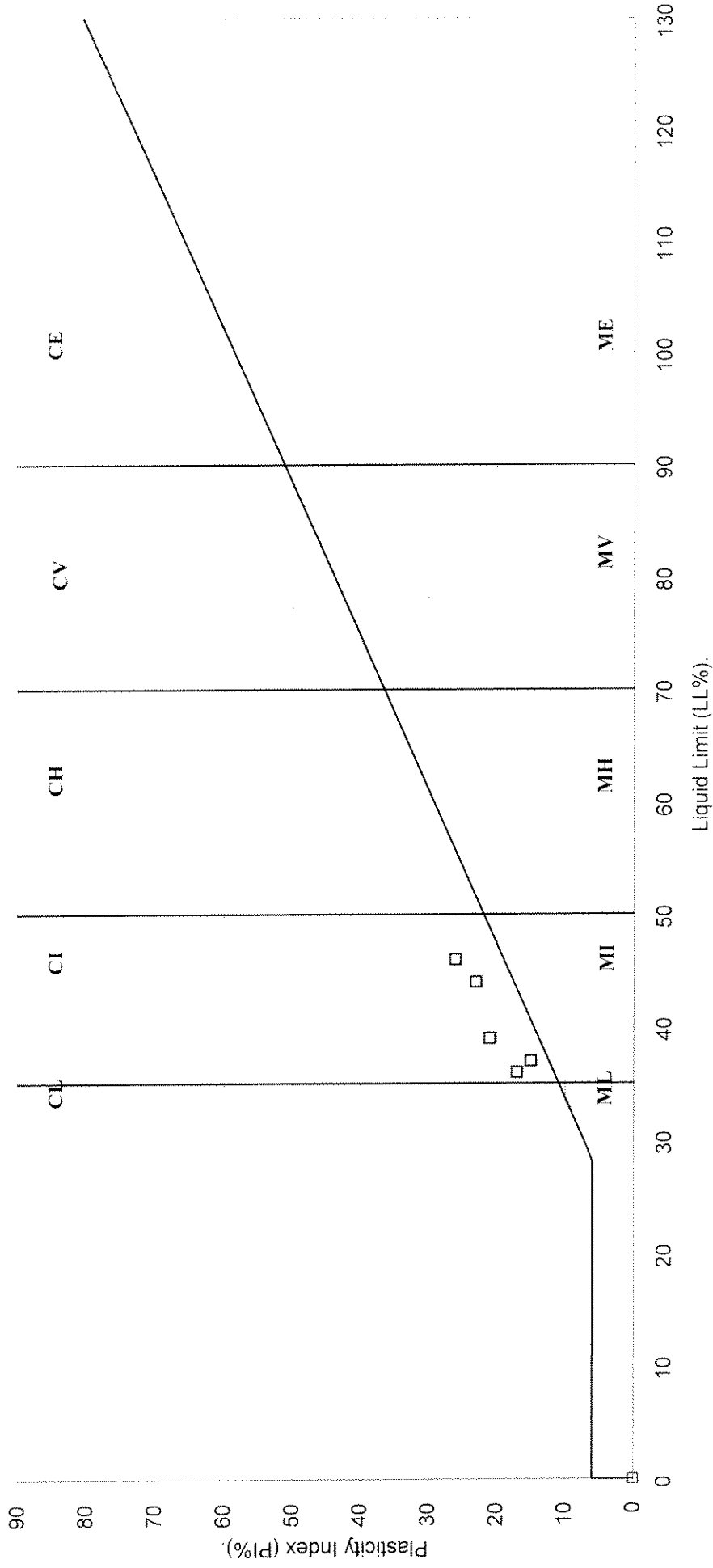
SYMBOLS: NP: Non Plastic

* : Liquid Limit and Plastic Limit Wet Sieved.

 Professional Soils Laboratory		<table border="1"> <tr> <td rowspan="2">Compiled by </td> <td>Date 14/5/08</td> <td>Checked by </td> <td>Date 14/5/08</td> <td>Approved by </td> <td>Date 14/5/08</td> </tr> <tr> <td colspan="5"> SHEFFIELD ROAD, BIRDWELL. Contract No: PSL08/1035 Client Ref: C1634 </td> </tr> </table>						Compiled by 	Date 14/5/08	Checked by 	Date 14/5/08	Approved by 	Date 14/5/08	SHEFFIELD ROAD, BIRDWELL. Contract No: PSL08/1035 Client Ref: C1634				
Compiled by 	Date 14/5/08	Checked by 	Date 14/5/08	Approved by 	Date 14/5/08													
	SHEFFIELD ROAD, BIRDWELL. Contract No: PSL08/1035 Client Ref: C1634																	

PLASTICITY CHART FOR CASAGRANDE CLASSIFICATION.

(B.S.5930 : 1999)





Professional Soils Laboratory

Compiled by	Date	Checked by	Date	Approved by	Date
<i>[Signature]</i>	14/5/08	<i>[Signature]</i>	14/5/08	<i>[Signature]</i>	14/5/08
SHEFFIELD ROAD, BIRDWELL.					
Contract No: PSL08/1035			Client Ref: C1634		

Schedule of Accreditation

issued by

United Kingdom Accreditation Service

21 - 47 High Street, Feltham, Middlesex, TW13 4UN, UK



4043

Accredited to
ISO/IEC 17025:2005

Professional Soils Laboratory Ltd

Issue No: 002 Issue date: 09 November 2007

5/7 Hexthorpe Road
Hexthorpe
Doncaster
DN4 0AG

Contact: Mr A Watkins
Tel: +44 (0)870 240 1964
Fax: +44 (0)870 240 1965
E-Mail: awatkin@prosoils.co.uk
Website: www.prosoils.co.uk

Testing performed at the above address only

DETAIL OF ACCREDITATION

Materials/Products tested	Type of test/Properties measured/Range of measurement	Standard specifications/ Equipment/Techniques used
AGGREGATES	Particle size distribution - sieving method	BS EN 933-1:1997
SOILS for civil engineering purposes	Moisture content - oven drying method	BS 1377-2:1990
	Liquid limit - cone penetrometer	BS 1377-2:1990
	Liquid limit - cone penetrometer - one point	BS 1377-2:1990
	Plastic limit	BS 1377-2:1990
	Plasticity index and liquidity index	BS 1377-2:1990
	Particle density - gas jar	BS 1377-2:1990
	Particle size distribution - wet sieving	BS 1377-2:1990
	Particle size distribution - dry sieving	BS 1377-2:1990
	Particle size distribution - sedimentation - pipette method	BS 1377-2:1990
	Dry density/moisture content relationship (2.5 kg rammer)	BS 1377-4:1990
	Dry density/moisture content relationship (4.5 kg rammer)	BS 1377-4:1990



4043
Accredited to
ISO/IEC 17025:2005

Schedule of Accreditation
issued by
United Kingdom Accreditation Service
21 - 47 High Street, Feltham, Middlesex, TW13 4UN, UK

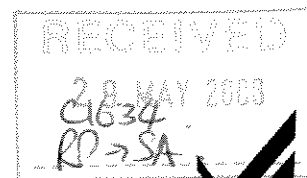
Professional Soils Laboratory Ltd
Issue No: 002 Issue date: 09 November 2007

Testing performed at main address only

Materials/Products tested	Type of test/Properties measured/Range of measurement	Standard specifications/ Equipment/Techniques used
SOILS for civil engineering purposes	California Bearing Ratio (CBR) <i>(loads from 0.2 to 50 kN)</i>	BS 1377-4:1990
	Moisture condition value (MCV)	BS 1377-4:1990
	MCV - natural moisture content	BS 1377:Part 4:1990
	MCV/moisture content relation	BS 1377:Part 4:1990
	Uniformity coefficient (221 2217)	BS 6100-2.2.1:1992
END		



2139



MCERTS
THE ENVIRONMENT AGENCY'S
MONITORING CERTIFICATION SCHEME

Date: 27/05/2008

Certificate of Analysis

Certificate Number: 08-19338

Client: Sirius Geotechnical & Environmental
4245 Park Approach
Thorpe Park
Leeds
LS15 8GB

Our Reference: 08-19338

Client Reference: C1634

Contract Title: Sheffield Road, Birdwell

Description: 18 soil samples, 4 leachate samples, 1 water sample

Date Received: 12/05/2008

Date Started: 13/05/2008

Date Completed: 27/05/2008

Test Procedures: Identified by prefix DETSn, details available upon request.

Notes: Observations and interpretations are outside the scope of UKAS accreditation
* denotes test not included in laboratory scope of accreditation
denotes test that holds MCERT accreditation
\$ denotes tests completed by approved subcontractors
I/S denotes insufficient sample to carry out test
N/S denotes that the sample is not suitable for testing
DETSM denotes tests carried out by DETS Midlands laboratory
Solid samples will be disposed 1 month and liquids 2 weeks
after the date of issue of this test certificate
Asbestos subsamples will be kept for 6 months
NAD denotes no Asbestos detected

Approved By: 

Authorised Signatories: Richard Bennett
Director

Page 1 of 18

This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.

Our Ref: 08-19338
 Client Ref: C1634
 Contract Title: Sheffield Road, Birdwell

Sample Details

<u>Sample ID</u>	<u>Depth</u>	<u>DETS Ref</u>	<u>Matrix Description</u>	<u>Date Sampled</u>	<u>Time Sampled</u>	<u>Preservation</u>	<u>Analysis Complete</u>
TP1	0.30	132197	Soft dark brown gravelly sandy CLAY (made ground includes plastic)	Not Provided	Not Provided	None	27/05/2008
TP3	0.20	132198	Soft dark brown gravelly sandy CLAY (made ground contains brick)	Not Provided	Not Provided	None	27/05/2008
TP3	2.00	132199	Very soft dark grey gravelly sandy CLAY (made ground includes slag) (strong hydrocarbon odour)	Not Provided	Not Provided	None	27/05/2008
TP3	2.20	132200	Soft light brown grey gravelly sandy CLAY	Not Provided	Not Provided	None	27/05/2008
TP5	0.30	132201	Loose dark brown sandy GRAVEL (made ground includes slag)	Not Provided	Not Provided	None	27/05/2008
TP7	0.20	132202	Soft dark brown / brown gravelly sandy CLAY	Not Provided	Not Provided	None	27/05/2008
TP7	1.60	132203	Soft brown gravelly sandy CLAY	Not Provided	Not Provided	None	27/05/2008
TP8	0.50	132204	Loose dark brown gravelly SAND (made ground contains brick)	Not Provided	Not Provided	None	27/05/2008
TP9	0.40	132205	Loose dark brown sandy GRAVEL (made ground includes brick & slag)	Not Provided	Not Provided	None	27/05/2008
TP11	0.40	132206	Loose dark brown clayey gravelly SAND (made ground includes brick)	Not Provided	Not Provided	None	27/05/2008
TP11	1.50	132207	Soft dark brown / black gravelly sandy CLAY (silty)	Not Provided	Not Provided	None	27/05/2008
TP11	3.50	132208	Very soft black gravelly CLAY (silty)	Not Provided	Not Provided	None	27/05/2008
TP13	0.30	132209	Loose brown clayey sandy GRAVEL (made ground includes tar)	Not Provided	Not Provided	None	27/05/2008
TP14	0.50	132210	Loose brown clayey sandy GRAVEL (made ground includes tar)	Not Provided	Not Provided	None	27/05/2008
TP14	0.80	132211	Loose brown clayey sandy GRAVEL (made ground contains brick)	Not Provided	Not Provided	None	27/05/2008
TP12	0.30	132212	Loose dark brown gravelly SAND (made ground contains brick)	Not Provided	Not Provided	None	27/05/2008
TP12	1.20	132213	Soft light brown / grey / orange sandy CLAY	Not Provided	Not Provided	None	27/05/2008
TP13	2.30	132214	Loose light brown sandy GRAVEL	Not Provided	Not Provided	None	27/05/2008

Summary of Chemical Analysis

Soil Samples

Our Ref: 08-19338
 Client Ref: C1634
 Contract Title: Sheffield Road, Birdwell

			Lab No.	132197	132198	132199	132200
			Sample Ref	TP1	TP3	TP3	TP3
			Depth	0.30	0.20	2.00	2.20
			Other Ref				
			Sample Type	D	D	D	D
Test	Units	DETSxx					
Arsenic	mg/kg	DETS 042#	21	14			10
Cadmium	mg/kg	DETS 042#	5	1.2			1.6
Chromium	mg/kg	DETS 042#	160	23			25
Copper	mg/kg	DETS 042#	590	75			46
Lead	mg/kg	DETS 042#	850	160			31
Mercury	mg/kg	DETS 081*	0.9	0.3			< 0.1
Nickel	mg/kg	DETS 042#	78	22			16
Selenium	mg/kg	DETS 042#	< 0.5	< 0.5			< 0.5
Zinc	mg/kg	DETS 042#	310	130			77
Calorific Value	KJ/kg	DETS 037*		1100			
Cyanide total	mg/kg	DETS 067#					
Cyanide free	mg/kg	DETS 067#					
Total Sulphate as SO4	%	DETS 075#	0.12	0.12			0.05
Sulphate Aqueous Extract as SO4	g/l	DETS 076#	0.18	0.23			0.11
Total Organic Carbon	%	DETS 002	8.9	7.6			0.6
pH		DETS 008#	8.5	8.2			7.7
Aliphatic C5-C6	mg/kg	DETS 072*	< 0.01	0.05	< 0.01		
Aliphatic C6-C8	mg/kg	DETS 072*	< 0.01	1.1	< 0.01		
Aliphatic C8-C10	mg/kg	DETS 072*	< 0.01	0.35	4.2		
Aliphatic C10-C12	mg/kg	DETS 072*	27	11	460		
Aliphatic C12-C16	mg/kg	DETS 072*	220	90	18000		
Aliphatic C16-C21	mg/kg	DETS 072*	1300	280	7400		
Aliphatic C21-C35	mg/kg	DETS 072*	11000	2200	530		
Aromatic C5-C7	mg/kg	DETS 072*	< 0.01	0.04	0.68		
Aromatic C7-C8	mg/kg	DETS 072*	< 0.01	0.04	2.3		
Aromatic C8-C10	mg/kg	DETS 072*	< 0.01	0.33	3.7		
Aromatic C10-C12	mg/kg	DETS 072*	2.7	7.1	76		
Aromatic C12-C16	mg/kg	DETS 072*	23	23	17000		
Aromatic C16-C21	mg/kg	DETS 072*	240	170	16000		
Aromatic C21-C35	mg/kg	DETS 072*	2300	700	20000		
Aliphatic C5-C35	mg/kg	DETS 072*	12000	2500	26000		
Aromatic C5-C35	mg/kg	DETS 072*	2500	900	53000		
TPH Ali/Aro	mg/kg	DETS 072*	15000	3400	79000		
Acenaphthene	mg/kg	DETS 050	30	7.6	740		0.9
Acenaphthylene	mg/kg	DETS 050	6.2	2.8	130		0.2
Anthracene	mg/kg	DETS 050	46	88	2200		0.5
Benzo(a)anthracene	mg/kg	DETS 050	140	120	560		< 0.1
Benzo(a)pyrene	mg/kg	DETS 050	190	74	76		< 0.1
Benzo(b)fluoranthene	mg/kg	DETS 050	140	97	210		< 0.1
Benzo(k)fluoranthene	mg/kg	DETS 050	93	33	74		< 0.1
Benzo(g,h,i)perylene	mg/kg	DETS 050	130	44	24		< 0.1
Chrysene	mg/kg	DETS 050	100	100	880		< 0.1
Dibenzo(a,h)anthracene	mg/kg	DETS 050	100	18	22		< 0.1
Fluoranthene	mg/kg	DETS 050	88	290	6500		0.7
Fluorene	mg/kg	DETS 050	15	53	4600		1.2

Summary of Chemical Analysis Soil Samples

Our Ref: 08-19338

Client Ref: C1634

Contract Title: Sheffield Road, Birdwell

			Lab No.	132197	132198	132199	132200
			Sample Ref	TP1	TP3	TP3	TP3
			Depth	0.30	0.20	2.00	2.20
			Other Ref				
			Sample Type	D	D	D	D
Test	Units	DETSxx					
Indeno(1,2,3-c,d)pyrene	mg/kg	DETS 050	120	49	29	< 0.1	
Napthalene	mg/kg	DETS 050	21	6.9	330	0.3	
Phenanthrene	mg/kg	DETS 050	36	280	22000	3.4	
Pyrene	mg/kg	DETS 050	63	220	4100	0.4	
PAH	mg/kg	DETS 050	1300	1500	43000	7.6	
Phenol - Monohydric	mg/kg	DETS 067#	0.7	0.7		< 0.3	
PCB	mg/kg	DETS 052*					
2,4,4'-Trichlorobiphenyl PCB 28	mg/kg	DETS 052*					
2,2',5,5'-Tetrachlorobiphenyl PCB 52	mg/kg	DETS 052*					
2,2',4,5,5'-Pentachlorobiphenyl PCB 101	mg/kg	DETS 052*					
2,3',4,4',5-Pentachlorobiphenyl PCB 118	mg/kg	DETS 052*					
2,2',4,4',5,5'-Hexachlorobiphenyl PCB 153	mg/kg	DETS 052*					
2,2',3,4,4',5'-Hexachlorobiphenyl PCB 138	mg/kg	DETS 052*					
2,2',3,4,4',5,5'-Heptachlorobiphenyl PCB 180	mg/kg	DETS 052*					

Summary of Chemical Analysis Soil Samples

Our Ref: 08-19338

Client Ref: C1634

Contract Title: Sheffield Road, Birdwell

			Lab No.	132201	132202	132203	132204
			Sample Ref	TP5	TP7	TP7	TP8
			Depth	0.30	0.20	1.60	0.50
			Other Ref				
			Sample Type	D	D	D	D
Test	Units	DETSxx					
Arsenic	mg/kg	DETS 042#	29	12	13	20	
Cadmium	mg/kg	DETS 042#	1.7	1.1	0.9	3.9	
Chromium	mg/kg	DETS 042#	26	17	14	240	
Copper	mg/kg	DETS 042#	150	27	11	79	
Lead	mg/kg	DETS 042#	1000	52	33	380	
Mercury	mg/kg	DETS 081*	0.2	0.2	0.2	0.1	
Nickel	mg/kg	DETS 042#	25	27	13	120	
Selenium	mg/kg	DETS 042#	< 0.5	< 0.5	1.2	0.8	
Zinc	mg/kg	DETS 042#	120	78	72	1300	
Calorific Value	KJ/kg	DETS 037*					
Cyanide total	mg/kg	DETS 067#					
Cyanide free	mg/kg	DETS 067#					
Total Sulphate as SO4	%	DETS 075#	0.74	0.04	0.07	0.4	
Sulphate Aqueous Extract as SO4	g/l	DETS 076#	1.7	0.09	0.2	1.1	
Total Organic Carbon	%	DETS 002	8.2	1.7	1.3	3.3	
pH		DETS 008#	7.3	7.6	7.9	10.3	
Aliphatic C5-C6	mg/kg	DETS 072*			< 0.01		
Aliphatic C6-C8	mg/kg	DETS 072*			< 0.01		
Aliphatic C8-C10	mg/kg	DETS 072*			< 0.01		
Aliphatic C10-C12	mg/kg	DETS 072*			2.1		
Aliphatic C12-C16	mg/kg	DETS 072*			69		
Aliphatic C16-C21	mg/kg	DETS 072*			85		
Aliphatic C21-C35	mg/kg	DETS 072*			46		
Aromatic C5-C7	mg/kg	DETS 072*			< 0.01		
Aromatic C7-C8	mg/kg	DETS 072*			< 0.01		
Aromatic C8-C10	mg/kg	DETS 072*			< 0.01		
Aromatic C10-C12	mg/kg	DETS 072*			1.2		
Aromatic C12-C16	mg/kg	DETS 072*			55		
Aromatic C16-C21	mg/kg	DETS 072*			310		
Aromatic C21-C35	mg/kg	DETS 072*			210		
Aliphatic C5-C35	mg/kg	DETS 072*			200		
Aromatic C5-C35	mg/kg	DETS 072*			580		
TPH Ali/Aro	mg/kg	DETS 072*			780		
Acenaphthene	mg/kg	DETS 050	1.4	0.1	86	0.6	
Acenaphthylene	mg/kg	DETS 050	0.7	0.1	11	0.3	
Anthracene	mg/kg	DETS 050	1.6	0.1	69	0.6	
Benzo(a)anthracene	mg/kg	DETS 050	3.9	1	19	1.4	
Benzo(a)pyrene	mg/kg	DETS 050	2.8	1.3	1.4	1	
Benzo(b)fluoranthene	mg/kg	DETS 050	5.3	1.5	2	1.3	
Benzo(k)fluoranthene	mg/kg	DETS 050	1.6	0.5	6.8	0.4	
Benzo(g,h,i)perylene	mg/kg	DETS 050	0.3	1	0.7	0.8	
Chrysene	mg/kg	DETS 050	3.6	0.8	6.8	1.2	
Dibenzo(a,h)anthracene	mg/kg	DETS 050	< 0.1	0.2	1.5	0.3	
Fluoranthene	mg/kg	DETS 050	6.1	0.9	97	2.3	
Fluorene	mg/kg	DETS 050	1.7	0.2	100	0.7	

Summary of Chemical Analysis Soil Samples

Our Ref: 08-19338

Client Ref: C1634

Contract Title: Sheffield Road, Birdwell

			Lab No.	132201	132202	132203	132204
			Sample Ref	TP5	TP7	TP7	TP8
			Depth	0.30	0.20	1.60	0.50
			Other Ref				
			Sample Type	D	D	D	D
Test	Units	DETSxx					
Indeno(1,2,3-c,d)pyrene	mg/kg	DETS 050	0.5	1.1	0.1	0.6	
Napthalene	mg/kg	DETS 050	2.3	1.5	2.2	0.5	
Phenanthrene	mg/kg	DETS 050	4.2	0.6	260	1.5	
Pyrene	mg/kg	DETS 050	5.1	0.7	70	1.9	
PAH	mg/kg	DETS 050	41	12	730	15	
Phenol - Monohydric	mg/kg	DETS 067#	< 0.3	< 0.3	1.1	< 0.3	
PCB	mg/kg	DETS 052*					
2,4,4'-Trichlorobiphenyl PCB 28	mg/kg	DETS 052*					
2,2',5,5'-Tetrachlorobiphenyl PCB 52	mg/kg	DETS 052*					
2,2',4,5,5'-Pentachlorobiphenyl PCB 101	mg/kg	DETS 052*					
2,3',4,4',5-Pentachlorobiphenyl PCB 118	mg/kg	DETS 052*					
2,2',4,4',5,5'-Hexachlorobiphenyl PCB 153	mg/kg	DETS 052*					
2,2',3,4,4',5'-Hexachlorobiphenyl PCB 138	mg/kg	DETS 052*					
2,2',3,4,4',5,5'-Heptachlorobiphenyl PCB 180	mg/kg	DETS 052*					

Summary of Chemical Analysis Soil Samples

Our Ref: 08-19338

Client Ref: C1634

Contract Title: Sheffield Road, Birdwell

			Lab No.	132205	132206	132207	132208
			Sample Ref	TP9	TP11	TP11	TP11
			Depth	0.40	0.40	1.50	3.50
			Other Ref				
			Sample Type	D	D	D	D
Test	Units	DETSxx					
Arsenic	mg/kg	DETS 042#	24	43	10	13	
Cadmium	mg/kg	DETS 042#	0.9	0.8	0.5	0.7	
Chromium	mg/kg	DETS 042#	14	14	6	5	
Copper	mg/kg	DETS 042#	66	260	29	55	
Lead	mg/kg	DETS 042#	130	50	25	67	
Mercury	mg/kg	DETS 081*	0.8	0.2	0.6	0.9	
Nickel	mg/kg	DETS 042#	18	20	15	22	
Selenium	mg/kg	DETS 042#	< 0.5	< 0.5	< 0.5	< 0.5	
Zinc	mg/kg	DETS 042#	76	65	40	150	
Calorific Value	KJ/kg	DETS 037*					
Cyanide total	mg/kg	DETS 067#			0.2	1.4	
Cyanide free	mg/kg	DETS 067#			< 0.1	< 0.1	
Total Sulphate as SO4	%	DETS 075#	0.12	0.24	0.06	0.11	
Sulphate Aqueous Extract as SO4	g/l	DETS 076#	0.19	0.14	0.09	0.23	
Total Organic Carbon	%	DETS 002	12	12	23	36	
pH		DETS 008#	9.6	8.8	8.7	8.6	
Aliphatic C5-C6	mg/kg	DETS 072*			< 0.01	< 0.01	
Aliphatic C6-C8	mg/kg	DETS 072*			< 0.01	< 0.01	
Aliphatic C8-C10	mg/kg	DETS 072*			< 0.01	< 0.01	
Aliphatic C10-C12	mg/kg	DETS 072*			0.4	0.8	
Aliphatic C12-C16	mg/kg	DETS 072*			0.5	1.9	
Aliphatic C16-C21	mg/kg	DETS 072*			6	26	
Aliphatic C21-C35	mg/kg	DETS 072*			120	670	
Aromatic C5-C7	mg/kg	DETS 072*			< 0.01	< 0.01	
Aromatic C7-C8	mg/kg	DETS 072*			< 0.01	< 0.01	
Aromatic C8-C10	mg/kg	DETS 072*			< 0.01	< 0.01	
Aromatic C10-C12	mg/kg	DETS 072*			0.2	0.2	
Aromatic C12-C16	mg/kg	DETS 072*			0.4	0.2	
Aromatic C16-C21	mg/kg	DETS 072*			4.4	4.3	
Aromatic C21-C35	mg/kg	DETS 072*			49	230	
Aliphatic C5-C35	mg/kg	DETS 072*			130	700	
Aromatic C5-C35	mg/kg	DETS 072*			54	230	
TPH Ali/Aro	mg/kg	DETS 072*			180	930	
Acenaphthene	mg/kg	DETS 050	4.1	1.6	1.5	5	
Acenaphthylene	mg/kg	DETS 050	2.6	0.7	0.6	3.7	
Anthracene	mg/kg	DETS 050	16	1.5	1	1.1	
Benzo(a)anthracene	mg/kg	DETS 050	26	3.4	0.4	0.8	
Benzo(a)pyrene	mg/kg	DETS 050	22	2.2	0.2	< 0.1	
Benzo(b)fluoranthene	mg/kg	DETS 050	34	4.2	< 0.1	< 0.1	
Benzo(k)fluoranthene	mg/kg	DETS 050	12	1.1	< 0.1	< 0.1	
Benzo(g,h,i)perylene	mg/kg	DETS 050	15	1.7	0.3	< 0.1	
Chrysene	mg/kg	DETS 050	22	3.3	0.5	< 0.1	
Dibenzo(a,h)anthracene	mg/kg	DETS 050	7.6	0.9	0.6	< 0.1	
Fluoranthene	mg/kg	DETS 050	48	7.1	0.8	< 0.1	
Fluorene	mg/kg	DETS 050	7.1	2	1.5	4.7	

Summary of Chemical Analysis Soil Samples

Our Ref: 08-19338

Client Ref: C1634

Contract Title: Sheffield Road, Birdwell

		Lab No.	132205	132206	132207	132208
		Sample Ref	TP9	TP11	TP11	TP11
		Depth	0.40	0.40	1.50	3.50
		Other Ref				
		Sample Type	D	D	D	D
Test	Units	DETSxx				
Indeno(1,2,3-c,d)pyrene	mg/kg	DETS 050	16	1.3	0.2	< 0.1
Napthalene	mg/kg	DETS 050	3.7	2.1	3.1	0.2
Phenanthrene	mg/kg	DETS 050	37	6.8	1.4	< 0.1
Pyrene	mg/kg	DETS 050	40	5.7	0.6	< 0.1
PAH	mg/kg	DETS 050	310	46	13	16
Phenol - Monohydric	mg/kg	DETS 067#	0.4	< 0.3	< 0.3	< 0.3
PCB	mg/kg	DETS 052*				
2,4,4'-Trichlorobiphenyl PCB 28	mg/kg	DETS 052*				
2,2',5,5'-Tetrachlorobiphenyl PCB 52	mg/kg	DETS 052*				
2,2',4,5,5'-Pentachlorobiphenyl PCB 101	mg/kg	DETS 052*				
2,3',4,4',5-Pentachlorobiphenyl PCB 118	mg/kg	DETS 052*				
2,2',4,4',5,5'-Hexachlorobiphenyl PCB 153	mg/kg	DETS 052*				
2,2',3,4,4',5'-Hexachlorobiphenyl PCB 138	mg/kg	DETS 052*				
2,2',3,4,4',5,5'-Heptachlorobiphenyl PCB 180	mg/kg	DETS 052*				

Summary of Chemical Analysis Soil Samples

Our Ref: 08-19338

Client Ref: C1634

Contract Title: Sheffield Road, Birdwell

			Lab No.	132209	132210	132211	132212
			Sample Ref	TP13	TP14	TP14	TP12
			Depth	0.30	0.50	0.80	0.30
			Other Ref				
			Sample Type	D	D	D	D
Test	Units	DETSxx					
Arsenic	mg/kg	DETS 042#	5	6	7	16	
Cadmium	mg/kg	DETS 042#	0.7	0.9	1.4	0.8	
Chromium	mg/kg	DETS 042#	40	94	520	15	
Copper	mg/kg	DETS 042#	13	19	46	42	
Lead	mg/kg	DETS 042#	13	20	32	170	
Mercury	mg/kg	DETS 081*	< 0.1	< 0.1	< 0.1	0.1	
Nickel	mg/kg	DETS 042#	7	16	15	11	
Selenium	mg/kg	DETS 042#	0.5	1.2	2.2	< 0.5	
Zinc	mg/kg	DETS 042#	41	57	75	120	
Calorific Value	KJ/kg	DETS 037*					1300
Cyanide total	mg/kg	DETS 067#					
Cyanide free	mg/kg	DETS 067#					
Total Sulphate as SO4	%	DETS 075#	0.2	0.26	0.16	0.17	
Sulphate Aqueous Extract as SO4	g/l	DETS 076#	0.54	0.55	0.39	0.2	
Total Organic Carbon	%	DETS 002	2.9	3.7	4.4	8.2	
pH		DETS 008#	10.8	11.2	11.7	9.1	
Aliphatic C5-C6	mg/kg	DETS 072*		< 0.01	< 0.01		
Aliphatic C6-C8	mg/kg	DETS 072*		< 0.01	< 0.01		
Aliphatic C8-C10	mg/kg	DETS 072*		< 0.01	< 0.01		
Aliphatic C10-C12	mg/kg	DETS 072*		14	5.5		
Aliphatic C12-C16	mg/kg	DETS 072*		100	40		
Aliphatic C16-C21	mg/kg	DETS 072*		160	64		
Aliphatic C21-C35	mg/kg	DETS 072*		860	350		
Aromatic C5-C7	mg/kg	DETS 072*		< 0.01	< 0.01		
Aromatic C7-C8	mg/kg	DETS 072*		< 0.01	< 0.01		
Aromatic C8-C10	mg/kg	DETS 072*		< 0.01	< 0.01		
Aromatic C10-C12	mg/kg	DETS 072*		1.4	0.7		
Aromatic C12-C16	mg/kg	DETS 072*		30	13		
Aromatic C16-C21	mg/kg	DETS 072*		380	120		
Aromatic C21-C35	mg/kg	DETS 072*		880	290		
Aliphatic C5-C35	mg/kg	DETS 072*		1100	460		
Aromatic C5-C35	mg/kg	DETS 072*		1300	430		
TPH Ali/Aro	mg/kg	DETS 072*		2400	890		
Acenaphthene	mg/kg	DETS 050	1.5	68	15	12	
Acenaphthylene	mg/kg	DETS 050	0.5	9.9	3.7	12	
Anthracene	mg/kg	DETS 050	3.3	88	17	47	
Benzo(a)anthracene	mg/kg	DETS 050	13	1.6	18	17	
Benzo(a)pyrene	mg/kg	DETS 050	14	< 0.1	13	41	
Benzo(b)fluoranthene	mg/kg	DETS 050	16	< 0.1	16	4.1	
Benzo(k)fluoranthene	mg/kg	DETS 050	5.5	< 0.1	6	1.7	
Benzo(g,h,i)perylene	mg/kg	DETS 050	6.9	22	5.9	5.8	
Chrysene	mg/kg	DETS 050	11	1.9	18	16	
Dibenzo(a,h)anthracene	mg/kg	DETS 050	0.9	< 0.1	< 0.1	9.1	
Fluoranthene	mg/kg	DETS 050	29	3.7	50	19	
Fluorene	mg/kg	DETS 050	1.4	59	14	25	

Summary of Chemical Analysis Soil Samples

Our Ref: 08-19338

Client Ref: C1634

Contract Title: Sheffield Road, Birdwell

		Lab No.	132209	132210	132211	132212
		Sample Ref	TP13	TP14	TP14	TP12
		Depth	0.30	0.50	0.80	0.30
		Other Ref				
		Sample Type	D	D	D	D
Test	Units	DETSxx				
Indeno(1,2,3-c,d)pyrene	mg/kg	DETS 050	7.5	< 0.1	6.1	3.4
Napthalene	mg/kg	DETS 050	1.9	4.1	2.6	19
Phenanthrene	mg/kg	DETS 050	13	< 0.1	49	89
Pyrene	mg/kg	DETS 050	25	< 0.1	39	16
PAH	mg/kg	DETS 050	150	260	270	340
Phenol - Monohydric	mg/kg	DETS 067#	< 0.3	0.8	1	0.7
PCB	mg/kg	DETS 052*				< 0.01
2,4,4'-Trichlorobiphenyl PCB 28	mg/kg	DETS 052*				< 0.01
2,2',5,5'-Tetrachlorobiphenyl PCB 52	mg/kg	DETS 052*				< 0.01
2,2',4,5,5'-Pentachlorobiphenyl PCB 101	mg/kg	DETS 052*				< 0.01
2,3',4,4',5-Pentachlorobiphenyl PCB 118	mg/kg	DETS 052*				< 0.01
2,2',4,4',5,5'-Hexachlorobiphenyl PCB 153	mg/kg	DETS 052*				< 0.01
2,2',3,4,4',5'-Hexachlorobiphenyl PCB 138	mg/kg	DETS 052*				< 0.01
2,2',3,4,4',5,5'-Heptachlorobiphenyl PCB 180	mg/kg	DETS 052*				< 0.01

Summary of Chemical Analysis

Soil Samples

Our Ref: 08-19338
 Client Ref: C1634
 Contract Title: Sheffield Road, Birdwell

		Lab No.	132213	132214
		Sample Ref	TP12	TP13
		Depth	1.20	2.30
		Other Ref		
		Sample Type	D	D
Test	Units	DETSxx		
Arsenic	mg/kg	DETS 042#		
Cadmium	mg/kg	DETS 042#		
Chromium	mg/kg	DETS 042#		
Copper	mg/kg	DETS 042#		
Lead	mg/kg	DETS 042#		
Mercury	mg/kg	DETS 081*		
Nickel	mg/kg	DETS 042#		
Selenium	mg/kg	DETS 042#		
Zinc	mg/kg	DETS 042#		
Calorific Value	KJ/kg	DETS 037*		
Cyanide total	mg/kg	DETS 067#		
Cyanide free	mg/kg	DETS 067#		
Total Sulphate as SO4	%	DETS 075#		
Sulphate Aqueous Extract as SO4	g/l	DETS 076#	0.18	0.07
Total Organic Carbon	%	DETS 002		
pH		DETS 008#	8.5	11.4
Aliphatic C5-C6	mg/kg	DETS 072*		
Aliphatic C6-C8	mg/kg	DETS 072*		
Aliphatic C8-C10	mg/kg	DETS 072*		
Aliphatic C10-C12	mg/kg	DETS 072*		
Aliphatic C12-C16	mg/kg	DETS 072*		
Aliphatic C16-C21	mg/kg	DETS 072*		
Aliphatic C21-C35	mg/kg	DETS 072*		
Aromatic C5-C7	mg/kg	DETS 072*		
Aromatic C7-C8	mg/kg	DETS 072*		
Aromatic C8-C10	mg/kg	DETS 072*		
Aromatic C10-C12	mg/kg	DETS 072*		
Aromatic C12-C16	mg/kg	DETS 072*		
Aromatic C16-C21	mg/kg	DETS 072*		
Aromatic C21-C35	mg/kg	DETS 072*		
Aliphatic C5-C35	mg/kg	DETS 072*		
Aromatic C5-C35	mg/kg	DETS 072*		
TPH Ali/Aro	mg/kg	DETS 072*		
Acenaphthene	mg/kg	DETS 050		
Acenaphthylene	mg/kg	DETS 050		
Anthracene	mg/kg	DETS 050		
Benzo(a)anthracene	mg/kg	DETS 050		
Benzo(a)pyrene	mg/kg	DETS 050		
Benzo(b)fluoranthene	mg/kg	DETS 050		
Benzo(k)fluoranthene	mg/kg	DETS 050		
Benzo(g,h,i)perylene	mg/kg	DETS 050		
Chrysene	mg/kg	DETS 050		
Dibenzo(a,h)anthracene	mg/kg	DETS 050		
Fluoranthene	mg/kg	DETS 050		
Fluorene	mg/kg	DETS 050		

Summary of Chemical Analysis Soil Samples

Our Ref: 08-19338

Client Ref: C1634

Contract Title: Sheffield Road, Birdwell

			Lab No.	132213	132214
			Sample Ref	TP12	TP13
			Depth	1.20	2.30
			Other Ref		
			Sample Type	D	D
Test	Units	DETSxx			
Indeno(1,2,3-c,d)pyrene	mg/kg	DETS 050			
Napthalene	mg/kg	DETS 050			
Phenanthrene	mg/kg	DETS 050			
Pyrene	mg/kg	DETS 050			
PAH	mg/kg	DETS 050			
Phenol - Monohydric	mg/kg	DETS 067#			
PCB	mg/kg	DETS 052*			
2,4,4'-Trichlorobiphenyl PCB 28	mg/kg	DETS 052*			
2,2',5,5'-Tetrachlorobiphenyl PCB 52	mg/kg	DETS 052*			
2,2',4,5,5'-Pentachlorobiphenyl PCB 101	mg/kg	DETS 052*			
2,3',4,4',5-Pentachlorobiphenyl PCB 118	mg/kg	DETS 052*			
2,2',4,4',5,5'-Hexachlorobiphenyl PCB 153	mg/kg	DETS 052*			
2,2',3,4,4',5'-Hexachlorobiphenyl PCB 138	mg/kg	DETS 052*			
2,2',3,4,4',5,5'-Heptachlorobiphenyl PCB 180	mg/kg	DETS 052*			

SHEFFIELD ROAD, BIRDWELL

Summary of Chemical Analyses on Soil Samples

Borehole or Trial Pit	Depth (m)	Sample Type	Laboratory Reference Number	Asbestos
TP7	0.20	S	132202	NAD
TP8	0.50	S	132204	NAD
TP11	0.40	S	132206	NAD

DETS 082

Client Reference: C1634

Laboratory Reference: 08-19338

DERWENTSIDE ENVIRONMENTAL TESTING SERVICES LIMITED

Summary of Chemical Analysis

Leachate Samples

Our Ref: 08-19338

Client Ref: C1634

Contract Title: Sheffield Road, Birdwell

			Lab No.	132216	132217	132218	132219
			Sample Ref	TP3	TP8	TP11	TP14
			Depth	0.20	0.50	1.50	0.80
			Other Ref				
			Sample Type	D	D	D	D
Test	Units	DETSxx					
Arsenic Dissolved	ug/l	DETS 010	< 1	< 1	< 1	< 1	1
Cadmium Dissolved	ug/l	DETS 042	< 2	< 2	< 2	< 2	< 2
Chromium Dissolved	ug/l	DETS 042	< 10	< 10	< 10	< 10	< 10
Copper Dissolved	ug/l	DETS 042	< 2	< 2	< 2	< 2	< 2
Lead Dissolved	ug/l	DETS 042	< 5	< 5	< 5	< 5	< 5
Mercury Dissolved	ug/l	DETS 078*	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Nickel Dissolved	ug/l	DETS 042	< 10	< 10	< 10	< 10	< 10
Selenium Dissolved	ug/l	DETS 017	< 3	< 3	< 3	< 3	< 3
Zinc Dissolved	ug/l	DETS 042	1	14	8	< 1	< 1
pH		DETS 008	7.2	7.1	7.3	7.0	7.0
Acenaphthene	ug/l	DETS 074*	< 0.01	< 0.01	< 0.01	0.15	0.15
Acenaphthylene	ug/l	DETS 074*	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Anthracene	ug/l	DETS 074*	< 0.01	< 0.01	< 0.01	0.02	0.02
Benzo(a)anthracene	ug/l	DETS 074*	< 0.01	< 0.01	< 0.01	0.01	0.01
Benzo(a)pyrene	ug/l	DETS 074*	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Benzo(b)fluoranthene	ug/l	DETS 074*	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Benzo(k)fluoranthene	ug/l	DETS 074*	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Benzo(g,h,i)perylene	ug/l	DETS 074*	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Chrysene	ug/l	DETS 074*	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Dibenzo(a,h)anthracene	ug/l	DETS 074*	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Fluoranthene	ug/l	DETS 074*	0.04	0.02	0.02	0.32	0.32
Fluorene	ug/l	DETS 074*	< 0.01	< 0.01	< 0.01	0.01	0.01
Indeno(1,2,3-c,d)pyrene	ug/l	DETS 074*	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Napthalene	ug/l	DETS 074*	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Phenanthrene	ug/l	DETS 074*	< 0.01	< 0.01	0.01	0.15	0.15
Pyrene	ug/l	DETS 074*	0.04	0.05	0.12	1.8	1.8
PAH	ug/l	DETS 074*	< 0.20	< 0.20	< 0.20	2.5	2.5
Phenol	ug/l	DETS 054*	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50

Summary of Chemical Analysis

Water Samples

Our Ref: 08-19338

Client Ref: C1634

Contract Title: Sheffield Road, Birdwell

Lab No. 132215
Sample Ref BH3
Depth
Other Ref
Sample Type J

Test	Units	DETSxx	
Arsenic Dissolved	ug/l	DETS 010	< 1
Cadmium Dissolved	ug/l	DETS 042	< 2
Chromium Dissolved	ug/l	DETS 042	< 10
Copper Dissolved	ug/l	DETS 042	< 2
Lead Dissolved	ug/l	DETS 042	< 5
Mercury Dissolved	ug/l	DETS 078*	0.09
Nickel Dissolved	ug/l	DETS 042	< 10
Selenium Dissolved	ug/l	DETS 017	< 3
Zinc Dissolved	ug/l	DETS 042	2
Sulphate	mg/l	DETS 055	380
Cyanide total	ug/l	DETS 067	< 40
Conductivity	uS/cm	DETS 009	1310
Hardness	mg/l	DETS 043*	810
Ammoniacal Nitrogen as N	mg/l	DETS 019	4.8
pH		DETS 008	6.6
Acenaphthene	ug/l	DETS 074*	27
Acenaphthylene	ug/l	DETS 074*	< 0.01
Anthracene	ug/l	DETS 074*	0.21
Benzo(a)anthracene	ug/l	DETS 074*	< 0.01
Benzo(a)pyrene	ug/l	DETS 074*	< 0.01
Benzo(b)fluoranthene	ug/l	DETS 074*	< 0.01
Benzo(k)fluoranthene	ug/l	DETS 074*	< 0.01
Benzo(g,h,i)perylene	ug/l	DETS 074*	< 0.01
Chrysene	ug/l	DETS 074*	< 0.01
Dibenzo(a,h)anthracene	ug/l	DETS 074*	< 0.01
Fluoranthene	ug/l	DETS 074*	0.08
Fluorene	ug/l	DETS 074*	9.1
Indeno(1,2,3-c,d)pyrene	ug/l	DETS 074*	< 0.01
Napthalene	ug/l	DETS 074*	14
Phenanthrene	ug/l	DETS 074*	0.27
Pyrene	ug/l	DETS 074*	0.55
PAH	ug/l	DETS 074*	51
PRO (C6-C10)	ug/l	DETS 062*	34000
TPH (C10-C40)	ug/l	DETS 051	3700
Phenol	ug/l	DETS 054*	38

Appendix A - Details of Analysis

Method details are shown only for those determinants listed in Annex A of the MCERTS standard. Anything not included on this list falls outside the scope of MCERTS. No Recovery Factors are used in the determination of results. Results reported assume 100% recovery
Full method statements are available on request.

<u>Method</u>	<u>Name of Parameter</u>	<u>Units</u>	<u>Limit of Detection</u>	<u>Sample Preparation</u>	<u>Sub-Contracted</u>	<u>UKAS</u>	<u>MCERTS</u>
DETS 002	Organic Matter	%	0.01	Air Dried	No	Yes	No
DETS 003	Loss on Ignition	%	0.01	Air Dried	No	Yes	Yes
DETS 004	Total Sulphate	%	0.01	Air Dried	No	Yes	Yes
DETS 075	Total Sulphate	%	0.01	Air Dried	No	Yes	Yes
DETS 004	Water Soluble Sulphate	g/l	0.01	Air Dried	No	Yes	Yes
DETS 076	Water Soluble Sulphate	g/l	0.01	Air Dried	No	Yes	Yes
DETS 006	Chloride	mg/kg	0.01	Air Dried	No	Yes	Yes
DETS 008	pH	pH Units	0.10	Air Dried	No	Yes	Yes
DETS 042	Selenium	mg/kg	0.30	Air Dried	No	Yes	No
DETS 055	Ammonia	mg/kg	0.02	Air Dried	No	No	No
DETS 020	Boron (Water Soluble)	mg/kg	0.20	Air Dried	No	Yes	Yes
DETS 024	Sulphide	mg/kg	10.00	Air Dried	No	Yes	Yes
DETS 042	Antimony	mg/kg	1.00	Air Dried	No	No	No
DETS 042	Arsenic	mg/kg	1.00	Air Dried	No	Yes	Yes
DETS 042	Barium	mg/kg	1.00	Air Dried	No	No	No
DET S 042	Beryllium	mg/kg	1.00	Air Dried	No	No	No

Appendix A - Details of Analysis

Method details are shown only for those determinants listed in Annex A of the MCERTS standard. Anything not included on this list falls outside the scope of MCERTS.
 No Recovery Factors are used in the determination of results. Results reported assume 100% recovery
 Full method statements are available on request.

<u>Method</u>	<u>Name of Parameter</u>	<u>Units</u>	<u>Limit of Detection</u>	<u>Sample Preparation</u>	<u>Sub-Contracted</u>	<u>UKAS</u>	<u>MCERTS</u>
DETS 042	Cadmium	mg/kg	0.20	Air Dried	No	Yes	No
DETS 042	Cobalt	mg/kg	0.20	Air Dried	No	No	No
DETS 042	Copper	mg/kg	1.00	Air Dried	No	Yes	No
DETS 042	Chromium	mg/kg	1.00	Air Dried	No	Yes	No
DETS 042	Iron	mg/kg	1.00	Air Dried	No	No	No
DETS 042	Lead	mg/kg	1.00	Air Dried	No	Yes	No
DETS 042	Manganese	mg/kg	1.00	Air Dried	No	No	No
DETS 081	Mercury	mg/kg	0.30	Air Dried	No	No	No
DETS 042	Molybdenum	mg/kg	1.00	Air Dried	No	No	No
DETS 042	Nickel	mg/kg	1.00	Air Dried	No	Yes	No
DETS 042	Thallium	mg/kg	1.00	Air Dried	No	No	No
DETS 042	Vanadium	mg/kg	1.00	Air Dried	No	No	No
DETS 042	Zinc	mg/kg	1.00	Air Dried	No	Yes	Yes
DETS 049	Sulphur (Free)	mg/kg	0.50	As Received	No	Yes	Yes
DETS 050	PAH	mg/kg	0.10	As Received	No	Yes	No

Appendix A - Details of Analysis

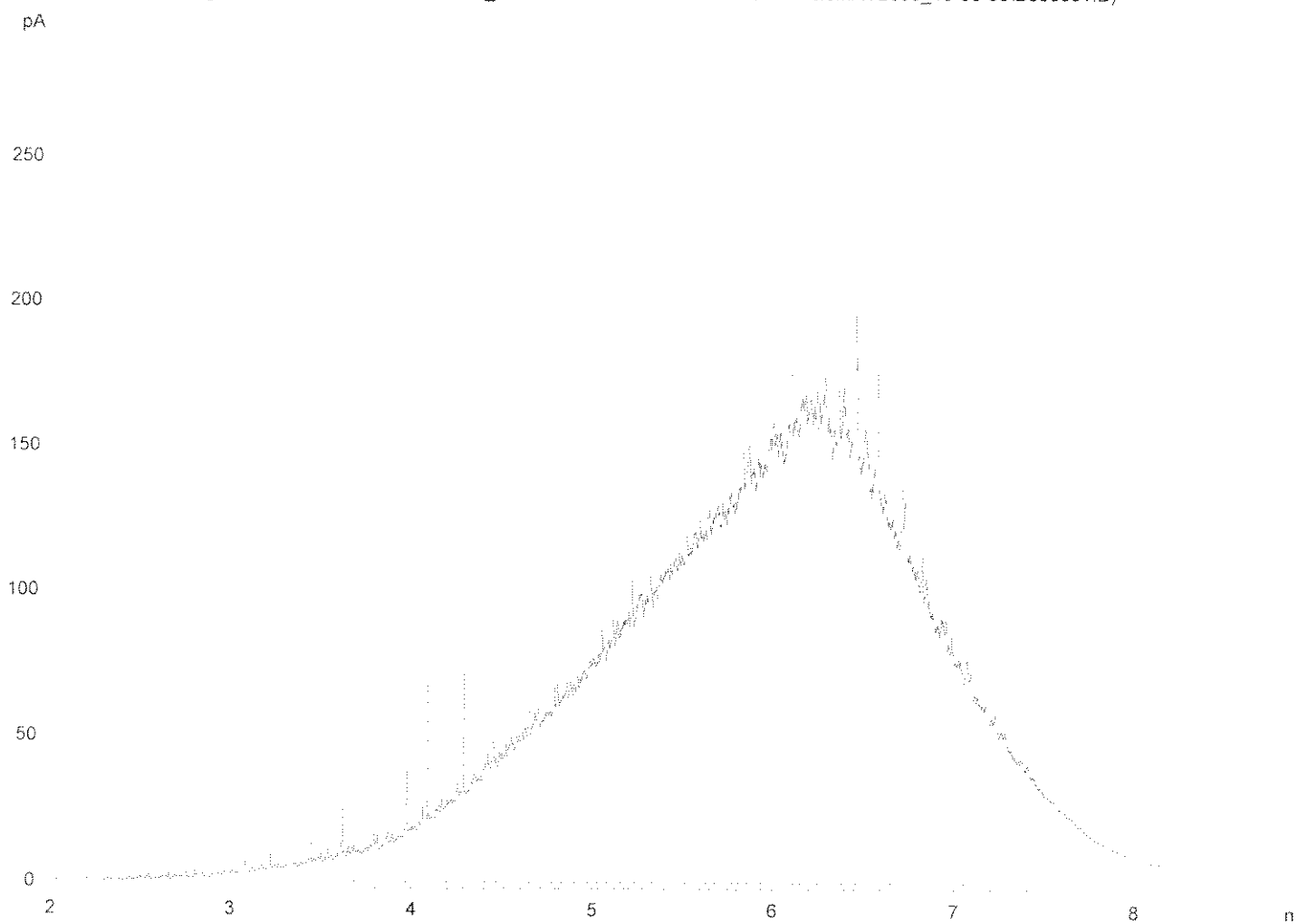
Method details are shown only for those determinants listed in Annex A of the MCERTS standard. Anything not included on this list falls outside the scope of MCERTS. No Recovery Factors are used in the determination of results. Results reported assume 100% recovery
Full method statements are available on request.

<u>Method</u>	<u>Name of Parameter</u>	<u>Units</u>	<u>Limit of Detection</u>	<u>Sample Preparation</u>	<u>Sub-Contracted</u>	<u>UKAS</u>	<u>MCERTS</u>
DETS 051	TPH (C10 - C40)	mg/kg	20.00	As Received	No	Yes	Yes
DETS 052	PCB	mg/kg	0.01	As Received	No	Yes	Yes
DETS 062	Benzene	mg/kg	0.01	As Received	No	Yes	Yes
DETS 062	Toluene	mg/kg	0.01	As Received	No	Yes	Yes
DETS 062	Ethylbenzene	mg/kg	0.01	As Received	No	Yes	Yes
DETS 062	Xylene	mg/kg	0.01	As Received	No	Yes	Yes
DETS 067	Phenol - Monohydric	mg/kg	0.3	Air Dried	No	Yes	Yes
DETS 067	Easily Liberatable Cyanide	mg/kg	0.1	Air Dried	No	Yes	Yes
DETS 067	Complex Cyanide	mg/kg	0.30	Air Dried	No	Yes	No
DETS 067	Total Cyanide	mg/kg	0.40	Air Dried	No	Yes	Yes
DETS 067	Thiocyanate	mg/kg	0.6	Air Dried	No	Yes	Yes
DETS 068	VOC	mg/kg	0.01	As Received	No	No	No

D8TS 072 Aliphatic Aromatic TPH by GC-FID

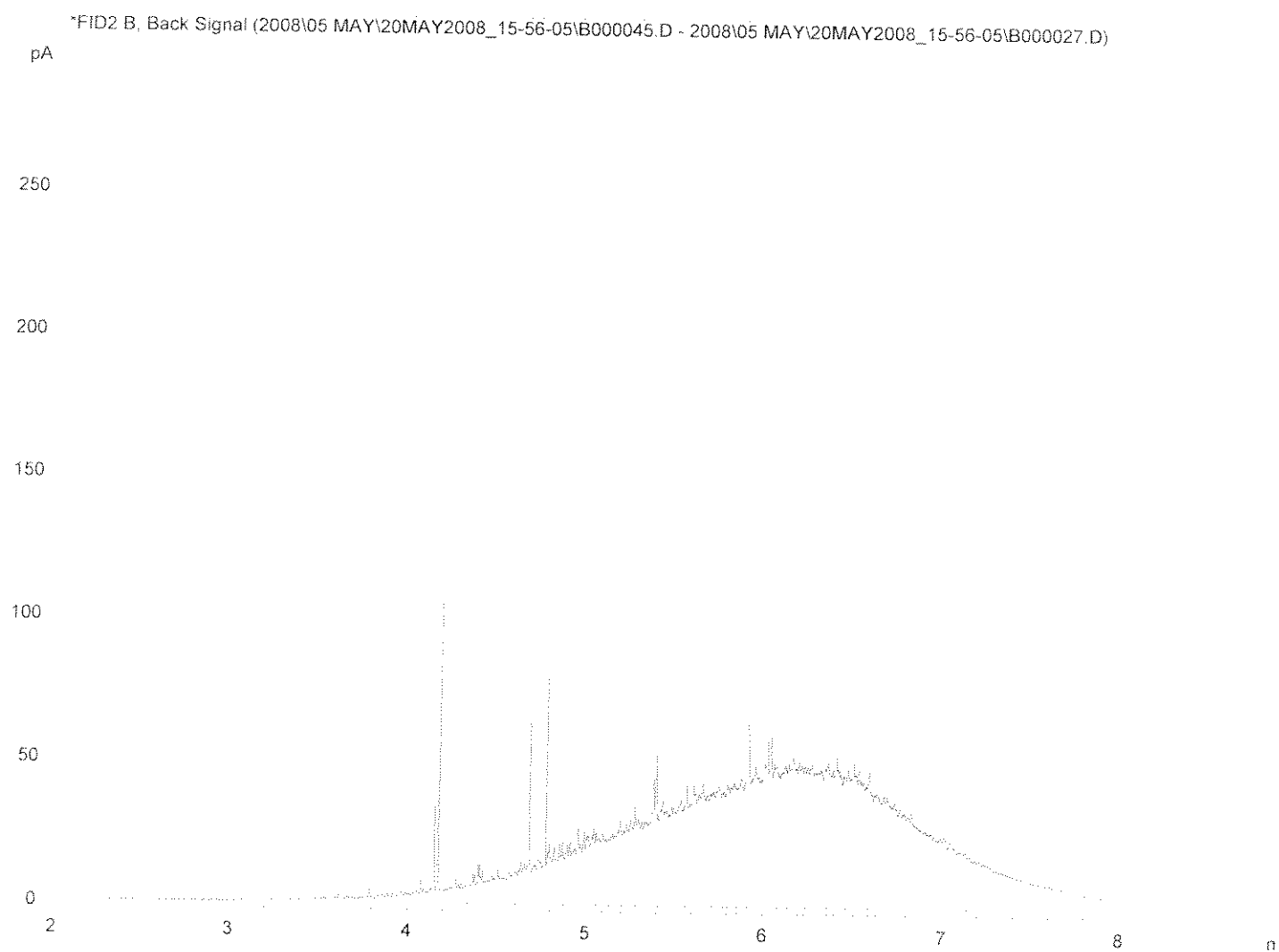
Sample Name: 19338-132197 AL

*FID2 B, Back Signal (2008\05 MAY\20MAY2008_15-56-05\B000020.D - 2008\05 MAY\20MAY2008_15-56-05\B000001.D)



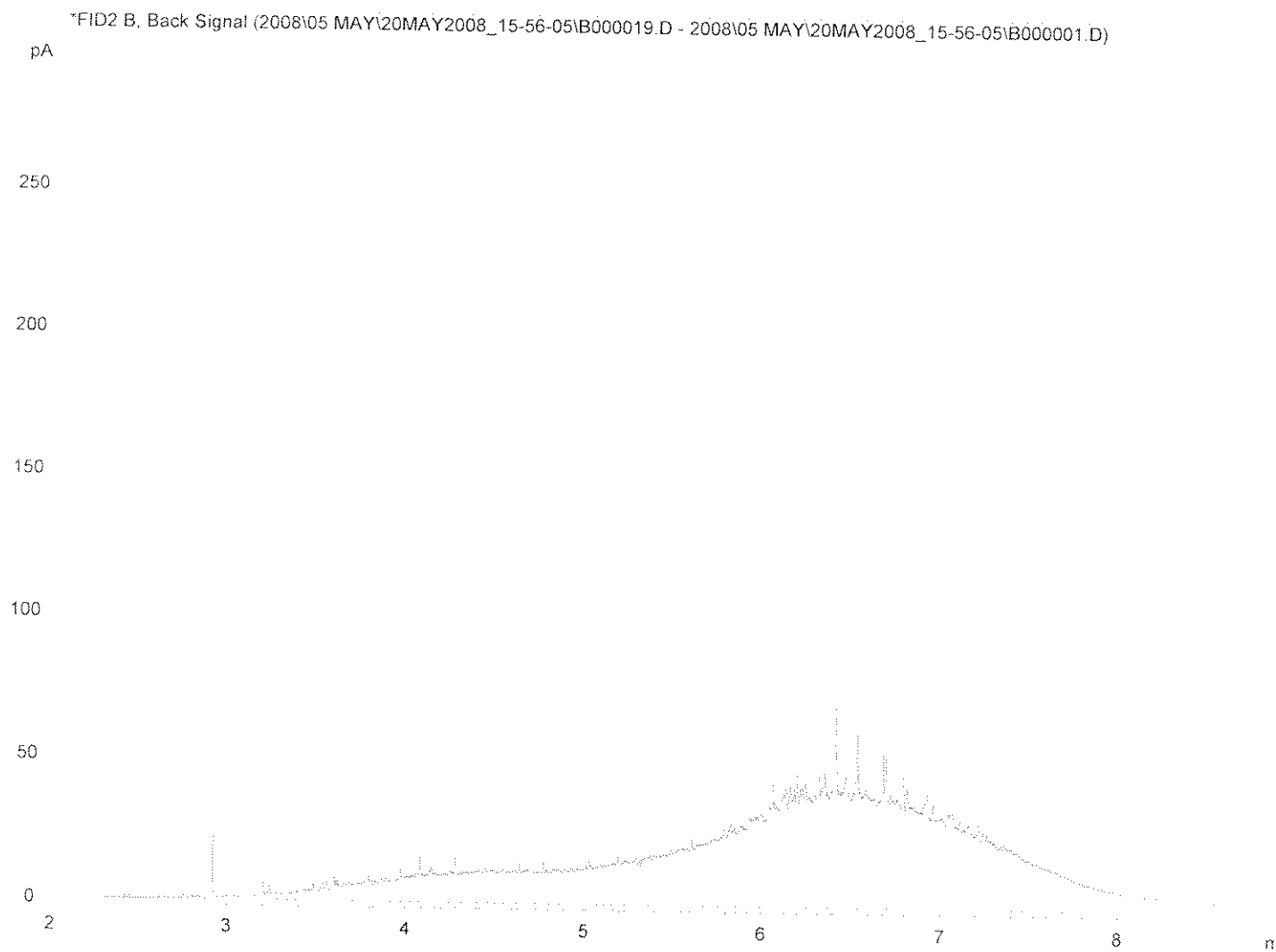
DETS 072 Aliphatic Aromatic TPH by GC-FID

Sample Name: 19338-132197 AR



DETS 072 Aliphatic Aromatic TPH by GC-FID

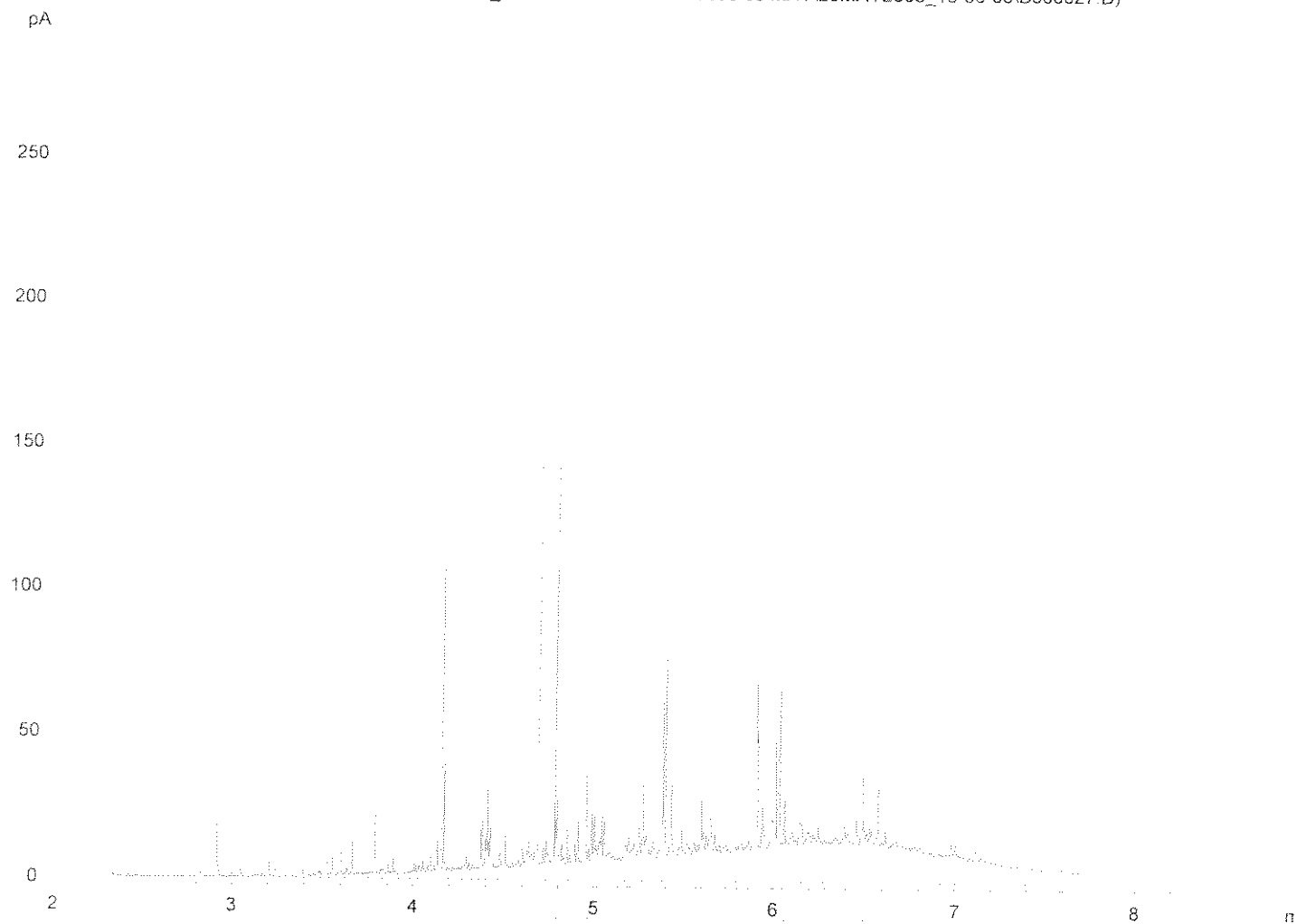
Sample Name: 19338-132198 AL



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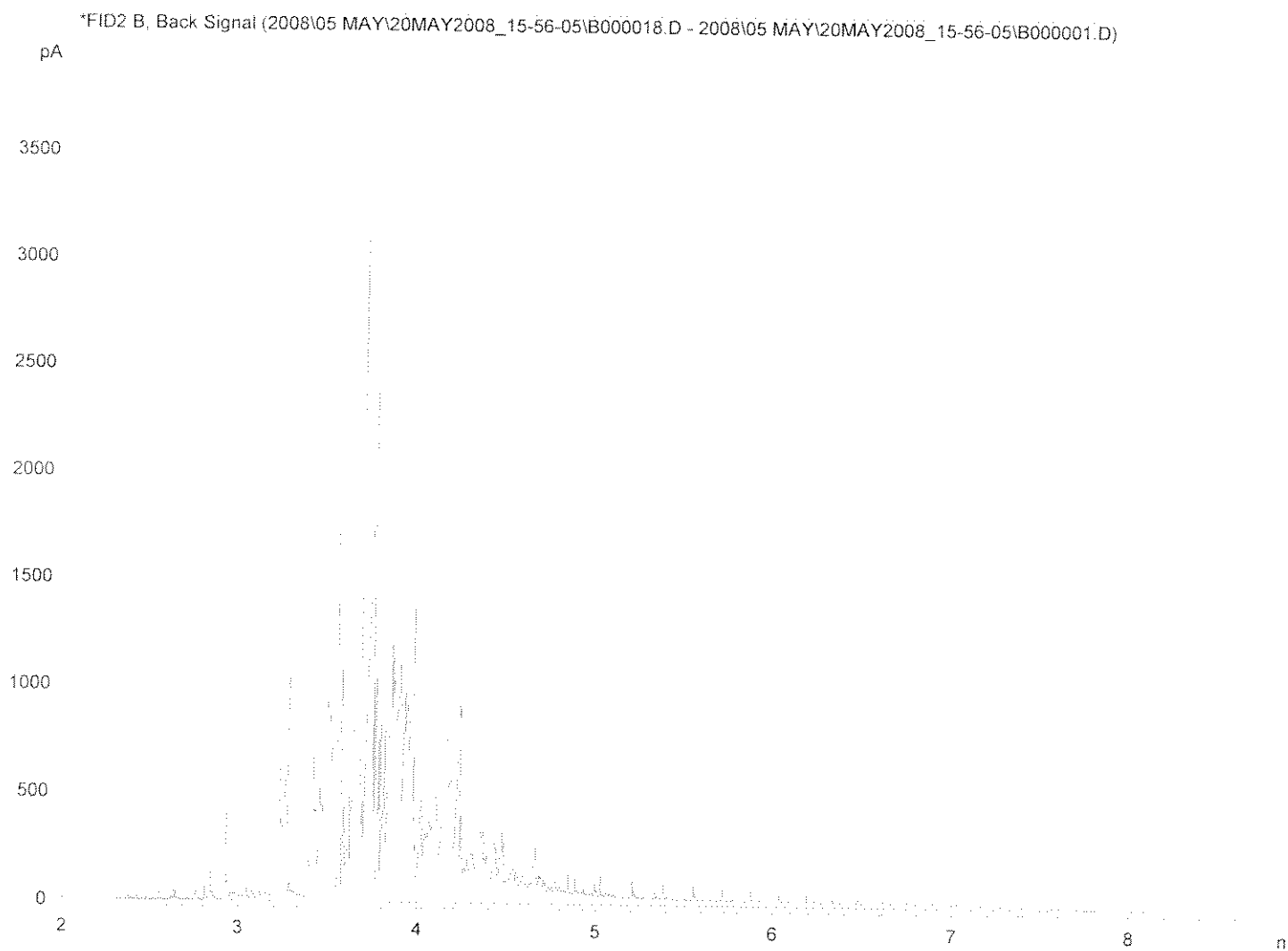
Sample Name: 19338-132198 AR

*FID2 B, Back Signal (2008\05 MAY\20MAY2008_15-56-05\B000044.D - 2008\05 MAY\20MAY2008_15-56-05\B000027.D)



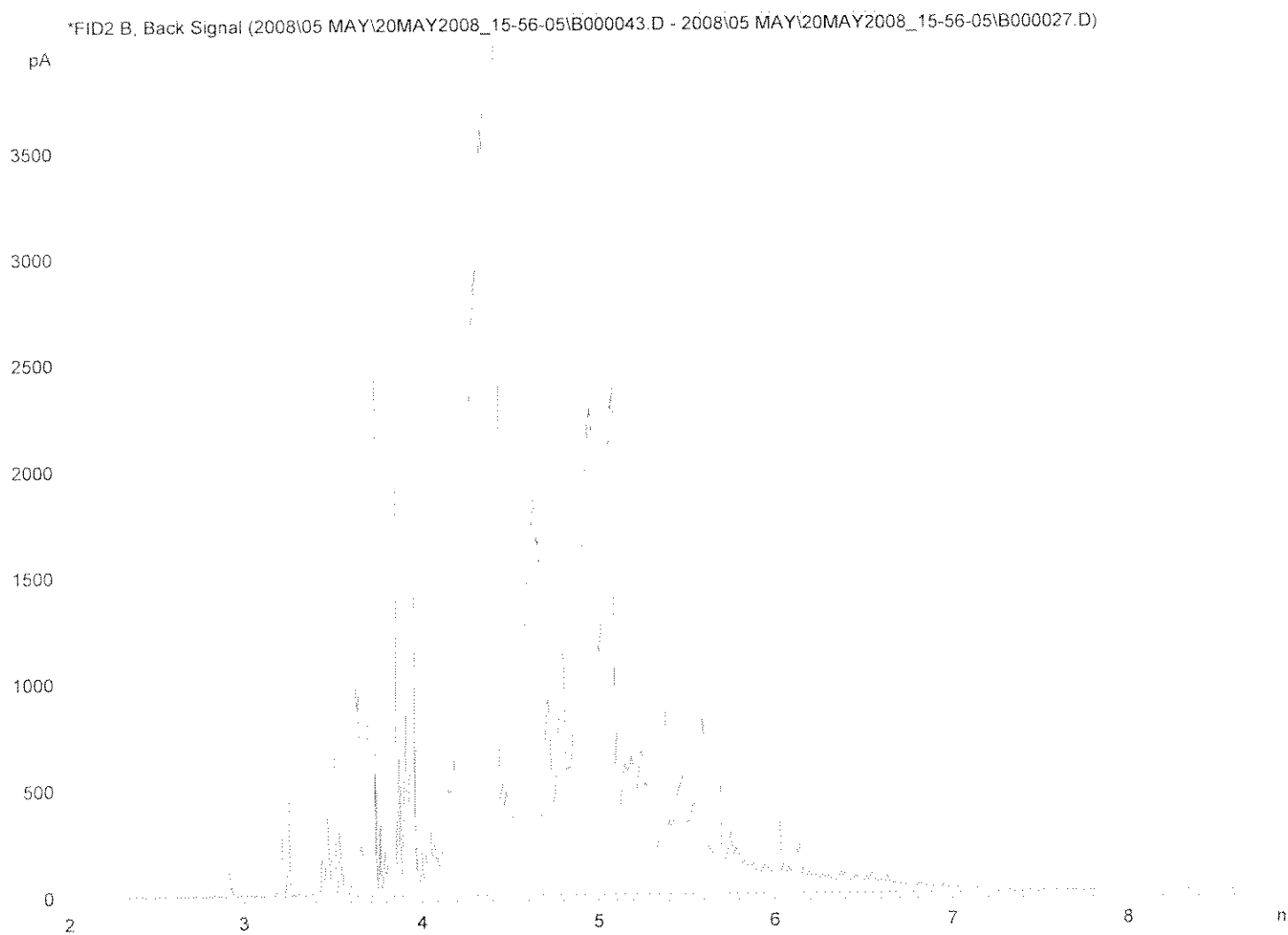
DETS 072 Aliphatic Aromatic TPH by GC-FID

Sample Name: 19338-132199 AL



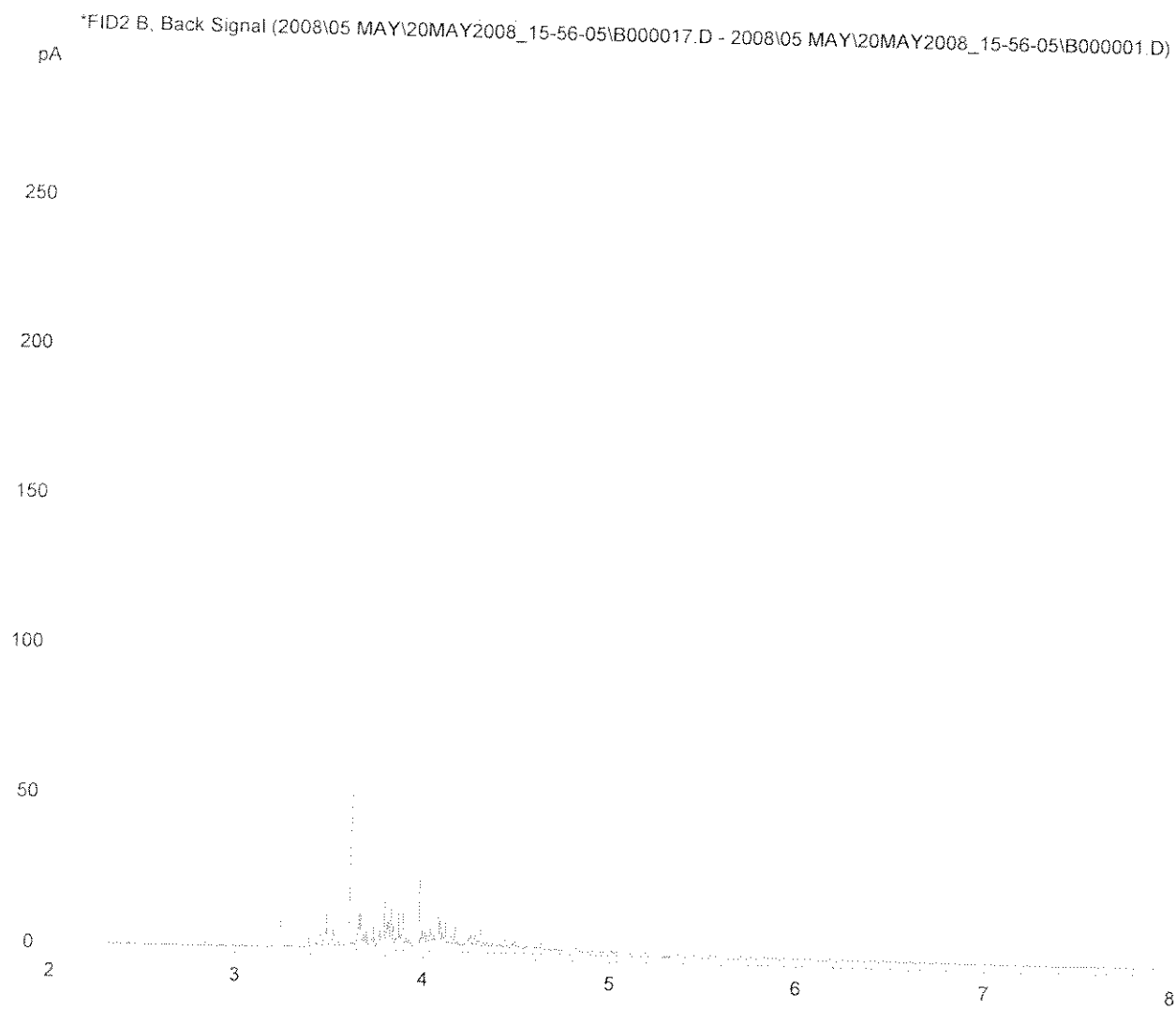
DETS 072 Aliphatic Aromatic TPH by GC-FID

Sample Name: 19338-132199 AR



DETS 072 Aliphatic Aromatic TPH by GC-FID

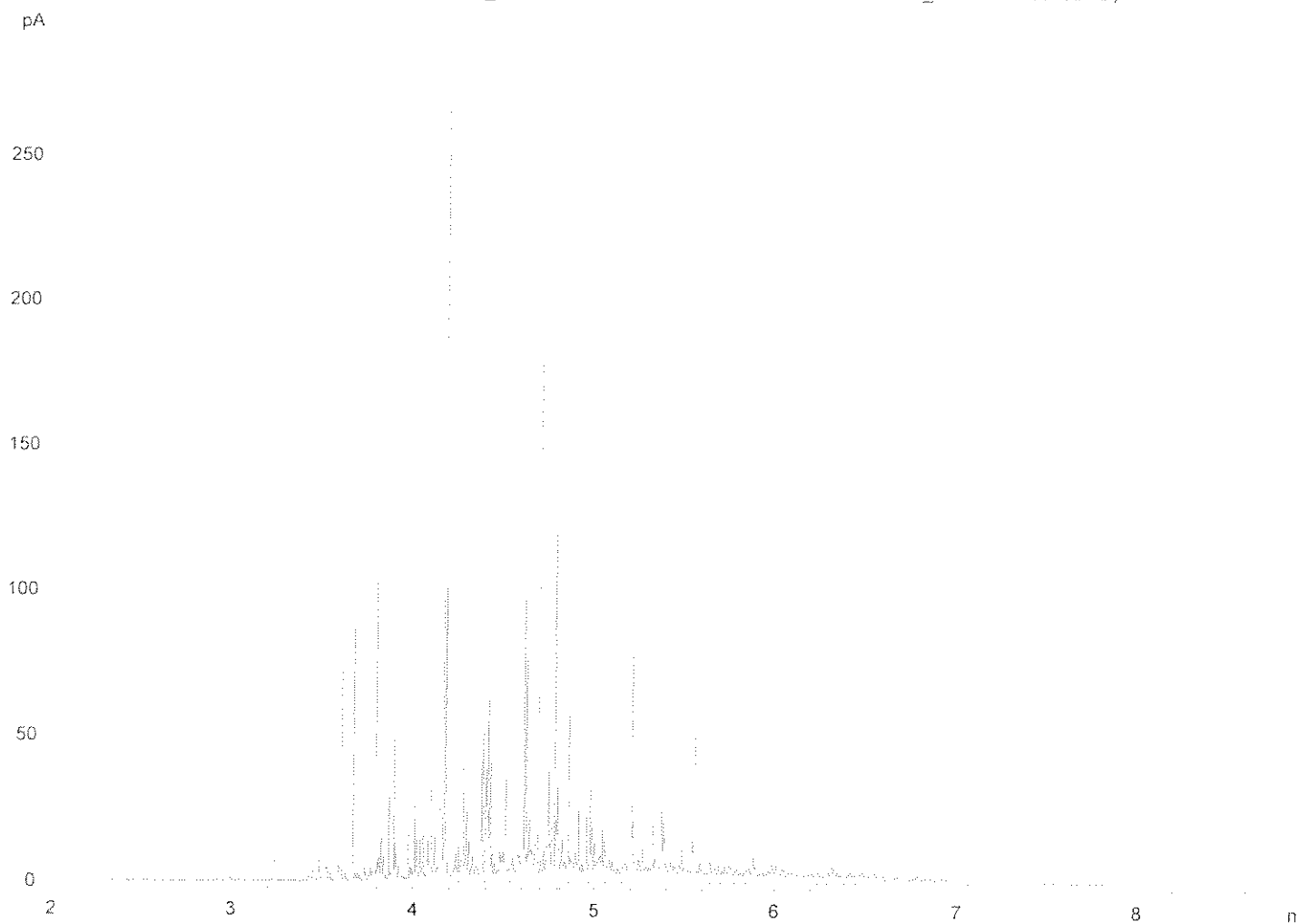
Sample Name: 19338-132203 AL



DETS 072 Aliphatic Aromatic TPH by GC-FID

Sample Name: 19338-132203 AR

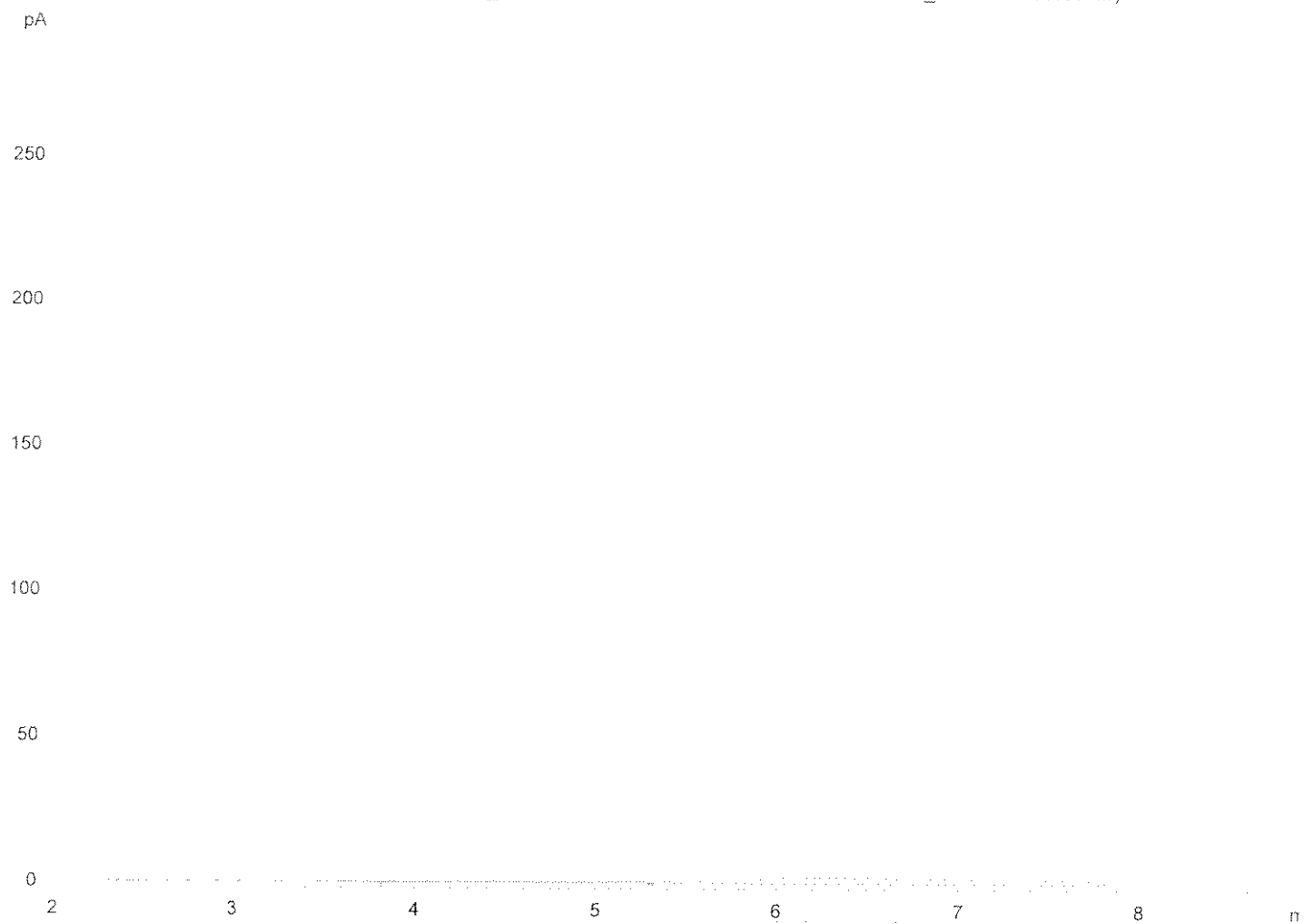
*FID2 B, Back Signal (2008\05 MAY\20MAY2008_15-56-05\B000042.D - 2008\05 MAY\20MAY2008_15-56-05\B000027.D)



DETS 072 Aliphatic Aromatic TPH by GC-FID

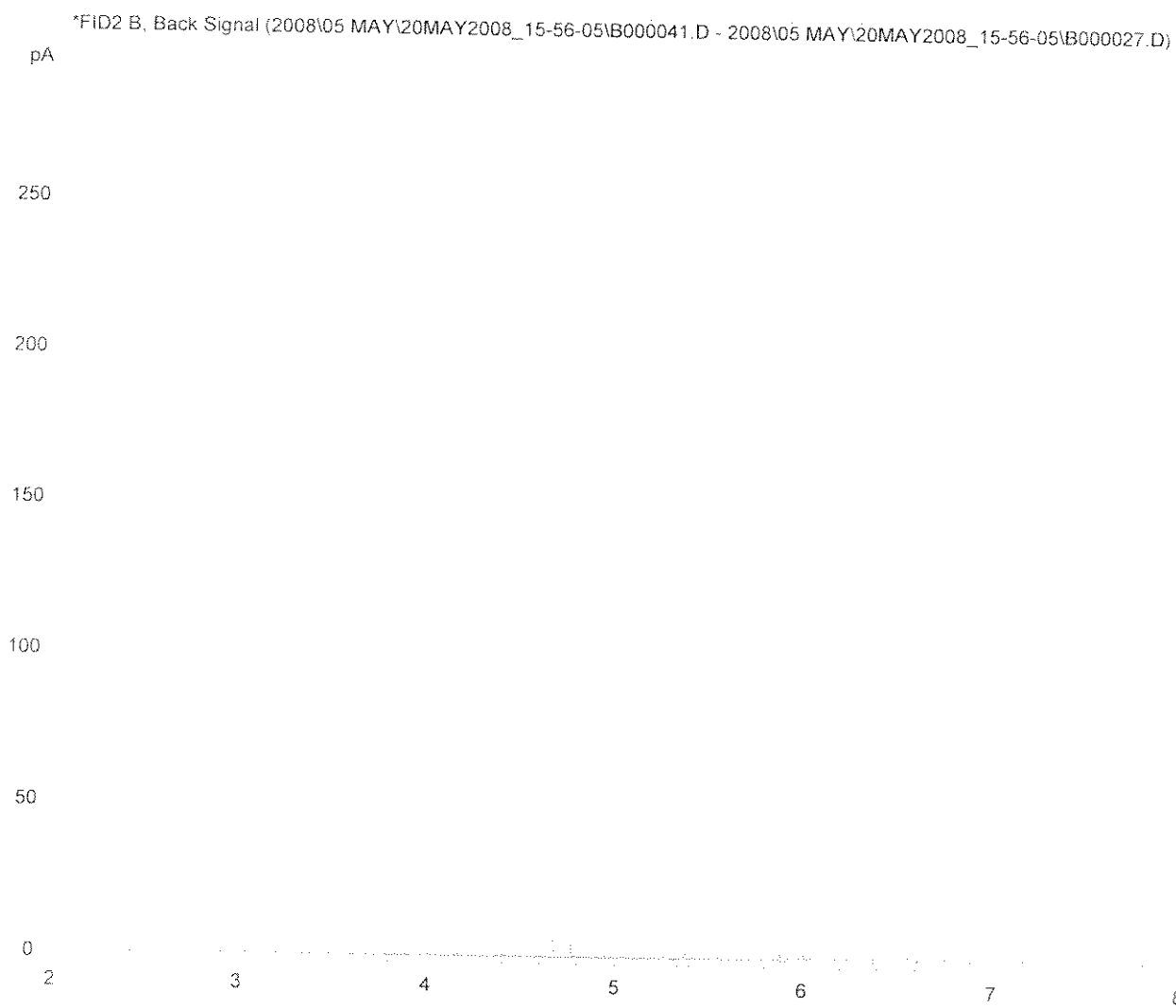
Sample Name: 19338-132207 AL

*FID2 B, Back Signal (2008\05 MAY\20MAY2008_15-56-05\B000016.D - 2008\05 MAY\20MAY2008_15-56-05\B000001.D)



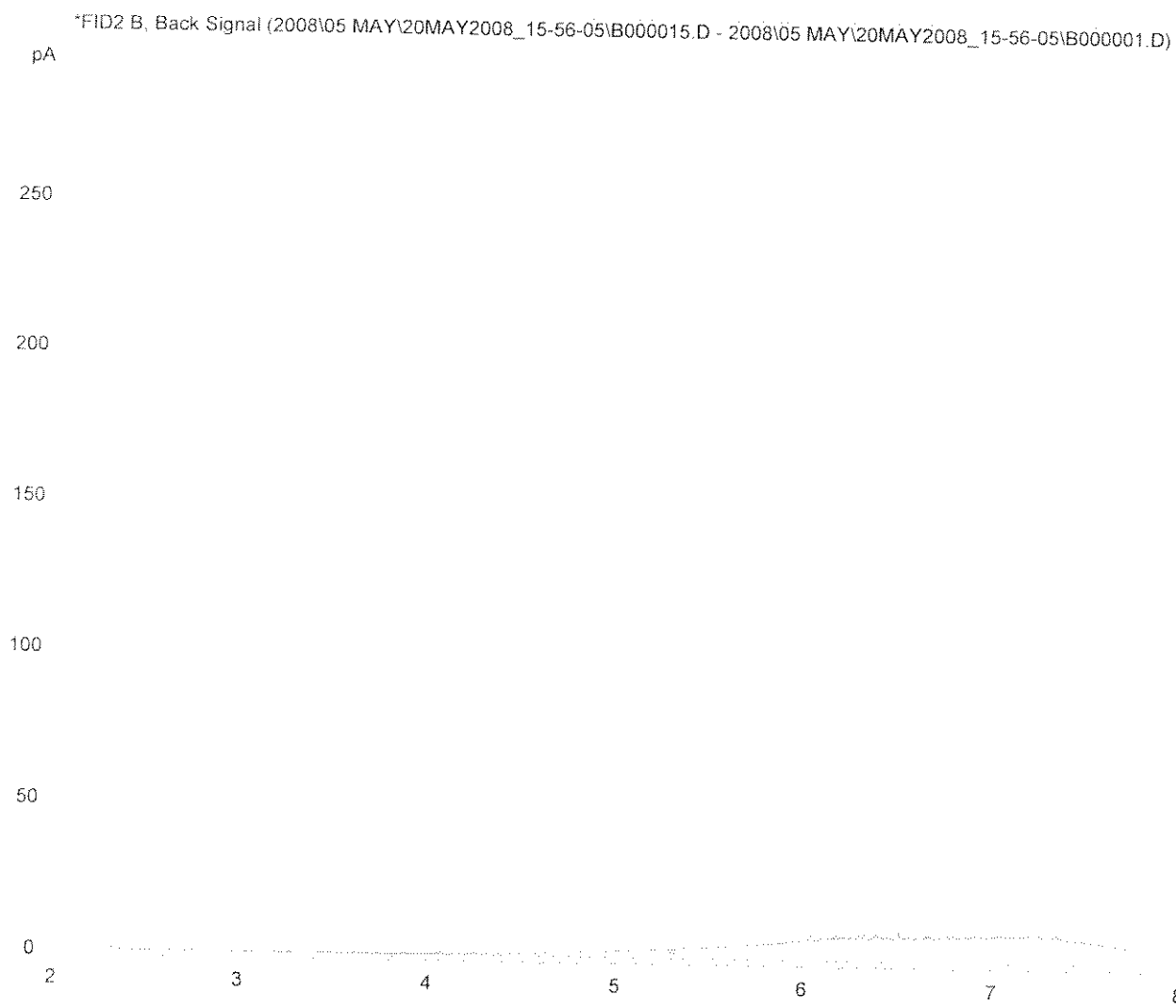
DETS 072 Aliphatic Aromatic TPH by GC-FID

Sample Name: 19338-132207 AR



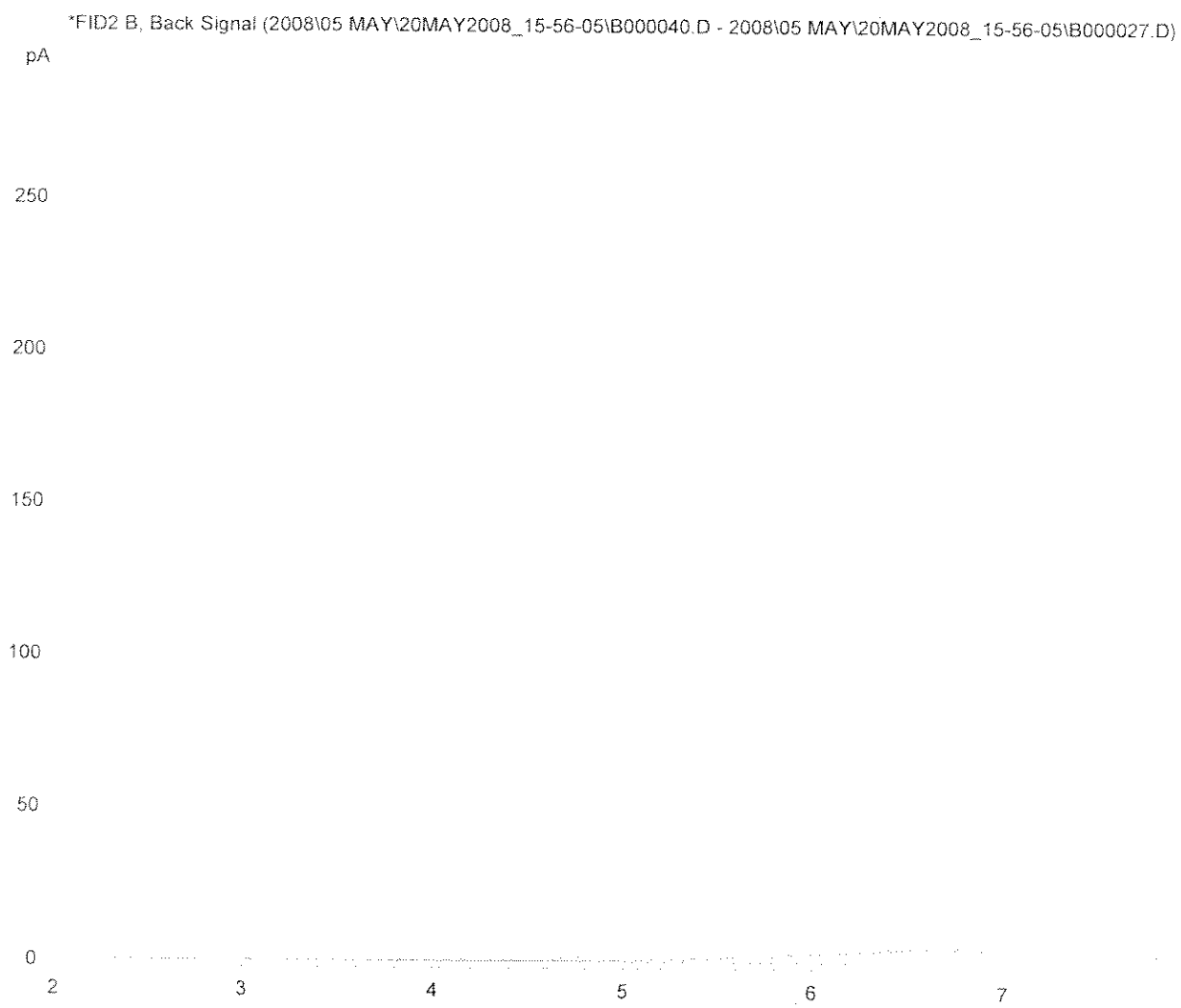
DETS 072 Aliphatic Aromatic TPH by GC-FID

Sample Name: 19338-132208 AL



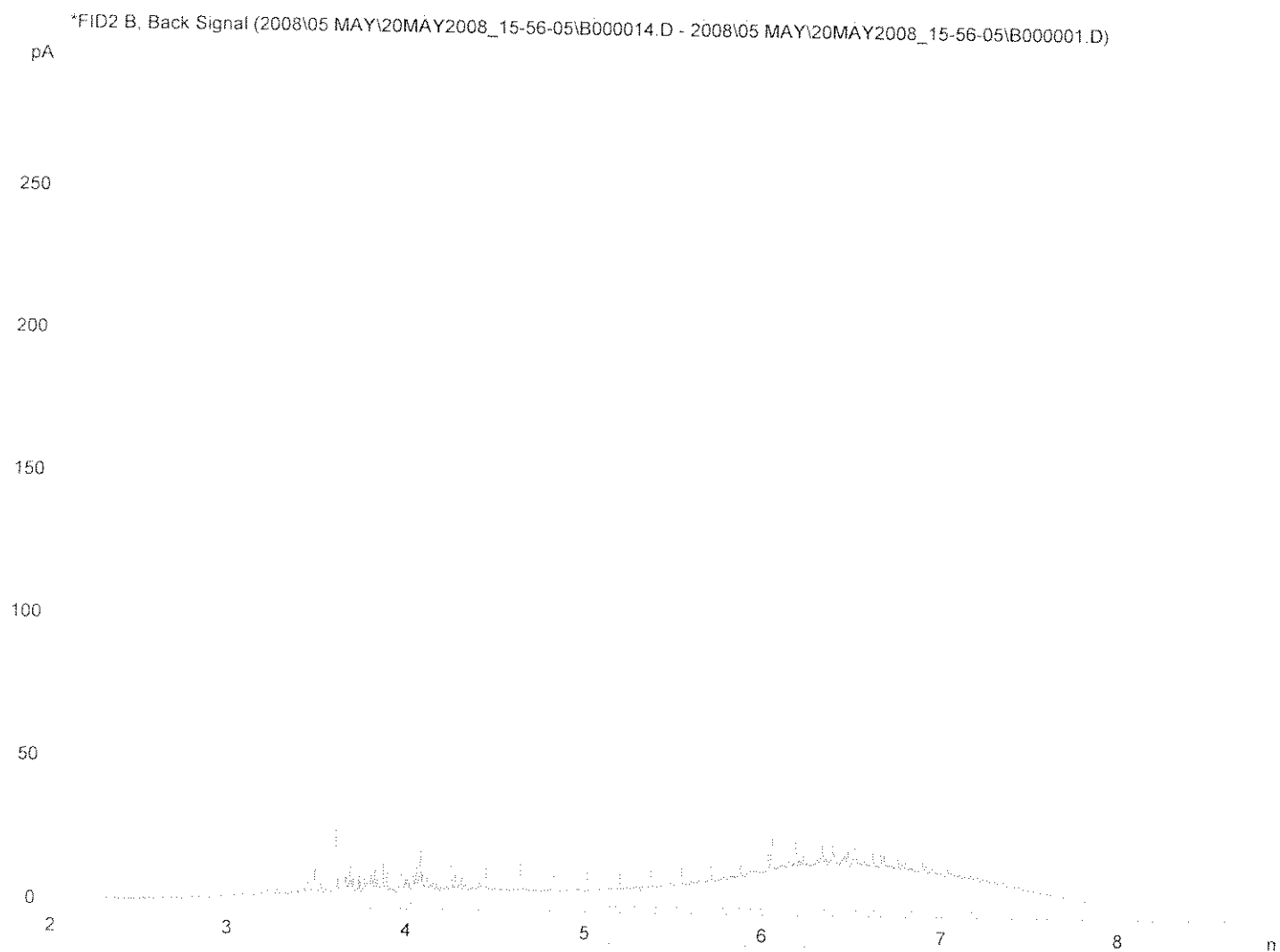
DETS 072 Aliphatic Aromatic TPH by GC-FID

Sample Name: 19338-132208 AR



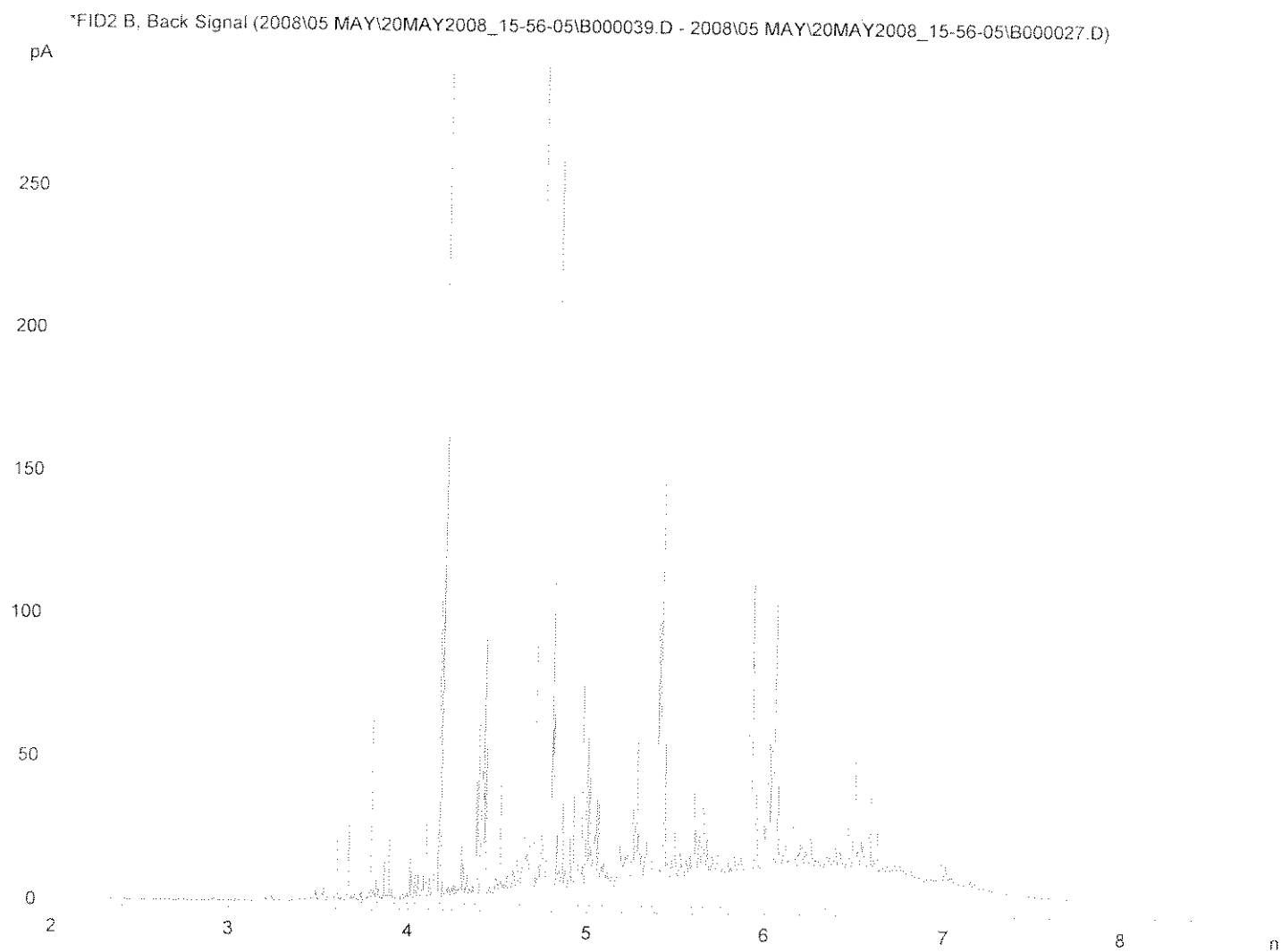
DETS 072 Aliphatic Aromatic TPH by GC-FID

Sample Name: 19338-132210 AL



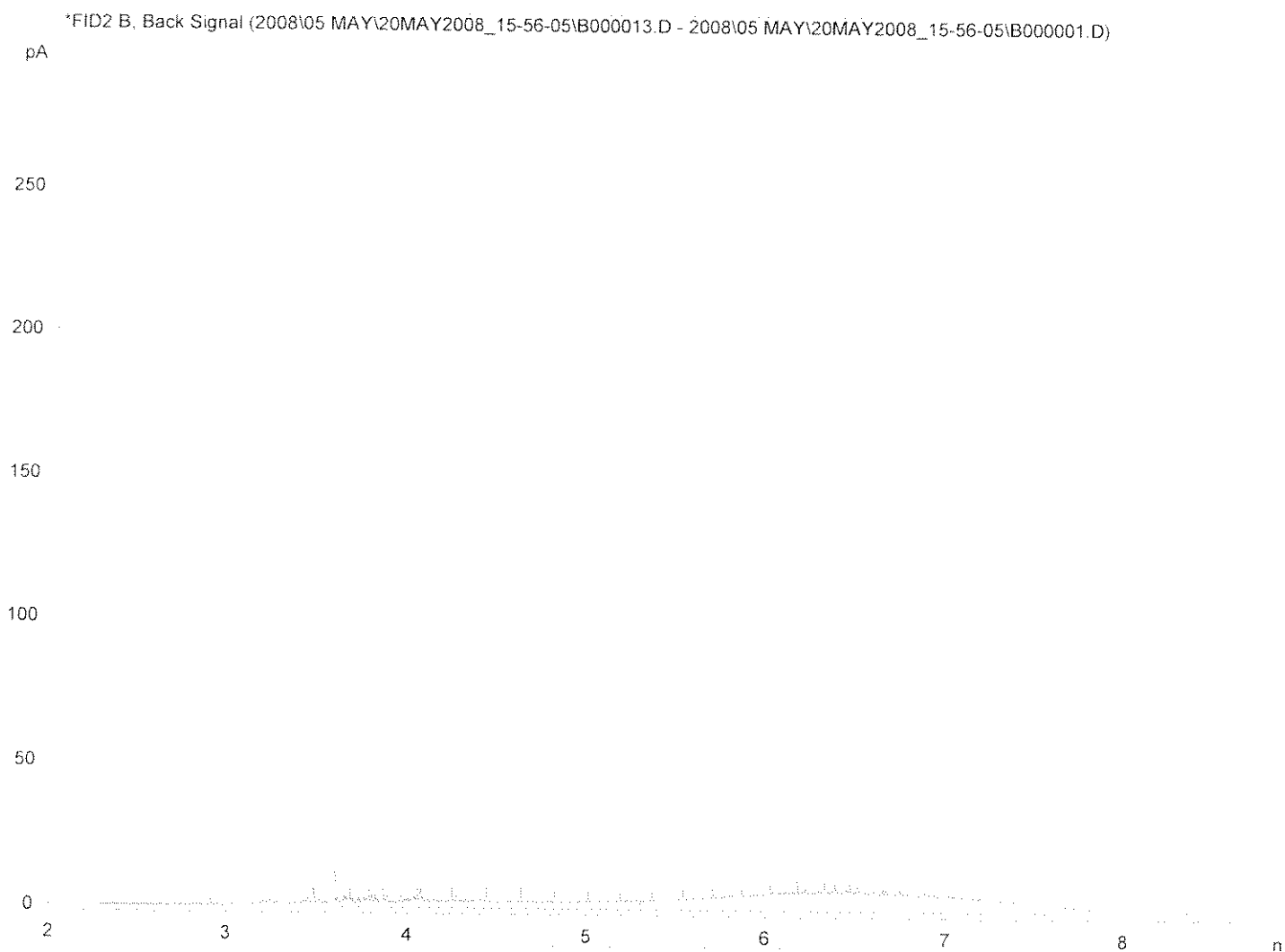
DETS 072 Aliphatic Aromatic TPH by GC-FID

Sample Name: 19338-132210 AR



DETS 072 Aliphatic Aromatic TPH by GC-FID

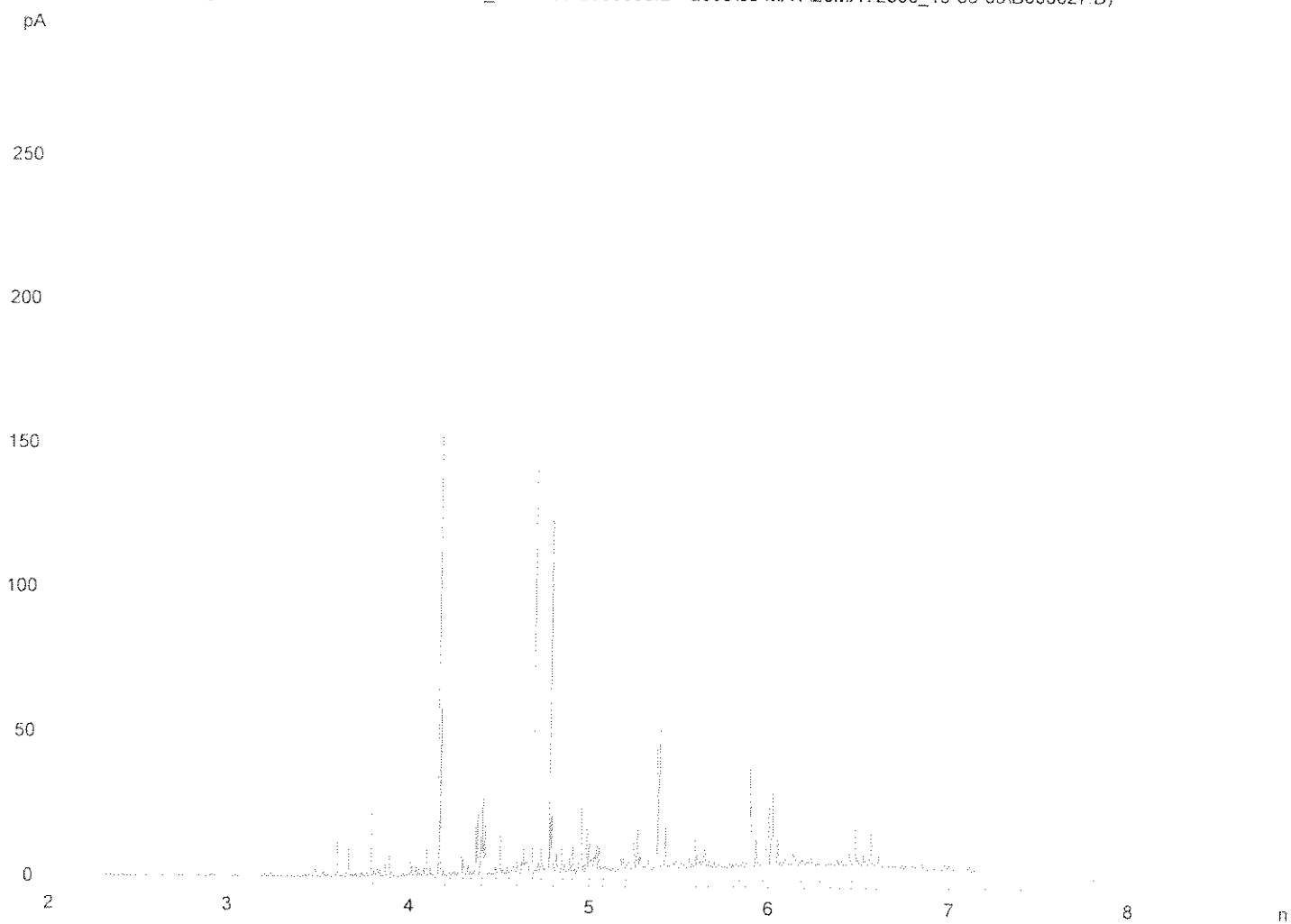
Sample Name: 19338-132211 AL



DETS 072 Aliphatic Aromatic TPH by GC-FID

Sample Name: 19338-132211 AR

*FID2 B, Back Signal (2008\05 MAY\20MAY2008_15-56-05\B000038.D - 2008\05 MAY\20MAY2008_15-56-05\B000027.D)





APPENDIX D

GAS AND GROUNDWATER RESULTS

Ground Gas and Groundwater Monitoring Record Sheet



JOB DETAILS:

Client: Hartwood Estates Ltd
Site: Sheffield Road, Birdwell
Date: 09/05/2008

Job No: C1634
Visit No: 1 of 6
Operator: SA

Project Manager: MB

Monitoring Point	GAS CONCENTRATIONS										VOLATILES		FLOW DATA				WELL AND WATER DATA			Strata sealed into	
	Methane (%v/v)		%LEL		Carbon dioxide (%v/v)		Carbon monoxide (ppmv)		Hydrogen sulphide (ppmv)		Oxygen (%v/v)		PID Peak (ppm)	Product thickness (mm)	Flow rate (l/hr)		Time for flow to equalise (secs)	Water level (mngl)	Depth of well (m)		Response Zone
	Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady					
	Readings not available due to missing gas tap																				
BHR1																					
BHR1A	ND	ND	ND	ND	1.1	1.7	2.0	2.0	ND	ND	18.5	18.5	1.0	ND	ND	ND	ND	Dry	5.00	0.50m to 2.00m	Made Ground
BHR2	ND	ND	ND	ND	1.7	1.7	6.0	6.0	ND	ND	13.3	13.3	4.9	ND	ND	ND	ND	Dry	1.00m to 5.00m	Sandstone	
BHR3	0.4	0.4	9.1	9.1	1.3	1.3	21.0	21.0	26.0	26.0	18.2	18.2	27.3	ND	ND	ND	ND	Dry	4.00	1.00m to 4.00m	Made Ground
																	ND	12.30	30.00	2.00m to 30.00m	Sandstone
Max	0.4	0.4	9.1	9.1	1.7	1.7	21.0	21.0	26	26	18.5	18.5	27.3								
Min	ND	ND	ND	ND	1.1	1.3	2.0	2.0	ND	ND	13.3	13.3	1.0	ND	ND	ND	ND	12.30	30.00		
GSV (l/hr)	0.0004				0.0017													ND	Dry	4.00	
METEOROLOGICAL AND SITE INFORMATION																					

METEOROLOGICAL AND SITE INFORMATION:

State of ground: ☒ Dry ☐ Frozen
Wind: ☒ Calm ☐ Strong
Cloud cover: ☒ None ☐ Overcast
Precipitation: ☒ None ☐ Heavy
Barometric pressure (mbar): ☐ Before ☐ Rising
Pressure trend: ☐ Falling ☐ After
Air Temperature (Deg. C): ☐ Steady

INSTRUMENTATION TECHNICAL SPECIFICATIONS:

Ground gas meter: GFM 430
Gas concentration: CH₄ 0.2% @ 5%, 1.0% @ 30%, 3.0% @ 100% CO₂ 0.1% @ 10%, 3.0% @ 30%, 3.0% @ 100% O₂ 0.50%
Gas Range: CH₄ 0 - 100% CO₂ 0 - 25%
Gas Flow range: (+/-) 30 l/hour
Differential Pressure: (+/-) 1000 Pa
Date of last calibration: 27/09/2007
Date of next calibration: 27/09/2008

PID:

Photocheck 3000
Calibrated range: 0.1 - 10,000 ppm
Calibration gas: i - C₂H₆
Response time: < 1 sec
Accuracy: (+/-) 5%
Date of last calibration: 24/10/2007
Date of next calibration: 24/10/2008

Ground Gas and Groundwater Monitoring Record Sheet



JOB DETAILS:

Client: Hartwood Estates Ltd
 Site: Sheffield Road, Birdwell
 Date: 23/05/2008

Job No: C1634
 Visit No: 2 of 6
 Operator: SA

Project Manager: MB

Monitoring Point	GAS CONCENTRATIONS						VOLATILES		FLOW DATA			WELL AND WATER DATA			Strata sealed into
	Methane (%v/v)	%LEL	Carbon dioxide (%v/v)	Carbon monoxide (ppm v)	Hydrogen sulphide (ppm v)	Oxygen (%v/v)	PID Peak (ppm)	Product thickness (mm)	Flow rate (l/hr)	Differential borehole pressure (Pa)	Time for flow to equalise (secs)	Water level (megl)	Depth of well (m)	Response Zone	
BHR1	ND	ND	ND	2.0	ND	21.2	21.2	ND	ND	ND	ND	Dry	1.00	0.50m to 2.20m	Made Ground
BHR1A	ND	ND	ND	ND	ND	21.2	21.2	ND	ND	ND	ND	Dry	5.00	1.00m to 5.00m	Sandstone
BHR2	ND	ND	ND	ND	ND	21.0	21.0	ND	ND	ND	ND	Dry	4.00	1.00m to 4.00m	Made Ground
BHR3	ND	ND	ND	ND	ND	21.2	21.2	ND	ND	ND	ND	13.36	30.00	2.00m to 30.00m	Sandstone
Max	ND	ND	ND	2	ND	21.2	21.2	ND	ND	ND	ND	13.36	30.00		
Min	ND	ND	ND	ND	ND	21.0	21.0	ND	ND	ND	ND	Dry	1.00		
GSV (l/hr)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	

METEOROLOGICAL AND SITE INFORMATION:

State of ground:

Wind: ☒ X Dry ☐ Calm ☐ None

Cloud cover:

Precipitation: ☒ X None

Barometric pressure (mbar):

Pressure trend:

Air Temperature (Deg. C):

(Select correct box with X or enter data, as applicable)

Moist ☐ Wet ☐ Frozen
 Light ☐ Moderate ☐
 Slight ☐ Cloudy ☐
 Slight ☐ Moderate ☐
 999 Before ☐ Rising ☐
 Falling ☐ After ☐

INSTRUMENTATION TECHNICAL SPECIFICATIONS:

Ground gas meter: GFM 430

Gas concentration: CH₄ 0.2% @ 5%, 1.0% @ 30%, 3.0% @ 100%

Gas Range: CH₄ 0 - 100% CO₂ 0 - 100% O₂ 0 - 25%

Gas Flow range: (+/-) 30 l/hour

Differential Pressure: (+/-) 1000 Pa

Date of last calibration: 27/09/2007

Date of next calibration: 27/09/2008

PID:

Calibrated range: Phocheck 3000

Calibration gas: i - C₂H₆

Response time: < 1 sec

Accuracy: (+/-) 5%

Date of last calibration: 24/10/2007

Date of next calibration: 24/10/2008