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A Jackson

Downham Road, Chatburn

Phase 2 Geo-Environmental Investigation & Assessment

G2235-GR-02

6th June 2016

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Document Control Sheet

Downham Road, Chatburn
Phase 2 Geo-Environmental Investigation & Assessment

Job	Date	Issue	Copy
G2235	*6th June 2016*	*G2235-GR-02*	

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1.0 PREFACE

The site is located at land off Downham Road, Chatburn. BB7 4AS. (NGR 376970 444080). Site occupies an area of approximately 0.14 hectares.

PSA Design were commissioned by A Jackson to provide a Phase 2 Geo-Environmental Investigation & Assessment of the site, in accordance with planning requirements. It is understood that consideration is being given to the redevelopment of the site as a *residential* development. A development layout plan has been provided, which is included in this report as Drawing No. G2235-03.

This report follows on from the Preliminary Risk Assessment, prepared by Worms Eye (ref. DownhamRoad/BB74AV/2015, 20th July 2015), which the reader is referred. PSA Design's investigation included a review of historical/environmental data. A summary of salient geo-environmental issues is provided in the table below.

Issue	Remarks
Former uses	Former uses of site have been a small haulage yard, prior to recent usage as private workshop and garden.
Proposed Development	Re-development of the site as a small estate of residential dwellings, with associated road access and parking and gardens.
Hazardous Gas	The presence of infill within the site represents a low/moderate risk of ground gas generation. Therefore, in accordance with CIRIA C665, and in view of the nature of the residential development, six gas monitoring visits were undertaken over a three month period. Readings from gas wells across the site showed very low levels of carbon dioxide (<5% v/v) and very low methane (<1% v/v), with minimal gas flow. Due to the low risk, no gas protection measures will be required for the development from methane and carbon dioxide however the desk study flagged up that basic radon protection measures will be required for the new buildings.
Ground Investigation	Intrusive investigation comprised window sampler boreholes across site. Chemical and geotechnical soils analysis was carried out with gas/groundwater monitoring.
Ground Conditions	General ground conditions consisted of a varying thickness of made ground (cohesive over granular materials), deepening from 0.0-3.4m, N to S, over LIMESTONE with a localized surface deposit of glacial till over limestone in the NW corner. No groundwater strikes were encountered during investigation.
Contamination	Two low/moderate risks to affected receptors from contaminated fill and haulage activities (including small underground fuel tank), and following testing, fill materials showed slightly elevated levels of contamination (lead, sulphate and PAH's) and as such the site will require remediation measures.
Preparatory Works	Demolition. Excavation and screening of localised Made Ground across the site to remove oversized materials, which may present obstruction to foundations of proposed buildings. Earthworks cut/fill exercise to create final landform. Removal of tank.
Anticipated Foundation Solutions	Shallow foundations may be suitable over the site, either on strip/trench foundations, except within the southern area, where deeper fill (approximately 2.3-3m depth) are present and a piled solution may be required. It is recommended that a trial pitting exercise is carried out along the S boundary of the proposed building structures to ascertain the depth to rock-head across this site area, prior to finalising foundation design. Depth of fill varies across the site and will be a contributing factor to the type of foundation, with a likely steeped foundation from N to S. Structural assessment will be required of building loadings and foundation proximity compared to the slope. Retaining structures are possibly required along the southern boundary to protect the watercourse slope, dependent upon final design proposals.
Environmental & Engineering Remediation Issues	1. Basic Radon Gas protection measures will be required; 2. Earthworks suitability assessment of made ground deposits for re-use; 3. Preparation of highways and parking footprints prior to construction (including possible ground improvement); 4. Cover system will be required in S garden areas;

	5. Waste disposal assessment of material arisings; 6. Validation of any imported topsoil and cover system materials for proposed garden/landscaped areas, if required; 7. Inert material trench surround of Water Supply pipes; 8. Concrete specification upgrade due to suphate; 9. Investigation & removal of fuel tank and validation.
Waste Disposal	Made ground materials should be either placed under hard standing areas (if proved suitable as an engineering material) or disposed of to a suitable licensed landfill site.
Geotechnical Issues	1. Depth, extent and variation in made ground deposits causing potential differential settlement; 2. Foundation type dependent upon depth of fill along S edge of proposed building structures; 3. Obstructions at depth within made ground deposits, such as building foundation brick structures and in-situ slabs; 4. Settlement issues regarding improvement of fill deposits; 5. Retaining structures are possibly likely for the southern slopes, close to the watercourse, dependent upon final design proposals. These will require careful temporary works design, due to the steep nature of the slopes; 6. Tank (fuel), within the N area will need removing and replacement with suitably engineered fill; 7. Close proximity of local structures near to new development.

2.0 INTRODUCTION

2.1 *Terms of Reference*

2.1.1 PSA Design were commissioned by *Alan Jackson* to carry out a Phase 2 Geo-Environmental Investigation & Assessment of the proposed development at Downham Road, Chatburn.

2.1.2 The agreed scope of works included:

- Borehole investigation reaching suitable founding strata
- Gas well installation, monitoring and gas risk assessment
- Assessment of anticipated ground conditions, including potential contaminants
- Assessment of anticipated foundation and engineering issues associated with redevelopment for a *residential* end-use

2.2 *Proposed Development*

2.2.1 It is understood that consideration is being given to the re-development of the site from historically industrial usage to residential properties with gardens.

2.2.2 A development layout plan has been provided, which is included in this report as Drawing No. G2235-03.

3.0 SITE DESCRIPTION

3.1 *General*

3.1.1 The site location is shown on Drawing Number G2235-01. Site details are summarised in the Table below. Current site layout plan shown in Drawing Number G2235-02. The site is situated in a *semi-rural* location.

Detail	Remarks
Location	Within E outskirts of Chatburn.
Address	9 Downham Road, Chatburn. BB7 4AS.
NGR	376970 444080
Area	0.14 ha

3.2 *Site Features*

3.2.1 A PSA Design Engineer completed a walkover survey of the site on the 19th January 2016 and the salient features are presented below.

3.2.2 The existing site is currently used for domestic purposes, with no commercial development on the site. One large brick structure (workshop) is situated in the E area of the site, with a full concrete floor. Various vehicles and equipment are stored within the building. A small underground fuel tank is present, adjacent to the E building, underlying the access road into the site.

3.2.3 Grassed vegetation is found only within NW area of the site, with various mature trees and shrubs along the S, E and particularly the W perimeter of the site.

3.2.4 Ground is on various levels within the site, with the flat N area, sloping down to the Brook along the S boundary.

3.2.5 Access to site off highway, Downham Road, to the N. Unbound gravel aggregate surfacing is present throughout the site, apart from in the NW corner.

3.2.6 Various reclaimed building materials are stored on pallets throughout the yard area.

3.2.7 Existing salient features are summarised in the Table below and shown in Drawing Number G2235-02.

Feature	Remarks
Current Access	Downham Road, to the N.
Topography	Sloping to the S.
Nature of boundaries	Mixed, with wood/wire fence and stone walls and hedging/trees along boundary with neighbouring properties.
Surrounding land uses	NESW – Rural residential. Railway to SE and Chatburn Brook at lower level to S.

3.3 *Site Operations*

3.3.1 No current operations on site and therefore not considered to represent a significant source of ground contamination.

4.0 HISTORICAL SITE INFORMATION

4.1 The desk study recorded minor developments within the site boundary, with the main activity being a haulage yard, with the current structures being in place for approximately 100 years, with the main building extended to the S in the early 1970's. The desk study reports anecdotal evidence that the haulage business was terminated on site in the mid 1980's, with recent usage as a private workshop/vehicle storage facility and garden. .

5.0 GROUND INVESTIGATION

5.1 PSA Design Ground Investigation

5.1.1 PSA Design conducted the following ground investigation works:

- Intrusive investigation of ground conditions beneath the site, to include 7No. window sampler boreholes
- 3No. gas/groundwater wells installed
- Detailed chemical and basic geotechnical analysis of soils beneath the site
- Monitoring of groundwater and gas regimes across the site.

5.1.2 Summary

A ground investigation was undertaken to assess the ground conditions at the site in preparation for the proposed re-development as a residential development with associated infrastructure. The investigation consisted of a borehole drilling exercise followed by chemical testing of representative samples. General ground conditions consisted of a varying thickness of cohesive and granular fill, overlying either stiff clay or directly onto limestone. Groundwater was not encountered. Testing showed minor evidence of contamination across the site. Gas monitoring showed a low gas risk from methane and carbon dioxide within the site.

5.2 Fieldwork

5.2.1 Objectives

5.2.1.1 To determine the general nature of the soils underlying the site, including the thickness and type of any made ground.

5.2.1.2 To assess the density and strength of natural soils on the site to enable foundation recommendations to be made.

5.2.1.3 To recover soil samples for chemical analysis.

5.2.1.4 Establish the potential for soil gas generation and migration through monitoring wells.

5.2.1.5 Identify and assess groundwater quality and flow regime through installation of monitoring wells.

5.2.2 Scope of Works

5.2.2.1 Fieldwork was carried out in one phase, drilling on the 11th February 2016. The fieldwork was supervised by PSA Design. The exploratory holes are listed in the following table.

Technique	Date	Exploratory Holes	Final Depth(s) & Location	Remarks
		Logs in Appendix A	Ground Investigation Plan (Drg G2235-06)	Lab Testing in Appendix B
Window Sample *Vertical* Boreholes	11/02/16	WS1	3.45mbgl [SW – proposed garden area]	General ground conditions, sampling for lab testing, in-situ testing, gas well installation.
		WS2	3.35mbgl [SE – proposed garden area]	General ground conditions, sampling for lab testing, in-situ testing, gas well installation.
		WS3	0.80mbgl [NW – proposed house area]	General ground conditions, sampling for lab testing, in-situ testing..
		WS3A	1.10mbgl [NW – proposed house area]	General ground conditions, sampling for lab testing, in-situ testing.
		WS4	1.80mbgl [NE – proposed house area-near existing tank]	General ground conditions, sampling for lab testing, in-situ testing, gas well installation.
		WS5	0.60mbgl [NE – proposed house area-near existing tank]	General ground conditions, sampling for lab testing, in-situ testing.
		WS6	2.4mbgl [SW – S edge of building]	General ground conditions, sampling for lab testing, in-situ testing.

The exploratory holes are presented in Appendix A. The records provide descriptions, in accordance with BS 5930 (1999) and Eurocode EN ISO 14688, of the materials encountered and details of the samples taken, together with observations made during drilling.

5.2.2.2 A total of 7No. boreholes were sunk across the site to depths of up to 3.45mbgl using a window sampler rig. Detailed logs are presented in Appendix A. All boreholes encountered refusal, assumed to be rock-head. Borehole WS3A was drilled to ascertain whether the gravel material encountered in borehole WS3 was part of a boulder encapsulated within the stiff clay or limestone bedrock material.

5.2.2.3 Gas/groundwater monitoring wells were installed in three of the boreholes, WS1, 2 and 4. The three monitoring wells comprised a lower slotted section of 50mm diameter HDPE pipe, surrounded by a filter pack of 10mm non-calcareous gravel and an upper plain pipe section, surrounded in part by a bentonite seal. The monitoring wells were protected by a flush lockable cover set in concrete.

5.2.3 Soil Descriptions, In-situ Testing and Sampling

5.2.3.1 The soils encountered during this investigation have been logged by a Chartered Geologist in accordance with BS5930:1999 "Code of Practice for Site Investigation" and EN ISO 14688.

5.2.3.2 Geotechnical in-situ testing of the materials encountered was undertaken using a Geonor H-60 Vane for measuring shear strength values.

5.2.3.3 During excavation representative samples were taken at regular intervals, to assist in the identification of soils and allow chemical testing to be programmed.

5.2.4 Exploratory Hole Locations

5.2.4.1 Exploratory hole locations were selected by PSA Design to provide a representative view of strata beneath the site and are shown on Drawing G2235-06.

5.3 Ground Conditions

5.3.1 Geological Summary

The ground conditions encountered within the exploratory pits at the site have been compiled and reviewed. They can be described in terms of the given lithologies (based on published geological data) and are discussed in the subsequent paragraphs. The lithologies encountered during this investigation are summarised in the following table;

Lithology	Depth (m) to base below current ground levels (present m)	Thickness (m)
TOPSOIL	0.05 [WS3+3A]	0.05
Concrete	0.14 [WS5]	0.14
Cohesive Fill	1.50-3.40 [WS1, 2, 4+6]	0.20-1.55
Granular Fill	0.20-3.20 [WS1, 2, 4-6]	0.20-2.00
Stiff CLAY	0.50-0.58 [WS3+3A]	0.45-0.58
LIMESTONE	Undetermined, at least to 3.45 [WS1-6]	Undetermined at least 0.05-0.55
[illegible]	None	

5.3.2 Made Ground

5.3.2.1 Made ground was encountered in 5No. of the 7No. boreholes (WS1, 2, 4-6) apart from in boreholes WS3+3A, during the course of the ground investigation, with the fill being either cohesive or granular fill.

5.3.2.2 The thickness of made ground was found to vary through the site from 0.50-3.40m, with a general thickening of fill within the southern area, where the original ground level has been raised over the last 50 years.

5.3.2.3 Three distinct types of made ground material was observed within the fill materials:

- Granular Fill;
- Cohesive Fill;
- Concrete.

5.3.2.4 The granular fill was found within 5No. of the 7No. boreholes (WS1, 2, 4-6) and varied in thickness from 0.20-2.00m, intermixed with the cohesive fill to depths of up to 3.20mbgl. The material was generally described as: *MADE GROUND: Medium dense (Driller's description), dark brown-grey, slightly sandy, occasionally slightly clayey GRAVEL. Gravel is predominantly fine to coarse, occasionally cobble sized, sub-angular to angular* *composed of limestone, shale with rare tarmac, road planings, brick, concrete, coal, ash and clinker (Granular Fill).*

5.3.2.5 The cohesive fill was found within 4No. of the 7No. boreholes (WS1, 2, 4+6) and varied in thickness from 0.20-1.55m, intermixed with the cohesive fill to depths of up to 3.40mbgl. The material was generally described as: *MADE GROUND: Firm, occasionally soft, dark grey, gravelly-very gravelly CLAY. Gravel is predominantly fine to coarse, sub-angular, comprised of limestone & shale. (Cohesive Fill).*

5.3.2.6 A concrete slab was encountered, within the building, in borehole WS5, with a thickness of 0.14m.

Natural Soils

5.3.3.1 Generally the site comprised a surface deposit of made ground overlying the natural deposits, apart from within the NW corner (boreholes WS3+3A, where TOPSOIL (Turf over dark grey brown slightly organic, CLAY with common fine rootlets [0.05m thick]) was present overlying CLAY over LIMESTONE.

Stiff CLAY

5.3.3.2 The stiff gravelly CLAY was encountered in 2No. of the 7No. boreholes (WS3+3A) in the NW area underlying the topsoil. The clay was generally described as: *stiff, light brown, mottled grey, gravelly CLAY with fine rootlets. Gravel is fine to coarse, sub-angular, comprised of limestone & shale. (Glacial Till).* The thickness varied from 0.45-0.50m. The extent of the clay is limited across the site.

Weak LIMESTONE

5.3.3.3 The weak grey mudstone was encountered in all the boreholes, underlying the fill or stiff clay. The rock was recovered as gravel-sized fragments of limestone, which is assumed to be the likely bedrock material, due to the difficulty in penetration. The thickness was undetermined, as the boreholes were terminated within the upper strata of the bedrock, due to drilling refusal in the competent strata.

5.3.4 Groundwater

5.3.4.1 During the ground investigation groundwater strikes were not encountered in any of the boreholes. Subsequent monitoring of the groundwater wells, recorded dry wells throughout the monitoring period.

6.0 GEOTECHNICAL TESTING & ASSESSMENT

6.1 Introduction

Selective strata was investigated to gain geotechnical parameters of the ground conditions using the in-situ testing techniques of shear vanes, in accordance with BS 1377:1990. Furthermore sulphate and chemical testing was carried out to aid concrete design.

6.2 In-situ Testing

6.2.1 2No. Hand Vane tests were carried out in the glacial till. The tests were carried out on both disturbed and undisturbed samples. Detailed results are tabulated in the logs (Appendix A).

6.2.2 Shear strength results for the clay was consistently high, ranging from 125-128kPa, described as stiff, classified as high strength.

6.3 Sulphate and PH

6.3.1 The concentration of water soluble sulphate (SO_4) was determined on samples of the natural soils. The results have been assessed in accordance with BRE Special Digest SD1; Concrete in Aggressive Ground, 2005.

6.3.2 Results of the 4No. samples are detailed in Appendix B. The sulphate values ranged from 570-6400 mg/kg. The upper limit for total sulphate in Design Sulphate Class 1 (DS - 1) is 0.24 %, which is equivalent to 2,400 mg/kg. The results would suggest that the materials tested lie within the Class DS-3 limit.

6.3.3 Soil pH values ranged from 7.59-8.36, indicating relatively neutral conditions, although slightly alkaline. The site can be described as *brownfield location* with *static* groundwater conditions

6.3.4 Therefore, the 'Aggressive Chemical Environment for Concrete' (ASEC) class for the site is considered to be *AC-3* for new structures and design/mix of buried concrete should be undertaken in accordance with these classifications.

6.4 Foundation Construction

6.4.1 The Made Ground material varied in thickness across the site and is not a suitable foundation stratum. The loose and varied nature of the fill will mean that any significant excavation will need support to ensure that cavings do not occur.

6.4.2 Foundations for the proposed new structure will need to be taken down on to the competent limestone, with uniform material properties. The limestone is considered to be competent founding strata (subject to loadings). In small parts of the site a clay deposit is present. To prevent differential settlement it is essential for the foundations not to be founded in part on this material, but go through this thin band onto the underlying limestone formation.

6.4.4 We estimate the allowable bearing capacity (ABC) of the Limestone deposit to be about ***300kN/m^2***.

6.4.5 The depth of fill varies across the site from 0.0mbgl (WS3+3A) to 3.40mbgl (WS1), with the thickness increasing to the S. The depth of fill within the footprint of the proposed buildings ranges from minimal in the NW corner to approximately 2.35mbgl (borehole WS6) in S extreme. It is advised that prior to foundation design/construction a trial excavation should be carried out along the southern boundary of the proposed building structures to ascertain the depth to rock-head throughout the length of the S boundary walls to check whether there are any depth variations, which may cause the foundation solution to vary.

6.4.6 The proposed floor slab levels for the houses have yet to be detailed but they are likely to be at approximately the same level as the existing ground levels. Due to the extent of fill materials encountered during the investigation of the site, it is recommended that the building foundations for the development be taken down on to the limestone. For the majority of the footprint of the proposed buildings (apart from those located in the deeper fill areas of the site) our basic foundation recommendation would be for trench fill with a lightly reinforced concrete strip footing. The variation in potential foundation depth will need to be considered as to the most economic solution, with the approximate maximum depth of fill in the entire site being 3.40m in a localised southern (proposed garden) area (borehole WS1), which may require a piled foundation, however the majority of the likely foundation depths are <2.35mbgl, decreasing northwards with some shallow within the N proposed building footprint. It is likely that a stepped foundation may be required, to reflect the deepening fill/rock-head interface, from N to S.

6.4.7 Should the position of the houses footprint vary from the initial design, in particular move any further S, or upon excavation, the depth to rock-head along the proposed S boundary wall is significantly deeper than 2.5mbgl then our basic foundation recommendation would be a deeper piled foundation solution. It is likely that within the footprint of the proposed structures, the depth to competent bedrock may vary significantly, due to the nature of the geometry of the infill.

6.4.8 Due to the amount of fill within the southern areas of the building footprint, trench support may be required during foundation construction. It is advised that during the recommended trial excavation along the S edge of the proposed buildings that an assessment can be made of the stability of the trench and what measures will be required during the construction phase.

6.4.9 Assessment of the suitability for re-engineering fill materials will need to be conducted to define whether the floor slabs will need to be suspended or not.

6.5 Road Pavement Construction

6.5.1 The localised made ground materials should not be used as a suitable sub formation material, without further assessment. The fill thicknesses are shallow within the N areas of the site, connecting Downham Road to the development however they become significant across the S areas.

6.5.2 Further investigation and appropriate testing should be carried out prior to future highways construction with formal pavement design.

6.5.3 Appropriate design measures should be adopted to ensure the long term integrity of the pavement. It is essential that any fill/pavement materials are placed and compacted in accordance with a suitable engineering specification. This may take the form of an excavation and replacement with engineered fill exercise, and/or possible geo-textile reinforcement.

6.5.4 Detailed pavement design will be required for all hard-standing areas and allowance should be made for potential ground improvement of the fill deposits. Further works are required including, a field trial/in-situ pavement investigation of the made ground deposits, to ascertain suitability for highways design.

6.6 Earthworks

6.6.1 The topography of the site is flat within the N area and sloping down to the south. It is likely that there will be some changes to the final formation levels for the proposed buildings and infrastructure.

6.6.2 Should materials be exported from site, the materials should be disposed of according to current waste disposal legislation.

6.6.3 Arisings consisting of the granular fill from the construction of the pavement & foundations are suitable for re-use as engineered fill around the site. Re-use of excavated materials should be based on approved material acceptability criteria following detailed pavement design.

6.6.4 The construction method statement should take account of compaction requirements of the appropriate highways specification for a cohesive material.

6.6.5 Proposed ground levels for the entire site have yet to be finalised. It should be noted that any infilling within the S area to create a flatter building development platform should be carried out with full engineering supervision to ensure that the slope down to Chatburn Brook is not de-stabilised. The southern boundary of the development may require a retaining wall design to prevent slope instability affecting the watercourse.

6.7 Excavations & Groundwater

6.7.1 Excavations at the site should be feasible using an appropriate scale of hydraulic plant. Rock is generally at depth across the site, but variations may occur, in particular along the periphery of the site area.

6.7.2 Groundwater was not encountered during the ground investigation but this may affect deeper excavations.

6.7.3 All excavations will require adequate lateral support to ensure their stability and a suitably designed dewatering system. Special care should be taken with the deep fill, in particular, due to the potential loose nature of the granular fill.

6.7.4 Excavations should not be left open for any long period of time, as the formation layer is likely to become compromised with the water affecting the quality and strength of the formation.

6.7.5 The close proximity to structures within the N areas of the site should be taken into consideration to prevent destabilisation during excavation works.

7.0 CONTAMINATION RESULTS & ANALYSIS

7.1 Introduction

The 2016 Ground Investigation by PSA Design was conducted to develop an understanding of the extent (if any) of the contamination. The PSA Design investigation recorded results with evidence of contamination within the fill materials across the site. Chemical testing results are presented within Appendix B.

7.2 Chemical Analysis

7.2.1 In view of the site history, selected soil samples were taken during the ground investigation and were analysed for a screening suite. On the basis of the Conceptual Environmental Risk Model, it has been considered that a range of potential contaminants could exist in soils at the site, as follows:

- Elements which could pose a risk to human health and/or controlled water: arsenic, cadmium, chromium, lead, mercury, nickel, selenium;
- Potentially phyto-toxic elements: boron, copper & zinc;
- Inorganic chemicals which could pose a risk to human health, buildings and/or controlled water: cyanide, nitrate, sulphate & sulphide;
- Other inorganic contaminants: pH conditions;
- Organic contaminants: Polynuclear Aromatic Hydrocarbons (PAH's with split of 16 priority EPA PAH's);
- Speciated And Total Hydrocarbons;
- Asbestos ID;
- VOC and SVOC.

7.2.2 Samples from the ground investigation were chemically tested at Envirolab Laboratories Ltd, a UKAS accredited laboratory.

7.2.3 Chemical testing was targeted at all the various surface strata identified within the ground investigation that would be deemed a threat to human health. This could be broken down into the following:

- Made Ground – Clay Fill;
- Made Ground – Granular Fill
-

7.2.4 Sample selection criteria for chemical testing included good coverage of the site area at various depths and lithologies. The samples to volume ratio reflected not only the spatial element of the various compositions of the ground but also represented the %composition of the particular lithological fill type in the total volume of the most recent fill, situated in the site. The sampling was in accordance with BS 10175:2011, Investigation of potentially contaminated sites- Code of Practice.

7.2.5 5No. soil samples obtained from the site, were tested in total with 4 No. analysed for the following suite of chemical determinands:

- Arsenic, cadmium, total & hexavalent chromium, lead, mercury, nickel, selenium
- Boron (water soluble), copper, zinc
- Cyanide (total)
- Sulphide (acid soluble)
- Nitrate (soluble)
- Phenol (total)
- PAH's (speciated)

7.2.6 4No. samples of the various sub-surface materials were analysed for the following suite of determinands:

- Sulphate (water soluble, 2:1 extract)
- pH conditions

7.2.7 4No. samples of the various sub-surface materials were analysed for the following suite of determinands:

- Aliphatic & Aromatic Hydrocarbons (speciated)

7.2.8 1No. sample of the various sub-surface materials were analysed for the following suite of determinands:

- VOC and SVOC

7.2.9 1No. sample of sub-surface material was analysed for the following suite of determinands:

- Leachate extract

7.2.10 5No. samples of the various sub-surface materials were analysed for the following suite of determinands:

- Asbestos ID

7.2.11 The analytical results of all the chemical testing undertaken are presented in full in Appendix B.

7.3 Current Guidance on Interpretation of Analytical Data

7.3.1 The UK approach to contaminated land is based upon the principles of risk assessment. This in turn is founded upon the use of so called source→pathway→receptor/target principles in order to establish the presence, or potential presence, of a pollutant linkage.

7.3.2 PSA Design adopts a tiered approach to risk assessment that is consistent with UK guidance. The initial step (tier 1) is the comparison of site data with published guidance levels or remedial targets. In March 2002 DEFRA and the Environment Agency published a series of technical research papers (R&D Publications CLR7,8,9 &10) introducing a new approach to the assessment of risk to human health from land contamination. This research includes the development of the new CLEA model and the Soil Guidance Values (SGV's).

7.3.3 Currently, these guidelines only address seven contaminants and the development of both the CLEA model and additional SGV's is ongoing. Where published, SGV's have been utilised as intervention values for the purpose of a Tier 1 assessment.

7.3.4 For chemical determinants that have yet to have an SGV published alternative literature guidance sources have been used to create a generic assessment criteria (GAC). These sources are as follows:

- LQM/CIEH (2015) *Suitable 4 Use Levels for Human Health Risk Assessment*
- EIC/AGS/CL:AIRE (2009) *Soil Generic Assessment Criteria for Human Health Risk Assessment*
- BRE (2005) *Concrete in Aggressive Ground* BRE Special Digest SD1
- ICRCL (1987) *Guidance on the Assessment and Redevelopment of Contaminated Land Note 59/83* (Landscaped/buildings), DoE
- CIRIA C733 (2014) *Asbestos in soil and made ground: a guide to understanding and managing risks.*

7.3.5 The potential risk to building material is considered through reference to relevant BRE Digests, with particular emphasis on BRE Special Digest SD1, 2005: "Concrete in Aggressive Ground".

7.3.6 Tier 1 groundwater risk assessments are undertaken by comparing leachate concentrations with the appropriate water quality standard. Depending upon the specific characteristics of the site, the appropriate standard may be one of the following:

- Water Supply (Water Quality) Regulations, 1989
- Environmental Quality Standards (for freshwater)
- The surface Waters (abstraction for drinking water) Regulations
- United Utilities (water supply pipes) Trigger and Action Levels for inorganic and organic contaminants.
- Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites (10/WM/03/21) [UK Water industry Research], 2011.
- United Utilities Water Supplementary guidance for the selection of water pipes in land potentially affected by contamination, July 2011

7.3.7 Since the withdrawal of the ICRCL values in December 2002, there has seemingly been no direct reference for the assessment of potential phyto-toxic effects of contaminants. PSA Design continue to use the former ICRCL values for copper, nickel and zinc as the withdrawal was in relation to human health implications.

7.3.8 Should any Tier 1 criteria-in terms of human health, environment and groundwater be exceeded, then two courses of action are available. The first is to 'break' the pollutant linkage by recommending an appropriate level of remedial action – removal of contaminated material for example. The alternative approach is to carry out a detailed risk assessment in order to determine whether contamination risks actually exist.

7.4 *Contamination Results*

7.4.1 The analytical results certificates are presented in Appendix B. Statistical analysis has been carried out on each sample as presented in Appendix C.

7.4.2 The preliminary screening process has been compared with the relevant SGV's and GAC's for a *residential* end land use, as the most suitable equivalent for the proposed development.

7.4.3 The *residential* development will be covered with associated hard standing and some landscaping/garden zones.

7.4.4 Several elevated US_{95} concentrations have been calculated for the following CLEA determinands by the statistical analysis within the made ground material:

- Lead
- Benzo-a-pyrene [PAH]
- Dibenzo-ah-anthracene [PAH]
- Benzo-b-fluoranthene [PAH]
- Sulphate

Raised levels of contamination were found within the various types of made ground across the site and at various depths. Slightly elevated levels of PAH were also found in the leachate test. The main contamination risk from hydrocarbons leaking from the tank appears not to have occurred, with testing across the site showing low values.

7.4.5 The chemical testing has confirmed that the *residential* development is at risk from significant contamination. The values would suggest that a suitable simple remediation strategy could be adopted to alleviate the risks.

7.4.6 No raised levels (compared to United Utilities trigger levels for ground surrounding water supply pipes on new developments) of hydrocarbons, VOC and SVOC, cresols and phenols prove that PE water supply pipes are suitable for the development.

8.0 GAS TESTING & ASSESSMENT

8.1 Introduction

8.1.1 In order to characterise the ground gas regime and to obtain information on the groundwater conditions beneath the site, 3 monitoring wells were installed (WS1, 2+4) across the site during the ground investigation.

8.2 Scope of Works

8.2.1 For the gas assessment the wells were monitored on 6No. visits, undertaken between February and May 2016, following installation of the standpipes.

8.2.2 A standard procedure was followed in accordance with CIRIA guidance; this procedure involved measurement, in the following order of:

- Atmospheric temperature, pressure and ambient oxygen concentration on site immediately prior to and on completion of, monitoring
- Weather conditions
- Emission rate using an internal GA500 flowmeter
- Methane, oxygen and carbon dioxide concentrations using a Geotechnical Instruments GA5000 infra-red gas analyser
- Measurements of peak and steady state concentrations of these gases were recorded via the standpipe gas valve over a time period of at least 180 seconds
- Standing water level using a dipmeter.

8.3 Current Guidance

8.3.1 Current guidance for the assessment of risk associated with the presence of methane and carbon dioxide within ground gas is provided by five recent publications; BS8576:2013 "*Guidance on investigations for ground gas. Permanent gases and Volatile Organic Compounds*", "*A pragmatic Approach to Ground Gas Risk Assessment*" CL:AIRE RB17 (2012), the "*Ground Gas Handbook*" Wilson, Card & Haines (2009), the NHBC "*Guidance on Evaluation of Development Proposals on sites where Methane and Carbon Dioxide are present*" (2007) and CIRIA Report C665 "*Assessing risks posed by hazardous ground gases to building*" (2007). These reports have developed from previous publications such as:

- BS8485:2007 "*Code of Practice for the characterization and remediation from ground gas in affected developments*"
- Waste Management Paper 27
- BRE Report 212 "*Construction of new buildings on gas-contaminated land*"
- CIRIA Report 149 "*Protecting Development from methane*"
- CIRIA Report 152 "*Risk assessment for methane and other gases from the ground*"
- CIRIA Report 150 "*Methane investigation strategies*"
- Wilson & Card, Ground Engineering "*Reliability and risk in gas protection design*".

8.3.2 As indicated in these documents, the level of potential risk associated with a given ground gas regime not only depends upon ground gas composition, but also upon ground gas pressure, as this is a significant driving force for gas migration, either horizontally or vertically through the sub-surface environment. Measurement of gas pressure within or gas flow from, a monitoring standpipe provides useful data which can be used, together with ground gas compositional analysis, to provide a more robust estimation of the level of risk posed to the building development, than consideration of gas composition data alone.

8.4 Monitoring Results

8.4.1 The results of the standpipe monitoring are presented in Appendix D and summarised in the table below.

Borehole	Response zone(mbgl)/strata	Evidence of contamination	No. of monitoring occasions & Dates	Methane (%)	Carbon dioxide (%)	Flow (l/hr)	Range of Atmospheric pressures during monitoring	Water Levels (mbgl)
WS1	*1.0-3.0 M*	*Y*	*6[18/02/16-24/05/16]*	*0.0-0.1*	*0.2-0.3*	*0.0-0.1*	*994-1014*	*dry*
WS2	*1.0-3.0 M*	*N*	*6[18/02/16-24/05/16]*	*0.0*	*0.1-0.2*	*0.0-0.1*	*994-1014*	*dry*
WS4	*1.0-1.8 M/R*	*N*	*6[18/02/16-24/05/16]*	*0.0*	*0.3-1.7*	*0.0*	*994-1014*	*dry*

M=Made Ground, R=Limestone

8.4.2 The monitoring results show that 1No. of the three borehole monitoring standpipes recorded methane (WS1), with recorded low readings, ranging from 0.0-0.1 % v/v.

8.4.3 The results for carbon dioxide recorded low concentrations within the three boreholes, ranging from 0.10-1.70% v/v. Oxygen concentrations were slightly depleted corresponding to the slightly elevated carbon dioxide levels.

8.4.4 Low flow rates were recorded, varying from 0.0-0.1 l/hr in the three boreholes during the monitoring period.

8.5 Source of Gas

8.5.1 The presence of infilled ground within the site represents a low-medium risk of elevated concentrations of ground gas at the site.

8.5.2 The type and amount of fill deposits found within the site, generally a mixture of cohesive and gravel fill, is considered a suitable source of the low quantities of gas, but also reflect the lack of gas flow recorded. The lack of flow shows that the material will not degrade significantly (unlike putrescible, household waste).

8.6 Frequency of Monitoring

8.6.1 The proposed likely end use for the development is classed as residential development. The sensitivity of the development has been classed as *high* with the generation potential of the source as *very low*.

8.6.2 The frequency of monitoring has been based on current guidance as set in the following table.

Typical minimum periods and frequency of monitoring (CIRIA 2007)

Sensitivity of development		Generation potential of source				
		Very Low	Low	Moderate	High	Very High
	Low	4/1	6/2	6/3	12/6	12/12
	Moderate	6/2	6/3	9/6	12/12	24/24
	High	6/3	9/6	12/6	24/12[3]	24/24[3]

1. First number is minimum number of readings and second number is minimum period, for example 4/1 – Four sets of readings over 1 month

2. At least two sets of readings must be at low and falling atmospheric pressure (<1000mb)

3. The acceptability of placing high sensitivity end use on a high gas hazard site is not normally acceptable unless source is removed or treated to reduce gassing potential

8.6.3 Potential temporal variable were accommodated within the monitoring regime with monitoring undertaken at barometric pressures below 1000mb on three occasions when the pressure was falling.

8.7 Gas Screening Values (GSVs)

8.7.1 Gas Screening Values (GSV's), which equate to the borehole gas volume flow rate, as defined by Wilson & Card (1999) as the borehole flow rate multiplied by the concentration in the air stream of the particular gas being considered have been calculated from a risk-based methodology for deriving threshold concentrations for gas flow rates. The Gas Screening Value (GSV) of a particular ground gas being considered equates to:

- GSV (l/hr) = borehole flow rate (l/hr) x gas concentration(%v/v).

8.7.2 Maximum methane concentration on site was 0.1% v/v. The maximum carbon dioxide concentration of 1.7% v/v, with a worst case flow rate of 0.1 l/hr (for arithmetic purposes). The GSV can thus be calculated as:

- Methane 0.001 x 0.1 = ***0.001 l/hr***
- Carbon Dioxide 0.017 x 0.1 = ***0.0017 l/hr***

8.8 *Traffic Light System of Gas Assessment*

8.8.1 The NHBC guidance has set out a series of 'Traffic Lights' that can be applied to gas risk assessments specific to low-rise housing developments (but have been assumed to be a worst case situation for this type of development). This is a risk-based approach that is designed to allow quick and easy design of gas protection for a low-rise development by comparing the measured gas emission rates to generic Traffic Lights. The Traffic Lights include 'Typical Maximum Concentrations' are provided for initial screening purposes and risk-based Gas Screening Values (GSVs) for consideration for situations where the Typical Maximum Concentrations are exceeded. The GSV's equate to the borehole gas volume flow rate, as defined by Wilson & Card (1999) as the borehole flow rate multiplied by the concentration in the air stream of the particular gas being considered. The calculations are carried out for both methane and carbon dioxide and the worst-case adopted in order to establish the appropriate protection measures. The table below sets out the gas risk assessment criteria:

GRA_Traffic Lights with Typical Max Concentrations and GSVs

Traffic Light Classification	Methane [1]		Carbon Dioxide [1]	
	Typical Maximum Concentration [3] (%v/v)	Gas Screening Value [2,4] (l/hr)	Typical Maximum Concentration [3] (%v/v)	Gas Screening Value [2,4] (l/hr)
Green				
	1	0.13	5	0.78
Amber 1				
	5	0.63	10	1.60
Amber 2				
	20	1.60	30	3.10
Red				

Notes:

1. The worst-case ground gas regime identified on the site, either methane or carbon dioxide, at the worst-case temporal conditions that the site may be expected to encounter will be the decider as to what Traffic Light is allocated;

2. Borehole Gas Volume Flow Rate, in litres per hour as defined in Wilson and Card (1999), is the borehole flow rate multiplied by the concentration in the air stream of the particular gas being considered;

3. The Typical Maximum Concentrations can be exceeded in certain circumstances should the Conceptual Site Model indicate it is safe to do so;

4. The Gas Screening Value thresholds should not generally be exceeded without the completion of a detailed ground gas risk assessment taking into account site-specific conditions.

8.8.2 The GSV for the site area has been calculated as 0.0017 l/hr which puts the site in the Green Classification for NHBC or the Characteristic Situation 1 for the Wilson et al.,2006/2007 (modified from Wison&Card,1999) Classification/CIRIA, 2006, with the typical carbon dioxide and methane concentrations being <5% and <1% respectively. The lack of flow, will have an affect on the final protection measures, with the GSV values alone, classified as Green, which stays green due to the maximum gas concentration being below typical maximum levels.

8.9 Assessment

8.9.1 The ground conditions throughout the site and surrounding land have been proved to be small pockets of cohesive and granular fill, surrounded by natural clay deposits and limestone. The natural materials will tend to inhibit gas migration, with the clay reducing potential migration of landfill gas, buffering flow, due to its' relative impermeability and lack of permanent granular pathways. The source of the low concentrations of gas is likely to be the fill, with minimal gas flow, although the low levels could reflect natural background levels. Elevated levels of methane and carbon dioxide, compared to background levels have not been recorded. The fill is aged and the landfill is of a relatively small volume.

8.9.2 The low potential of gas source combined with the lack of pathways and the low potential of at risk sensitive receptors for the infill would lead to the conclusion that the landfill gas risk for the site is low. The shallow thickness and small volume of material would give a very small gas generation potential for this infill and combined with ground conditions would most likely prevent any migration of gas into the dwelling.

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8.10 Gas Protection Measures

8.10.1 Based upon the Traffic Light classification the ground gas protection measures required can be defined as presented in the Table below:

Ground Gas Protection Measures

Traffic Light	Ground Gas Protection Measures Required
Green	Ground gas protection measures are not required.
Amber 1	Low-level ground gas protection measures are required, using a membrane and ventilated sub-floor void that creates a permeability contrast to limit the ingress of gas into buildings. Gas protection measures are to be installed as prescribed in BRE 414. Ventilation of the sub-floor void should be designed to provide a minimum of one complete volume change per 24 hours.
Amber 2	High-level ground gas protection measures are required, creating a permeability contrast to prevent ingress of gas into buildings. Gas protection measures are to be installed as prescribed in BRE 414. Membranes used should always be fitted by a specialist contractor and should be fully certified (see Appendix E). As with Amber 1, ventilation of the sub-floor void should be designed to provide a minimum of one complete volume change per 24 hours.
Red	Standard residential housing is not normally acceptable without further Ground Gas Risk Assessment and/or possible remedial mitigation measures to reduce/remove the source of the ground gases. In certain circumstances, active protection methods could be applied, but only when there is a legal agreement assuring the management and maintenance of the system for the life of the property.

8.10.2 On the basis of the Traffic Light Classification it is recommended that for the site development gas protection measures are not required for methane and carbon dioxide.

8.10.3 From the readings, it is concluded that the risks posed by the presence of gas underlying the site is very low. The residential development is classified as Green (Table 14.2, NHBC, 2007) or Characteristic 1 (Table 8.5, CIRIA 665, 2007). As such, basic gas protection measures will not be required for the scheme for methane and carbon dioxide.

8.10.4 The desk study stated that the site is at risk from radon gas and that basic radon protection measures will be required within the construction.

9.0 HAZARD ASSESSMENT

9.1 Sources

9.1.1 The industrial processes and activities undertaken on or adjacent to the site that may act as potential historical or current sources of environmental hazard are shown in the Table below.

Type of Issue	SOURCE-Specific Issue	HAZARD-Remarks
Potential on-site contamination sources HISTORICAL	1. Made Ground beneath site from historic filling to create a level platform. 2. Haulage Yard activities. 3. Fuel Tank.	1. Potential source of soil and groundwater contamination (metalloids, PAH, sulphates, asbestos). 2. Risk of ground gas production (CO_2 & CH_4). 3. Potential source of soil and groundwater contamination (hydrocarbons).
Potential off-site contamination sources HISTORICAL	1. Infill within surrounding area. 2. Railway.	1. Risk of ground gas production (CO_2 & CH_4). 2. Potential source of soil and groundwater contamination (metalloids, PAH, hydrocarbons).
Potential on-site contamination sources CURRENT	1. None	N/A
Potential off-site contamination sources CURRENT	1. None	N/A
Potential geotechnical hazards	1. Variable Rockhead. 2. Localised fill deposits in sloping site. 3. Mature trees to margins. 4. Deep fill. 5. Close proximity of neighbouring structures 6. Relict Foundations.	1. Difficulties in excavating for foundation and drainage construction. 2. Localised deeper foundations, dependent upon final footprint of buildings and potential retaining walls along S boundary of site development. 3. Deeper foundations/root protection due to tree influence (dependent upon ground conditions). 4. Potential differential settlement affecting pavement, possible reinforcement/treatment required. 5. Instability. 6. Obstructions.

9.2 Pathways and Receptors

9.2.1 *Six* pollutant receptors have been identified for the site, and are listed in the table below, together with the pathways through which they may be linked to pollutant sources.

Receptor	Pathways
HUMAN HEALTH Re-development Workers End users-residents	Inhalation, ingestion, skin contact
FAUNA & FLORA Landscaping	Root uptake
WATER ENVIRONMENT Surface water-Brook Groundwater	Ground & Surface water
BUILT ENVIRONMENT Buildings and services	Direct contact with contaminated soil Diffusion of landfill gas through ground and collection in confined spaces

9.3 *Conceptual Model and Qualitative Risk Assessment*

9.3.1 A preliminary conceptual model of pollutant linkages is given in the table below, together with a qualitative risk assessment for each linkage. The risk assessment uses the method of risk evaluation set out in CIRIA 552 'Contaminated Land Risk Assessment'. The scale of risk is determined from a matrix that combines the *consequence* of a hazard with the *likelihood* of the event happening. Details of the assessment method are included in Appendix E. A schematic summary of the revised conceptual model is given in Drawing Number G2235-05.

Source	Pathway	Receptor	Consequence	Probability	Risk Classification	Remediation Measures
On-site historic sources of ground contamination arising from *infill materials*, including metalloids, PAHs, sulphates & asbestos	Inhalation, ingestion, skin contact	Re-development workers	medium	low	**Moderate/low risk**	*PPC required during ground-works.*
		End users-residents	medium	low	**Moderate/low risk**	*Remediation required. Options include either containment (by hard-standing barrier and/or removal of contaminated fill). In addition, affected garden areas will require remediation measures, either 600mm cover system &/or removal of contaminated soils.*
	Root Uptake	Landscaping Vegetation	minor	likely	Low risk	*Imported topsoil to be validated.*
	Groundwater	Chatburn Brook	medium	low	**Moderate/low risk**	*Due to the low testing levels for the leachate testing from the GI remediation is unlikely to be required.*
		Groundwater	mild	unlikely	Low risk	*Due to the low testing levels for the leachate testing from the GI remediation is unlikely to be required.*
	Direct Contact	Buildings and Services	medium	low	**Moderate/low risk**	*For utility pipes, no higher specification barrier pipe materials are required with PE OK according to UU guidelines. Upgraded concrete specification to AC-3 for foundations.*

Source	Pathway	Receptor	Consequence	Probability	Risk Classification	Remediation Measures
On & off-site sources of ground contamination (gas) arising from *landfill* (CO_2 and CH_4 gas).	Inhalation, ingestion, skin contact	Re-development workers	Severe	unlikely	**Low/moderate risk**	*Following 3 month gas monitoring and a risk analysis based on the site conceptual model, no gas protection measures will be required (methane & carbon dioxide) for the proposed new dwelling, however **basic radon protection measures** are required.*
		End users- residents	Severe	unlikely	**Low/moderate risk**	
	Direct Contact	Buildings and Services	Medium	unlikely	Low risk	

Source	Pathway	Receptor	Consequence	Probability	Risk Classification	Remediation Measures
On-site historic sources of ground contamination arising from *haulage activities and fuel tank*, including metalloids, PAHs, and hydrocarbons.	Inhalation, ingestion, skin contact	Re-development workers	medium	low	**Moderate/low risk**	*PPC required during ground-works.*
		End users-residents	medium	low	**Moderate/low risk**	*Remediation required. Options include either containment (by hard-standing barrier and/or removal of contaminated fill. In addition, affected garden areas will require remediation measures, either 600mm cover system &/or removal of contaminated soils.*
	Root Uptake	Landscaping Vegetation	minor	likely	Low risk	*Imported topsoil to be validated.*
	Groundwater	Chatburn Brook	medium	low	**Moderate/low risk**	*Due to the low testing levels for the leachate testing from the GI remediation is unlikely to be required.*
		Groundwater	mild	unlikely	Low risk	*Due to the low testing levels for the leachate testing from the GI remediation is unlikely to be required.*
	Direct Contact	Buildings and Services	medium	low	**Moderate/low risk**	*For utility pipes, no higher specification barrier pipe materials are required with PE OK according to UU guidelines. Upgraded concrete specification to AC-3 for foundations.*

Source	Pathway	Receptor	Consequence	Probability	Risk Classification	Remediation Measures
Off-site historic sources of ground contamination arising from *railway activities*, including metalloids, PAHs, sulphates & hydrocarbons	Inhalation, ingestion, skin contact	Re-development workers	medium	unlikely	Low risk	*Remediation unlikely to be required.*
		End users-residents	medium	unlikely	Low risk	
	Root Uptake	Landscaping Vegetation	minor	unlikely	Very Low risk	
	Groundwater	Chatburn Brook	medium	unlikely	Low risk	
		Groundwater	mild	unlikely	Very Low risk	
	Direct Contact	Buildings and Services	medium	unlikely	Low risk	

9.3.2 *On-site historical ground and groundwater contamination from infill material*

The risk classification for *six* pollutant linkages relating to potential sources of contamination in the underlying ground and groundwater from infill contamination sources, varied between *moderate/low* risk to *low* risk. Investigation, if not already undertaken, is normally required in cases where the risk is classified as *moderate* or higher, and some remedial works may be required.

Four *low/moderate* risks were identified for the re-development workers, residents, surface water and services receptors and two low risks for the vegetation and groundwater via the pathway of direct contact with contaminated soil/groundwater. The risk of pollution from the historic fill within the site was assumed to be relatively low risk due to various factors. These included the likely ground conditions being surrounded by relatively impermeable boulder clay overlying limestone, with likely engineering property of underlying fill being inert granular/cohesive fill (>50 years old), hydrogeology and no visual signs of distress of surface vegetation during walkover.

Following investigation and testing the risks to future residential users from on-site historical contamination from ground and groundwater migration from the made ground material would appear to be *low/moderate.* The shallow made ground material, within the site appears to have raised levels of lead and various PAH's. This will require some form of remediation measure to reduce the risk of affecting end user human health within the potential garden areas. Options of remediation measures should be developed in a remediation strategy.

The chemical characteristics of soil, as tested from the site poses some human health risk upon prolonged and repeated exposure to materials on site, specifically through ingestion or inhalation of soil particles during site work. The level of risk to construction staff can be adequately controlled by the implementation of good working practices during the site clearance/earthworks. During the ground works phase of the development, appropriate personal protective equipment, adequate hygiene and accommodation facilities, and the implementation of dust control when required should be implemented. The work force should undergo a site safety briefing to identify the site as 'brownfield' and potentially contaminated.

No raised levels of contaminants within the made ground of the site (compared to UU guidance trigger values) and as such would provide a *low* risk to the water supply pipes if they were sat directly upon the material. As such the pipe type for the water supply pipe can be PE. However, in terms of risk to protection to utilities maintenance staff it is recommended that remediation measures are undertaken for construction of the water supply trenches, such as correct material specification of pipe bedding surround with inert materials, or divert the pipes away from the affected zone.

The risk to groundwater receptor from the contamination source appears to be *low risk.* Groundwater was not encountered within the investigation. The overlying clay and cohesive fill will tend to inhibit migration, buffering and diluting the concentrations of contaminants during transportation into the aquifer. Leachate test results show no significant raised contamination levels that could affect the aquifer, at depth. Likewise, the risk to the brook is assumed to be low, due to the distance to the brook, the lack of mobile contaminants (minimal hydrocarbons) and the type of fill.

For any proposed planting areas either excavation and replacement or clean cover should be provided to mitigate against potential phyto-toxic effects from elevated concentrations of various elements within the ground. Remediation options should be developed in a remediation strategy. Care should be taken to guarantee that imported topsoil for the garden areas is within clean soil guidance levels.

9.3.3 *Gas Risk from infill*

A gas risk assessment for the site is set out in Section 8.0.

9.3.4 *On site historical ground and groundwater contamination from haulage activities and fuel tank*

The risk classification for *six* pollutant linkages relating to potential sources of contamination in the underlying ground and groundwater from sources related to the historic haulage activities and the fuel tank, varied between *moderate/low* risk to *low* risk. Investigation, if not already undertaken, is normally required in cases where the risk is classified as *moderate* or higher, and some remedial works may be required.

Four *low/moderate* risks were identified for the re-development workers, residents, surface water and services receptors and two low risks for the vegetation and groundwater via the pathway of direct contact with contaminated soil/groundwater. The risk of pollution from the historic fuel spillages and haulage activities within the site was assumed to be relatively low risk due to various factors. These included the small scale size of the site and sloping topography, with the narrow access likely to restrict the amount of vehicles in usage, concrete floors within the building would inhibit any spillages reaching the underlying ground, small tank volume size, no historic pollution records, likely ground conditions being surrounded by relatively impermeable boulder clay overlying limestone, with likely engineering property of underlying fill being inert granular/cohesive fill, hydrogeology and no visual signs of distress of surface vegetation during walkover.

Following investigation and testing the risks to future residential users from on-site historical contamination from haulage activities and fuel spillages from the tank would appear to be *low/moderate*. The shallow made ground material, within the site appears to have raised levels of lead and various PAH's, likely to be related to the infill, with minimal elevated levels of hydrocarbons noted within the testing results. This will require some form of remediation measure to reduce the risk of affecting end user human health within the potential garden areas. Options of remediation measures should be developed in a remediation strategy.

The chemical characteristics of soil, as tested from the site poses some human health risk upon prolonged and repeated exposure to materials on site, specifically through ingestion or inhalation of soil particles during site work. The level of risk to construction staff can be adequately controlled by the implementation of good working practices during the site clearance/earthworks. During the ground works phase of the development, appropriate personal protective equipment, adequate hygiene and accommodation facilities, and the implementation of dust control when required should be implemented. The work force should undergo a site safety briefing to identify the site as 'brownfield' and potentially contaminated.

No raised levels of contaminants within the made ground of the site (compared to UU guidance trigger values) and as such would provide a *low* risk to the water supply pipes if they were sat directly upon the material. As such the pipe type for the water supply pipe can be PE. However, in terms of risk to protection to utilities maintenance staff it is recommended that remediation measures are undertaken for construction of the water supply trenches, such as correct material specification of pipe bedding surround with inert materials, or divert the pipes away from the affected zone.

The risk to groundwater receptor from the contamination source appears to be *low risk*. Groundwater was not encountered within the investigation. The overlying clay and cohesive fill will tend to inhibit migration, buffering and diluting the concentrations of contaminants during transportation into the aquifer. Leachate test results show no significant raised contamination levels that could affect the aquifer, at depth. Likewise, the risk to the brook is assumed to be low, due to the distance to the brook, the lack of mobile contaminants (minimal hydrocarbons) and the type of fill.

For any proposed planting areas either excavation and replacement or clean cover should be provided to mitigate against potential phyto-toxic effects from elevated concentrations of various elements within the ground. Remediation options should be developed in a remediation strategy. Care should be taken to guarantee that imported topsoil for the garden areas is within clean soil guidance levels.

As part of the remediation strategy the safe removal of the fuel tank should be set out in the method statement.

9.3.5 *Off-site historical contamination from railway activities, through migration*

The risk classification for *six* pollutant linkages relating to potential sources of contamination in the underlying ground and groundwater from migration of off-site historic railway contamination sources varied between *low* risk to *very low* risk. Investigation, if not already undertaken, is normally required in cases where the risk is classified as *moderate* or higher, and some remedial works may be required.

Five *low* risks were identified for the residents, re-development workers, surface water and services receptors via the pathway of direct contact with contaminated soil/groundwater. The risk of pollution from the contamination migration was assumed to be relatively low risk due to various factors. These include distance from the site, topography (railway in cutting), ground conditions – any spillages will tend to drain vertically into the underlying glacial deposits, impermeable clay acting as a buffer to migration, working practices reducing pollution linkages and hydrogeology. The *very low* risk was identified for groundwater and landscaping that were deemed less of a risk due to the *minor* consequences from pollution or unlikely nature of connection.

Following investigation and testing the risks to future end users from this particular source contamination from ground and groundwater migration would appear to be *low.*

9.3.6 *Uncertainties*

There remains the possibility that some historical occupation of the site has not been identified, which could lead to unforeseen ground contamination.

10.0 CONCLUSIONS/RECOMMENDATIONS

10.1 General

A summary of the data collated in the ground investigation and assessment in terms of the various revisions to the original risk assessments in terms of contamination and geotechnical issues for the site and remediation recommendations are set out below in the summary table:

Issue	Remarks
Former uses	Former uses of site have been a small haulage yard, prior to recent usage as private workshop and garden.
Proposed Development	Re-development of the site as a small estate of residential dwellings, with associated road access and parking and gardens.
Hazardous Gas	The presence of infill within the site represents a low/moderate risk of ground gas generation. Therefore, in accordance with CIRIA C665, and in view of the nature of the residential development, six gas monitoring visits were undertaken over a three month period. Readings from gas wells across the site showed very low levels of carbon dioxide (<5% v/v) and very low methane (<1% v/v), with minimal gas flow. Due to the low risk, no gas protection measures will be required for the development from methane and carbon dioxide however the desk study flagged up that basic radon protection measures will be required for the new buildings.
Ground Investigation	Intrusive investigation comprised window sampler boreholes across site. Chemical and geotechnical soils analysis was carried out with gas/groundwater monitoring.
Ground Conditions	General ground conditions consisted of a varying thickness of made ground (cohesive over granular materials), deepening from 0.0-3.4m, N to S, over LIMESTONE with a localized surface deposit of glacial till over limestone in the NW corner. No groundwater strikes were encountered during investigation.
Contamination	Two low/moderate risks to affected receptors from contaminated fill and haulage activities (including small underground fuel tank), and following testing, fill materials showed slightly elevated levels of contamination (lead, sulphate and PAH's) and as such the site will require remediation measures.
Preparatory Works	Demolition. Excavation and screening of localised Made Ground across the site to remove oversized materials, which may present obstruction to foundations of proposed buildings. Earthworks cut/fill exercise to create final landform. Removal of tank.
Anticipated Foundation Solutions	Shallow foundations may be suitable over the site, either on strip/trench foundations, except within the southern area, where deeper fill (approximately 2.3-3m depth) are present and a piled solution may be required. It is recommended that a trial pitting exercise is carried out along the S boundary of the proposed building structures to ascertain the depth to rock-head across this site area, prior to finalising foundation design. Depth of fill varies across the site and will be a contributing factor to the type of foundation, with a likely steeped foundation from N to S. Structural assessment will be required of building loadings and foundation proximity compared to the slope. Retaining structures are possibly required along the southern boundary to protect the watercourse slope, dependent upon final design proposals.
Environmental & Engineering Remediation Issues	1. Basic Radon Gas protection measures will be required; 2. Earthworks suitability assessment of made ground deposits for re-use; 3. Preparation of highways and parking footprints prior to construction (including possible ground improvement); 4. Cover system will be required in S garden areas; 5. Waste disposal assessment of material arisings; 6. Validation of any imported topsoil and cover system materials for proposed garden/landscaped areas, if required; 7. Inert material trench surround of Water Supply pipes; 8. Concrete specification upgrade due to suphate; 9. Investigation & removal of fuel tank and validation.
Waste Disposal	Made ground materials should be either placed under hard standing areas (if proved suitable as an engineering material) or disposed of to a suitable licensed landfill site.
Geotechnical Issues	1. Depth, extent and variation in made ground deposits causing potential differential settlement; 2. Foundation type dependent upon depth of fill along S edge of proposed building structures; 3. Obstructions at depth within made ground deposits, such as building foundation brick structures and in-situ slabs;

	4. **Settlement issues regarding improvement of fill deposits;** 5. **Retaining structures are possibly likely for the southern slopes, close to the watercourse, dependent upon final design proposals. These will require careful temporary works design, due to the steep nature of the slopes;** 6. **Tank (fuel), within the N area will need removing and replacement with suitably engineered fill;** 7. Close proximity of local structures near to new development.

11.0 REPORT LIMITATIONS

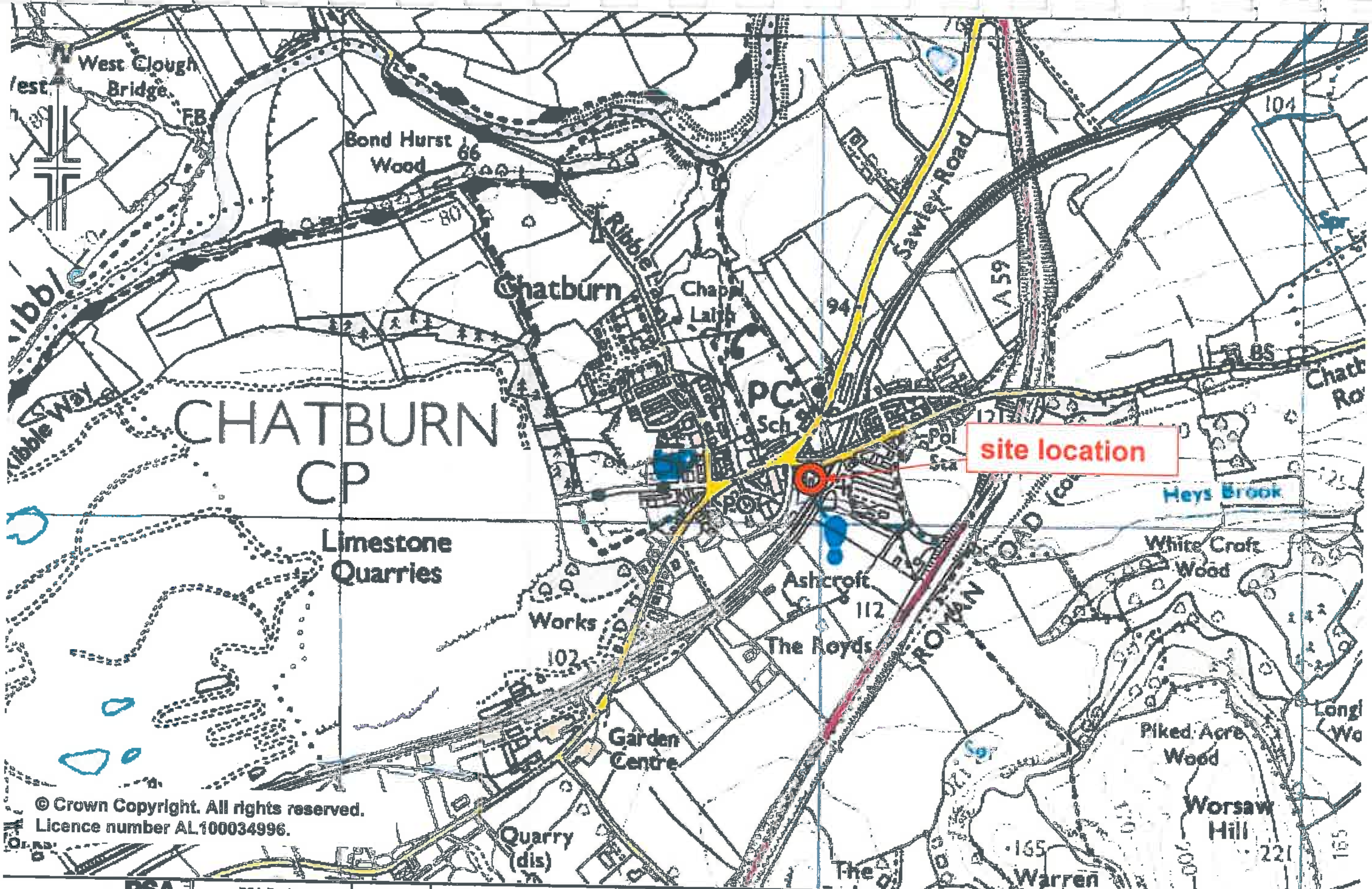
11.1 PSA Design believes that providing information with regard to limitations is essential to assist *the client* identify and therefore manage its risks. The ground is a product of continuing natural and artificial processes and, as a result, may exhibit a variety of characteristics which may vary from place to place, and with time. The risks associated with these variations may be mitigated by appropriate investigations, but cannot be eliminated.

11.2 This report contains interpretations of information which has been gathered from published sources and observations. Such information is only relevant to the ground at the published sources and observations. The information from these is interpreted here in good faith and is believed to be accurate. PSA Design cannot guarantee the authenticity of data obtained from external sources.

11.3 An interpretation or recommendation based on this information and given in this report is based on our judgment and experience of this information and not on any greater knowledge that might be implied.

11.4 The interpretations and recommendations contained herein represent our opinions which are provided for the sole use of our client in accordance with a specific brief. As such these do not necessarily address all aspects of ground behaviour at the site. Should these interpretations be used by any third party to assess ground conditions then verification should be made by reference to the appropriate factual information.

DRAWINGS



PSA Design The Old Bank House 6 Berry Lane, Longridge Preston, PR3 3JA Tel. 01772 786066	Client	A Jackson	Drawn	JB	Date	24.05.2016	Drawing No. G2235-01
	Job	Downham Road, Chatburn	Checked				
	Title	Regional Location Plan	Approved		Scale	NTS	Rev

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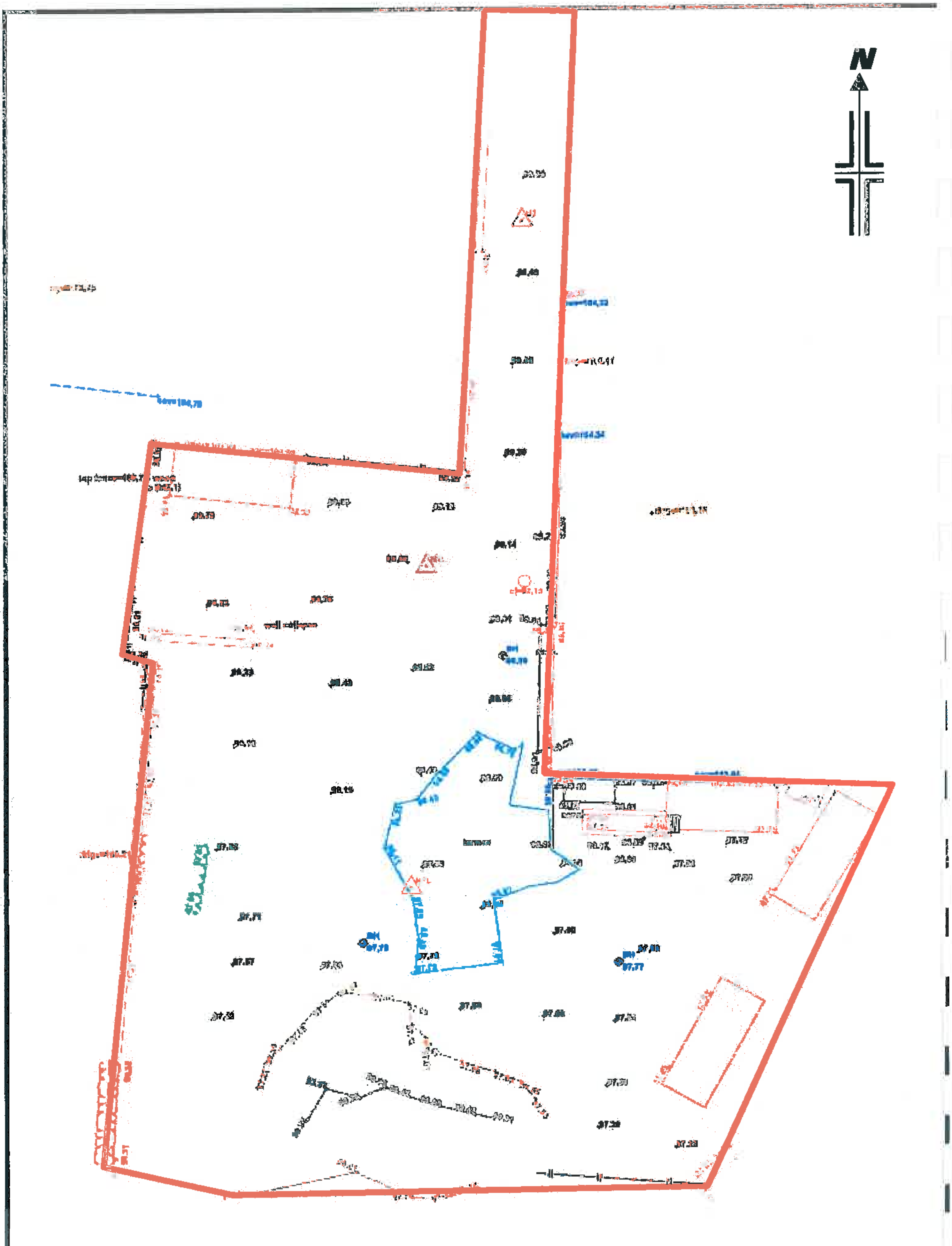
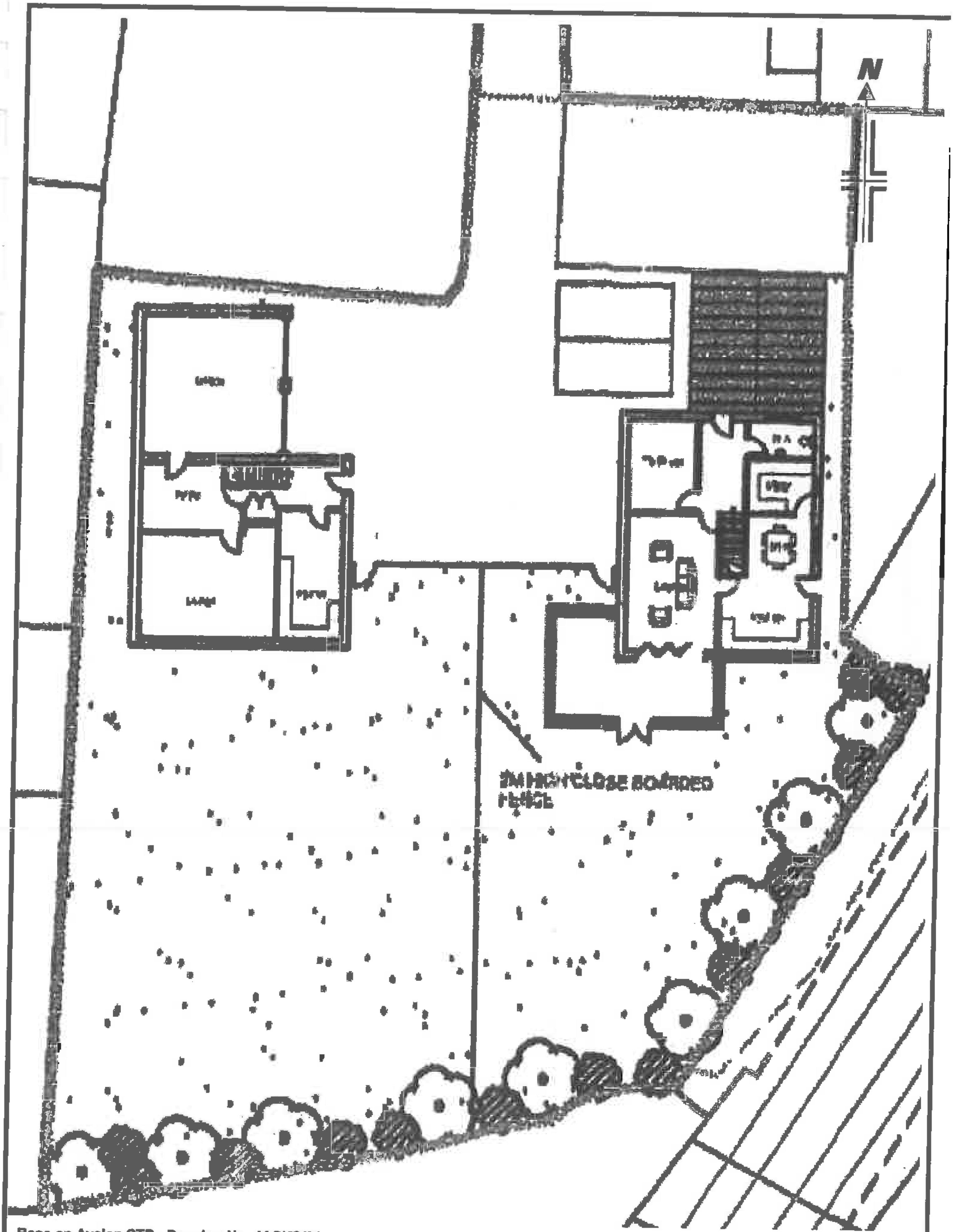


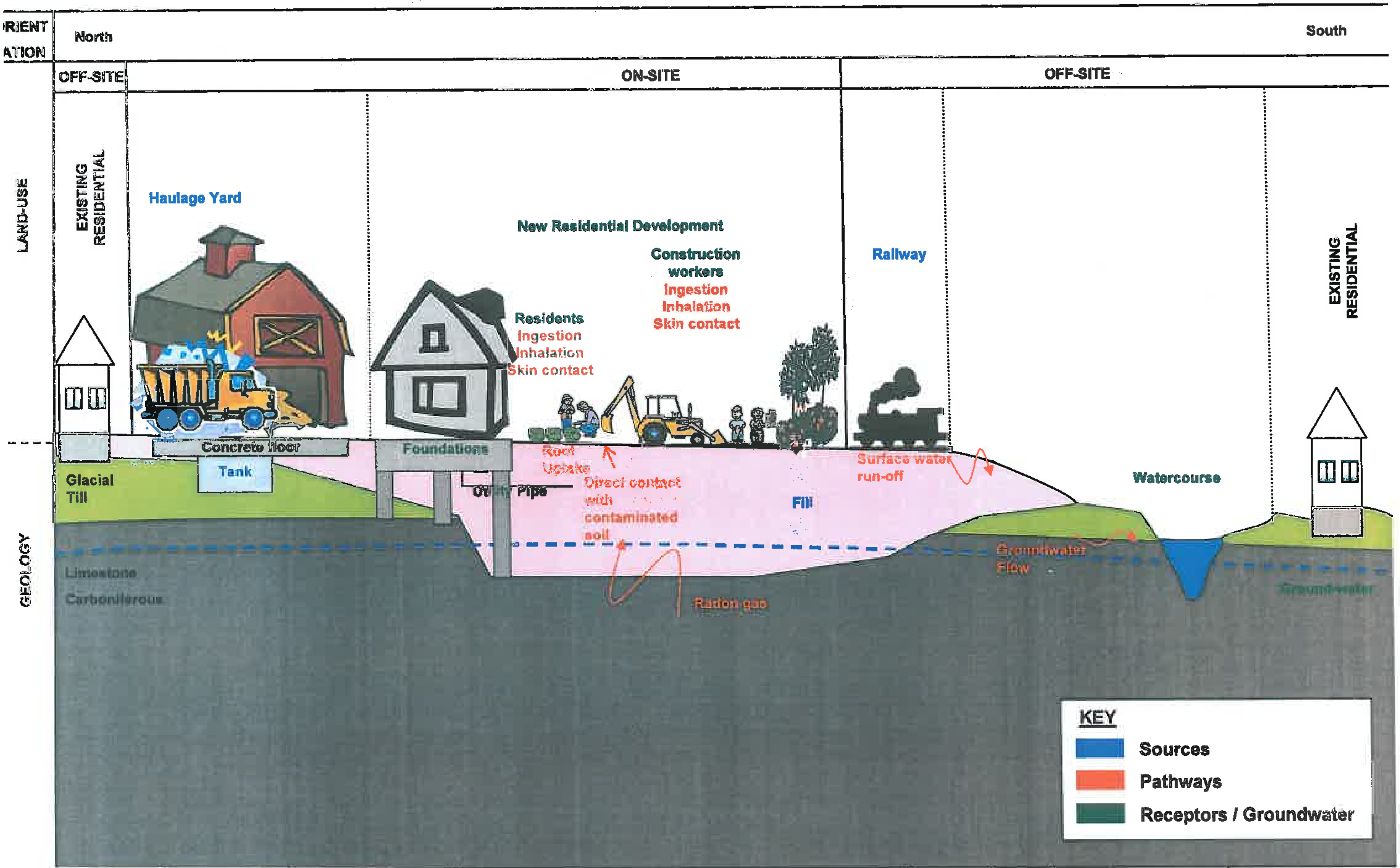
Base on Site Survey Services Drawing No. SSS6693.

PSA DESIGN engineering your environment	PSA Design The Old Bank House 6 Berry Lane, Longridge Preston, PR3 3JA Tel. 01772 786066	Client	A Jackson	Scale NTS			Dwg No. G2235-02
		Job	Downham Road, Chatburn	Drawn JSB	Check JSB	Appr JSB	Date 03-06-2016
		Title	Current Site Features Plan				Rev

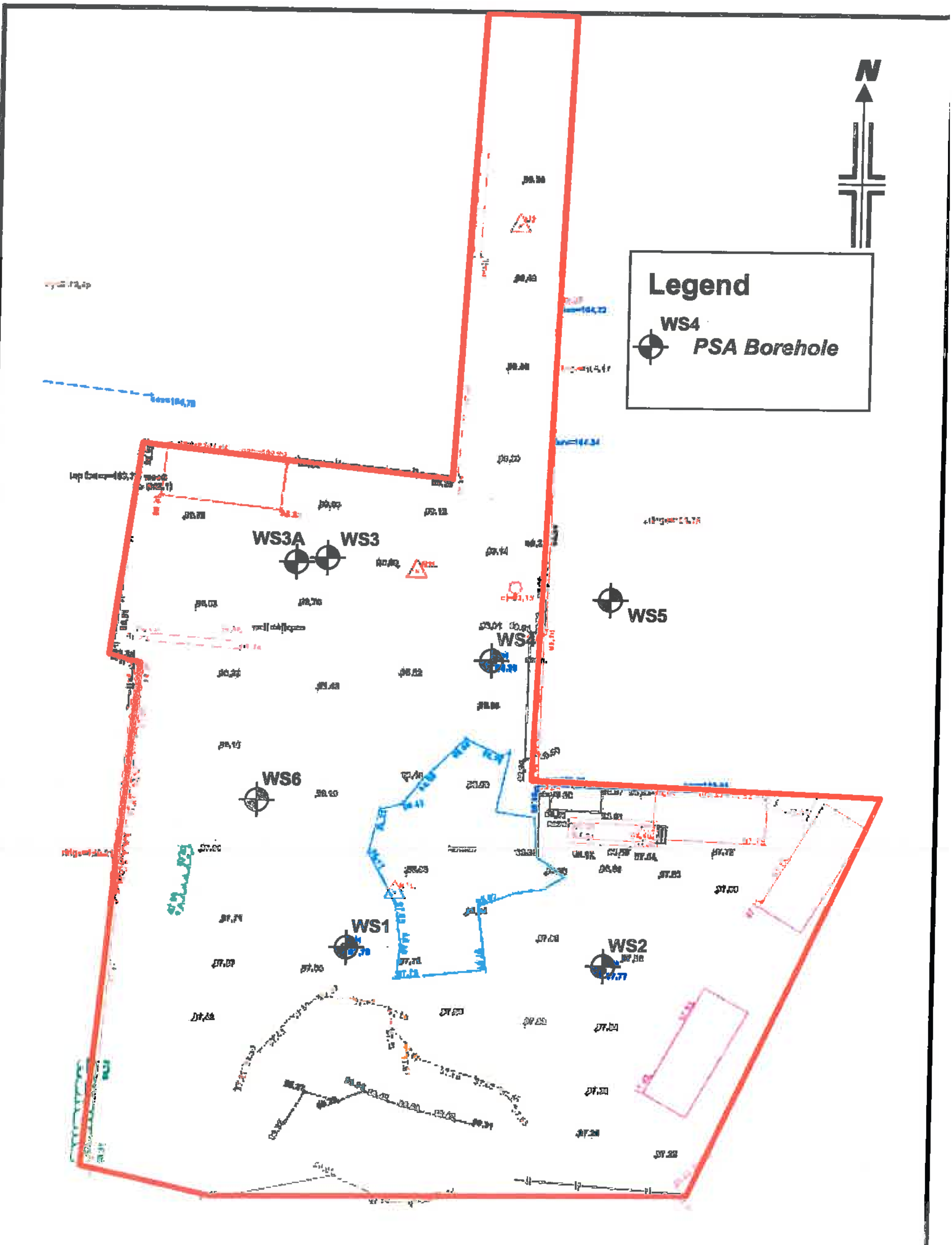


Base on Avalon CTP - Drawing No. JACKS/04-Dwg01.

PSA DESIGN engineering your environment	PSA Design The Old Bank House 6 Berry Lane, Longridge Preston, PR3 3JA Tel. 01772 786066	Client: A Jackson Job: Downham Road, Chatburn Title: Development Proposals	Scale: NTS Drawn: JSB Check: JSB Appr: JSB	Dwg No. G2235-03 Date: 03-06-2016 Rev



PSA Design The Old Bank House 6 Berry Lane, Longridge Preston, PR3 3JA Tel. 01772 786066	Client	A Jackson	Drawn	JB	Date: 25.05.2016 / Drawing No. G2235-05
	Job	Downham Road, Chatburn	Checked		Scale: Not to Scale
	Title	Revised Conceptual Model	Approved		



Base on Site Survey Services Drawing No. SSS6693.

PSA DESIGN engineering your environment CIVIL STRUCTURAL GEOTECHNICAL TRANSPORT	PSA Design The Old Bank House 6 Berry Lane, Longridge Preston, PR3 3JA Tel. 01772 786066	Client	A Jackson	Scale NTS		Dwg No. G2235-06
		Job	Downham Road, Chatburn	Drawn JSB	Check JSB	Appr JSB	Date 03-06-2016
		Title	Ground Investigation Plan			Rev

APPENDICES

APPENDIX A BOREHOLE LOGS

PSA Design
Tel: 01772 786066
Fax: 01772 786265
email: mail@psadesign.co.uk

Project Name: Downham Road	Project No. G2235	Co-ords: -	Borehole No WS1 Sheet 1 of 1
Location: Chatburn		Level: -	Hole Type WS; Scale 1:50
Client: Alan Jackson		Dates: 11/02/2016	Logged By JSB

Well	Water Strikes	Depth (m)	Type	Results	Depth (m)	Level (m AOD)	Legend	Stratum Description
		0.30-0.60	ES		1.00			MADE GROUND: Medium dense (Driller's description), dark brown-grey, slightly sandy, occasionally slightly clayey GRAVEL. Gravel is predominantly fine to coarse, occasionally cobble sized, sub-angular to angular composed of limestone, shale with rare tarmac, road planings, brick, concrete, coal, ash and clinker (Granular Fill). (MADE GROUND)
					2.10			MADE GROUND: Firm, grey brown, gravelly-very gravelly CLAY. Gravel is predominantly fine to coarse, sub-angular, comprised of limestone, brick and shale. (Cohesive Fill). (MADE GROUND)
					3.20			MADE GROUND: Medium dense (Driller's description), dark brown-grey, slightly sandy, occasionally slightly clayey GRAVEL. Gravel is predominantly fine to coarse, occasionally cobble sized, sub-angular to angular composed of limestone, shale and brick (Granular Fill). (MADE GROUND)
					3.40			MADE GROUND: Firm, occasionally soft, dark grey, gravelly-very gravelly CLAY. Gravel is predominantly fine to coarse, sub-angular, comprised of limestone shale. (Cohesive Fill). (MADE GROUND)
					3.45			Very dense (driller's description) dark grey, strong, medium-coarse LIMESTONE gravel fragements. (possible weathered bedrock - Chatburn Limestone) Refusal of drilling (possible bedrock)

End of Borehole at 3.45 m

Scale: 1 2 3 4 5 6 7 8 9

Remarks: Premier Plant Hydraulic Compact Rubber Tracked Percussion Drilling Rig.In-situ shear strength (IVN) in kPa, based on avg of 3 tests using Geonor H-60 Vane. 50mm HDPE Gas/Groundwater Standpipe Installation.

AGS

PSA Design
Tel: 01772 786066
Fax: 01772 786265
email: mail@psadesign.co.uk

Project Name: Downham Road	Project No.: G2235	Co-ords: -	Borehole No: **WS2**, Sheet 1 of 1
Location: Chatburn		Level: -	Hole Type: WS
			Scale: 1:50
Client: Alan Jackson		Dates: 11/02/2016	Logged By: JSB

Well	Water Strikes	Samples & In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m AOD)	Legend	Stratum Description
		0.30-0.70	ES					MADE GROUND: Dense (Driller's description), dark brown-grey, slightly sandy, occasionally slightly clayey GRAVEL. Gravel is predominantly fine to cobble sized, sub-angular to angular composed of limestone, shale, road planings and rare brick, concrete, coal, ash and clinker (Granular Fill). (MADE GROUND)
					2.00			MADE GROUND: Soft-firm, grey brown, very gravelly CLAY. Gravel is predominantly fine to coarse, sub-angular, comprised of limestone and rare brick, pottery and shale. (Cohesive Fill). (MADE GROUND)
					3.10			MADE GROUND: Firm, occasionally soft, dark grey, gravelly-very gravelly CLAY. Gravel is predominantly fine to coarse, sub-angular, comprised of limestone shale. (Cohesive Fill). (MADE GROUND)
					3.30			Very dense (driller's description) dark grey, strong, medium-coarse LIMESTONE gravel fragements. (possible weathered bedrock - Chatburn Limestone) Refusal of drilling (possible bedrock)
					3.35			End of Borehole at 3.35 m

Remarks: Premier Plant Hydraulic Compact Rubber Tracked Percussion Drilling Rig.In-situ shear strength (IVN) in kPa, based on avg of 3 tests using Geonor H-60 Vane. 50mm HDPE Gas/Groundwater Standpipe Installation.

AGS

PSA Design
Tel: 01772 786066
Fax: 01772 786265
email: mail@psadesign.co.uk

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Project Name Downham Road	Project No. G2235	Co-ords: -	Borehole No **WS3** Sheet 1 of 1
Location: Chatburn		Level: -	Hole Type WS
			Scale 1:50
Client: Alan Jackson		Dates: 11/02/2016	Logged By JSB

Well	Water Strikes	Samples & In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m AOD)	Legend	Stratum Description
					0.05			TOPSOIL:Turf over grey brown slightly organic CLAY with common fine rootlets. (TOPSOIL)
		0.30	IVN 1	125	0.50			Stiff, light brown, mottled grey, gravelly CLAY with fine rootlets. Gravel is fine to coarse, sub-angular, comprised of limestone & shale. (Glacial Till). (GLACIAL TILL)
					0.80			Very dense (driller's description) dark grey, strong, medium-coarse LIMESTONE gravel fragements. (possible weathered bedrock - Chatburn Limestone). Refusal of drilling (possible bedrock).

End of Borehole at 0.80 m

1 2 3 4 5 6 7 8 9

Remarks: Premier Plant Hydraulic Compact Rubber Tracked Percussion Drilling Rig.In-situ shear strength (IVN) in kPa, based on avg of 3 tests using Geonor H-60 Vane.

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PSA Design
Tel: 01772 786066
Fax 01772 786265
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Borehole No	**WS03A**	Sheet 1 of 1	
Project Name: Downham Road	Project No.: G2235	Co-ords: -	Hole Type: WS
Location: Chatburn		Level: -	Scale: 1:50
Client: Alan Jackson		Dates: 11/02/2016	Logged By: JSB

Well	Water Strikes	Samples & In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m AOD)	Legend	Stratum Description
		0.30	IVN 1	128	0.05			TOPSOIL:Turf over grey brown slightly organic CLAY with common fine rootlets. (TOPSOIL)
					0.55			Stiff, light brown, mottled grey, gravelly CLAY with fine rootlets. Gravel is fine to coarse, sub-angular, comprised of limestone & shale. (Glacial Till). (GLACIAL TILL)
					1.10			Very dense (driller's description) dark grey, strong, medium-coarse LIMESTONE gravel fragements. (possible weathered bedrock - Chatburn Limestone). Refusal of drilling (possible bedrock).

End of Borehole at 1.10 m

Remarks: Premier Plant Hydraulic Compact Rubber Tracked Percussion Drilling Rig.In-situ shear strength (IVN) in kPa, based on avg of 3 tests using Geonor H-60 Vane.

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HoleBASE II (Standard Borehole Log v2 dated 27th Nov 03)

PSA Design
Tel: 01772 786066
Fax: 01772 786265
email: mail@psadesign.co.uk

Borehole No **WS4**	Sheet 1 of 1	
Project Name: Downham Road	Project No.: G2235	Co-ords: -
Hole Type: WS	Scale: 1:50	Logged By: JSB
Location: Chatburn	Level: -	
Client: Alan Jackson	Dates: 11/02/2016	

Well	Water Strikes	Samples & In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m AOD)	Legend	Stratum Description
					0.20			MADE GROUND: Dense (Driller's description), dark brown-grey, slightly sandy GRAVEL. Gravel is predominantly fine to coarse, sub-angular to angular composed of limestone and road planings (Granular Fill). (MADE GROUND)
		0.50-0.90	ES		0.90			MADE GROUND: Firm, grey brown, gravelly-very gravelly CLAY. Gravel is predominantly fine to coarse, sub-angular, comprised of limestone, brick and shale. (Cohesive Fill). (MADE GROUND)
					1.75			MADE GROUND: Soft-firm, occasionally stiff, grey brown, gravelly CLAY. Gravel is predominantly fine to coarse, sub-angular, comprised of limestone. (Cohesive Fill). (MADE GROUND)
					1.80			Very dense (driller's description) dark grey, strong, medium-coarse LIMESTONE gravel fragements. (possible weathered bedrock - Chatburn Limestone). Refusal of drilling (possible bedrock)

End of Borehole at 1.80 m

Remarks: Premier Plant Hydraulic Compact Rubber Tracked Percussion Drilling Rig.In-situ shear strength (IVN) in kPa, based on avg of 3 tests using Geonor H-60 Vane. 50mm HDPE Gas/Groundwater Standpipe Installation.

PSA Design
Tel: 01772 786066
Fax: 01772 786265
email: mail@psadesign.co.uk

Project Name: Downham Road	Project No.: G2235	Co-ords: -
Location: Chatburn		Level: -
Client: Alan Jackson		Dates: 11/02/2016

Borehole No: **WS5**
Sheet 1 of 1
Hole Type: WS
Scale: 1:50
Logged By: JSB

Well	Water Strikes	Depth (m)	Type	Results	Depth (m)	Level (m AOD)	Legend	Stratum Description
					0.14			MADE GROUND: Weak, grey CONCRETE (Concrete Slab). (MADE GROUND)
		0.20-0.50	ES		0.50			MADE GROUND: Dense (Driller's description), dark brown-grey, slightly sandy GRAVEL. Gravel is predominantly fine to coarse, sub-angular to angular composed of limestone (Granular Fill). (MADE GROUND)
					0.60			Very dense (driller's description) dark grey, strong, medium-coarse LIMESTONE gravel fragements. (possible weathered bedrock - Chatburn Limestone). Refusal of drilling (possible bedrock).

End of Borehole at 0.60 m

Remarks: Premier Plant Hydraulic Compact Rubber Tracked Percussion Drilling Rig.In-situ shear strength (IVN) in kPa, based on avg of 3 tests using Geonor H-60 Vane.

PSA engineering your environment — CIVIL STRUCTURAL GEOTECHNICAL TRANSPORT	PSA Design Tel: 01772 786066 Fax: 01772 786265 email: mail@psadesign.co.uk	Borehole No **WS6** Sheet 1 of 1
Project Name: Downham Road	Project No.: G2235	Co-ords: -
Hole Type: WS		
Location: Chatburn	Level: -	Scale: 1:50
Client: Alan Jackson	Dates: 11/02/2016	Logged By: JSB

Well	Water Strikes	Samples & In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m AOD)	Legend	Stratum Description
		0.30-0.60	ES		0.30			MADE GROUND: Dense (Driller's description), dark brown-grey, slightly sandy, occasionally slightly clayey GRAVEL. Gravel is predominantly fine to cobble sized, sub-angular to angular composed of limestone, shale, road planings and rare brick, concrete, coal, ash and clinker (Granular Fill). (MADE GROUND)
					1.50			MADE GROUND: Firm, grey brown, gravelly-very gravelly CLAY. Gravel is predominantly fine to coarse, sub-angular, comprised of limestone, brick and shale. (Cohesive Fill). (MADE GROUND)
					2.35			MADE GROUND: Medium dense (Driller's description), dark grey, slightly clayey GRAVEL. Gravel is predominantly fine to coarse, occasionally cobble sized, sub-angular to angular, composed of limestone (Granular Fill). (MADE GROUND)
					2.40			Very dense (driller's description) dark grey, strong, medium-coarse LIMESTONE gravel fragements. (possible weathered bedrock - Chatburn Limestone). Refusal of drilling (possible bedrock).

End of Borehole at 2.40 m

Remarks: Premier Plant Hydraulic Compact Rubber Tracked Percussion Drilling Rig.In-situ shear strength (IVN) in kPa, based on avg of 3 tests using Geonor H-60 Vane.

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APPENDIX B CHEMICAL LABORATORY TESTING RESULTS

envirolab

Units 7 & 8 Sandpits Business Park
Mottram Road, Hyde, Cheshire, SK14 3AR

FINAL ANALYTICAL TEST REPORT

Envirolab Job Number: 16/00847
Issue Number: 1
Date: 25 February, 2016

Client: PSA Design
The Old Bank House
6 Berry Lane
Longridge
Preston
Lancashire
UK
PR3 3JA

Project Manager: John Birtwhistle
Project Name: Downham Rd, Chatburn
Project Ref: G2235
Order No: G2235-01
Date Samples Received: 12/02/16
Date Instructions Received: 12/02/16
Date Analysis Completed: 25/02/16

Prepared by:

Danielle Brierley
Administrative Assistant

Approved by:

John Gustafson
Director

mCERTS
UKAS TESTING 1247

envirolab

Envirolab Job Number: 16/00847

Client Project Name: Downham Rd, Chatburn

Client Project Ref: G2235

Lab Sample ID	16/00847/1	16/00847/2	16/00847/3	16/00847/4	16/00847/5				Units	Method ref
Client Sample No	1	1	1	1	1					
Client Sample ID	WS1	WS2	WS4	WS5	WS6					
Depth to Top	0.30	0.30	0.50	0.30	0.20					
Depth To Bottom	0.60	0.70	0.90	0.60	0.50					
Date Sampled	11-Feb-16	11-Feb-16	11-Feb-16	11-Feb-16	11-Feb-16					
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES					
Sample Matrix Code	4AB	4A	6A	4A	6A					
% Stones >10mm$_A^{\#}$	4.2	23.6	36.0	11.4	14.9				% w/w	A-T-044
pH$_D^{M\#}$	8.36	-	8.07	8.24	7.59				pH	A-T-031s
Sulphate (acid soluble)$_D^{M\#}$	6400	-	570	1100	720				mg/kg	A-T-028s
Cyanide (total)$_A^{M\#}$	3	-	<1	<1	5				mg/kg	A-T-042sTCN
Phenols - Total by HPLC$_A$	<0.2	-	<0.2	<0.2	<0.2				mg/kg	A-T-050s
Arsenic$_D^{M\#}$	16	-	6	9	18				mg/kg	A-T-024s
Boron (water soluble)$_D^{M\#}$	<1.0	-	<1.0	<1.0	<1.0				mg/kg	A-T-027s
Cadmium$_D^{M\#}$	1.0	-	0.6	0.6	1.3				mg/kg	A-T-024s
Copper$_D^{M\#}$	61	-	14	16	55				mg/kg	A-T-024s
Chromium$_D^{M\#}$	17	-	8	6	16				mg/kg	A-T-024s
Chromium (hexavalent)$_D$	<1	-	<1	<1	<1				mg/kg	A-T-040s
Lead$_D^{M\#}$	337	-	35	41	193				mg/kg	A-T-024s
Mercury$_D$	1.11	-	1.29	2.41	0.71				mg/kg	A-T-024s
Nickel$_D^{M\#}$	18	-	13	14	28				mg/kg	A-T-024s
Selenium$_D$	<1	-	<1	<1	2				mg/kg	A-T-024s
Zinc$_D^{M\#}$	124	-	54	61	214				mg/kg	A-T-024s

envirolab

Envirolab Job Number: 16/00847

Client Project Name: Downham Rd, Chatburn

Client Project Ref: G2235

Lab Sample ID	16/00847/1	16/00847/2	16/00847/3	16/00847/4	16/00847/5				Units	Method ref
Client Sample No	1	1	1	1	1					
Client Sample ID	WS1	WS2	WS4	WS5	WS6					
Depth to Top	0.30	0.30	0.50	0.30	0.20					
Depth To Bottom	0.60	0.70	0.90	0.60	0.50					
Date Sampled	11-Feb-16	11-Feb-16	11-Feb-16	11-Feb-16	11-Feb-16					
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES					
Sample Matrix Code	4AB	4A	6A	4A	6A					
Asbestos in Soil (inc. matrix)										
Asbestos in soil$_A$$^{\#}$	NAD	NAD	NAD	NAD	NAD					A-T-045
Asbestos ACM - Suitable for Water Absorption Test?$_D$	N/A	N/A	N/A	N/A	N/A					Gravimetry

envirolab

Envirolab Job Number: 16/00847

Client Project Name: Downham Rd, Chatburn

Client Project Ref: G2235

Lab Sample ID	16/00847/1	16/00847/2	16/00847/3	16/00847/4	16/00847/5				Units	Method ref
Client Sample No	1	1	1	1	1					
Client Sample ID	WS1	WS2	WS4	WS5	WS6					
Depth to Top	0.30	0.30	0.50	0.30	0.20					
Depth To Bottom	0.60	0.70	0.90	0.60	0.50					
Date Sampled	11-Feb-16	11-Feb-16	11-Feb-16	11-Feb-16	11-Feb-16					
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES					
Sample Matrix Code	4AB	4A	6A	4A	6A					
PAH 16										
Acenaphthene$_A^{M\#}$	0.71	-	0.03	<0.01	0.43				mg/kg	A-T-019s
Acenaphthylene$_A^{M\#}$	0.03	-	0.04	<0.01	0.69				mg/kg	A-T-019s
Anthracene$_A^{M\#}$	0.84	-	0.16	<0.02	2.39				mg/kg	A-T-019s
Benzo(a)anthracene$_A^{M\#}$	1.58	-	0.38	<0.04	13.1				mg/kg	A-T-019s
Benzo(a)pyrene$_A^{M\#}$	1.84	-	0.36	<0.04	14.9				mg/kg	A-T-019s
Benzo(b)fluoranthene$_A^{M\#}$	2.24	-	0.46	<0.05	17.6				mg/kg	A-T-019s
Benzo(ghi)perylene$_A^{M\#}$	1.06	-	0.19	<0.05	8.60				mg/kg	A-T-019s
Benzo(k)fluoranthene$_A^{M\#}$	1.18	-	0.25	<0.07	6.84				mg/kg	A-T-019s
Chrysene$_A^{M\#}$	1.85	-	0.40	<0.06	12.9				mg/kg	A-T-019s
Dibenzo(ah)anthracene$_A^{M\#}$	0.18	-	0.04	<0.04	1.36				mg/kg	A-T-019s
Fluoranthene$_A^{M\#}$	5.19	-	1.02	<0.08	31.6				mg/kg	A-T-019s
Fluorene$_A^{M\#}$	0.43	-	0.06	<0.01	0.49				mg/kg	A-T-019s
Indeno(123-cd)pyrene$_A^{M\#}$	1.11	-	0.22	<0.03	9.36				mg/kg	A-T-019s
Naphthalene$_A^{M\#}$	0.08	-	<0.03	<0.03	0.08				mg/kg	A-T-019s
Phenanthrene$_A^{M\#}$	2.36	-	0.62	<0.03	8.05				mg/kg	A-T-019s
Pyrene$_A^{M\#}$	3.61	-	0.65	<0.07	25.8				mg/kg	A-T-019s
PAH (total 16)$_A^{M\#}$	24.3	-	4.86	<0.08	154				mg/kg	A-T-019s
Leachate Prep BS EN 12457-1 (2:1)$_A$	-	*	-	-	-					A-T-046
pH (leachable)$_A^{\#}$	-	9.44	-	-	-				pH	A-T-031w
Electrical Conductivity (leachable)$_A$	-	134	-	-	-				µs/cm	A-T-037w
COD (settled) (leachable)$_A$	-	72	-	-	-				mg/l	A-T-034w
Ammoniacal nitrogen (leachable)$_A$	-	0.03	-	-	-				mg/l	A-T-033w
Chloride (leachable)$_A^{\#}$	-	2.07	-	-	-				mg/l	A-T-026w
Sulphate (leachable)$_A^{\#}$	-	15.42	-	-	-				mg/l	A-T-026w
Cyanide (total) (leachable)$_A$	-	<0.005	-	-	-				mg/l	A-T-042w/TCN
Phenols (total by HPLC) (leachable)$_A$	-	0.02	-	-	-				mg/l	A-T-050w
Sulphide (leachable)$_A$	-	<0.1	-	-	-				mg/l	A-T-S2-w
Arsenic (leachable)$_A^{\#}$	-	3	-	-	-				µg/l	A-T-025w
Boron (leachable)$_A^{\#}$	-	11	-	-	-				µg/l	A-T-025w
Cadmium (leachable)$_A^{\#}$	-	<1	-	-	-				µg/l	A-T-025w
Copper (leachable)$_A^{\#}$	-	9	-	-	-				µg/l	A-T-025w
Chromium (leachable)$_A^{\#}$	-	5	-	-	-				µg/l	A-T-025w

envirolab

Envirolab Job Number: 16/00847

Client Project Name: Downham Rd, Chatburn

Client Project Ref: G2235

Lab Sample ID	16/00847/1	16/00847/2	16/00847/3	16/00847/4	16/00847/5				Units	Method ref
Client Sample No	1	1	1	1	1					
Client Sample ID	WS1	WS2	WS4	WS5	WS6					
Depth to Top	0.30	0.30	0.50	0.30	0.20					
Depth To Bottom	0.60	0.70	0.90	0.80	0.50					
Date Sampled	11-Feb-16	11-Feb-16	11-Feb-16	11-Feb-16	11-Feb-16					
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES					
Sample Matrix Code	4AB	4A	6A	4A	6A					
Iron (leachable)$_A$#	-	19	-	-	-				µg/l	A-T-025w
Lead (leachable)$_A$#	-	5	-	-	-				µg/l	A-T-025w
Mercury (leachable)$_A$#	-	<0.1	-	-	-				µg/l	A-T-025w
Nickel (leachable)$_A$#	-	<1	-	-	-				µg/l	A-T-025w
Selenium (leachable)$_A$#	-	<1	-	-	-				µg/l	A-T-025w
Zinc (leachable)$_A$#	-	3	-	-	-				µg/l	A-T-025w
Nitrogen, Total Oxidised TOxN (leachable)$_A$#	-	0.8	-	-	-				mg/l	A-T-026w
TPH Total >C6-C40 (leachable)$_A$	-	1667	-	-	-				µg/l	A-T-007w

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Envirolab Job Number: 16/00847

Client Project Name: Downham Rd, Chatburn

Client Project Ref: G2235

Lab Sample ID	16/00847/1	16/00847/2	16/00847/3	16/00847/4	16/00847/5				Units	Method ref
Client Sample No	1	1	1	1	1					
Client Sample ID	WS1	WS2	WS4	WS5	WS6					
Depth to Top	0.30	0.30	0.50	0.30	0.20					
Depth To Bottom	0.60	0.70	0.90	0.60	0.50					
Date Sampled	11-Feb-16	11-Feb-16	11-Feb-16	11-Feb-16	11-Feb-16					
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES					
Sample Matrix Code	4AB	4A	6A	4A	6A					
PAH 16MS (leachable)										
Acenaphthene (leachable)A	-	4.73	-	-	-				µg/l	A-T-019w
Acenaphthylene (leachable)A	-	0.08	-	-	-				µg/l	A-T-019w
Anthracene (leachable)A	-	3.05	-	-	-				µg/l	A-T-019w
Benzo(a)anthracene (leachable)A	-	2.39	-	-	-				µg/l	A-T-019w
Benzo(a)pyrene (leachable)A	-	0.83	-	-	-				µg/l	A-T-019w
Benzo(b)fluoranthene (leachable)A	-	1.10	-	-	-				µg/l	A-T-019w
Benzo(ghi)perylene (leachable)A	-	0.17	-	-	-				µg/l	A-T-019w
Benzo(k)fluoranthene (leachable)A	-	0.40	-	-	-				µg/l	A-T-019w
Chrysene (leachable)A	-	2.09	-	-	-				µg/l	A-T-019w
Dibenzo(ah)anthracene (leachable)A	-	0.05	-	-	-				µg/l	A-T-019w
Fluoranthene (leachable)A	-	8.71	-	-	-				µg/l	A-T-019w
Fluorene (leachable)A	-	1.99	-	-	-				µg/l	A-T-019w
Indeno(123-cd)pyrene (leachable)A	-	0.23	-	-	-				µg/l	A-T-019w
Naphthalene (leachable)A	-	0.47	-	-	-				µg/l	A-T-019w
Phenanthrene (leachable)A	-	13.72	-	-	-				µg/l	A-T-019w
Pyrene (leachable)A	-	7.46	-	-	-				µg/l	A-T-019w
PAH (total 16) (leachable)A	-	47.47	-	-	-				µg/l	A-T-019w

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Envirolab Job Number: 16/00847

Client Project Name: Downham Rd, Chatburn

Client Project Ref: G2235

Lab Sample ID	16/00847/1	16/00847/2	16/00847/3	16/00847/4	16/00847/5				Units	Method ref
Client Sample No	1	1	1	1	1					
Client Sample ID	WS1	WS2	WS4	WS5	WS6					
Depth to Top	0.30	0.30	0.50	0.30	0.20					
Depth To Bottom	0.60	0.70	0.90	0.60	0.50					
Date Sampled	11-Feb-16	11-Feb-16	11-Feb-16	11-Feb-16	11-Feb-16					
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES					
Sample Matrix Code	4AB	4A	6A	4A	6A					
SVOC (PSA Design)										
Hexachlorobenzene$_A$	-	-	<100	-	-				µg/kg	A-T-052s
Diethyl phthalate$_A$	-	-	<100	-	-				µg/kg	A-T-052s
Dimethyl phthalate$_A$	-	-	<100	-	-				µg/kg	A-T-052s
Dibenzofuran$_A$	-	-	<100	-	-				µg/kg	A-T-052s
Carbazole$_A$	-	-	<100	-	-				µg/kg	A-T-052s
Butylbenzyl phthalate $_A$	-	-	<100	-	-				µg/kg	A-T-052s
Bis(2-ethylhexyl)phthalate$_A$	-	-	<100	-	-				µg/kg	A-T-052s
Bis(2-chloroethoxy)methane$_A$	-	-	<100	-	-				µg/kg	A-T-052s
Bis(2-chloroethyl)ether$_A$	-	-	<100	-	-				µg/kg	A-T-052s
4-Nitrophenol$_A$	-	-	<100	-	-				µg/kg	A-T-052s
4-Methylphenol$_A$	-	-	<100	-	-				µg/kg	A-T-052s
4-Chloro-3-methylphenol$_A$	-	-	<100	-	-				µg/kg	A-T-052s
2-Nitrophenol$_A$	-	-	<100	-	-				µg/kg	A-T-052s
2-Methylphenol$_A$	-	-	<100	-	-				µg/kg	A-T-052s
2-Chlorophenol$_A$	-	-	<100	-	-				µg/kg	A-T-052s
2,6-Dinitrotoluene$_A$	-	-	<100	-	-				µg/kg	A-T-052s
2,4-Dinitrotoluene$_A$	-	-	<100	-	-				µg/kg	A-T-052s
2,4-Dimethylphenol$_A$	-	-	<100	-	-				µg/kg	A-T-052s
2,4-Dichlorophenol$_A$	-	-	<100	-	-				µg/kg	A-T-052s
2,4,6-Trichlorophenol$_A$	-	-	<100	-	-				µg/kg	A-T-052s
2,4,5-Trichlorophenol$_A$	-	-	<100	-	-				µg/kg	A-T-052s
2-Chloronaphthalene$_A$	-	-	<100	-	-				µg/kg	A-T-052s
2-Methylnaphthalene$_A$	-	-	<100	-	-				µg/kg	A-T-052s
Bis(2-chloroisopropyl)ether$_A$	-	-	<100	-	-				µg/kg	A-T-052s
Phenol $_A$	-	-	<100	-	-				µg/kg	A-T-052s
Pentachlorophenol$_A$	-	-	<100	-	-				µg/kg	A-T-052s
n-Nitroso-n-dipropylamine$_A$	-	-	<100	-	-				µg/kg	A-T-052s
n-Dioctylphthalate$_A$	-	-	<100	-	-				µg/kg	A-T-052s
n-Dibutylphthalate$_A$	-	-	<100	-	-				µg/kg	A-T-052s
Nitrobenzene$_A$	-	-	<100	-	-				µg/kg	A-T-052s
Isophorone$_A$	-	-	<100	-	-				µg/kg	A-T-052s
Hexachloroethane$_A$	-	-	<100	-	-				µg/kg	A-T-052s

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Envirolab Job Number: 16/00847

Client Project Name: Downham Rd, Chatburn

Client Project Ref: G2235

Lab Sample ID	16/00847/1	16/00847/2	16/00847/3	16/00847/4	16/00847/5					
Client Sample No	1	1	1	1	1					
Client Sample ID	WS1	WS2	WS4	WS5	WS6					
Depth to Top	0.30	0.30	0.50	0.30	0.20					
Depth To Bottom	0.60	0.70	0.90	0.60	0.50					
Date Sampled	11-Feb-16	11-Feb-16	11-Feb-16	11-Feb-16	11-Feb-16					
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES					
Sample Matrix Code	4AB	4A	6A	4A	6A				Units	Method ref
Hexachlorocyclopentadiene$_A$	-	-	<100	-	-				µg/kg	A-T-052s
SVOC Total (excl. PAH/Phenols/Cresols)$_A$	-	-	<100	-	-				µg/kg	A-T-052s
Phenol Total$_A$	-	-	<100	-	-				µg/kg	A-T-052s
Cresol & Chlorinated Phenol Total$_A$	-	-	<100	-	-				µg/kg	A-T-052s
Perylene$_A$	-	-	<100	-	-				µg/kg	A-T-052s

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Envirolab Job Number: 16/00847

Client Project Name: Downham Rd, Chatburn

Client Project Ref: G2235

Lab Sample ID	16/00847/1	16/00847/2	16/00847/3	16/00847/4	16/00847/5				Units	Method ref
Client Sample No	1	1	1	1	1					
Client Sample ID	WS1	WS2	WS4	WS5	WS6					
Depth to Top	0.30	0.30	0.50	0.30	0.20					
Depth To Bottom	0.60	0.70	0.90	0.60	0.50					
Date Sampled	11-Feb-16	11-Feb-16	11-Feb-16	11-Feb-16	11-Feb-16					
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES					
Sample Matrix Code	4AB	4A	6A	4A	5A					
VOC (PSA Design)										
Dichlorodifluoromethane$_{A}^{\#}$	-	-	<1	-	-				µg/kg	A-T-006s
Chloromethane$_{A}^{\#}$	-	-	<10	-	-				µg/kg	A-T-006s
Vinyl Chloride$_{A}^{\#}$	-	-	<1	-	-				µg/kg	A-T-006s
Bromomethane$_{A}^{\#}$	-	-	<1	-	-				µg/kg	A-T-006s
Chloroethane$_{A}^{\#}$	-	-	<1	-	-				µg/kg	A-T-006s
Trichlorofluoromethane$_{A}^{\#}$	-	-	<1	-	-				µg/kg	A-T-006s
1,1-Dichloroethene$_{A}^{\#}$	-	-	<1	-	-				µg/kg	A-T-006s
Carbon Disulphide$_{A}^{\#}$	-	-	<1	-	-				µg/kg	A-T-006s
Dichloromethane $_{A}$	-	-	<5	-	-				µg/kg	A-T-006s
trans 1,2-Dichloroethene$_{A}^{\#}$	-	-	<1	-	-				µg/kg	A-T-006s
1,1-Dichloroethane$_{A}^{\#}$	-	-	<1	-	-				µg/kg	A-T-006s
cis 1,2-Dichloroethene$_{A}^{\#}$	-	-	<1	-	-				µg/kg	A-T-006s
2,2-Dichloropropane$_{A}^{\#}$	-	-	<1	-	-				µg/kg	A-T-006s
Bromochloromethane$_{A}^{\#}$	-	-	<5	-	-				µg/kg	A-T-006s
Chloroform$_{A}^{\#}$	-	-	<1	-	-				µg/kg	A-T-006s
1,1,1-Trichloroethane$_{A}^{\#}$	-	-	<1	-	-				µg/kg	A-T-006s
1,1-Dichloropropene$_{A}^{\#}$	-	-	<1	-	-				µg/kg	A-T-006s
Carbon Tetrachloride$_{A}^{\#}$	-	-	<1	-	-				µg/kg	A-T-006s
1,2-Dichloroethane$_{A}^{\#}$	-	-	<2	-	-				µg/kg	A-T-006s
Benzene $_{A}^{\#}$	-	-	<1	-	-				µg/kg	A-T-006s
Trichloroethene$_{A}^{\#}$	-	-	<1	-	-				µg/kg	A-T-006s
1,2-Dichloropropane$_{A}^{\#}$	-	-	<1	-	-				µg/kg	A-T-006s
Dibromomethane$_{A}^{\#}$	-	-	<1	-	-				µg/kg	A-T-006s
Bromodichloromethane$_{A}^{\#}$	-	-	<10	-	-				µg/kg	A-T-006s
cis 1,3-Dichloropropene$_{A}^{\#}$	-	-	<1	-	-				µg/kg	A-T-006s
Toluene $_{A}^{\#}$	-	-	<1	-	-				µg/kg	A-T-006s
trans 1,3-Dichloropropene$_{A}^{\#}$	-	-	<1	-	-				µg/kg	A-T-006s
1,1,2-Trichloroethane$_{A}^{\#}$	-	-	<1	-	-				µg/kg	A-T-006s
1,3-Dichloropropane$_{A}^{\#}$	-	-	<1	-	-				µg/kg	A-T-006s
Tetrachloroethene$_{A}^{\#}$	-	-	<1	-	-				µg/kg	A-T-006s
Dibromochloromethane$_{A}^{\#}$	-	-	<3	-	-				µg/kg	A-T-006s
1,2-Dibromoethane$_{A}^{\#}$	-	-	<1	-	-				µg/kg	A-T-006s

Envirolab Job Number: 16/00847

Client Project Name: Downham Rd, Chatburn

Client Project Ref: G2235

Lab Sample ID	16/00847/1	16/00847/2	16/00847/3	16/00847/4	16/00847/5				Units	Method ref
Client Sample No	1	1	1	1	1					
Client Sample ID	WS1	WS2	WS4	WS5	WS6					
Depth to Top	0.30	0.30	0.50	0.30	0.20					
Depth To Bottom	0.60	0.70	0.90	0.60	0.50					
Date Sampled	11-Feb-16	11-Feb-16	11-Feb-16	11-Feb-16	11-Feb-16					
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES					
Sample Matrix Code	4AB	4A	6A	4A	6A					
Chlorobenzene$_{A}^{\#}$	-	-	<1	-	-				µg/kg	A-T-006s
1,1,1,2-Tetrachloroethane$_{A}$	-	-	<1	-	-				µg/kg	A-T-006s
Ethylbenzene$_{A}^{\#}$	-	-	<1	-	-				µg/kg	A-T-006s
m & p Xylene$_{A}^{\#}$	-	-	<1	-	-				µg/kg	A-T-006s
o-Xylene$_{A}^{\#}$	-	-	<1	-	-				µg/kg	A-T-006s
Styrene$_{A}^{\#}$	-	-	<1	-	-				µg/kg	A-T-006s
Bromoform$_{A}^{\#}$	-	-	<1	-	-				µg/kg	A-T-006s
Isopropylbenzene$_{A}^{\#}$	-	-	<1	-	-				µg/kg	A-T-006s
1,1,2,2-Tetrachloroethane$_{A}$	-	-	<1	-	-				µg/kg	A-T-006s
1,2,3-Trichloropropane$_{A}^{\#}$	-	-	<1	-	-				µg/kg	A-T-006s
Bromobenzene$_{A}^{\#}$	-	-	<1	-	-				µg/kg	A-T-006s
n-Propylbenzene$_{A}^{\#}$	-	-	<1	-	-				µg/kg	A-T-006s
2-Chlorotoluene$_{A}^{\#}$	-	-	<1	-	-				µg/kg	A-T-006s
1,3,5-Trimethylbenzene$_{A}^{\#}$	-	-	<1	-	-				µg/kg	A-T-006s
4-Chlorotoluene$_{A}^{\#}$	-	-	<1	-	-				µg/kg	A-T-006s
tert-Butylbenzene$_{A}^{\#}$	-	-	<2	-	-				µg/kg	A-T-006s
1,2,4-Trimethylbenzene$_{A}^{\#}$	-	-	<1	-	-				µg/kg	A-T-006s
sec-Butylbenzene$_{A}^{\#}$	-	-	<1	-	-				µg/kg	A-T-006s
4-Isopropyltoluene$_{A}^{\#}$	-	-	<1	-	-				µg/kg	A-T-006s
1,3-Dichlorobenzene$_{A}$	-	-	<1	-	-				µg/kg	A-T-006s
1,4-Dichlorobenzene$_{A}^{\#}$	-	-	<1	-	-				µg/kg	A-T-006s
n-Butylbenzene$_{A}^{\#}$	-	-	<1	-	-				µg/kg	A-T-006s
1,2-Dichlorobenzene$_{A}^{\#}$	-	-	<1	-	-				µg/kg	A-T-006s
1,2-Dibromo-3-chloropropane$_{A}$	-	-	<2	-	-				µg/kg	A-T-006s
1,2,4-Trichlorobenzene$_{A}$	-	-	<3	-	-				µg/kg	A-T-006s
Hexachlorobutadiene$_{A}^{\#}$	-	-	<1	-	-				µg/kg	A-T-006s
1,2,3-Trichlorobenzene$_{A}$	-	-	<3	-	-				µg/kg	A-T-006s
VOC Total$_{A}$	-	-	<100	-	-				µg/kg	A-T-006s

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Envirolab Job Number: 16/00847

Client Project Name: Downham Rd, Chatburn

Client Project Ref: G2235

Lab Sample ID	16/00847/1	16/00847/2	16/00847/3	16/00847/4	16/00847/5				Units	Method ref
Client Sample No	1	1	1	1	1					
Client Sample ID	WS1	WS2	WS4	WS5	WS6					
Depth to Top	0.30	0.30	0.50	0.30	0.20					
Depth To Bottom	0.60	0.70	0.90	0.60	0.50					
Date Sampled	11-Feb-16	11-Feb-16	11-Feb-16	11-Feb-16	11-Feb-16					
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES					
Sample Matrix Code	4AB	4A	6A	4A	6A					
TPH CWG (PSA Design)										
Ali >C5-C6$_A^{\#}$	<0.01	-	<0.01	<0.01	<0.01				mg/kg	A-T-022s
Ali >C6-C8$_A^{\#}$	<0.01	-	<0.01	<0.01	<0.01				mg/kg	A-T-022s
Ali >C8-C10$_A^{\#}$	<0.01	-	<0.01	<0.01	<0.01				mg/kg	A-T-022s
Ali >C10-C12$_A^{\#}$	<0.1	-	<0.1	<0.1	<0.1				mg/kg	A-T-023s
Ali >C12-C16$_A^{\#}$	<0.1	-	<0.1	<0.1	<0.1				mg/kg	A-T-023s
Ali >C16-C21$_A^{\#}$	<0.1	-	<0.1	<0.1	<0.1				mg/kg	A-T-023s
Ali >C21-C35$_A^{\#}$	<0.1	-	<0.1	<0.1	1.2				mg/kg	A-T-023s
Total Aliphatics$_A$	<0.1	-	<0.1	<0.1	1.2				mg/kg	A-T-022+23s
Aro >C5-C7$_A^{\#}$	<0.01	-	<0.01	<0.01	<0.01				mg/kg	A-T-022s
Aro >C7-C8$_A^{\#}$	<0.01	-	<0.01	<0.01	<0.01				mg/kg	A-T-022s
Aro >C8-C10$_A^{\#}$	<0.01	-	<0.01	<0.01	<0.01				mg/kg	A-T-022s
Aro >C8-C9$_A^{\#}$	<0.01	-	<0.01	<0.01	<0.01				mg/kg	A-T-022s
Aro >C9-C10$_A^{\#}$	<0.01	-	<0.01	<0.01	<0.01				mg/kg	A-T-022s
Aro >C10-C12$_A^{\#}$	<0.1	-	<0.1	<0.1	<0.1				mg/kg	A-T-023s
Aro >C12-C16$_A^{\#}$	1.8	-	<0.1	<0.1	2.7				mg/kg	A-T-023s
Aro >C16-C21$_A^{\#}$	12.1	-	1.1	<0.1	28.6				mg/kg	A-T-023s
Aro >C21-C35$_A^{\#}$	43.9	-	2.9	0.6	89.1				mg/kg	A-T-023s
Total Aromatics$_A$	57.8	-	4.1	0.6	120				mg/kg	A-T-022+23s
EPH Total Ali & Aro (>C10-C16)$_A^{\#}$	1.8	-	<0.1	<0.1	2.7				mg/kg	A-T-023s
EPH Total Ali & Aro (>C16-C35)$_A^{\#}$	56.0	-	4.1	0.6	119				mg/kg	A-T-023s
TPH (Ali & Aro)$_A$	57.8	-	4.1	0.6	122				mg/kg	A-T-022+23s
BTEX and MTBE Total$_A$	<0.01	-	<0.01	<0.01	<0.01				mg/kg	A-T-022s
BTEX - Benzene$_A^{\#}$	<0.01	-	<0.01	<0.01	<0.01				mg/kg	A-T-022s
BTEX - Toluene$_A^{\#}$	<0.01	-	<0.01	<0.01	<0.01				mg/kg	A-T-022s
BTEX - Ethyl Benzene$_A^{\#}$	<0.01	-	<0.01	<0.01	<0.01				mg/kg	A-T-022s
BTEX - m & p Xylene$_A^{\#}$	<0.01	-	<0.01	<0.01	<0.01				mg/kg	A-T-022s
BTEX - o Xylene$_A^{\#}$	<0.01	-	<0.01	<0.01	<0.01				mg/kg	A-T-022s
MTBE$_A^{\#}$	<0.01	-	<0.01	<0.01	<0.01				mg/kg	A-T-022s
VPH total (>C5-C10)$_A^{\#}$	<0.01	-	<0.01	<0.01	<0.01				mg/kg	A-T-022s

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REPORT NOTES

Notes - Soil chemical analysis
All results are reported as dry weight (<40°C).
For samples with Matrix Codes 1 - 6 natural stones and brick and concrete fragments >10mm are removed or excluded from the sample prior to analysis and reported results corrected to a whole sample basis. For samples with Matrix Code 7 the whole sample is dried and crushed prior to analysis.

Notes - General
This report shall not be reproduced, except in full, without written approval from Envirolab.
Subscript "A" indicates analysis performed on the sample as received. "D" indicates analysis performed on the dried sample, crushed to pass a 2mm sieve, unless asbestos is found to be present in which case all analysis is performed on the sample as received.
All analysis is performed on the dried and crushed sample for samples with Matrix Code 7 and this supersedes any "A" subscripts.
All analysis is performed on the sample as received for soil samples which are positive for asbestos and/or if they are from outside the European Union and this supercedes any "D" subscripts.
Superscript "M" indicates method accredited to MCERTS.
If results are in italic font they are associated with an AQC failure. These are not accredited and are unreliable.
A deviating samples report is appended and will indicate if samples or tests have been found to be deviating. Any test results affected may not be an accurate record of the concentration at the time of sampling and, as a result, may be invalid.

TPH analysis of water by method A-T-007
Free and visible oils are excluded from the sample used for analysis so that the reported result represents the dissolved phase only.

Asbestos in soil
Asbestos in soil analysis is performed on a dried aliquot of the submitted sample and cannot guarantee to identify asbestos if present as discrete fibres/fragments. Stones etc. are not removed from the sample prior to analysis.
Quantification of asbestos is a 3 stage process including visual identification, hand picking and weighing and fibre counting by sedimentation/phase contrast optical microscopy if required. If asbestos is identified as being present but is not in a form that is suitable for analysis by hand picking and weighing (normally if the asbestos is present as free fibres) quantification by sedimentation is performed. Where ACMs are found a percentage asbestos is assigned to each with reference to 'HSG264, Asbestos: The survey guide' and the calculated asbestos content is expressed as a percentage of the dried soil sample aliquot used.

Predominant Matrix Codes:
1 = SAND, 2 = LOAM, 3 = CLAY, 4 = LOAM/SAND, 5 = SAND/CLAY, 6 = CLAY/LOAM, 7 = OTHER, 8 = Asbestos bulk ID sample.
Samples with Matrix Code 7 are not predominantly a SAND/LOAM/CLAY mix and are not covered by our BSEN 17025 or MCERTS accreditations.

Secondary Matrix Codes:
A = contains stones, B = contains construction rubble, C = contains visible hydrocarbons, D = contains glass/metal,
E = contains roots/twigs.

IS indicates Insufficient sample for analysis.
NDP indicates No Determination Possible.
NAD indicates No Asbestos Detected.
N/A indicates Not Applicable.
Superscript # indicates method accredited to ISO 17025.
Analytical results reflect the quality of the sample at the time of analysis only. Opinions and interpretations expressed are outside the scope of our accreditation.

Please contact us if you need any further information.

APPENDIX C STATISTICAL ANALYSIS OF CHEMICAL TEST DATA

Maximum Value Test
Downham Rd, Chatham
Soil

	LOD	Units	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	logarithms of results					average	standard dev	y max	no. samples	T
Trial Pit/BH			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]										
Sample No			1	[illegible]	[illegible]	[illegible]	[illegible]										
Sample Depth Top (mbgl)			0.30	0.30	[illegible]	[illegible]	[illegible]										
Sample Depth Base (mbgl)			0.60	0.75	[illegible]	[illegible]	[illegible]										
Soil Type			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]										
Soil name																	
arsenic	1	mg/kg	[illegible]		[illegible]	[illegible]	[illegible]	1.20		0.78	0.86	1.28	1.05	0.22	1.28	4.00	0.83
boron	1	mg/kg	1		1	[illegible]	1	0.00		0.00	0.00	0.00	0.00	[illegible]	0.00	4.00	#DIV/0!
cadmium	0.5	mg/kg	1		0.6	0.6	1.3	0.00		-0.22	-0.22	0.11	-0.08	0.17	0.11	4.00	1.17
copper	6	mg/kg	61		14	19	55	1.79		1.15	1.28	1.74	1.47	0.14	1.79	4.00	0.93
Total chromium	4.5	mg/kg	17		6	6	20	1.23		0.80	0.78	1.30	1.03	0.22	1.23	4.00	0.90
Hexavalent Chromium	1	mg/kg	1		1	1	1	0.00		0.00	0.00	0.00	0.00	0.00	0.00	4.00	#DIV/0!
lead	2	mg/kg	387		69	41	195	2.59		1.84	1.61	2.29	1.89	0.40	2.59	4.00	1.58
mercury	0.17	mg/kg	1.11		1.29	2.41	[illegible]	0.05		0.11	0.38	-0.16	0.10	[illegible]	0.38	4.00	1.20
nickel	0.9	mg/kg	11		13	13	29	1.38		1.11	1.18	1.46	1.24	0.16	1.46	4.00	1.37
selenium	1	mg/kg	1		1	1	2	0.00		0.00	0.00	0.30	0.06	0.15	0.30	4.00	1.80
zinc	2.5	mg/kg	124		61	61	214	2.09		1.79	1.79	2.33	1.69	0.26	2.33	4.00	1.25
cyanide (total)	1	mg/kg	3		1	1	[illegible]	0.48		0.00	0.00	0.70	0.29	[illegible]	0.70	4.00	1.15
phenols	0.2	mg/kg	0.2		0.2	0.2	0.2	-0.70		-0.70	-0.70	-0.70	-0.79	0.00	-0.70	4.00	#DIV/0!
sulphate	200	mg/kg	[illegible]		670	1100	725	3.61		2.79	3.04	2.86	3.12	0.44	3.61	4.00	1.45
pH			[illegible]		[illegible]	[illegible]	[illegible]	0.82		0.81	0.82	0.83	0.91	[illegible]	0.82	4.00	0.88
Asbestos screen		visual	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]										
PAH (total)	0.05	mg/kg	[illegible]		[illegible]	[illegible]	[illegible]	1.30		0.62	1.10	2.18	0.79	1.40	2.18	4.00	1.00
Acenaphthene	0.01	mg/kg	0.71		[illegible]	[illegible]	[illegible]	-0.14		-1.82	-2.00	-0.37	-1.01	0.86	-0.18	4.00	0.98
Acenaphthylene	0.01	mg/kg	0.03		0.04	[illegible]	[illegible]	-1.52		-1.40	-2.00	-0.14	-1.27	0.73	-0.19	4.00	1.42
Anthracene	0.02	mg/kg	0.84		0.13	0.02	[illegible]	-0.08		-0.89	-1.70	0.38	-0.58	0.91	0.36	4.00	1.02
Benzo(a)anthracene	0.04	mg/kg	1.60		0.38	0.04	[illegible]	0.20		-0.42	-1.40	1.12	-0.13	1.00	1.12	4.00	1.16
Benzo(a)pyrene	0.04	mg/kg	1.82		0.36	0.04	[illegible]	0.25		-0.44	-1.40	1.17	-0.10	1.08	1.17	4.00	1.17
Benzo(b)fluoranthene	0.05	mg/kg	2.24		0.45	0.05	14.9	0.35		-0.34	-1.30	1.25	-0.01	1.08	1.25	4.00	1.17
Benzo(ghi)perylene	0.05	mg/kg	1.08		0.19	0.05	17.8	0.03		-0.72	-1.30	0.93	-0.27	0.87	0.93	4.00	1.24
Benzo(k)fluoranthene	0.07	mg/kg	1.18		0.25	0.07	[illegible]	0.07		-0.60	-1.15	0.82	-0.22	0.85	0.82	4.00	1.21
Chrysene	0.06	mg/kg	1.89		0.4	0.06	[illegible]	0.27		-0.40	-1.22	1.11	-0.06	0.90	1.11	4.00	1.18
Dibenzo(ah)anthracene	0.04	mg/kg	0.18		0.04	0.04	[illegible]	-0.74		-1.40	-1.40	0.18	-0.85	0.73	0.18	4.00	1.38
Fluoranthene	0.08	mg/kg	5.19		1.02	0.08	31.5	0.72		0.01	-1.10	1.50	0.28	1.19	1.59	4.00	1.10
Fluorene	0.01	mg/kg	0.43		0.06	0.01	0.49	-0.37		-1.22	-2.00	-0.31	-0.97	0.80	-0.31	4.00	0.83
Indeno(123-cd)pyrene	0.03	mg/kg	1.11		0.22	0.03	[illegible]	0.05		-0.60	-1.82	0.87	-0.29	1.03	0.87	4.00	1.19
Naphthalene	0.03	mg/kg	[illegible]		0.03	0.03	[illegible]	1.10		1.82	-1.82	-1.10	-1.31	[illegible]	-1.10	4.00	0.87
Phenanthrene	0.03	mg/kg	2.36		0.62	[illegible]	[illegible]	0.37		-0.21	-1.82	0.91	-0.11	1.04	0.84	4.00	0.88
Pyrene	0.07	mg/kg	[illegible]		[illegible]	[illegible]	[illegible]	0.56		-0.18	-1.15	1.41	0.16	1.08	1.41	4.00	1.18
Petroleum Hydrocarbons TPH	0.1	mg/kg	57.6	[illegible]	[illegible]	[illegible]	[illegible]	1.76		0.81	-0.22	2.09	1.06	1.05	2.09	4.00	[illegible]
Aliphatic Fraction																	
C5-C6	0.01	mg/kg	0.01		[illegible]	[illegible]	[illegible]	-2.00		-2.00	-2.00	-2.00	-2.00	0.00	-2.00	4.00	#DIV/0!
>C6-C8	0.01	mg/kg	0.01		0.01	0.01	[illegible]	-2.00		-2.00	-2.00	-2.00	-2.00	0.00	-2.00	4.00	#DIV/0!
>C8-C10	0.01	mg/kg	0.01		0.01	0.01	0.01	-2.00		-2.00	-2.00	-2.00	-2.00	0.00	-2.00	4.00	#DIV/0!
>C10-C12	0.1	mg/kg	0.1		0.1	0.1	0.1	-1.00		-1.00	-1.00	-1.00	-1.00	0.00	-1.00	4.00	#DIV/0!
>C12-C16	0.1	mg/kg	0.1		0.1	0.1	0.1	-1.00		-1.00	-1.00	-1.00	-1.00	0.00	-1.00	4.00	#DIV/0!
>C16-C21	0.1	mg/kg	0.1		0.1	0.1	0.1	-1.00		-1.00	-1.00	-1.00	-1.00	0.00	-1.00	4.00	#DIV/0!
>C21-C35	0.1	mg/kg	0.1		0.1	0.1	0.1	-1.00		-1.00	-1.00	-1.00	-1.00	0.00	-1.00	4.00	#DIV/0!
Total Aliphatics	0.1	mg/kg	0.1		[illegible]	[illegible]	[illegible]	-1.00		-1.00	-1.00	-1.00	-1.00	0.00	-1.00	4.00	#DIV/0!
Aromatic Fraction																	
>C5-C7 (Benzene)	0.01	mg/kg	[illegible]		[illegible]	[illegible]	[illegible]	-2.00		-2.00	[illegible]	-2.00	-2.00	[illegible]	-2.00	4.00	#DIV/0!
>C7-C8 (Toluene)	0.01	mg/kg	0.01		0.01	0.01	[illegible]	-2.00		-2.00	[illegible]	-2.00	-2.00	[illegible]	-2.00	4.00	#DIV/0!
>C8-C10	0.01	mg/kg	0.01		0.01	0.01	[illegible]	-2.00		-2.00	[illegible]	-2.00	-2.00	[illegible]	-2.00	4.00	#DIV/0!
>C10-C12	0.1	mg/kg	0.1		0.1	0.1	0.1	-1.00		-1.00	[illegible]	-1.00	-1.00	[illegible]	-1.00	4.00	#DIV/0!
>C12-C16	0.1	mg/kg	1.6		0.1	0.1	2.7	0.20		-1.00	[illegible]	0.43	-0.23	0.77	0.43	4.00	0.98
>C16-C21	0.1	mg/kg	12.1		1.1	0.1	[illegible]	1.09		0.04	[illegible]	1.48	0.40	1.11	1.46	4.00	0.95
>C21-C35	0.1	mg/kg	43.9		2.8	0.8	[illegible]	1.64		0.49	[illegible]	1.95	0.96	1.01	1.95	4.00	0.98
Total Aromatics	0.1	mg/kg	[illegible]		4.1	0.4	120	1.78		0.61	[illegible]	2.08	1.06	1.06	2.08	4.00	0.96
BTEX - Benzene	0.01	mg/kg	0.01		0.01	0.01	0.01	-2.00		-2.00	[illegible]	-2.00	-2.00	0.00	-2.00	4.00	#DIV/0!
BTEX - Toluene	0.01	mg/kg	0.01		0.01	0.01	[illegible]	-2.00		-2.00	[illegible]	-2.00	-2.00	0.00	-2.00	4.00	#DIV/0!
BTEX - Ethyl Benzene	0.01	mg/kg	0.01		0.01	0.01	[illegible]	-2.00		-2.00	[illegible]	-2.00	-2.00	0.00	-2.00	4.00	#DIV/0!
MTBE	0.01	mg/kg	[illegible]		[illegible]	[illegible]	[illegible]	-2.00		-2.00	[illegible]	-2.00	-2.00	0.00	-2.00	4.00	#DIV/0!
VOC & SVOC																	
Chloroalkenes & alkanes																	
1,2 Dichloroethane [V]	2	ug/kg			[illegible]					0.30			0.30	#DIV/0!	0.30	1.00	#DIV/0!
1,1,1 Trichloroethane [V]	1	ug/kg			1					0.00			0.00	#DIV/0!	0.00	1.00	#DIV/0!
1,1,2,2-tetrachloroethane [V]	1	ug/kg			1					0.00			0.00	#DIV/0!	0.00	1.00	#DIV/0!
Carbon tetrachloride [V]	1	ug/kg			1					0.00			0.00	#DIV/0!	0.00	1.00	#DIV/0!
Trichloroethene	1	ug/kg			1					0.00			0.00	#DIV/0!	0.00	1.00	#DIV/0!
Chloroform [V]	25	ug/kg			25					1.40			1.40	#DIV/0!	1.40	1.00	#DIV/0!
Vinyl Chloride [V]	1	ug/kg			1					0.00			0.00	#DIV/0!	0.00	1.00	#DIV/0!
2-methylphenol [S]	100	ug/kg			100					2.00			2.00	#DIV/0!	2.00	1.00	#DIV/0!
4-methylphenol [S]	100	ug/kg			100					2.00			2.00	#DIV/0!	2.00	1.00	#DIV/0!
2,4 Dimethylphenol [S]	100	ug/kg			100					2.00			2.00	#DIV/0!	2.00	1.00	#DIV/0!
Toluene [V]	1	ug/kg			1					0.00			0.00	#DIV/0!	0.00	1.00	#DIV/0!
Benzene [V]	1	ug/kg			1					0.00			0.00	#DIV/0!	0.00	1.00	#DIV/0!
Chlorobenzene [V]	1	ug/kg			1					0.00			0.00	#DIV/0!	0.00	1.00	#DIV/0!
Bromobenzene [V]	1	ug/kg			1					0.00			0.00	#DIV/0!	0.00	1.00	#DIV/0!
Carbon Disulphide [V]	1	ug/kg			1					0.00			0.00	#DIV/0!	0.00	1.00	#DIV/0!
m&p Xylene [V]	1	ug/kg			1					0.00			0.00	#DIV/0!	0.00	1.00	#DIV/0!
Styrene [V]	1	ug/kg			1					0.00			0.00	#DIV/0!	0.00	1.00	#DIV/0!
Hexachloroethane [S]	100	ug/kg			100					2.00			2.00	#DIV/0!	2.00	1.00	#DIV/0!
Bromoform [V]	1	ug/kg			1					0.00			0.00	#DIV/0!	0.00	1.00	#DIV/0!
Chloroethane [V]	1	ug/kg			1					0.00			0.00	#DIV/0!	0.00	1.00	#DIV/0!
Chloromethane [V]	1	ug/kg			1					0.00			0.00	#DIV/0!	0.00	1.00	#DIV/0!
Isopropylbenzene [V]	1	ug/kg			1					0.00			0.00	#DIV/0!	0.00	1.00	#DIV/0!
UU Total C5-C10	0.01	mg/kg	[illegible]		[illegible]	[illegible]	[illegible]	-2.00		[illegible]	-2.00	-2.00	-2.00	0.00	-2.00	4.00	#DIV/0!
UU Total C10-C16	0.1	mg/kg	1.6		0.1	0.1	2.7	0.28		[illegible]	-1.00	0.43	-0.33	0.74	0.43	4.00	0.98
UU Total C16-C40	0.1	mg/kg	56		4.1	0.6	119	1.75		[illegible]	-0.22	2.08	1.05	1.08	2.08	4.00	0.97
UU BTEX & MTBE	0.01	mg/kg	0.01		0.01	0.01	0.01	-2.00		[illegible]	-2.00	-2.00	-2.00	0.00	-2.00	4.00	#DIV/0!
UU VOC Total	0.1	mg/kg			0.1					-1.00			-1.00	#DIV/0!	-1.00	1.00	#DIV/0!
UU SVOC Total	0.1	mg/kg			0.1					-1.00			-1.00	#DIV/0!	-1.00	1.00	#DIV/0!
UU Phenol	0.1	mg/kg			0.1					-1.00			-1.00	#DIV/0!	-1.00	1.00	#DIV/0!
UU Cresols	0.1	mg/kg			0.1					-1.00			-1.00	#DIV/0!	-1.00	1.00	#DIV/0!

T value for 10%, N = 4 is 1.42 statistical analysis

Dereham Rd, Chatham
Mean Value Test
Soil

number of samples = 4

statistical analysis

generic reference values

Trial Pit/BH	WS1	WS2	WS4	WS5	WS6
Sample No	1	1	1	1	1
Sample Depth Top (mbgl)	0.20	0.30	0.60	0.20	0.20
Sample Depth Base (mbgl)	0.50	0.70	0.80	0.60	0.50
Soil (S)/Water(W)	Gran Fill	Gran Fill	Coh Fill	Gran Fill	Coh Fill

dsl page	units	WS1	WS2	WS4	WS5	WS6	average	std dev	t value	UB 95		SGV (res)	LCH 2015 S4UL's (res) or DEFRA C4SL's 2014	EIC/AGS/CL	BRE	USEPA	ICNCL (landscp. ed/bldgs)	UU (PE thresh)
arsenic	mg/kg	16		2	9	22	12.3	6.7	2.353	18.85	arsenic		37					
boron	mg/kg	1		1	1	1	1.0	0.0	2.353	1.00	boron		290					
cadmium	mg/kg	1		0.9	0.6	1.3	0.9	0.3	2.353	1.25	cadmium		11					
copper	mg/kg	41		14	16	68	34.8	25.0	2.353	64.87	copper		2400					
Total chromium	mg/kg	17		8	6	16	11.8	5.6	2.353	18.39	Total chromium	130						
Hexavalent Chromium	mg/kg	1		1	1	1	1.0	0.0	2.353	1.00	Hexavalent Chromium		6					
lead	mg/kg	337		36	41	133	161.8	144.1	2.353	329.52	lead		200					
mercury	mg/kg	1.11		1.20	2.41	0.71	1.4	0.7	2.353	2.24	mercury		40					
nickel	mg/kg	16		13	14	23	16.3	4.5	2.353	21.51	nickel		130					
selenium	mg/kg	1		1	1	2	1.3	0.5	2.353	1.84	selenium		250					
zinc	mg/kg	126		54	61	214	113.8	74.7	2.353	200.82	zinc		3700					
cyanide (complex)	mg/kg	3		1	1	5	2.5	1.9	2.353	4.75	cyanide (complex)						250	
phenols	mg/kg	0.2		0.2	0.2	0.2	0.2	0.0	2.353	0.20	phenols		550					
sulphate	mg/kg	6480		570	1700	720	2367.5	2810.5	2.353	5674.82	sulphate				2000			
pH		8.36		8.67	8.24	7.59	8.1	0.3	2.353	8.48	pH							
PAH (total)	mg/kg	24.3		3.9	0.2	154.6	45.8	72.9	2.353	131.66	PAH (total)						1000	
Acenapthene	mg/kg	0.71		0.03	0.01	0.63	0.3	0.3	2.353	0.69	Acenapthene		510					
Acenaphthylene	mg/kg	0.03		0.04	0.01	0.69	0.2	0.3	2.353	0.56	Acenaphthylene		420					
Anthracene	mg/kg	0.54		0.10	0.02	2.35	0.8	1.1	2.353	2.13	Anthracene		5400					
Benzo(a)anthracene	mg/kg	1.80		0.36	0.04	18.1	3.6	6.2	2.353	11.13	Benzo(a)anthracene		11.00					
Benzo(a)pyrene	mg/kg	1.80		0.30	0.04	14.9	4.3	7.1	2.353	12.66	Benzo(a)pyrene		2.70					
Benzo(b)fluoranthene	mg/kg	2.20		0.46	0.06	17.4	5.1	8.4	2.353	14.93	Benzo(b)fluoranthene		3.30					
Benzo(ghi)perylene	mg/kg	1.07		0.19	0.02	8.6	2.5	4.1	2.353	7.31	Benzo(ghi)perylene		340.0					
Benzo(k)fluoranthene	mg/kg	1.10		0.25	0.07	4.01	2.0	3.1	2.353	5.60	Benzo(k)fluoranthene		93.00					
Chrysene	mg/kg	1.56		0.4	0.04	12.6	3.8	6.1	2.353	11.00	Chrysene		22.00					
Dibenzo(ah)anthracene	mg/kg	0.18		0.04	0.04	1.19	0.4	0.6	2.353	1.16	Dibenzo(ah)anthracene		0.25					
Fluoranthene	mg/kg	5.12		1.02	0.08	31.8	9.5	14.9	2.353	27.02	Fluoranthene		560					
Fluorene	mg/kg	0.43		0.09	0.01	0.35	0.2	0.2	2.353	0.44	Fluorene		400					
Indeno(123-cd)pyrene	mg/kg	1.11		0.22	0.03	0.22	2.7	4.5	2.353	7.96	Indeno(123-cd)pyrene		26.00					
Napthalene	mg/kg	0.03		0.03	0.03	0.03	0.1	0.0	2.353	0.05	Napthalene		5.80					
Phenanthrene	mg/kg	2.39		0.62	0.03	8.06	2.8	3.7	2.353	7.07	Phenanthrene		220					
Pyrene	mg/kg	3.91		0.95	0.07	24.7	7.6	12.3	2.353	21.96	Pyrene		1200					
Petroleum Hydrocarbons																		
TPH	mg/kg	37.6	0	4.1	0.6	102	36.3	53.5	2.353	86.80	TPH		165					
Aliphatic Fraction											Aliphatic Fraction							
C5-C6	mg/kg	0.01		0.01	0.01	0.01	0.0	0.0	2.353	0.01	C5-C6		78					
>C6-C8	mg/kg	0.01		0.01	0.01	0.01	0.0	0.0	2.353	0.01	>C6-C8		230					
>C8-C10	mg/kg	0.01		0.01	0.01	0.01	0.0	0.0	2.353	0.01	>C8-C10		65					
>C10-C12	mg/kg	0.1		0.1	0.1	0.1	0.1	0.0	2.353	0.10	>C10-C12		330					
>C12-C16	mg/kg	0.1		0.1	0.1	0.1	0.1	0.0	2.353	0.10	>C12-C16		2400					
>C16-C21	mg/kg	0.1		0.1	0.1	0.1	0.1	0.0	2.353	0.10	>C16-C21		92000					
>C21-C35	mg/kg	0.1		0.1	0.1	0.1	0.1	0.0	2.353	0.10	>C21-C35		92000					
Aromatic Fraction											Aromatic Fraction							
>C5-C7 (Benzene)	mg/kg	0.01		0.01	0.01	0.01	0.0	0.0	2.353	0.01	>C5-C7 (Benzene)		140					
>C7-C8 (Toluene)	mg/kg	0.01		0.01	0.01	0.01	0.0	0.0	2.353	0.01	>C7-C8 (Toluene)		290					
>C8-C10	mg/kg	0.01		0.01	0.01	0.01	0.0	0.0	2.353	0.01	>C8-C10		83					
>C10-C12	mg/kg	0.1		0.1	0.1	0.1	0.1	0.0	2.353	0.10	>C10-C12		180					
>C12-C16	mg/kg	1.8		0.1	0.1	2.7	1.2	1.3	2.353	2.78	>C12-C16		330					
>C16-C21	mg/kg	12.1		1.1	0.1	28.6	10.5	13.3	2.353	26.16	>C16-C21		540					
>C21-C35	mg/kg	49.8		2.6	0.6	83.7	34.1	41.7	2.353	83.19	>C21-C35		1500					
BTEX - Benzene		0.01		0.01	0.01	0.01	0.0	0.0	2.353	0.01	BTEX - Benzene		0.17					
BTEX - Toluene		0.01		0.01	0.01	0.01	0.0	0.0	2.353	0.01	BTEX - Toluene		290					
BTEX - Ethyl Benzene		0.01		0.01	0.01	0.01	0.0	0.0	2.353	0.01	BTEX - Ethyl Benzene		110					
MTBE		0.01		0.01	0.01	0.01	0.0	0.0	2.353	0.01	MTBE							
VOC & SVOC																		
Chloroalkanes & alkenes																		
1,2 Dichloroethane[V]	ug/kg			2			2.0	#DIV/0!	6.314	#DIV/0!	1,2 DichloroethaneV		11					
1,1,1 Trichloroethane[V]	ug/kg			1			1.0	#DIV/0!	6.314	#DIV/0!	1,1,1 TrichloroethaneV		18000					
1,1,2,2-tetrachloroethane[V]	ug/kg			1			1.0	#DIV/0!	6.314	#DIV/0!	1,1,2,2-tetrachloroethaneV		3400					
Carbon tetrachloride[V]	ug/kg			1			1.0	#DIV/0!	6.314	#DIV/0!	Carbon tetrachlorideV		56					
Trichloroethene	ug/kg			1			1.0	#DIV/0!	6.314	#DIV/0!	Trichloroethene		34					
Chloroform[V]	ug/kg			25			25.0	#DIV/0!	6.314	#DIV/0!	ChloroformV		1700					
Vinyl Chloride[V]	ug/kg			1			1.0	#DIV/0!	6.314	#DIV/0!	Vinyl ChlorideV		6.7					
2-methylphenol[S]	ug/kg			100			100.0	#DIV/0!	6.314	#DIV/0!	2-methylphenolS			80000				
4-methylphenol[S]	ug/kg			100			100.0	#DIV/0!	6.314	#DIV/0!	4-methylphenolS			80000				
2,4 Dimethylphenol[S]	ug/kg			100			100.0	#DIV/0!	6.314	#DIV/0!	2,4 DimethylphenolS			19000				
Toluene[V]	ug/kg			1			1.0	#DIV/0!	6.314	#DIV/0!	TolueneV		290000					
Benzene[V]	ug/kg			1			1.0	#DIV/0!	6.314	#DIV/0!	BenzeneV		170					
Chlorobenzene[V]	ug/kg			1			1.0	#DIV/0!	6.314	#DIV/0!	ChlorobenzeneV		1000					
Bromobenzene[V]	ug/kg			1			1.0	#DIV/0!	6.314	#DIV/0!	BromobenzeneV			97000				
Carbon Disulphide[V]	ug/kg			1			1.0	#DIV/0!	6.314	#DIV/0!	Carbon DisulphideV		280					
m&p Xylene[V]	ug/kg			1			1.0	#DIV/0!	6.314	#DIV/0!	m&p XyleneV			4000				
Styrene[V]	ug/kg			1			1.0	#DIV/0!	6.314	#DIV/0!	StyreneV			8100				
Hexachloroethane[S]	ug/kg			100			100.0	#DIV/0!	6.314	#DIV/0!	HexachloroethaneS			22000				
Bromoform[V]	ug/kg			1			1.0	#DIV/0!	6.314	#DIV/0!	BromoformV			780000				
Chloroethane[V]	ug/kg			1			1.0	#DIV/0!	6.314	#DIV/0!	ChloroethaneV			960000				
Chloromethane[V]	ug/kg			1			1.0	#DIV/0!	6.314	#DIV/0!	ChloromethaneV			1000				
Isopropylbenzene[V]	ug/kg			1			1.0	#DIV/0!	6.314	#DIV/0!	IsopropylbenzeneV			1400000				
UU Total C5-C10	mg/kg	0.01		0.01	0.01	0.01	0.0	0.0	2.353	#DIV/0!	UU Total C5-C10							2
UU Total C10-C16	mg/kg	1.8		0.1	0.1	2.7	1.2	1.3	2.353	#DIV/0!	UU Total C10-C16							10
UU Total C16-C40	mg/kg	58		4.1	0.6	110	44.8	50.5	2.353	#DIV/0!	UU Total C16-C40							500
UU BTEX & MTBE	mg/kg	0.01		0.01	0.01	0.01	0.0	0.0	2.353	#DIV/0!	UU BTEX & MTBE							0.1
UU VOC Total	mg/kg			0.1			0.1	#DIV/0!	6.314	#DIV/0!	UU VOC Total							0.5
UU SVOC Total	mg/kg			0.1			0.1	#DIV/0!	6.314	#DIV/0!	UU SVOC Total							2
UU Phenol	mg/kg			0.1			0.1	#DIV/0!	6.314	#DIV/0!	UU Phenol							2
UU Cresols	mg/kg			0.1			0.1	#DIV/0!	6.314	#DIV/0!	UU Cresols							2

Chatburn
Mean Value Test
Leachate

number of samples =

statistical analysis

Trial Pit/BH		W62						**generic reference values**	
Sample No		1							
Sample Top (mbgl)		0.3	average	std dev	[illegible]	US 95		WTV	Ref WHO2006 or EQS (WFD -River Basin) 2010 or EA SW discharges 2011
Sample Base (mbgl)		0.7							
det name	units								
pH (w)	pH	8.44	8.4	#DIV/0!	6.314	#DIV/0!	pH (w)	6.5-8.5	
Electrical conductivity @ 20degC (w)	µs/cm	134	134.0	#DIV/0!	6.314	#DIV/0!	Electrical conductivity @ 20degC (w)		
COD (settled)	mg/l	72	72.0	#DIV/0!	6.314	#DIV/0!	COD (settled)		
Total Dissolved Solids (w)	mg/l		#DIV/0!	#DIV/0!	6.314	#DIV/0!	Total Dissolved Solids (w)		
Ammonia as NH3 (w)	mg/l	0.03	0.0	#DIV/0!	6.314	#DIV/0!	Ammonia as NH3 (w)	0.2	EQS
Chloride (w)	mg/l	2.07	2.1	#DIV/0!	6.314	#DIV/0!	Chloride (w)	188	EQS
Sulphate (w)	mg/l	15.42	15.4	#DIV/0!	6.314	#DIV/0!	Sulphate (w)	400000	EA
Cyanide (total) (w)	mg/l	0.006	0.0	#DIV/0!	6.314	#DIV/0!	Cyanide (total) (w)	70	WHO
Phenols - Total by HPLC (w)	mg/l	0.02	0.0	#DIV/0!	6.314	#DIV/0!	Phenols - Total by HPLC (w)	0.3	
Sulphide (w)	mg/l	0.1	0.1	#DIV/0!	6.314	#DIV/0!	Sulphide (w)	0.00025	
Arsenic (dissolved)	µg/l	3	3.0	#DIV/0!	6.314	#DIV/0!	Arsenic (dissolved)	50	EQS
Boron (dissolved)	µg/l	11	11.0	#DIV/0!	6.314	#DIV/0!	Boron (dissolved)	500	WHO
Cadmium (dissolved)	µg/l	1	1.0	#DIV/0!	6.314	#DIV/0!	Cadmium (dissolved)	3	WHO
Copper (dissolved)	µg/l	9	9.0	#DIV/0!	6.314	#DIV/0!	Copper (dissolved)	6	EQS
Chromium (dissolved)	µg/l	5	5.0	#DIV/0!	6.314	#DIV/0!	Chromium (dissolved)	3.4	EQS
Iron (dissolved)	µg/l	19	19.0	#DIV/0!	6.314	#DIV/0!	Iron (dissolved)	1000	EQS
Lead (dissolved)	µg/l	5	5.0	#DIV/0!	6.314	#DIV/0!	Lead (dissolved)	7.2	EQS
Mercury (dissolved)	µg/l	0.1	0.1	#DIV/0!	6.314	#DIV/0!	Mercury (dissolved)	0.05	EQS
Nickel (dissolved)	µg/l	1	1.0	#DIV/0!	6.314	#DIV/0!	Nickel (dissolved)	20	EQS
Selenium (dissolved)	µg/l	1	1.0	#DIV/0!	6.314	#DIV/0!	Selenium (dissolved)	10	WHO
Sulphur (elemental/free) (w)	mg/l		#DIV/0!	#DIV/0!	6.314	#DIV/0!	Sulphur (elemental/free) (w)		
Zinc (dissolved)	µg/l	3	3.0	#DIV/0!	6.314	#DIV/0!	Zinc (dissolved)	6-125	EQS
PAH 16MS (w)									
Acenaphthene (w)	µg/l	4.73	4.7	#DIV/0!	6.314	#DIV/0!	Acenapthene		
Acenaphthylene (w)	µg/l	0.08	0.1	#DIV/0!	6.314	#DIV/0!	Acenapthylene		
Anthracene (w)	µg/l	3.05	3.1	#DIV/0!	6.314	#DIV/0!	Anthracene		
Benzo(a)anthracene (w)	µg/l	2.39	2.4	#DIV/0!	6.314	#DIV/0!	Benzo(a)anthracene		
Benzo(a)pyrene (w)	µg/l	0.83	0.8	#DIV/0!	6.314	#DIV/0!	Benzo(a)pyrene	0.05	EQS
Benzo(b)fluoranthene (w)	µg/l	1.1	1.1	#DIV/0!	6.314	#DIV/0!	Benzo(b)fluoranthene		
Benzo(ghi)perylene (w)	µg/l	0.17	0.2	#DIV/0!	6.314	#DIV/0!	Benzo(ghi)perylene		
Benzo(k)fluoranthene (w)	µg/l	0.4	0.4	#DIV/0!	6.314	#DIV/0!	Benzo(k)fluoranthene		
Chrysene (w)	µg/l	2.09	2.1	#DIV/0!	6.314	#DIV/0!	Chrysene		
Dibenzo(ah)anthracene (w)	µg/l	0.05	0.1	#DIV/0!	6.314	#DIV/0!	Dibenzo(ah)anthracene		
Fluoranthene (w)	µg/l	8.71	8.7	#DIV/0!	6.314	#DIV/0!	Fluoranthene		
Fluorene (w)	µg/l	1.99	2.0	#DIV/0!	6.314	#DIV/0!	Fluorene		
Indeno(123-cd)pyrene (w)	µg/l	0.23	0.2	#DIV/0!	6.314	#DIV/0!	Indeno(123-cd)pyrene		
Naphthalene (w)	µg/l	0.47	0.5	#DIV/0!	6.314	#DIV/0!	Napthalene		
Phenanthrene (w)	µg/l	13.72	13.7	#DIV/0!	6.314	#DIV/0!	Phenanthrene		
Pyrene (w)	µg/l	7.46	7.5	#DIV/0!	6.314	#DIV/0!	Pyrene		
PAH (total 16) (w)	µg/l	47.47	47.5	#DIV/0!	6.314	#DIV/0!	PAH (total 16) (w)		
TPH CWG									
Ali >C5-C6 (w)	µg/l		#DIV/0!	#DIV/0!	6.314	#DIV/0!	Ali >C5-C6 (w)		
Ali >C6-C8 (w)	µg/l		#DIV/0!	#DIV/0!	6.314	#DIV/0!	Ali >C6-C8 (w)		
Ali >C8-C10 (w)	µg/l		#DIV/0!	#DIV/0!	6.314	#DIV/0!	Ali >C8-C10 (w)	300	WHO
Ali >C10-C12 (w)	µg/l		#DIV/0!	#DIV/0!	6.314	#DIV/0!	Ali >C10-C12 (w)	300	WHO
Ali >C12-C16 (w)	µg/l		#DIV/0!	#DIV/0!	6.314	#DIV/0!	Ali >C12-C16 (w)	300	WHO
Ali >C16-C21 (w)	µg/l		#DIV/0!	#DIV/0!	6.314	#DIV/0!	Ali >C16-C21 (w)		
Ali >C21-C35 (w)	µg/l		#DIV/0!	#DIV/0!	6.314	#DIV/0!	Ali >C21-C35 (w)		
Total Aliphatics (w)	µg/l		#DIV/0!	#DIV/0!	6.314	#DIV/0!	Total Aliphatics (w)		
Aro >C5-C7 (w)	µg/l		#DIV/0!	#DIV/0!	6.314	#DIV/0!	Aro >C5-C7 (w)		
Aro >C7-C8 (w)	µg/l		#DIV/0!	#DIV/0!	6.314	#DIV/0!	Aro >C7-C8 (w)		
Aro >C8-C10 (w)	µg/l		#DIV/0!	#DIV/0!	6.314	#DIV/0!	Aro >C8-C10 (w)		
Aro >C10-C12 (w)	µg/l		#DIV/0!	#DIV/0!	6.314	#DIV/0!	Aro >C10-C12 (w)	100	WHO
Aro >C12-C16 (w)	µg/l		#DIV/0!	#DIV/0!	6.314	#DIV/0!	Aro >C12-C16 (w)	100	WHO
Aro >C16-C21 (w)	µg/l		#DIV/0!	#DIV/0!	6.314	#DIV/0!	Aro >C16-C21 (w)	90	WHO
Aro >C21-C35 (w)	µg/l		#DIV/0!	#DIV/0!	6.314	#DIV/0!	Aro >C21-C35 (w)	90	WHO
Total Aromatics (w)	µg/l		#DIV/0!	#DIV/0!	6.314	#DIV/0!	Total Aromatics (w)		
TPH (Ali & Aro) (w)	µg/l	1667	1667.0	#DIV/0!	6.314	#DIV/0!	TPH (Ali & Aro) (w)		
BTEX - Benzene (w)	µg/l		#DIV/0!	#DIV/0!	6.314	#DIV/0!	BTEX - Benzene (w)	10	WHO/EQS
BTEX - Toluene (w)	µg/l		#DIV/0!	#DIV/0!	6.314	#DIV/0!	BTEX - Toluene (w)	50	EQS
BTEX - Ethyl Benzene (w)	µg/l		#DIV/0!	#DIV/0!	6.314	#DIV/0!	BTEX - Ethyl Benzene (w)	300	WHO
BTEX - m & p Xylene (w)	µg/l		#DIV/0!	#DIV/0!	6.314	#DIV/0!	BTEX - m & p Xylene (w)	500	WHO
BTEX - o Xylene (w)	µg/l		#DIV/0!	#DIV/0!	6.314	#DIV/0!	BTEX - o Xylene (w)	500	WHO
MTBE (w)	µg/l		#DIV/0!	#DIV/0!	6.314	#DIV/0!	MTBE (w)		

APPENDIX D GAS/GROUNDWATER MONITORING RESULTS

Gas Monitoring Results

PSA DESIGN
engineering your environment
CIVIL, STRUCTURAL, GEOTECHNICAL, TRANSPORT

JOB DETAILS					
Location:	Downham Rd, Chatburn			Sheet No:	1
Date:	18/02/2016	Job No:	G2235	Engineer:	Dr J Birtwhistle
				Time:	8.05

Meteorological and site information

State of ground.		Dry		Moist	✓	Wet		
Wind.		Calm	✓	Light		Moderate		Strong
Cloud cover.		None		Slight		Cloudy	✓	Overcast
Precipitation.	✓	None		Slight		Moderate		Heavy
Barometric pressure (mb)		994			Air Temp.	5'C		

Calibration (Start)	O.K.	Calibration (End)	O.K.

B.H. Ref:	CH4 (% vol in air)	CO2 (% vol in air)	O2 (% vol in air)	Flow Range (l/hr)	Average Flow (l/hr)	Pressure difference (Mb)	Groundwater Level (mbgl)
WS1	0.0	0.3	19.9	0.0	0.0	0.02	dry
WS2	0.0	0.1	20.3	0.0	0.0	0.00	dry
WS4	0.0	1.0	20.0	0.0	0.0	0.01	dry

Notes: Low pressure across UK
GA5000

	CO2 (% vol in air)	O2 (% vol in air)
Background	0	20.4

Gas Monitoring Results

PSA DESIGN
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JOB DETAILS				Sheet No:	1
Location:	Downham Rd, Chatburn			Engineer:	Dr J Birtwhistle
Date:	07/03/2016	Job No:	G2235	Time:	7.55

Meteorological and site information

State of ground.		Dry		Moist	✓	Wet			
Wind.		Calm	✓	Light		Moderate		Strong	
Cloud cover.		None	✓	Slight		Cloudy		Overcast	
Precipitation.	✓	None		Slight		Moderate		Heavy	
Barometric pressure (mb)		996		Air Temp.		0'C			

Calibration (Start)	O.K.	Calibration (End)	O.K.	

B.H. Ref:	CH4 (% vol in air)	CO2 (% vol in air)	O2 (% vol in air)	Flow Range (l/hr)	Average Flow (l/hr)	Pressure difference (Mb)	Groundwater Level (mbgl)
WS1	0.0	0.3	20.2	0.0	0.0	-0.02	dry
WS2	0.0	0.2	20.3	0.0	0.0	0.00	dry
WS4	0.0	1.0	20.0	0.0	0.0	0.00	dry

Notes: Low pressure across UK
GA5000

	CO2 (% vol in air)	O2 (% vol in air)
Background	0	20.5

Gas Monitoring Results

PSA DESIGN
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JOB DETAILS				Sheet No:	1
Location:	Downham Rd, Chatburn			Engineer:	Dr J Birtwhistle
Date:	25/03/2016	Job No:	G2235	Time:	7.45

Meteorological and site information

State of ground.		Dry	✓	Moist		Wet			
Wind.		Calm	✓	Light		Moderate		Strong	
Cloud cover.		None	✓	Slight		Cloudy		Overcast	
Precipitation.	✓	None		Slight		Moderate		Heavy	
Barometric pressure (mb)		1008		Air Temp.		5'C			

Calibration (Start)	O.K.	Calibration (End)	O.K.

B.H. Ref:	CH4 (% vol in air)	CO2 (% vol in air)	O2 (% vol in air)	Flow Range (l/hr)	Average Flow (l/hr)	Pressure difference (Mb)	Groundwater Level (mbgl)
WS1	0.0	0.3	21.3	0.0	0.0	0.03	dry
WS2	0.0	0.1	21.4	0.0	0.0	0.01	dry
WS4	0.0	0.8	20.9	0.0	0.0	0.00	dry

Notes: Mixed pressure across UK
GA5000

	CO2 (% vol in air)	O2 (% vol in air)
Background	0	21.6

Gas Monitoring Results

PSA DESIGN
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JOB DETAILS				Sheet No:	1
Location:	Downham Rd, Chatburn			Engineer:	Dr J Birtwhistle
Date:	11/04/2016	Job No:	G2235	Time:	7.45

Meteorological and site information

State of ground.		Dry	✓	Moist		Wet		
Wind.		Calm	✓	Light		Moderate		Strong
Cloud cover.		None	✓	Slight		Cloudy		Overcast
Precipitation.	✓	None		Slight		Moderate		Heavy
Barometric pressure (mb)		998			Air Temp.	7'C		

Calibration (Start)	O.K.	Calibration (End)	O.K.	

B.H. Ref:	CH4 (% vol in air)	CO2 (% vol in air)	O2 (% vol in air)	Flow Range (l/hr)	Average Flow (l/hr)	Pressure difference (Mb)	Groundwater Level (mbgl)
WS1	0.1	0.3	21.3	0.0	0.0	0.03	dry
WS2	0.0	0.1	21.2	0.0	0.0	-0.02	dry
WS4	0.0	1.0	20.8	0.0	0.0	0.00	dry

Notes: Low pressure across UK
GA5000

	CO2 (% vol in air)	O2 (% vol in air)
Background	0	21.5

Gas Monitoring Results

PSA DESIGN
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JOB DETAILS				Sheet No:	1
Location:	Downham Rd, Chatburn			Engineer:	Dr J Birtwhistle
Date:	04/05/2016	Job No:	G2235	Time:	7.45

Meteorological and site information

State of ground.		Dry	✓	Moist		Wet		
Wind.		Calm	✓	Light		Moderate		Strong
Cloud cover.		None	✓	Slight		Cloudy		Overcast
Precipitation.	✓	None		Slight		Moderate		Heavy
Barometric pressure (mb)		1013			Air Temp.	11'C		

Calibration (Start)	O.K.	Calibration (End)	O.K.	

B.H. Ref:	CH4 (% vol in air)	CO2 (% vol in air)	O2 (% vol in air)	Flow Range (l/hr)	Average Flow (l/hr)	Pressure difference (Mb)	Groundwater Level (mbgl)
WS1	0.1	0.2	21.2	0.0-0.1	0.1	0.00	dry
WS2	0.0	0.1	21.3	0.0-0.1	0.1	0.02	dry
WS4	0.0	0.3	21.1	0.0	0.0	0.01	dry

Notes: Mixed pressure across UK
GA5000

	CO2 (% vol in air)	O2 (% vol in air)
Background	0	21.5

Gas Monitoring Results

PSA DESIGN
engineering your environment
CIVIL, STRUCTURAL, GEOTECHNICAL, TRANSPORT

JOB DETAILS				Sheet No:	1
Location:	Downham Rd, Chatburn			Engineer:	Dr J Birtwhistle
Date:	24/05/2016	Job No:	G2235	Time:	8.45

Meteorological and site information

State of ground.	✓	Dry		Moist		Wet		
Wind.	✓	Calm		Light		Moderate		Strong
Cloud cover.	✓	None		Slight		Cloudy		Overcast
Precipitation.	✓	None		Slight		Moderate		Heavy
Barometric pressure (mb)		1014		Air Temp.		13'C		

Calibration (Start)	O.K.	Calibration (End)	O.K.

B.H. Ref:	CH4 (% vol in air)	CO2 (% vol in air)	O2 (% vol in air)	Flow Range (l/hr)	Average Flow (l/hr)	Pressure difference (Mb)	Groundwater Level (mbgl)
WS1	0.0	0.2	21.0	0.0	0.0	-0.02	dry
WS2	0.0	0.2	21.0	0.0	0.0	0.00	dry
WS4	0.0	1.7	19.3	0.0	0.0	0.00	dry

Notes: Mixed pressure across UK
GA5000

	CO2 (% vol in air)	O2 (% vol in air)
Background	0	21.3

APPENDIX E RISK ASSESSEMENT CRITERIA

Table 6.3 Classification of Consequence

Classification	Definition	Examples
Severe	Short-term (acute) risk to human health likely to result in "significant harm" as defined by the Environment Protection Act 1990, Part IIA. Short-term risk of pollution (note: Water Resources Act contains no scope for considering significance of pollution) of sensitive water resource. Catastrophic damage to buildings/property. A short-term risk to a particular ecosystem (note: the definitions of ecological systems within the Draft Circular on Contaminated Land, DETR, 2000).	High concentrations of cyanide on the surface of an informal recreation area. Major spillage of contaminants from site into controlled water. Explosion, causing building collapse (can also equate to a short-term human health risk if buildings are occupied)
Medium	Chronic damage to Human Health ("significant harm" as defined in DETR, 2000). Pollution of sensitive water resources (note: Water Resources Act contains no scope for considering significance of pollution). A significant change in a particular ecosystem, or organism forming part of such ecosystem. (Note: the definitions of ecological systems within the Draft Circular on Contaminated Land, DETR, 2000).	Concentrations of a contaminant from site exceed the generic, or site -specific assessment criteria. Leaching of contaminants from a site to a major or minor aquifer. Death of a species within a designated nature reserve.
Mild	Pollution of non-sensitive water resources. Significant damage to crops, buildings, structures and services ("significant harm" as defined in the *Draft Circular on Contaminated Land*, DETR, 2000). Damage to sensitive buildings/structures or the environment.	Pollution of non-classified groundwater. Damage to building rendering it unsafe to occupy (e.g. foundation damage resulting in instability).
Minor	Harm, although not necessarily significant harm, which may result in a financial loss, or expenditure to resolve. Non-permanent health effects to health (easily prevented by means such as personal protective clothing etc). Easily repairable effects of damage to buildings, structures and services.	The presence of contaminants at such concentrations that protective equipment is required during site works. The loss of plants in a landscaping scheme. Discoloration of concrete.

Table 6.4 Classification of Probability

Classification	Definition
High Likelihood	There is a pollution linkage and an event that either appears very likely in the short term and almost inevitable over the long term, or there is evidence at the receptor of harm or pollution.
Likely	There is a pollution linkage and all the elements are present and in the right place, which means that it is probable that an event will occur. Circumstances are such that an event is not inevitable, but possible in the short term and likely over the long term.
Low likelihood	There is a pollution linkage and circumstances are possible under which an event could occur. However, it is by no means certain that even over a longer period such an event would take place, and is less likely in the shorter term.
Unlikely	There is a pollution linkage but circumstances are such that it is improbable that an event would occur even in the very long term.

Table 6.5 Comparison of consequence against probability

		consequence			
		severe	medium	mild	minor
probability	high likelihood	very high risk	high risk	moderate risk	moderate/ low risk
	likely	high risk	moderate risk	moderate/ low risk	low risk
	low likelihood	moderate risk	moderate/low risk	low risk	very low risk
	unlikely	moderate/ low risk	low risk	very low risk	very low risk

Table 6.6 Description of the classified risks and likely action required

Very high risk	There is a high probability that severe harm could arise to a designated receptor from an identified hazard, OR, there is evidence that severe harm to a designated receptor is currently happening. This risk, if realised, is likely to result in a substantial liability. Urgent investigation (if not undertaken already) and remediation are likely to be required.
High risk	Harm is likely to arise to a designated receptor from an identified hazard. Realisation of the risk is likely to present a substantial liability. Urgent investigation (if not undertaken already) is required and remedial work may be necessary in the short term and are likely over the longer term.
Moderate risk	It is possible that harm could arise to a designated receptor from an identified hazard. However, if it is either relatively unlikely that any such harm would be severe, or if any harm were to occur it is more likely that the harm would be relatively mild. Investigation (if not already undertaken) is normally required to clarify the risk and to determine the potential liability. Some remedial works may be required in the longer term.
Low risk	It is possible that harm could arise to a designated receptor from an identified hazard, but it is likely that this harm, if realised, would at worst normally be mild.
Very low risk	There is a low possibility that harm could arise to a receptor. In the event of such harm being realised it is not likely to be severe.