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Interim Phase II Geotechnical & Environmental Assessment

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SUTCLIFFE INVESTIGATIONS

INTERIM GEOTECHNICAL AND ENVIRONMENTAL ASSESSMENT

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Summary

Liverpool Housing Trust has appointed Sutcliffe Investigations to undertake a Phase II Geotechnical and Environmental Assessment at Church Raike, Chipping.
This report should be read in conjunction with:

- Phase I Desk Study, Church Raike, April 2012, Ref:26192LG

The site is located on Church Raike in the area of Chipping. The site is approximately 10 miles north-east of Preston. A plan indicating the site location can be found in Appendix B.

The site is to be developed housing comprising 6 houses for affordable rent and 1 for private sale. Based upon these proposals the site will be assessed against a Residential with Plant Uptake Scenario end use.

Site Investigations were carried out on 10th December 2012 and have been designed based upon the findings in the Phase I Desk Study, preliminary risk assessment and conceptual model.

Executive Summary

A summary of salient geo-environmental issues is provided in the table below:

SITE DESCRIPTION	The site is located at Church Raike, Chipping, Preston, PR3 2QL. Grid reference 362120, 443430. The site is 0.21Ha in size. The site is roughly rectangular in shape and consists of a roughly grassed plot that is noted to slope down to the north. The surrounding area consists of residential buildings, fields and a brook.
SITE INVESTIGATION	The site was investigated using the following: 3No. Window Sample holes: WS1, WS2 and WS3 5No. Trial Holes: TH1-TH5 10No. Contamination tests 3No. Geotechnical Laboratory tests (WS1, WS2 and WS3) 5No. Leachate Analysis
MADE GROUND	Made Ground has been noted on site in samples WS1, WS2, WS3 and TH1, TH3 and TH5. MADE GROUND goes to a maximum depth of 2.4mbgl in WS1. The Medium dense MADE GROUND noted in these samples generally consists of orangish brown silty sandy gravelly cobbly CLAY with rare half bricks. Gravels and cobbles are sub angular of sandstone and mudstone.
NATURAL GROUND	In all trial holes and window samples with the exception of WS1, the natural ground across the site was noted as Medium dense very dark brown slightly silty gravelly cobbly boulder CLAY. Gravels, cobbles and boulders are sub rounded to sub angular of limestone, sandstone and slate. Slate fragments are veined with feldspar. Window sample WS1 noted natural ground between 2.40mbgl and 5.45mbgl as consisting of soft to firm dark brown sandy gravelly CLAY with sub angular cobbles and boulders of sandstone, mudstone and slate.
SOLID GEOLOGY	Solid Geology was not encountered in the site investigation works.
GROUNDWATER	Ground water seepage was not noticed during the site investigation. All sample holes and trial holes were noted as dry during monitoring visits.
CONTAMINATION EVALUATION	**SOIL EVALUATION** Site investigations have indicated the following elevated levels on site: Elevated levels of contamination have been noted in three of the exploratory hole positions. TH1, TH2 and WS2 and are detailed as follows: • Arsenic noted in WS2 at 0.5m; 38mg/kg • Naphthalene noted in TH1 at 0.6m; 0.613mg/kg • benzo(a)anthracene noted in TH1 at 0.6m and TH2 at 0.4m; levels of 55.5mg/kg and 6.44mg/kg respectively • benzo(b)flouranthene noted in TH1 at 0.6m; 36.7 mg/kg • benzo(a)pyrene noted in TH1 at 0.6m and TH2 at 0.4m; levels of 39.4mg/kg and 6.49mg/kg respectively

- dibenzo(ah)anthracene noted in TH1 at 0.6. and TH2 at 0.4m; levels of 5.21 and 0.953 respectively
- indeno(123cd)pyrene noted in TH1 at 0.6m; 17.6mg/kg

Statistical analysis was performed on all of the contaminant data received, particular attention was placed on contaminants initially indicating elevated levels:

- Arsenic upper confidence limit is below the critical concentration value for Atkins Atrisk 1% levels. Arsenic therefore passes the mean value test and no remediation is required for the area of WS3 as it is not a hotspot for contamination.
- Benzo(a)pyrene results reveal an upper confidence limit that is greater that the critical concentration value for Atkins Atrisk 1%. If the results at TH1 and TH2 are removed as outliers then the values fall into acceptable levels. Therefore the areas of TH1 and TH2 are hotspots for benzo(a)pyrene and remediation will be required.
- Naphthalene passes the mean value test despite the elevated level recorded in TH1. However due to hotspots of benzo(a)pyrene in the sample position the contamination that is noted is to be removed as part of the proposed remediation.
- Benzo(b)flouranthene Indeno(123cd)pyrene, Benzo(a)anthracene and Dibenzo(ah)anthracene require only one outlier to be removed in order for the samples to pass the mean value test. However due to the presence of the two hotspots of Benzo(a)pyrene in the sample positions, the contamination that is noted is to be removed as part of the proposed remediation.

As the contaminant hotspots of Benzo(a)pyrene have been identified in the region of TH1 and TH2 it is proposed that the entire area south east of the water main be included for remediation. This will also ensure that all PAH elevated levels recorded will be covered.

Full statistical analysis results can be found in Appendix F

LEACHATE EVALUATION

UK Drinking Water Standards
None of the contaminants exceeds the DWS values.

Elevated levels of Benzo(a)pyrene are noted in TH3 at 0.6m and WS3 at 0.5m however this is due to reporting limitations.

Environmental Quality Standards
The majority of the samples pass for EQS standards:
An elevated level of sulphide is noted in WS1 at 0.5m

An elevated level of Naphthalene is noted in TH3 at 0.6m

Lead values in WS1 and WS2 at 0.5m fall within the EQS range of 4-250 µg/l

ASBESTOS	Asbestos analysis was undertaken on all samples. Testing revealed no asbestos fibres in any of the samples.
WATER SOLUBLE SULPHATE	Therefore, in accordance with Table C2 of BRE: Special Digest 1 2005, sub-surface concrete that is in contact with Made Ground should be Design Sulphate Class DS-1, with the ACEC classification of AC-1s.
GROUND GAS MONITORING	Although the site is currently classed as Green, ground gas monitoring is still on-going and a final assessment will be made upon completion of the final gas monitoring results, monitoring is on-going.
FOUNDATIONS / GROUND FLOOR	**Foundations** Based upon the water main running directly through the site and the depth of made ground encountered and the fall to the rear of the site it is not recommended that a traditional mass fill foundation be utilised on site as this could damage the existing water main and be unstable and un-economical. Sutcliffe Investigations therefore propose CFA piles to be employed; CFA piles will limit vibration to the water main. **Ground Floor** Due to the amount of MADE GROUND on site in excess of 2.4m in areas, it is not proposed to employ a ground bearing slab, therefore a suspended P.C unit ground floor should be adopted. With a gas membrane and should be incorporated into any piling until the full ground gas monitoring is complete.

REMEDIATION SUMMARY

SOIL CONTAMINATION

Soil contamination has been noted in hotspots at TH1 and TH2 therefore localised remediation work is proposed in these areas.

600mm removal and replacement capping layer is advised in all garden/landscaped areas to the south east of the site beyond the waste sewer; Levels on site are varied and may or may not have to be revised to ensure a 600mm capping layer is achieved.

Plan of Area recommended can be found in Appendix B

LEACHATE CONTAMINATION
None of the contaminants exceed the DWS value.

GROUND GAS
The site is currently classed as Green; however ground gas monitoring is still on-going.

Contents

FOREWORD (Geotechnical and Environmental Assessment)

This report has been prepared for the sole internal use and reliance of the Client named on page 1. This report shall not be relied upon or transferred to any other parties without the express written authorisation of Sutcliffe Investigation; such authorisation not to be unreasonably withheld. If any unauthorised third party comes into possession of this report, they rely on it at their risk and the authors owe them no duty of care and skill.

The report presents observations and factual data obtained during our site investigation, and provides an assessment of Geotechnical and environmental issues with respect to information provided by the Client regarding the proposed development. Further advice should be sought from Sutcliffe Investigation prior to significant revision of the development proposals.

The report should be read in its entirety, including all associated drawings and appendices. Sutcliffe Investigation cannot be held responsible for any misinterpretations arising from the use of extracts that are taken out of context.

The findings and opinions conveyed in this report (including review of any third party reports) are based on information obtained from a variety of sources as detailed within this report, and which Sutcliffe Investigation believes are reliable. All reasonable care and skill has been applied in examining the information obtained. Nevertheless, Sutcliffe Investigation cannot and does not guarantee the authenticity or reliability of the information it has relied upon.

The report represents the findings and opinions of experienced Geotechnical and environmental consultants. Sutcliffe Investigations does not provide legal advice and the advice of lawyers may also be required.

Intrusive investigation can only investigate shallow ground beneath a small proportion of the total site area. It is possible therefore that the intrusive investigation undertaken by Sutcliffe Investigation, whilst fully appropriate, may not have encountered all significant subsurface conditions. Any opinions expressed as to the possible configuration of strata between or below exploratory holes are for guidance only and no responsibility is accepted as to its accuracy.

It should be borne in mind that the timescale over which the investigation was undertaken might not allow the establishment of equilibrium groundwater levels. Particularly relevant in this context is that groundwater levels are susceptible to seasonal and other variations and may be higher during the wetter periods than those encountered during this commission.

Where the report refers to the potential presence of invasive weeds such as Japanese Knotweed, or the presence of asbestos containing materials, it should be noted that the observations are for information only and should be verified by a suitably qualified expert.

This report assumes that ground levels will not change significantly from those existing at present and that houses will be of two storey construction. If this is not to be the case, then some modification to this report may be required.

It should be noted that the banning of the co-disposal of hazardous and non-hazardous waste was introduced in 2004, as a result of the implementation within the UK of the Landfill Directive. This will considerably affect the current practices and procedures for the handling and disposal of wastes, in particular hazardous wastes. In addition, it will be a requirement for all wastes to be pre-treated and to comply with certain waste acceptance procedures prior to sending wastes to landfill. The full potential effects of these important changes are not known at this stage, but it is perceived that disposal costs will rise, particularly for hazardous wastes, and waste pre-treatment may, in some cases, become an 'additional' redevelopment cost with regard to the remediation of contaminated sites.

Should this report recommend that materials could be excavated and removed off site for landfill disposal, then it should be noted that the costs, timescales and implications of the pending changes to waste management legislation couldn't be predicted at this stage. Sutcliffe Investigation will not be responsible for changing practices, etc that may affect the viability of necessary remedial actions or of the implications of potential alternative treatment techniques.

Sutcliffe Investigation reserves the right to amend their conclusions and recommendations in the light of further information that may become available.

1 Introduction

1.1 Scope of Assessment

1.1.1 Liverpool Housing Trust (The Client) has appointed Sutcliffe Investigations to conduct an Environmental and Geotechnical Investigation on land at Church Raike, Chipping, Preston, (shown in Appendix B). The present report is submitted in fulfilment of that brief and combines the following elements:

- An intrusive investigation exploring the actual ground conditions
- Dual gas and groundwater monitoring wells
- Assessment of the geotechnical properties
- A qualitative and quantitative risk assessment of contamination risks, with respect to potential receptors, including a conceptual site model
- Recommendations for further work and remediation where appropriate

1.1.2 The report was devised to generally comply with the relevant principals and requirements of a wide range of guidance including BS5930:1999 as amended 2007: "Code of Practice for Site Investigations", BS10175: 2001 "Investigation of Potentially Contaminated Sites – Code of Practice", and the DEFRA / Environment Agency Report CLR11 "Model Procedures for the Management of Land Contamination.

1.2 The Proposed Development

1.2.1 The site is to be developed as housing 6 houses for affordable rent and 1 for private sale. A copy of the proposed site plan can be found in Appendix B. Based on these proposals the site will be assessed against a Residential with Plant Uptake end use.

1.3 Report Format and Limitations

1.3.1 This report has been prepared and written for the exclusive benefit of the client for the purpose of providing environmental and/or geotechnical information and data relevant to the site and its redevelopment. The client shall not assign charge or otherwise transfer all or any of the contents contained within this report without the prior written consent of the consultant. The report contents should be used only in that context. Furthermore, new information, changed practices or new legislation may necessitate revised interpretation of the report after the date of its submission.

1.3.2 General notes and limitations relevant to all Sutcliffe Investigations are described in the Foreword and in Appendix A and should be read in conjunction with this report.

1.3.3 Primary aims of this exploratory phase of investigation were to identify salient geotechnical and environmental issues affecting the site to enable the client to obtain budget costs for the necessary site preparatory and remedial works.

2 Site Investigation / Fieldwork

2.1 Investigation Strategy

2.1.1 Sampling Strategy

The site was investigated using the Secondary Model Procedure for the Development of Appropriate Soil Sampling Strategies for Land Contamination R & D Technical Report P5-006/TR.

Due to the history of the site a non-targeted sampling strategy was used.

The site area is 2,100m^2 ÷ 8 sample positions = 262.50m^2 ÷ 0.8 = 328.13
√328.13m^2 = an 18.11m grid.
Therefore this gives an 80% probability of finding a circular area of interest of 328.13m^2.

The chosen method of this ground investigation is summarised in Table 2.1 below.

Table 2.1: Purpose of Exploratory Holes

Exploratory Holes	Purpose
Window Samples	To install monitoring wells across the site in order to determine groundwater levels and monitor for hazardous gas. To determine the general nature of soils underlying the site, including the: • Nature, distribution and thickness of Made Ground • Nature, degree and extent of contamination • Proportion of undesirable elements e.g. biodegradable matter, foundations etc. • Suitability of the ground for founding structures.
Trial Holes	To determine the general nature of soils underlying the site, including: • Nature, distribution and thickness of MADE GROUND • Nature, degree and extent of contamination • Proportion of undesirable elements e.g. biodegradable matter, foundations etc.

2.1.2 Notes describing ground investigation techniques, in-situ testing and sampling are included in Appendix A to this report.

2.1.3 Analytical Strategy

For the purpose of the analytical testing suite, consideration has been given to the conceptual model, the Tier 1 Risk Assessment and the former usages of the site as summary of which is noted below:

FORMER SITE USES / FEATURES	POSSIBLE CONTAMINANTS
Field **Trees** **Out Buildings**	**Metals** **pH** **Asbestos**

2.1.3.1 The analytical suite for soil / leachate / water samples comprised the following compounds (full suites of testing were not carried out on all of the samples):

SOILS
Arsenic, Boron, Cadmium, Chromium (III, VI), Copper, Lead, Mercury, Nickel, Selenium, Zinc, Cyanide, Phenols, Sulphate (Total), Sulphide, Sulphur (Total), pH, Organic Matter, Asbestos, PAH (Speciated), TPH (Speciated).
LEACHATES
Arsenic, Boron, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Selenium, Zinc, Cyanide, Sulphate, Sulphide, Sulphur (Total), pH, PAH (Speciated).
WATER
Arsenic, Boron, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Selenium, Zinc, Cyanide, Sulphate, Sulphide, Sulphur (Total), pH, PAH (Speciated), BTEX.

2.1.3.2 All samples were analysed by MCERTS accredited soil analysis laboratory ALcontrol under UKAS accredited methods. All samples have been taken in accordance with current British Standards.

2.1.3.3 TPH Speciated aromatic and aliphatic bands with BTEX analysis have been carried out in line with the TPHCWG. The toxicity and migration risk associated with a TPH is dependent on the specific aliphatic aromatic carbon banding. Of particular concern are the low molecular weight compounds, which are highly mobile and show a greater level of toxicity that the higher molecular weight compounds. Therefore a low TPH consisting of low molecular weight aliphatic and aromatic carbon banding compounds may present more of a risk than a high TPH consisting of heavy weight aliphatic and aromatic carbon banding compounds.

2.1.3.4 Based on the TPHCWG the aromatic band C5 – C7 is considered to consist only of Benzene and the aromatic band C7 – C8 of Toluene. Therefore the more specific BTEX analysis has been used for risk assessment rather than the aromatic bands.

2.1.2.5 3No. installation wells have been installed on the site for ground gas monitoring.

2.2 Ground Investigation

2.2.1 Intrusive investigations are conducted to identify and quantify any contaminants present, in particular those anticipated in the light of the sites previous use. Intrusive investigation also enables the effects of soil conditions on contaminant migration and exposure pathways to be clarified; notably, the presence of groundwater can be determined and the permeability of soil strata can be assessed. Intrusive site investigations are necessary to allow determination of site-specific foundation strata for Geotechnical purposes.

2.2.2 The intrusive site investigation comprised of:

1. 3No. Window samples with a Dando Terrier Rig WS1- WS3 (Appendix D)
2. 5 No. Trial holes with a JCB 3CX; TH1-TH5 (Appendix D)
3. 10No. Soil samples taken for contamination testing purposes at varying depths from the Made Ground and Natural Ground (Appendix E)
4. 10No. Speciated TPH sample from the Made Ground material. (Appendix E)
5. 5No. Leachate sample from the Made Ground. (Appendix E)
6. 3No. Gas monitoring wells. (Appendix D)
7. 3No. Geotechnical Samples (Appendix D)

2.2.3 The intrusive site investigation took place on the 10th December 2012. The results of this investigation are reported in Section 3 and 4.

2.3 Installations and In-situ Testing

2.3.1 3No. Gas and groundwater monitoring wells were installed in the window samples across the site to enable monitoring of groundwater levels and soil gas emissions, and sampling of groundwater following the site works. The response zone in the standpipe installation was filter wrapped and installed with a gravel filter.

2.3.2 Details of the installation are presented on the borehole log in Appendix D. The response zones of the groundwater standpipe installations are within the Made Ground strata.

3 Ground and Groundwater Conditions

3.1 General

3.1.1 A summary of the ground conditions for this site are noted below, but a complete record of strata encountered is given on the various exploratory hole logs, presented in Appendix D. These logs include details of the samples taken, descriptions of the strata and groundwater encountered, results of the in-situ testing and the monitoring well depths.

3.2 Made Ground

3.2.1 Possible Made Ground has been noted on site in samples WS1, WS2, WS3 and TH1, TH3 and TH5. Possible MADE GROUND goes to a maximum depth of 2.4mbgl in WS1. The Medium dense possible MADE GROUND noted in these samples generally consists of orangish brown silty gravelly cobbly SAND with rare half bricks. Gravels and cobbles are sub angular of sandstone and mudstone.

At shallower depths of up to 1.0m in trial holes TH1 and TH3 MADE GROUND was found to be comprised of light brown sandy GRAVEL with rare brick and glass fragments. Gravel is sub angular fine to coarse limestone.

3.3 Natural Deposits

3.3.1 In all trial holes and window samples with the exception of WS1, the natural ground across the site was noted as Medium dense very dark brown slightly silty gravelly cobbly boulder SAND. Gravels, cobbles and boulders are sub rounded to sub angular of limestone, sandstone and slate. Slate fragments are veined with feldspar.

Window sample WS1 noted natural ground between 2.40mbgl and 5.45mbgl as consisting of soft to firm dark brown sandy gravelly CLAY with sub angular cobbles and boulders of sandstone, mudstone and slate.

3.4 Solid Geology

3.4.1 Solid Geology was not encountered in any of the investigation positions.

3.5 Hydrogeology

3.5.1 The site overlies bedrock that is classified as a Secondary A aquifer. According to the EA Groundwater Vulnerability Maps the site is not within a Source Protection Zone.

3.6 Visual & Olfactory Evidence of Organic Contamination

3.6.1 No visual or olfactory evidence of organic contamination was noted in any of the exploratory holes during site investigation works.

3.7 Stability

3.7.1 Stability of excavations within Natural Ground was generally good; however some instability was noted on TH4 between 0.20mbgl and 1.40mbgl and TH5 between 0.20mbgl and 1.70mbgl.

3.8 Geotechnical Testing and Issues

3.8.1 Geotechnical Testing

Samples from WS1, WS2 and WS3 were sent to PTS laboratory for Geotechnical testing.

3.8.2 Made Ground

Made Ground was encountered in window sample positions WS1 and WS3 and generally comprised of Medium dense MADE GROUND comprising orangish brown silty gravelly cobbly CLAY with rare half bricks. Gravels and cobbles are sub angular of sandstone and mudstone. Thickness of Made Ground was most extensive in WS1 which was noted to a depth of 2.40mbgl.

Table 3.1: Material Properties Made Ground

Property	No. of Tests	Range	Average
SPT N Values	3	7-13	9

Note: Made Ground is not suitable for foundations

3.8.3 Clay Deposits

A clay deposits was encountered in window sample position WS1 and generally comprised of soft to firm dark brown sandy gravelly CLAY with, sub-angular cobbles and boulders of sandstone, mudstone and slate.

Table 3.2: Material Properties CLAY

Property	No. of Tests	Range	Average
SPT N Values	5	11-59	23.20

3.8.4 **Plasticity Analysis**

Plasticity analysis was undertaken on three samples of CLAY and based on NHBC Chapter 4.2 Building near Trees (Table 1: Volume Change Potential), the results were as follows as follows:

- Sample WS1a plasticity of 26 was recorded indicating a medium volume change potential
- Sample WS2 a plasticity of 15 was recorded indicating a low volume change potential
- Sample WS3 a plasticity of 17 was recorded indicating a low volume change potential
- Using the average across the 3 samples (19.3%)

3.8.5 Un-drained Triaxial Compression Tests

Initial site investigations determined ground as sand. PTS testing has indicated the samples WS1-WS3 all clay. However no un-drained triaxial or bulk density tests have been carried out

3.8.6 Bulk Density Tests

Initial site investigations determined ground as sand. PTS testing has indicated the samples WS1-WS3 all clay. However no triaxial or bulk density tests have been carried out. Further testing is awaited for clarification.

3.8.7 A summary of the results of in-situ and geotechnical testing are presented below:

Table 3.4: Summary of the Material Properties

Property	No. of Tests	Result
Moisture Content %	3	16-22
Liquid Limit %	3	31-47
Plastic Limit %	3	16-21
Plasticity Index %	3	15-26
% Ret.425 µm sieve	3	12-29

The widow samples recovered and tested equate to a ground bearing pressure value of between 90 - 232kN/m^2.

3.8.8 Soluble Sulphate and pH

It is envisaged foundations will extend through the Made Ground and into the natural strata and samples taken from the Made Ground have been submitted for pH and water-soluble sulphate (2:1 soil/water extract) analysis.

3.8.8.1 The highest water-soluble sulphate concentration and the lowest pH value for the Made Ground are shown in Table 3.5.

Table 3.5: Soluble sulphate and pH classification

Soil Type	Lowest pH Values	Highest Soluble Sulphate Concentration (g/l)
Made Ground	6.1	0.155
Natural Ground	7.59	0.0499

3.8.8.2 Therefore, in accordance with Table C2 of BRE: Special Digest 1 2005, sub-surface concrete that is in contact with Made Ground should be Design Sulphate Class **DS-1**, with the ACEC classification of **AC-1s**.

3.8.9 General

It is understood that consideration is being given to the development of houses. A site layout has been provided and is in Appendix B.

3.8.9.1 Generally the investigations revealed Made Ground across the site, with many of the locations noting Made Ground over 1.50m in depth (WS1, WS2, WS3, TH3, and TH5).

There is a Non-Potable water main that runs across the site carrying Raw Water. United Utilities require a 5m easement on either side of the pipe and will require access at all times. The recommendations for the site investigation will have to take this into consideration

3.8.10 Foundations

Based upon the water main running directly through the site and the depth of made ground encountered and the fall to the rear of the site it is not recommended that a traditional mass fill foundation be utilised on site as this could damage the existing water main and be unstable and un-economical. Sutcliffe Investigations therefore propose CFA piles to be employed; CFA piles will limit vibration to the water main.

3.8.10.1 Groundwater was not recorded in any of the exploratory holes during site investigation works.

3.8.10.2 Excavations within the natural ground were generally stable with the exception of TH4 that experienced instability between 0.20mbgl and 1.40mbgl and TH5 that experienced instability between 0.20mbgl and 1.70mbgl.

3.8.10.3 Sub-surface concrete that is only in contact with Made Ground can be Design Sulphate Class DS-1, with an ACEC Classification of AC-1s.

3.8.11 Ground Floor

Due to the amount of MADE GROUND on site in excess of 2.4m in areas, it is not proposed to employ a ground bearing slab, therefore a suspended P.C unit ground floor should be adopted. With a gas membrane and incorporated in any piling until the full ground gas monitoring is complete.

The water main running through the site means the location would not allow an economic traditional mass concrete deep trench fill foundation solution.

3.8.11.1 Based upon the water main running directly through the site it is not recommended that a ground-bearing slab be utilised on site as this could damage the existing water main. Sutcliffe Investigations therefore propose CFA piles to be employed site wide with installation to ensure they are employed outside the zone of influence to ensure they may not cause damage to the existing water main. Ground gas monitoring is still on-going.

3.8.12 Designated Concrete Mixes

The following designated mix in accordance with BRE Special Digest SD1 and BS 8500: Part1: 2002 will be suitable for use on this site.

Table 3.6: Designated Concrete Mixes

Application	DS-2 Conditions (Made Ground and Natural) ACEC Class AC-1s
Unreinforced strip / trench fill footings	GEN1
Reinforced strip / trench fill footing (mesh reinforcement)	RC30
Reinforced strip / trench fill footings (rebar etc)	RC30
Unreinforced concrete floor slabs	GEN2
In situ reinforced concrete floor slabs	RC30

*Note: Although RC 30 is in line with BS8500, Sutcliffe Investigation recommend the use of RC35 for concrete used in structurally sensitive works, to provide greater certainty of compliance with strength verification tests. Tolerable mixes dispatched by a batching plant are +/- 10%, and delays on site can also result in deterioration of the concrete.

3.8.13 Drainage

It is recommended that the developer contact United Utilities with respect to capacity in existing foul and surface water sewers in the vicinity of the development area.

Please note the testing suite carried out for this site is for human health purposes and may not cover the suite of contaminants required by United Utilities for pipe selection, therefore further

4 Contamination Hazard Assessment and Evaluation

4.1 General

4.1.1 The site's former usages may have given rise to some ground contamination. Furthermore, Made Ground was encountered in the majority of the exploratory locations during the ground investigation.

4.2 Testing Schedule

4.2.1 Based on the above assessment, the following testing was carried out at ALcontrol which is a UKAS accredited laboratory. No visual and/or olfactory evidence was recorded during the ground investigation.

Table 4.1: Testing Schedule

Type of Sample	No. of Samples	Determinands
Made Ground	10	pH, water-soluble boron, total metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium and zinc) and total sulphate, PAH suite.
Made Ground	10	Asbestos
Made Ground	10	Organic matter
Made Ground	4	Speciated TPH Aliphatic / Aromatic
Made Ground	5	Leachable: pH, water-soluble boron, total metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium and zinc) and total sulphate, nitrate, and PAH suite.

4.3 Hazard Evaluation: Soils

4.3.1 General

The soil contamination test results are summarised in Table 4.2 for Made Ground. Laboratory test certificates as received from the laboratory and summary sheets are presented in Appendix E.

4.3.2 Made Ground

Of the ten samples of Made Ground analysed for contaminant parameters two of the samples contained contaminants that could be classified as elevated above the Generic Assessment Criteria (GAC).

4.3.2.1 These samples are classified by comparison of parameters concentrations with the relevant current UK guidance threshold value for a proposed residential with plant uptake end use.

4.3.2.2 The analysis of acidity / alkalinity of the soil samples indicated that the pH of the samples tested was in the acidic to alkaline range, with a minimum of 6.06, a maximum of 8.31, and a mean of 7.63

4.3.2.3 The samples were assessed against Tier 1 values for a residential with plant uptake end use. Elevated levels of Arsenic, Naphthalene, Benzo(a)anthracene, Benzo(b)fluoranthene, Benzo(a)pyrene, Dibenzo(ah)anthracene and Indeno(123cd)pyrene have been noted.

4.3.2.4 The statistical analysis results for Arsenic, Naphthalene, Benzo(a)anthracene, Benzo(b)fluoranthene, Benzo(a)pyrene, Dibenzo(ah)anthracene and Indeno(123cd)pyrene are summarised in Table 4.2. Appendix F details the statistics reports for all contaminants.

Table 4.2: Statistical Analysis Results for Made Ground Stratum

Contaminant	Guideline Assessment Value	95% ile	Mean Value Test	Max Value Test	No. of Outliers removed to pass
Arsenic	32 (SGV)	23.957494	Passes	1 Outliers	N/A
Naphthalene	0.585 (Atkins)	0.37770017	Passes	1 Outliers	N/A
Benzo(a)anthracene	4.52 (Atkins)	33.563539	Fails	2 Outlier	1
Benzo(b)fluoranthene	7.72 (Atkins)	22.4339413	Fails	1 Outlier	1
Benzo(a)pyrene	0.818 (Atkins)	24.0553844	Fails	2 Outlier	2
Dibenzo(ah)anthracene	0.838 (Atkins)	3.19887104	Fails	2 Outlier	1
Indeno(123cd)pyrene	7.31 (Atkins)	10.8363851	Fails	1 Outlier	1

4.3.2.5 The statistical analysis results for Arsenic indicate that the upper 95th percentile bound value (US95) is below the relevant UK guidance threshold value for a residential with plant uptake scenario, and the mean value test for Arsenic is noted to pass with no outliers required to be removed. The only elevated level of Arsenic detected was noted in WS2 at 0.50mbgl with a value of 38mg/kg, slightly above the acceptable assessment value of 32mg/kg. As WS2 at 0.5mbgl has no further elevated contaminant levels and Arsenic passes the mean value test; the area need not be treated as a contaminant hotspot.

4.3.2.6 The statistical analysis results for Napthalene indicate that the upper 95th percentile bound value (US95) is below the relevant UK guidance threshold value for a residential with plant uptake scenario, and the mean value test for naphthalene is noted to pass with no outliers required to be removed. The only elevated level of Napthalene detected was noted in TH1 at 0.60mbgl with a value of 0.613mg/kg, slightly above the acceptable assessment value of 0.585mg/kg. TH1 has been determined a hotspot area for benzo(a)pyrene and remediation needed, therefore Napthalene contamination will be dealt with during this process.

4.3.2.7 The statistical analysis results for Benzo(a)anthracene indicate that the upper 95th percentile bound value (US95) is above the relevant UK guidance threshold value for a residential with plant uptake scenario. Benzo(a)anthracene fails the mean value test with one outlier, when the outlier is removed from the dataset Benzo(a)anthracene passes with no statistical outliers indicating localised Benzo(a)anthracene contamination. Contamination is note in TH1 at 0.60mbgl and TH2 at 0.40mbgl; TH1 and TH2 have been determined as hotspot areas for benzo(a)pyrene and remediation is needed, therefore Benzo(a)anthracene contamination will be dealt with during this process.

4.3.2.8 The statistical analysis results for Benzo(b)fluoranthene indicate that the upper 95th percentile bound value (US95) is above the relevant UK guidance threshold value for a residential with plant uptake scenario. Benzo(b)fluoranthene fails the mean value test with one outlier, when the outlier is removed from the dataset Benzo(b)fluoranthene passes with no statistical outliers indicating localised Benzo(b)fluoranthene contamination. Contamination is note in TH1 at 0.60mbgl; TH1 has been determined as a hotspot area for benzo(a)pyrene and remediation is needed, therefore Benzo(b)fluoranthene contamination will be dealt with during this process.

4.3.2.9 The statistical analysis results for Benzo(a)pyrene indicate that the upper 95th percentile bound value (US95) is above the relevant UK guidance threshold value for a residential with plant uptake scenario. Benzo(a)pyrene fails the mean value test with two outliers, when the outliers are removed from the dataset Benzo(a)pyrene passes the mean value test with no statistical outliers indicating hotspots of Benzo(a)pyrene contamination in the areas of TH1 and TH2. Remediation work will be required in these areas.

4.3.2.10 The statistical analysis results for Dibenzo(ah)anthracene indicate that the upper 95th percentile bound value (US95) is above the relevant UK guidance threshold value for a residential with plant uptake scenario. Dibenzo(ah)anthracene fails the mean value test with one outlier, when the outlier is removed from the dataset Dibenzo(ah)anthracene passes with no statistical outliers indicating localised Dibenzo(ah)anthracene contamination. Contamination is note in TH1 at 0.60mbgl and TH2 at 0.40mbgl; TH1 and TH2 have been determined as hotspot areas for benzo(a)pyrene and remediation is needed, therefore Benzo(a)anthracene contamination will be dealt with during this process

4.3.2.11 The statistical analysis results for Indeno(123cd)pyrene indicate that the upper 95th percentile bound value (US95) is above the relevant UK guidance threshold value for a residential with plant uptake scenario. Indeno(123cd)pyrene fails the mean value test with one outlier, when the outlier is removed from the dataset Indeno(123cd)pyrene passes with no statistical outliers indicating localised Indeno(123cd)pyrene contamination. Contamination is note in TH1 at 0.60mbgl; TH1 has been determined as a hotspot area for benzo(a)pyrene and remediation is needed, therefore Indeno(123cd)pyrene contamination will be dealt with during this process.

4.3.2.12 To accommodate the proposed development, the levels of contaminant on site require reduction. As the contaminant hotspots of benzo(a)pyrene have been identified in the region of TH1 and TH2 it is proposed that the entire area south east of the water main be included for remediation. This will also ensure that all elevated PAH levels recorded will be removed. The proposed remedial works is for a 600mm removal and replacement capping layer in all garden/landscaped areas to the south east of the site beyond the waste sewer; Levels on site are varied and may or may not have to be revised to ensure a 600mm capping layer is achieved.

4.3.3 Asbestos

No Asbestos was identified in any samples taken.

4.4 Leachates

4.4.1 The results of all the chemical contamination testing for leachable concentrations are summarised in Appendix E, leachate analysis was performed on three samples of MADE GROUND recovered; TH2 at 0.4mbgl, TH3 at 0.6mbgl, WS1at 0.5mbgl, WS2 at 0.5mbgl and WS3 at 0.5mbgl.

4.4.2 The concentrations of the leachate samples are assessed against the UK Drinking Water standards (UKDWS) for the purpose of the Principal Aquifer and the Environmental Quality Standards (EQS) for the purpose of the nearest surface water feature which is noted 23m north east of the site, this is not named, but appears to be Chipping Brook.

UK DRINKING WATER STANDARDS

4.4.3 The concentrations of leachate samples for metals, TPHs and PAHs are all below the UK Drinking Water Standards (UK DWS), with the exception Benzo(a)pyrene.

The UK DWS for Benzo(a)pyrene is 0.01µg/l, elevated levels were noted in TH3 at a depth of 0.60m with a value of <0.9µg/l, WS3 at a depth of 0.50m with a value of <0.9µg/l, however this is due to laboratory detection limits.

ENVIRONMENTAL QUALITY STANDARDS

4.4.4 The Environmental Quality Standard (EQS) for Lead is 4 to 250µg/l; the Lead value for WS1 at 0.50m is recorded at 8.57µg/l and WS2 at 0.50m is recorded at 5.11. These values fall within the EQS range for Lead.

The Environmental Quality Standard (EQS) for Copper is 1 to 28µg/l; all Copper values are noted to fall within the EQS range, these include the highest recorded value of 6.77µg/l noted in WS1 at 0.50m.

The Environmental Quality Standard (EQS) for Sulphide is 0.25µg/l; all values are noted to be above the EQS for Sulphide however this is due to laboratory detection limits, with the exception of WS1 at 0.5m that recorded a level of 20µg/l.

The Environmental Quality Standard (EQS) for Benzo(a)pyrene is 0.03µg/l; three values are noted below the EQS for Benzo(a)pyrene and two values are noted above the EQS assessment value however this is again due to laboratory detection limits.

4.4.5 Dilution, dispersion and attenuation of any leached contaminants will occur in the unsaturated zone, i.e. the volume of ground below the contaminant source but above the groundwater surface (the unsaturated zone), reducing any impact on ground waters.

4.5 Groundwater

4.5.1 Groundwater was not recorded in any of the exploratory holes during site investigation works and all monitoring wells have been noted as dry during all gas / groundwater monitoring visits.

4.6 Hazard Evaluation: Soil Gas

4.6.1 Gas monitoring wells were installed in there of the window samples on the site. A full copy of all gas monitoring readings and water levels can be found in Appendix D.

Table 4.3: Gas monitoring results

Window Sample	Visit No	1 20.12.12					
WS1	Methane %	0.0					
	CO_2 %	2.1					
	O_2 %	20.1					
	Atmospheric Pressure	998					
	Flow Rate	0.0					
WS2	Methane %	0.0					
	CO_2 %	1.4					
	O_2 %	20.4					
	Atmospheric Pressure	998					
	Flow Rate	0.1					
WS3	Methane %	0.0					
	CO_2 %	1.0					
	O_2 %	21.0					
	Atmospheric Pressure	998					
	Flow Rate	0.1					

Note: Atmospheric Pressure – (R) Rising, (S) Steady, (F) Falling.

4.6.2 The principal components of landfill gas are methane (CH_4) and carbon dioxide (CO_2) pose a risk to both health and safety if it enters a building. These two gases are also associated with coal strata, river silt, sewage and peat.

4.6.3 Methane is a flammable, asphyxiating gas, and a flammable range being 5 to 15% by volume in air. If such a methane/air mixture is confined in some way and then ignited it will explode. The 5% volume concentration is known as the lower explosive limit.

4.6.4 Carbon dioxide is a non-flammable toxic gas with a long-term exposure limit of 0.5% and a short-term exposure limit of 1.5% by volume.

4.6.5 Assessing gas-contaminated land is difficult for a variety of reasons:

1 Concentrations can vary significantly with time in permeable strata.
2 Methane presents an explosive risk, which is difficult to quantify.
3 Background concentrations of these gases in the ground are not zero and they can be found in high concentrations in innocuous environments.

4.6.6 With many of the natural sources of methane and carbon dioxide, the rate of production of gas is low and so is the quantity of gas. In some cases if the gas becomes trapped, e.g. by an overlying material with low permeability, then when first tapped the rate of emissions may be high, but subsequent emissions will be very much lower because the reservoir is not replenished.

4.6.7 Using CIRIA C665 – Assessing risks posed by hazardous ground gases to buildings the NHBC Traffic light system for the site is Green however ground gas monitoring is on-going.

4.6.8 The site is to be developed as new housing and the soil gas investigation has identified a maximum methane concentration of 0.1 per cent methane and a worst case flow rate of 0.1l/hr. The GSV will be calculated as:

Limiting volume flow rate of gas = gas concentration x measured borehole flow rate
= 0.001 x 0.1 (gas concentration in table is %)
= 0.0001

4.6.9 The GSV classifies the site as Green for Methane.

4.6.10 The site is to be developed as new housing and the soil gas investigation has identified a maximum carbon dioxide concentration of 2.1 per cent and a worst case flow rate of 0.1l/hr. The GSV will be calculated as:

Limiting volume flow rate of gas = gas concentration x measured borehole flow rate
= 0.021 x 0.1 (gas concentration in table is %)
= 0.0021

4.6.11 The GSV classifies the site as Green for Carbon Dioxide; however ground gas monitoring is still on-going.

4.6.12 Although the site is currently classed as Green, ground gas monitoring is still on-going and a final assessment will be made upon completion of the final gas monitoring results.

5 Risk Assessment

5.1 Introduction

5.1.1 In order to design a risk management strategy; it is necessary to identify any unacceptable risks. The method used to evaluate any risk from contamination is based upon CIRIA C552 "Contaminated Land Risk Assessment – A Guide to Good Practise". This method of risk evaluation detailed in Appendix G, is a qualitative method and involves the classification of the:

- Magnitude of the potential consequence (severity) of risk occurring.
- Magnitude of the probability (likelihood) of the risk occurring.

5.1.2 The following qualitative risk assessment has been developed to consider the plausible exposure scenarios, in conjunction with the results of laboratory analysis. Each exposure scenario has been assigned a risk classification that is based upon the CIRIA guidance indicated above.

5.1.3 The following groups of receptors have been identified for the site:

- Humans, i.e. current site users, construction / maintenance workers involved in redevelopment and future site users (general public / residents);
- Controlled ground and surface waters
- Vegetation
- Ecosystems (through Environmental Quality Standards)
- Materials used in building and infrastructure development.

Table 5.1 Qualitative Risk Assessment Summary (Page 1 of 5)

Receptor	Contaminant	Pathway	Consequence	Probability	Risk Classification	Comments
Humans (Construction /Maintenance Workers)	Shallow soil toxic 'contamination' Metals, TPH, BTEX and PAH's	Direct Contact Dermal Contact Ingestion Inhalation	Existing Condition: Medium Redeveloped Condition: None Identified	Existing Condition: Likely Redeveloped Condition: None Identified	Existing Condition: Moderate Redeveloped Condition: None Identified	Benzo(a)pyrene results reveal an upper confidence limit that is greater that the critical concentration value for Atkins Atrisk 1%. If the results at TH1 and TH2 are removed as outliers then the values fall into acceptable levels. Therefore the areas of TH1 and TH2 are hotspots for Benzo(a)pyrene and remediation will be required. Hot spot contamination of Benzo(a)pyrene has been noted in TH1 at 0.6m and TH2 at 0.4m. Localised remediation will therefore be required in this contamination hotspot in order to break all source pathway receptor linkages. The proposed remediation covers the area south east of the current water main running through the site. Other toxic contamination hot spots may exist at the site that could be encountered during the site redevelopment ground works; therefore there is some potential for a pollution linkage occurring. The risks can be adequately controlled by good working practices, particularly hygiene and personal protective equipment. Operatives should use suitable PPE and follow guidance in health and safety guidance note HSG66 "Protection of workers and the general public during the development of contaminated land".
	Superficial Groundwater contamination – contaminated groundwater could be in contact with a construction worker	Inhalation Ingestion Dermal Contact	Existing Condition: Medium Redeveloped Condition: None Identified	Existing Condition: Low Likelihood Redeveloped Condition: None Identified	Existing Condition: Low Risk Redeveloped Condition: None Identified	Groundwater was not recorded in any of the exploratory holes during site investigation works and all monitoring wells have been noted as dry during all gas / groundwater monitoring visits.

Table 5.1 Qualitative Risk Assessment Summary (Page 2 of 5)

Receptor	Contaminant	Pathway	Consequence	Probability	Risk Classification	Comments
Humans (End Users)	Shallow soil toxic 'contamination' Metals, TPH, BTEX and PAH's	Direct Contact Dermal Contact Ingestion Inhalation	Existing Condition: Medium Redeveloped Condition: None Identified	Existing Condition: Likely Redeveloped Condition: None Identified	Existing Condition: Moderate Redeveloped Condition: None Identified	As the contaminant hotspots of benzo(a)pyrene have been identified in the region of TH1 and TH2 it is proposed that the entire area south east of the water main be included for remediation. This will also ensure that all PAH elevated levels recorded will be covered. 600mm removal and replacement capping layer is advised in all garden/landscaped areas to the south east of the site beyond the waste sewer; Levels on site are varied and may or may not have to be revised to ensure a 600mm capping layer is achieved.
	Soil Gas	Inhalation Combustion	Existing Condition: Medium Redeveloped Condition: None Identified	Existing Condition: Low Likelihood Redeveloped Condition: None Identified	Existing Condition: Moderate Redeveloped Condition: None Identified	Using CIRIA C665 – Although the site is currently classed as Green, ground gas monitoring is still on-going and a final assessment will be made upon completion of the final gas monitoring results.

Table 5.1 Qualitative Risk Assessment Summary (Page 3 of 5)

Receptor	Contaminant	Pathway	Consequence	Probability	Risk Classification	Comments
Wider Environment (Adjacent Property and Land Users)	Shallow soil toxic 'contamination' as Metals, TPH, BTEX and PAH's	Migration via wind-blown dust	Existing Condition: Minor Redeveloped Condition: None identified	Existing Condition: Low Likelihood Redeveloped Condition: None identified	Existing Condition: Very Low Risk Redeveloped Condition: None identified	Although the risk is very low, soil contamination as wind-blown dust could theoretically impact on adjacent sites in particular during redevelopment earth works in dry periods. This very low risk can be adequately controlled by using dust control methods (damping). Dust control is also likely to be required to stop dust nuisance.
	Superficial Groundwater contamination Causing Contaminated groundwater	Inhalation Ingestion Dermal Contact	Existing Condition: Medium Redeveloped Condition: None Identified	Existing Condition: Low Likelihood Redeveloped Condition: None Identified	Existing Condition: Low Risk Redeveloped Condition: None Identified	**UK Drinking Water Standards** – The concentrations of leachate samples for metals, TPHs and PAHs are all below the UK Drinking Water Standards (UK DWS), with the exception Benzo(a)pyrene. The UK DWS for Benzo(a)pyrene is 0.01µg/l, elevated levels were noted in TH3 at a depth of 0.60m with a value of <0.9µg/l, WS3 at a depth of 0.50m with a value of <0.9µg/l, however this is due to laboratory detection limits. **Environmental Quality Standards** – The Environmental Quality Standard (EQS) for Lead is 4 to 250µg/l; the Lead value for WS1 at 0.50m is recorded at 8.57µg/l and WS2 at 0.50m is recorded at 5.11. These values fall within the EQS range for Lead.The Environmental Quality Standard (EQS) for Copper is 1 to 28µg/l; all Copper values are noted to fall within the EQS range, these include the highest recorded value of 6.77µg/l noted in WS1 at 0.50m. The Environmental Quality Standard (EQS) for Sulphide is 0.25µg/l; all values are noted to be above the EQS for Sulphide however this is due to laboratory detection limits, with the exception of WS1 at 0.5m that recorded a level of 20µg/l.The Environmental Quality Standard (EQS) for Benzo(a)pyrene is 0.03µg/l; three values are noted below the EQS for Benzo(a)pyrene and two values are noted above the EQS assessment value however this is again due to laboratory detection limits.. Dilution, dispersion and attenuation of any leached contaminants will occur in the unsaturated zone, i.e. the volume of ground below the contaminant source but above the groundwater surface (the unsaturated zone), reducing any impact on groundwaters. In the site's existing condition, leaching of contaminants may occur from contamination hot spots but dilution, dispersion and attenuation will occur in the unsaturated zone, lessening the effect.

Table 5.1 Qualitative Risk Assessment Summary (Page 4 of 5)

Receptor	Contaminant	Pathway	Consequence	Probability	Risk Classification	Comments
Vegetation	Shallow soil toxic 'contamination' as Metals, TPH, BTEX and PAH's	Plant uptake	Existing Condition: Minor Redeveloped Condition: None identified	Existing Condition: Low Likelihood Redevelope d Condition: None identified	Existing Condition: Very Low Risk Redeveloped Condition: None identified	No areas of inhibited plant growth due to direct contact of plants with soils have been identified at the site. The proposed development is for houses, to accommodate the proposed development; the levels on site require reduction. The proposed remedial works is for a 600mm removal and replacement capping layer is advised in all garden/landscaped areas to the south east of the waste sewer
Building Materials	Sulphide in shallow soils	Direct contact (attack on plastic drinking water pipe work)	Existing Condition: Minor Redeveloped Condition: None identified	Existing Condition: Low Likelihood Redevelope d Condition: None identified	Existing Condition: Very Low Risk Redeveloped Condition: None identified	It is recommended for concrete a Design Sulphate Class DS-1, with the ACEC classification of AC-1s to be used for the Made Ground.

Table 5.1: Qualitative Risk Assessment Summary (Page 5 of 5)

Receptor	Contaminant	Pathway	Consequence	Probability	Risk Classification	Comments
Controlled Waters - Groundwaters (Unclassified Shallow Groundwaters)	Shallow soil toxic 'contamination' as Metals, TPH, BTEX and PAH's	Infiltration & percolation of precipitation leaching contaminants from the Made Ground	Existing Condition: Medium Redeveloped Condition: None Identified	Existing Condition: Low Likelihood Redeveloped Condition: None Identified	Existing Condition: Low Risk Redeveloped Condition: None Identified	**UK Drinking Water Standards** – The concentrations of leachate samples for metals, TPHs and PAHs are all below the UK Drinking Water Standards (UK DWS), with the exception Benzo(a)pyrene. The UK DWS for Benzo(a)pyrene is 0.01µg/l, elevated levels were noted in TH3 at a depth of 0.60m with a value of <0.9µg/l, WS3 at a depth of 0.50m with a value of <0.9µg/l, however this is due to laboratory detection limits.. **Environmental Quality Standards** – The Environmental Quality Standard (EQS) for Lead is 4 to 250µg/l; the Lead value for WS1 at 0.50m is recorded at 8.57µg/l and WS2 at 0.50m is recorded at 5.11. These values fall within the EQS range for Lead. The Environmental Quality Standard (EQS) for Copper is 1 to 28µg/l; all Copper values are noted to fall within the EQS range, these include the highest recorded value of 6.77µg/l noted in WS1 at 0.50m. The Environmental Quality Standard (EQS) for Sulphide is 0.25µg/l; all values are noted to be above the EQS for Sulphide however this is due to laboratory detection limits, with the exception of WS1 at 0.5m that recorded a level of 20µg/l.The Environmental Quality Standard (EQS) for Benzo(a)pyrene is 0.03µg/l; three values are noted below the EQS for Benzo(a)pyrene and two values are noted above the EQS assessment value however this is again due to laboratory detection limits.. Dilution, dispersion and attenuation of any leached contaminants will occur in the unsaturated zone, i.e. the volume of ground below the contaminant source but above the groundwater surface (the unsaturated zone), reducing any impact on ground waters. In the site's existing condition, leaching of contaminants may occur from contamination hot spots but dilution, dispersion and attenuation will occur in the unsaturated zone, lessening the effect.

	Dispersion of leachates to surface water courses	Dispersion from Groundwater to Surface Water	Existing & Redeveloped Conditions: Mild	Existing & Redeveloped Conditions: Unlikely	Existing & Conditions: Very Low Risk	In the site's existing condition, leaching of contaminants may occur from contamination hot spots but dilution, dispersion and attenuation will occur in the unsaturated zone, lessening the effect.

6 Conclusion and Recommendations

6.1 Potential Remedial Options

6.1.1 General

Approval of the recommendations given below should be sought from the appropriate regulatory authorities prior to commencement of site redevelopment.

6.1.1.2 The risk assessment has identified potential source – pathway – receptor linkages present once the site is developed. To remove these pollutant linkages the source, pathway or receptor must be removed or broken. Table 6.1 below identifies the pollutant linkages, and mitigation measures.

Table 6.1: Summary of Pollution Linkages and Remediation Proposals

Source	Pathway	Receptor	Mitigation Measures
Contaminants found in soil: • Metals • PAH	• Inhalation • Ingestion • Dermal contact	• Human Health • Aquifer	• As the contaminant hotspots of Benzo(a)pyrene have been identified in the region of TH1 and TH2 it is proposed that the entire area south east of the water main be included for remediation. This will also ensure that all PAH elevated levels recorded will be covered. • 600mm removal and replacement capping layer is advised in all garden/landscaped areas to the south east of the site beyond the waste sewer; Levels on site are varied and may or may not have to be revised to ensure a 600mm capping layer is achieved.
Ground gas	• Inhalation	• End users • Buildings	• Using CIRIA C665 – Although the site is currently classed as Green, ground gas monitoring is still on-going and a final assessment will be made upon completion of the final gas monitoring results.

6.1.1.3 To break the pollutant linkages for Benzo(a)pyrene remediation is required in the contamination hotspots to the south east of the water main running across the site.
The proposed development is for houses, to accommodate the proposed development; the levels on site require reduction. The proposed remedial works is for a 600mm removal and replacement capping layer is advised in all garden/landscaped areas to the south east of the waste sewer. Not only will this break all source pathway receptor linkages it will make the site levels suitable for the build.

6.1.1.4 Within all landscape/garden areas, 150mm of growing medium for plants and grass is required as part of the capping layer.

6.1.1.5 The specification criteria for water supply pipe selection include measures to prevent contamination of water from contaminants in soil. We would therefore recommend a copy of this report to be sent to United Utilities for their guidance.
Please note the testing suite carried out for this site is for human health purposes and may not cover the suite of contaminants required by United Utilities for pipe selection, therefore further testing may be required.

6.1.1.6 Approved remediation works should be carried out in full on site under a quality assurance scheme to demonstrate compliance with the proposed methodology and best practice guidance. If during the works contamination is encountered which has not previously been identified then the additional contamination will need to be fully assessed

6.1.2 Gas
Using CIRIA C665 – Although the site is currently classed as Green, ground gas monitoring is still on-going and a final assessment will be made upon completion of the final gas monitoring results.

6.1.3 Waste Classification
No hazardous waste has been noted on site. Therefore no material will need to be removed from site as hazardous waste.

6.1.4 Validation
Validation will be required to determine that the site is suitable for the proposed end use as houses:

- Ensuring material in contamination hotspot areas has been removed to a minimum of 600mm below the new proposed finished ground floor level and replaced with a 600mm cover system
- Ensure the imported material is suitable for use.

6.2 Remedial Strategies

6.2.1 Redevelopment of this site will almost certainly be subject to planning conditions relating to remediation and validation. Sutcliffe have prepared this document in accordance with the proposed development plans enclosed in Appendix B. A detailed remediation / validation strategy will also be completed in due course and will contain details of the removal of material from site to reduce site levels, details of the placement of a 600mm cover system, details of the remediation of the 'hotspot' area and details of the supervision of the works by a suitably qualified consultant which will include detailed records of testing requirements, etc.

6.2.2 Validation of the remediated site in the form of a detailed Completion Statement will also be completed to confirm that the works set out in this document are agreed and completed and that the site is suitable for its intended use.

6.3 Health and Safety Issues

6.3.1 Contractors' personnel engaged in ground works should, as a matter of course, be counselled in good practice with particular regard to the avoidance of dust inhalation and skin contact with soils. Smoking or eating on the immediate worksite should be avoided and the importance of washing after contact with soils or plant operating on the site should be given due consideration.

6.3.2 Furthermore, for protection of workers and the general public, contractors would need to adopt effective dust suppression measures including, *inter alia*, water spraying in dry weather conditions and sheeting of lorries transporting site soils.

6.3.3 If during earthworks operatives discover any further adverse ground conditions and suspect it to be contaminated then they must contact the relevant parties immediately to report it. Sutcliffe Investigations should be employed with a watching brief with respect to earthworks conducted on site.

6.3.4 A full health and safety plan should be prepared before commencement of works on site. Operatives should use suitable PPE and follow guidance in health and safety guidance note HSG66 "Protection of workers and the general public during the development of contaminated land".

6.4 Protection of Controlled Waters

UK Drinking Water Standards

6.4.1 The concentrations of leachate samples for metals, TPHs and PAHs are all below the UK Drinking Water Standards (UK DWS), with the exception Benzo(a)pyrene.

The UK DWS for Benzo(a)pyrene is 0.01µg/l, elevated levels were noted in TH3 at a depth of 0.60m with a value of <0.9µg/l, WS3 at a depth of 0.50m with a value of <0.9µg/l, however this is due to laboratory detection limits.

Environmental Quality Standards

6.4.2 The Environmental Quality Standard (EQS) for Lead is 4 to 250µg/l; the Lead value for WS1 at 0.50m is recorded at 8.57µg/l and WS2 at 0.50m is recorded at 5.11. These values fall within the EQS range for Lead.

The Environmental Quality Standard (EQS) for Copper is 1 to 28µg/l; all Copper values are noted to fall within the EQS range, these include the highest recorded value of 6.77µg/l noted in WS1 at 0.50m.

The Environmental Quality Standard (EQS) for Sulphide is 0.25µg/l; all values are noted to be above the EQS for Sulphide however this is due to laboratory detection limits, with the exception of WS1 at 0.5m that recorded a level of 20µg/l.

The Environmental Quality Standard (EQS) for Benzo(a)pyrene is 0.03µg/l; three values are noted below the EQS for Benzo(a)pyrene and two values are noted above the EQS assessment value however this is again due to laboratory detection limits..

Dilution, dispersion and attenuation of any leached contaminants will occur in the unsaturated zone, i.e. the volume of ground below the contaminant source but above the groundwater surface (the unsaturated zone), reducing any impact on groundwaters. In the site's existing condition, leaching of contaminants may occur from contamination hot spots but dilution, dispersion and attenuation will occur in the unsaturated zone, lessening the effect.

Dilution, dispersion and attenuation of any leached contaminants will occur in the unsaturated zone, i.e. the volume of ground below the contaminant source but above the groundwater surface (the unsaturated zone), reducing any impact on groundwaters.

6.5 Foundations

6.5.1 It is understood that consideration is being given to the development of houses and apartments on site.

6.5.2 Based upon the water main running directly through the site and the depth of made ground encountered and the fall to the rear of the site it is not recommended that a traditional mass fill foundation be utilised on site as this could damage the existing water main and be unstable and un-economical. Sutcliffe Investigations therefore propose CFA piles to be employed; CFA piles will limit vibration to the water main.

6.5.3 Groundwater was not recorded in any of the exploratory holes during site investigation works and all monitoring wells have been noted as dry during all gas / groundwater monitoring visits.

6.5.4 Excavations within the natural ground were stable.

6.5.5 Sub-surface concrete that is only in contact with Made Ground can be Design Sulphate Class DS-1, with an ACEC Classification of AC-1s.

6.6 Ground Floor Construction

6.6.1 Due to the amount of MADE GROUND on site in excess of 2.4m in areas, it is not proposed to employ a ground bearing slab, therefore a suspended P.C unit ground floor should be adopted. With a gas membrane and incorporated in any piling until the full ground gas monitoring is complete.

6.7 Diversion

6.7.1 Services are noted on site and diversions will not be possible.

6.8 Recommended Consultations

6.8.1 There are drainage and services at the edge of the site, that may be suitable for re-use. Sutcliffe would recommend a full drainage survey be undertaken.

6.8.2 At the time of writing, the classification of materials removed from the site for waste disposal purposes must be negotiated with the receiving waste management facility. All removal will be included in the remediation / validation report.

6.9 Further Monitoring / Investigation and Management Measures

6.9.1 The following risk reduction / management measures are recommended in order to reduce the identified risks from contamination to an acceptable level:

- Construction workers involved in the redevelopment of the site and future maintenance workers should follow good working practices with regard to contamination, including a site induction, practicing high standards of hygiene and the use of personal protective equipment (PPE).
- The provision of surface water drainage in the redevelopment to prevent infiltration and potential leaching of contaminants into the groundwater. It is likely that this will be part of the planned development anyway.
- Damping-down of earth works in the redevelopment should be undertaken during dry periods when there is the potential for dust blow from the site.
- If deeper foundations are required as part of the development, i.e. below the groundwater level, the Sulphate and Chloride content of the groundwater should also be considered.

- Surplus Made Ground material will need to be disposed of under conditions regulated by the Waste Management Licensing Regulations 1994.

6.9.2 If requested, Sutcliffe Investigations can act as the agent of our client in seeking approval of the Local Authority Contaminated Land Officer and statutory consultees as appropriate. Sutcliffe Investigations can also be employed to provide remediation validation works, and signing-off of works.

6.9.3 The comments given in this report and the opinions expressed assume that the ground conditions do not vary beyond the range revealed by this investigation. There may be, however, conditions within the site, which have not been disclosed by this investigation and consequently have not been considered in this report. Accordingly, a careful watch should be maintained during any future groundwork, and the recommendations of this report reviewed as necessary.

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It should be noted that Sutcliffe Investigations have used reasonable skill, care and diligence in the design of the investigation of this site. The inherent infinite variation of ground conditions allows only definition of the actual conditions at the location and depth of exploratory holes, while those at intermediate locations can only be inferred. This site has not been checked for Japanese Knotweed or other detrimental plants.

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Appendix A – General Notes

Generic Notes – Sutcliffe Investigations

Environmental Setting

General

Third party information obtained from the British Geological Survey (BGS), the Coal Authority, the Local Authority etc is presented in the Correspondence Appendix of the Geoenvironmental Report.

Geology, Mining & Quarrying

In order to establish the geological setting of a site, Sutcliffe Investigations refer to BGS maps for the area and the relevant geological memoir.

A coal mining report is obtained from the Coal Authority. Further information is sourced from the Local Authority and by reference to current and historical OS plans.

Landfills

Sutcliffe Investigations obtain data from the Landmark Information Group, the Environment Agency and the Local Authority with respect to known areas of landfilling within 250m of the proposed development site. Reference is also made to historical OS plans, which are inspected for evidence of backfilled quarries, railway cuttings, colliery spoil tips etc.

Radon

Radon is a colourless, odourless gas, which is radioactive. It is formed in strata that contain uranium and radium (most notably granite) and can move through fissures eventually discharging to atmosphere, or the spaces under and within buildings. Where radon occurs in high concentrations, it can pose a risk to health.

In order to assess potential risks associated with radon gas, Sutcliffe Investigations refer to BRE Report BR211, 1999: *"Radon: guidance on protective measures for new dwellings"*.

BR211 provides a preliminary indication of the measures required for a particular site, but it is also often necessary to request a Stage 2 Protective Measures Site Report from the BGS.

The level of protection needed is site-specific and is determined by reference to the radon potential map for the area followed by a geological assessment of the site. This information is contained in the Annexes of BR211.

Annex A – derived from statistical analysis of radon measurements in existing houses carried out by the NRPB and grouped on 5km grid.

Annex B – based on an assessment of the same radon measurements grouped by geological units. The maps show the 5km grid squares underlain completely or in part, by geological units which potentially exceed the action levels for radon protective measures. The grid squares are coded according to highest potential within the square. In many cases the actual geological radon potential varies considerably within a grid square.

Sutcliffe Investigations adopt the following procedure when assessing risk associated with radon.

Firstly, Annex A maps are reviewed to see whether the site requires full, basic or no measures. If the site is in a dark brown square, full radon protection measures are required. If the site is in a light brown square, reference should be made to Annex B.

Secondly, Annex B maps are reviewed to see whether a further geological assessment is required which may result in upgrading the result from Annex A. If a site lies within a shaded square, it may require radon protection and Sutcliffe Investigations request a Stage 2 Protective Measures Site Report from the BGS.

If the site is in a square that is not coloured or shaded in either set of maps then no radon protection is needed and therefore a BGS Report is not normally necessary.

The BGS geological assessment involves checking whether the site is on or close to a geological unit that has statistically been found to have elevated radon potential. The geological assessment is based on either 1:50,000 or the 1:250,000 scale data. The search area specified as part of the request is increased by 50m in areas where 1:50,000 data is available and by 500m in areas with 1:250,000 scale data to allow for potential inaccuracies in the position of boundaries. The BGS report indicates the highest level of protection required within the search area and its buffer zone.

When requesting a BGS report, Sutcliffe Projects select the search radius carefully, since too large a search radius may result in the inclusion of areas underlain by geological units of a higher radon potential, thereby giving rise to recommending too high a level of protection.

The report also includes (where available), a list of the geological units included in the assessment. Sutcliffe Investigations check that these actually underlie the site, rather than the buffer zone only.

On the basis of radon measurements in dwellings and on their geological interpretation, the BGS report stipulates the level of protective measures required for the proposed development site, and this could be:

1. no measures
2. basic measures or
3. full measures

Details of these measures are provided in the Hazardous Gas section of this Geoenvironmental Report.

Hydrogeology

Sutcliffe Investigations obtain information from the Environment Agency (EA) and the Landmark Information Group with respect to:

- groundwater quality
- recorded pollution incidents
- licensed groundwater abstractions

Reference is also made to the EA document "Policy and Practice for the Protection of Groundwater" (1998) and the relevant Groundwater Vulnerability Map.

Bedrock and any overlying granular Drift deposits are classified by the EA.

Major aquifers: "*Highly permeable formations, usually with a known or probable presence of significant fracturing. They may be highly productive and able to support large abstractions for public water supply and other purposes*".

Minor aquifers: "*Fractured or potentially fractured rocks which do not have a high primary permeability, or other formations or variable permeability. Although these acquifers will seldom produce large quantities of water for abstractions, they are important both for local supplies and in supplying base flow to rivers*".

Non-aquifers: "*Formations which are generally regarded as containing insignificant quantities of groundwater. However groundwater flow through such rocks, although imperceptible, does take place and needs to be considered in assessing the risk associated with persistent pollutants. Some non-acquifers can yield water in sufficient quantities for domestic use*".

Groundwater vulnerability is determined by 4 variables:

1. The presence and nature of overlying soil (the weathered zone affected by living organisms; soil in the UK can extend up to 2m in depth). Physical properties of the soil affect the downward passage of water and its ability to attenuate pollutants. The EA make reference to a three-fold classification of soil types:-

   - Soils of **low** leaching potential are defined as "*soils in which the pollutants are unlikely to penetrate the soil layer because either water movement is largely horizontal, or they have the ability to attenuate diffuse pollutants*".

   - Soils of **intermediate** leaching potential are defined as "*soils which have a moderate ability to attenuate diffuse source pollutants or in which it is possible that some non-absorbed diffuse source pollutants and liquid discharges could penetrate the soil layer*".

   - Soils of high leaching potential are defined as "*soils with little ability to attenuate diffuse source pollutants and in which non-absorbed diffuse source pollutants and liquid discharges have the potential to move rapidly to underlying strata or to shallow groundwater*".

   In urban areas and restored mineral workings the soil information is based on fewer observations than elsewhere. A worst-case vulnerability (H) is therefore assumed for these areas and for current mineral workings by the EA. All are given a designation of **HU** unless proved otherwise.

2. The presence and nature of Drift, which often overlies bedrock. Where Drift is of substantial thickness and low permeability, it can provide an effective barrier to surface pollutant migration. Permeability Drift is classified as a Minor Aquifer except where it is in probable hydraulic continuity with a Major Aquifer, where it is regarded as part of the Major Aquifer unless proven otherwise by site investigation.

3. The nature of the geological strata (bedrock). Rocks that contain groundwater in exploitable quantities are called aquifers.

4. The depth of the unsaturated zone; i.e. that part of the aquifer which lies above the water table.

The EA have also designated Source Protection Zones, which are based on proximity to a groundwater source (springs, wells and abstraction boreholes). The size of a Source Protection Zone may vary from tens to several thousand hectares.

Hydrology

Sutcliffes obtain information from the Environment Agency and the Landmark Information Group with respect to:

- Surface water quality
- Recorded pollution incidents
- Licensed abstractions (groundwater & surface waters)
- Licensed discharge consents
- Site susceptibility to flooding

The EA have set **water quality** targets for all rivers. These targets are known as River Quality Objectives (RQOs). The water quality scheme used to set RQO planning targets is known as the River Ecosystem scheme. The scheme comprises five classes (RE1 to RE5) which reflect the chemical quality requirements of communities of plants and animals occurring in our rivers.

General Quality Assessment (GQA) grades reflect actual water quality. They are based on the most recent analytical testing undertaken by the EA. There are six GQA grades (denoted A to F) defined by the concentrations of biochemical oxygen demand, total ammonia and dissolved oxygen.

The susceptibility of a site to **flooding** is assessed by reference to a Flood Map on the Environment Agency's website. These maps provides show natural floodplains – areas potentially at risk of flooding it a river rises above its banks or high tides and stormy seas cause flooding in coastal areas.

There are different kinds of area shown on the Flood Map:

1. Dark blue areas could be flooded by the sea by a flood that has a 0.5% (1 in 200) or greater chance of happening each year, or by a river by a flood that has a 1% (1 in 200) or greater chance of happening each year.

2. Light blue areas show the additional extend of an extreme flood from rivers or the sea. These outlying areas are likely to be affected by a major flood, with up to a 0.1% (1 in 1000) chance or occurring each year.

These two colours show the extent of the natural floodplain if there were no flood defences or certain other manmade structures and channel improvements.

The maps also show all flood defences built in the last five years to protect against river floods with a 1% (1 in 100) chance of happening each year, or floods from the sea with a 0.5% (1 in 200) chance of happening each year, together with some, but not all, older defences and defences which protect against smaller floods.

The Agency's assessment of the likelihood of flooding from rivers and the sea at any location is based on the presence and effect of all flood defences, predicted flood levels and ground levels.

It should also be noted that as the floodplain shown is the 1 in 100 year (or 1 in 200 year as appropriate) areas outsic this may be flooded by more extreme floods (e.g. the 1 in 1000 year flood). Also, parts of the areas shown at risk of flooding will be flooded by lesser floods (e.g. the 1 in 5 year flood). In some places due to the shape of the river valley the smaller floods will flood a very similar extent to larger floods but to a lesser depth.

If a site falls within a floodplain, it is recommended that a flood survey be undertaken by a specialist consultant who can advise on appropriate mitigating measures; i.e. raising slab levels, provision of storage etc.

COMAH & Explosive Sites

Sutcliffe Investigations obtain information from the Landmark Information Group with respect to COMAH or explosive sites within 1km of the proposed development site. Sutcliffe Investigations' report refers to any that are present and recommends that the Client seeks further advice from the HSE.

Areas around COMAH sites (chemical plants etc) are zoned with respect to the implementation of emergency plans. The HSE are a statutory consultee to the local planning authority for all COMAH sites. The COMAH site may have to revise its emergency action plan if development occurs. This might be quite straightforward or could entail significant expenditure. Consequently, the COMAH site may object to a proposed development (although it is the Local Authority who have final say and they are likely to place more weight on advice from the HSE).

Preliminary Conceptual Ground Model

The site's environmental setting (and proposed end use) is used by Sutcliffe Investigations to assess the significance of any contamination encountered during the subsequent ground investigation.

Generic Notes – Sutcliffes Geoenvironmental Investigations

2. Ground Investigation Fieldwork

General

Sutcliffe Ground Investigations are undertaken in accordance with current UK guidance including:

- BS5930:1999 "*Code of practice for site investigation*"
- BS10175:2001 "Code of practice for the identification of potentially contaminated sites"
- Contaminated Land Reports 1 to 6, most notably CLR Report No. 4 "*Sampling strategies for contaminated land*"
- "*Guidance on the protection soil sampling strategies for land contamination*" – EA R&D Technical report P5-066/TR (2001)
- AGS: 1996 "*Guide to the selection of Geotechnical Soil Laboratory Testing*"

Exploratory hole logs are represented in Appendices to this Geoenvironmental Report. These logs include details of the:

- Investigation technique adopted
- Samples taken
- Descriptions of the solid strata and any groundwater encountered
- Results of any insitu testing
- Any gas/groundwater monitoring well installed

Exploratory Hole Locations

Exploratory hole locations are selected by Sutcliffe Investigations, prior to commencement of fieldwork, to provide a representative view of the strata beneath the site and to target potential contaminant sources identified during the preliminary investigation (desk study). Additional exploratory locations are often determined by the site engineer in light of the ground conditions actually encountered; this enables better delineation of the depth and lateral extent of organic contamination, poor ground, relict structures etc.

Investigation Techniques

Ground conditions can be investigated by a number of techniques; the procedures used are in general accordance with BS5930: 1999 and BS1377: 1990. Techniques most commonly used by Sutcliffe Investigations include:

- Machine excavated trial pits, usually equipped with a backactor and a 0.6m wide bucket
- Cable percussive (Shell & Auger) boreholes, typically using 150mm diameter tools and casing
- Window or windowless sampling boreholes. Constraints associated with existing buildings, operations and underground service runs can render some sites partly or wholly inaccessible to a mechanical excavator. In such circumstances, window sampling is often the most appropriate technique. A window sampling drilling rig can be manoeuvred in areas of restricted access and results in minimal disturbance of the ground (a 150mm diameter tarmac/concrete core can be lifted and put to one side). However, it should be noted that window sampling allows only a limited inspection of the ground (especially made ground with a significant proportion of coarse material).
- Rotary percussive open-hole probeholes are typically drilled using a tricone rock roller bit with air as the flushing medium. Probeholes are generally lined through made ground with temporary steel casing to prevent hole collapse.

Where installed, gas/groundwater monitoring wells typically comprise a lower slotted section, surrounded by a filter pack of 10mm non-calcareous gravel and an upper plain section surrounded in part by a bentonite seal and in part by gravel or arisings. The top of the plain pipe is cut off below ground level and the monitoring well protected by a square, stopcock type manhole cover set in concrete, or the plain pipe is cut off just above ground level and the well protected by 100mm diameter steel borehole helmet set in concrete.

Monitoring well details, including the location of the response zone and bentonite seal are presented on the relevant exploratory hole logs.

Insitu Testing

Where relative densities of granular materials given on the trial pit and window sample logs are based on visual inspection only, they do not relate to any specific bearing capacities. However, wherever possible, Sutcliffe Investigations employ a mackintosh probe to assess relative density. Mackintosh probe results can be related to approximate allowable bearing capacities.

The relative densities of granular materials encountered in cable percussive boreholes are based on Standard Penetration Test (SPT) results. SPTs are carried out boreholes, in accordance with BS 1377 1990, Part 9 Section 3.3. Where full penetration (600mm) is not possible, N values are calculated by linear extrapolation and are shown on the logs as N* = x.

The strength of cohesive deposits is determined using a hand shear vane.

Shear strength test results reported on trial pit logs are considered to be more reliable than those reported on window sample logs. Significant sample disturbance occurs during window sampling and consequently shear strength results on disturbed window samples are generally lower than results obtained during trial pitting, in-situ or in large excavated blocks.

Sampling

Representative soil/fill samples are taken at regular intervals from the exploratory holes to assist in description of the ground and to allow selected laboratory testing to be performed. The type of sample taken is dependent on the nature of the stratum and the purpose of the analysis.

Where the soils encountered contain a significant proportion of coarse grained material, truly representative samples are not typically obtained – only the finer fraction is placed in sample containers. However, a visual estimate of the amount of coarse material is made on site.

NB: Coarse constituents not sampled are defined as: coarse gravel, cobble and boulder (i.e. any 'particles' with an average diameter greater than 20mm).

Occasionally, unrepresentative 'spot' samples are also taken from some exploratory locations for contaminant analysis, typically where unusual, localised pockets of materials are encountered.

Samples of soil for chemical testing are placed into 1 litre plastic tubs prior to delivery to the selected laboratory. Samples of water are taken in one litre brown glass bottles and stored in cool boxes, at a temperature of approximately 4°C, until delivery to the selected laboratory. Soil/fill samples for organic analysis are also stored in cool boxes.

Groundwater

Where encountered during fieldwork, groundwater is recorded on exploratory hole logs. If monitoring wells are installed, groundwater levels are also recorded on one or more occasions after completion of the fieldwork.

It should be borne in mind that the rapid excavation rates used during a ground investigation may not allow the establishment of equilibrium water levels. Water levels are likely to fluctuate with season/rainfall and could be substantially higher at wetter times of the year than those found during this investigation.

Long term monitoring of standpipes of piezometers is always recommended if water levels are likely to have a significant effect on earthworks or foundation design.

Description of Strata

The soils encountered during an Sutcliffes ground investigation are described (logged) in general accordance with BS 5930. The descriptions and depth of strata encountered are presented on the exploratory hole logs and summarised in the Ground Conditions section within the main body of text.

The materials encountered in the trial pits are logged, samples taken and tests performed on the in-situ materials in the excavation faces, to depths of up to 1.2m; below this depth these operations are conducted at the surface on disturbed samples recovered from the excavation.

Key to Exploratory Hole Logs

Keys to logs are presented in the Appendix(ces) containing the logs. These are two keys – Symbols and Legends and Terms and Definitions.

Health and Safety

All work was carried out in accordance with the procedures detailed in the DGEL Health and Safety Manuel and SUKD health and Safety Procedures.

Generic Notes – Sutcliffes Geoenvironmental Investigations

3. Geotechnical Laboratory Tests

General

Soil Samples are delivered to the laboratory for testing along with a schedule of testing drawn up by Sutcliffe Investigations. All tests are carried out in accordance with BS 1377:1990.

The test results are presented as received in an Appendix to this Geoenvironmental Report.

The following laboratory testing are routinely carried out on a selection of samples:

- Atterberg limits & moisture contents
- Soluble sulphate & pH

The additional tests are typically only scheduled where significant earthworks regrade is anticipated:

- Grading
- Compaction tests
- Particle density

Attenberg Limits & Moisture Content

The Liquid and Plastic Limits of samples of natural in-situ clay are determined using the cone penetrometer method and the rolling thread test. These tests enable determination of an average Plasticity Index (PI) for each "type" of clay, although judgement is applied where variable results are reported.

PI can be related to shrinkability (low, medium or high) and then to minimum founding depth. Sutcliffe Investigations typically only consider a soil to be shrinkable if the proportion finer than 63μm is > 35%.

PI results are compared against guidance given in the NHBC Standards, Chapter 4.2 (revised April 2003) which advocates the use of modified Plasticity Index (I'p) defined as:

I'p = Ip * (% < 425μm/100)

ie if PI is 30%, but the soil contains 80% < 425μm, then I'p = 30 * 80/100 = 24%

It should be noted that in accordance with the requirements of BS 1377, the % passing the 425μm sieve is routinely reported by testing labs.

Sutcliffe Investigations apply engineering judgement where PI results are spread over a range of classifications. Consideration is given to:

- The average values for each particular soil type (ie differentiate between residual soil and alluvium)
- The number of results in each class and
- The actual values

Unless the judgement strongly indicates otherwise, Sutcliffe Investigations typically adopt a conservative approach and recommend assumption of the higher classification.

Soluble Sulphate and pH

Sulphates in soil and groundwater are the chemical agents most likely to attack sub-surface concrete, resulting in expansion and softening of the concrete to a mush. Another common cause of concrete deterioration is groundwater acidity.

The rate of chemical attack depends on the concentration of aggressive ions and their replenishment at the reaction surface. The rate of replenishment is related to the presence and mobility of groundwater.

Sutcliffe Investigations refer to BRE Special Digest 1 (SD1) "Concrete in aggressive ground. Part 1: Assessing the aggressive chemical environment" (2001). SD 1 provides definitions of:

- The nature of the site (Greenfield, brownfield or pyretic)
- The groundwater regime (static, mobile or highly mobile)
- The Design Sulphate Class (DC Class) and
- The Aggressive Chemical Environment for Concrete (ACEC Class)

Sutcliffe reports clearly state each of the above for the site being considered.

The concentrations of sulphate in aqueous soil/fill extracts are determined in the laboratory using the gravimetric method. The results are expressed in terms of SO_4 for direct comparison with BS 5328:1997. The pH value of each sample was determined by the electrometric method.

SD1 also discusses determination of "representative" sulphate concentration from a number of tests. Essentially if <10 samples of a given soil-type have been tested, the highest measured sulphate concentration should be taken. If >10 samples have been tested, the mean of the highest 20% of the sulphate test can be taken. With respect to groundwater, the highest sulphate concentration should always be taken.

With respect to pH (soil & groundwater) the value used is the lowest value if <10 samples have been tested and the mean of the lowest 20% if >10 samples have been tested.

Generic Notes – Sutcliffe Investigations Geoenvironmental Investigations

4. Contamination Laboratory Analysis & Interpretation (including WAC)

General

An assessment of potential contaminants associated with the former usages of the site is undertaken with reference to CLR 8 "*Potential contaminants for the assessment of land*" and the relevant DETR Industry Profile(s).

Common Inorganic Contaminants

These include:

- Metals, most notably cadmium, copper, chromium, mercury, lead, nickel and zinc
- Semi-metals, most notably arsenic, selenium and (water soluble) boron
- Non-metals, most notably sulphur
- Inorganic anions, most notably cyanides (free & complex), sulphates, sulphides and nitrates

With respect to the terminology used by most analytical laboratories:

Total cyanide = Free cyanide + Complex cyanide

Total cyanide (CN) is determined by acid extraction; whereas free cyanide is the water soluble fraction.

Complex cyanide is "bound" in compounds and is hard to breakdown. Laboratory determination of complex CN involves subjecting the sample to uv digestion for determination of both free and total CN.

Thiocyanate (SCN) is a different species combined with sulphur.

Elemental sulphur (S) and free sulphur are the same. Total sulphur is all forms, including that present in sulphates (SO_4) sulphates etc.

There are 2 forms of chromium (Cr), chromium VI and chromium III. Chromium VI is the more toxic of these. In soils, total chromium is determined by a strong aqua regia acid digestion. Chromium VI is an empirical method based on a water extract test.

Common Organic Contaminants

Petroleum hydrocarbons are a mixture of hydrocarbons produced from the distillation of crude oil. They include aliphatics (alkanes, alkenes and cycloalkanes), aromatics (single or multi benzene ringed compounds) a[r] hydrocarbon-like compounds containing minor amounts of oxygen, sulphur or nitrogen.

Petroleum hydrocarbons can be grouped based on the carbon number range:-

GRO – Gasoline Range Organics (typically C_6 to C_{10}). Also referred to as PRO – Petroleum Range Organics
DRO – Diesel Range Organics (typically C_{10} to C_{28})
LRO – Lubricating Oil Range Organics (typically C_{28} to C_{40})
MRO – Mineral Oil Range Organics (typically C_{18} to C_{44})

However, it should be borne in mind that the terms "GRO" and "DRO" analysis are purely descriptive terms, the exact definition of which varies.

Total Petroleum Hydrocarbons (TPH) is also a poorly defined term; some testing laboratories regard TPH as hydrocarbons ranging from $C_5 – C_{40}$, whereas other define TPH as $C_{10} – C_{30}$.

The composition of a TPH plume migrating through the ground can vary significantly; this is primarily dictated by the nature of the source (eg petrol, diesel, engine oil etc). Furthermore, different hydrocarbons are affected differently by weathering processes and this can result in further variation in the chemical composition of the TPH.

Gasoline contains light aliphatic hydrocarbons rapidly (especially within the C4 to C5 range) that will evaporate. The aromatic hydrocarbons in gasoline are primarily benzene, toluene, ethylbenzene and xylenes, referred to as BTEX. Small amounts of polyaromatic hydrocarbons (PAHs) such as benzo(a)pyrene may also be present.

Diesel and light fuel oils have higher molecular weights than gasoline. Consequently, they are less volatile and less water soluble. About 25 to 35% is composed of aromatic hydrocarbons. BTEX concentrations are generally low.

Heavy Fuel Oils are typically dark in colour and considerably more viscous than water. They contain 15 to 40% aromatic hydrocarbons. Polar NSO compounds are also present.

Lubricating Oils are relatively viscous and insoluble in groundwater. They may contain 10 to 30% aromatics, including the heavier PAHs. NSO compounds are also common.

Polycyclic Aromatic Hydrocarbons (PAHs) have more than two fused benzene rings as a structural characteristic. PAH compounds are present in both petrol and diesel, although insignificantly lower concentrations than in coal tars. Certain PAH compounds are carcinogenic (Benzo(a)pyrene) and/or mobile in the environment (naphthalene).

Polychlorinated Biphenyls (PCBs)

Volatile Organic Compounds (VOCs) The volatile organic compound (VOC) headspace concentration of all soil samples was made with a photoionization detector (PID) fitted with a 10.2 eV lamp. This gives a semi-quantitative VOC concentration record as parts per million (ppm) (Vol/Vol). Prior to the VOC headspace reading, the background levels of VOCs were recorded. The PID was recalibrated with standard isobutylene in zero air after every 10 headspace readings.

Semi-Volatile Organic Compounds (sVOCs)

Phenols

Solvents, pesticides, herbicides

Dioxins & furans

Methods of Analysis (Organic Compounds)

Toluene Extractable Matter (TEM) results provide a screening test for organic contamination. The sample is air dried a 30°C and ground prior to addition of the solvent (toluene). The solvent extraction is aggressive and most organic compounds (fuels, oils, tars, humic material, animal fats and vegetable oil) are dissolved, as are some other inorganic contaminants such as sulphur. However, the volatiles (lighter fuel fraction etc) are lost during evaporation of the solvent.

Total Petroleum Hydrocarbon (TPH) by IR (also known as mineral oil by some testing laboratories) is undertaken on "as received" samples. Tetrachloroethylene is the solvent, and fluoroscil is used to removed humic material, animal fats and vegetable oil. Consequently this analysis detects a wide range of "mineral" organics from volatiles (BTEX and gasoline) through diesel and oils to tars (including the very heavy, stable tars such as asphalt and bitumen).

TPH by GC-FID is more refined analytical technique which only detects hydrocarbons (aliphatic and aromatic) in the range C_{10} to C_{40} (volatiles, heavy tars, humic material and sulphur are not detected). The laboratory can provide a breakdown of the TPH results into diesel range organics (**DRO**) and heavier lubricating oil range organics (**LRO**).

GRO (PRO) by GC-FID analysis detects the more volatile C_6 – C_9 hydrocarbons (aliphatic and aromatic) including those organic compounds present in petrol.

Speciated VOC (by GC-MS) analysis quantifies the concentrations of 30 USA-EPA priority compounds. These include chlorinated alkanes and alkenes (in the molecular weight range chloroethane to tetrachloroethane); trimethlybenzenes; and the 4 BTEX compounds (benzene, ethyl-benzene, toluene & xylene).

Speciated sVOC by (GC-MS) analysis quantifies the concentration of a variety of organic compounds, including the 16 USA-EPA priority PAHs, phenols, 7 USA EPA priority PCB congeners, herbicides & pesticides.

Note: PAHs are hydrocarbons and consequently (where present) will be picked up when scheduling TPH by GC-FID. Napthalene (the lightest PAH) is also one of the 58 US EPA VOCs.

Speciated TPH by GC-FID provides a "banded "TPH", initially split into aromatic and aliphatic fractions and then further divided into fraction specific carbon bandings based upon behavioural characteristics.

Note: Risk assessment models require physiochemical properties (solubilities, toxicitities etc) of compounds in order to model their behaviour in the environment. These physiochermical properties cannot be derived from a single "TPH", "GRO" or "DRO" value. However, the carbon banded fractions can be used in risk assessment models.

If the relative proportion of each carbon banding within the "TPH" impact at a site is known, the risks posed by each individual fraction can be assessed and a simple back calculation applied to calculate an overall "TPH" screening value based upon the percentage weight fraction of each banding present in the "TPH". Specialised analytical techniques and data interpretation skills are required to identify each carbon banding.

Current Guidance

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

Sutcliffe Investigations adopt a tiered approach to risk assessment, consistent with UK guidance and best practice. The initial step of such a risk assessment (or Tier 1) is the comparison of site data with appropriate guidance levels, intervention levels or remedial targets.

In March 2002 DEFRA and the Environment Agency published a series of technical research papers (R & D Publications CLR 7, 8, 9 and 10) introducing the UK approach to the assessment of risk to **human health** from land contamination. This methodology and approach represents current scientific knowledge and thinking. The overall methodology also included the Contaminated Land Exposure Model (CLEA) and some Soil Guidance Values (SGV's).

At the time of writing this report, these guidelines only address seven contaminants and the development of both the CLEA model and additional SGV's in ongoing. Where published, SGV's have been utilised as intervention values for the purpose of an initial Tier 1 assessment.

Where SGV's were not published at the time of writing this report, appropriate Tier 1 human health related assessment have been based upon information that was best available at the time of the study.

With respect to the assessment of potential **phytotoxic effects** of contaminants, Sutcliffe Investigations refer to "The Soil Code" (Maff, 1998) for copper and zinc. The CLEA SGV is adopted for nickel.

The potential risk to **building materials** is considered through reference to relevant BRE Digests, with particular emphasis on BRE Special Digest 1, 'Sulphate and Acid Resistance of Concrete in the Ground', 2001.

With respect to the interpretation of the calorific values, at present there are no accepted methods to assess whether a sample is combustible and under what circumstances it might smoulder. Some guidance is given in ICRCL Note 61/84 "Notes on the fire hazards of contaminated land" which states that:

"In general ..... it seems likely that materials whose CV's exceed 10MJ/kg are almost certainly combustible, while those with values below 2MJ/kg are unlikely to burn".

Tier 1 **groundwater** risk assessments are undertaken by comparing leachate concentrations with the appropriate water quality standard. Depending upon the specific characteristics and environmental setting of the site the appropriate standard is likely to be one of the following:

- Water Supply (Water Quality) Regulations 1989
- Environmental Quality Standards (for Freshwater)
- The Surface Waters (Abstraction for Drinking Water) Regulations

The tier 1 risk assessment of **landfill gas** is undertaken through reference to the following documents:

- Approved Document C, Building Regulations 1991
- CIRIA Report 149, "Protecting Development from Methane", 1995

Should any Tier 1 criteria be exceeded, then three potential courses of action are available. (The first is only applicable in terms of human health, but the second and third could also be applied to groundwater or landfill gas).

- Undertake further statistical following the approach set out in Appendix A of CLR 7 in order to determine whether contaminant concentrations of inorganic contaminants within soil/fill actually present a risk (only applicable to assessing the risk to human health).
- Based on a qualitative risk assessment, advocate an appropriate level of remediation to "break" the pollutant linkage – for example the removal of the contaminated materials or the provision of a clean cover.
- Carry out a more detailed quantitative risk assessment in order to determine whether contamination risks actually exist.

However, the issue of **averaging area** requires further consideration. CLR 7 is ambiguous and could be interpreted as advocating the concept of a single garden as an appropriate averaging area.

This concept has massive implications with respect to ground investigation design and cost. To comply, investigations for residential development on brownfield sites would need to recover and analyse about 6 samples from each garden; this implies exploratory locations on a very tight grid, perhaps 5m to 10m spacings, with a huge increase in the number of samples analysed (cf test schedules currently issued by most practitioners).

In any case, Sutcliffe Investigations consider the concept of a single garden as an averaging area to be inappropriate. Statistical analysis of sample results by fill type, and/or by former use in a given sub-area of the site (i.e. with reference to the Conceptual Site Model), is considered a more appropriate methodology.

Analysis by soil/fill type is appropriate for essentially immobile contaminants associated with a particular fill type, for example arsenic in colliery spoil, metals in ash & clinker, sulphate in plaster-rich demolition rubble etc.

Analysis by former use is appropriate where more mobile contaminants have entered the ground, for example diesel associated with leakage from a former fuel tank, downward migration of leachable metals through granular materials, various soluble contaminants present in a wastewater leaking into the ground via a fractured sewer etc. In these circumstances, it may be appropriate to undertake statistical analysis of sample results from a variety of different soil/fill types. However, consideration would have to be given to factors such as porosity which might influence impregnation of a mobile contaminant into the soil mass; ie contamination would be normally be more pervasive and significant in granular soils than cohesive soils.

There is a suggestion in para 4.7 of CLR 7 that the approach outlined above was intended and the Environment Agency have confirmed that an averaging area can be larger than a single garden, if:

- Contaminant concentrations are within the same statistical population as determined using the maximum value test. The sample data being representative of the averaging area and the mean concentration of the averaging area.
- "Hot spots" are treated as separate zones or averaging areas (as defined by the maximum value test).
- The sampling strategy takes into account uncertainty (spatial heterogeneity) in contaminant concentration

Waste Classification & WAC

In the context of waste soils generated by remediation and/or groundworks activities on brownfield sites, the following definitions (from the Landfill Regulations 2002) apply:

- Inert (e.g. uncontaminated 'natural soil, bricks, concrete, tiles & ceramics)
- Non-Hazardous (e.g. soil excavated from a contaminated site which contains dangerous substances, but at concentrations below prescribed thresholds).
- Hazardous (e.g. soil excavated from a contaminated site which contains dangerous substances at concentrations above prescribed thresholds).

Dangerous substances include compounds containing a variety of determinants commonly found in contaminated soils on brownfield sites, for example arsenic, lead, chromium, benzene etc.

From 16th July 2005, landfill operators will require Waste Acceptance Citeria (WAC) laboratory data, if soil is classified as **hazardous** and such waste must have been subjected to pre-treatment. However, subject to WAC testing it may be possible to classify it as stable, non-reactive hazardous waste, which can be placed within a dedicated cell within the non-hazardous landfill.

Sutcliffe Investigations typically only include WAC analysis in site investigation proposals and reports, if significant off-site disposal (of soil classified as hazardous waste) is anticipated for example where redevelopment proposals include basement construction etc.

If off-site disposal of soils classified as hazardous waste were undertaken during redevelopment, then WAC analysis should be scheduled at an early stage in the remediation programme.

However, organic compounds (BTEX, TPH, PAH etc) are the most common contaminants that result in soils being classed as hazardous. These contaminants can often be dealt with by alternative technologies (eg by bioremediation or stabilisation) and consequently retention on site is often possible.

It should be noted that **non-hazardous** soil waste can go to a non-hazardous landfill facility; no further testing (eg WAC) is required.

5. Hazardous Gas

General

Hazardous gas is considered to be any mixture of potentially explosive, toxic or asphyxiating gases, most notably methane, carbon dioxide and oxygen (deficiency).

In addition, radon, a naturally occurring radioactive gas is also considered. Further information about radon is included in Notes 1 – Environmental Setting.

Assessment of potential risks associated with hazardous gas are based on a review of data obtained from the Landmark information Group, the Environment Agency and the Local Authority and the British Geological Survey.

Reference is also made to historical OS plans, which are inspected for evidence of backfilled quarries, railway cuttings, colliery spoil tips etc.

Where landfilling has occurred within 250m of the site boundary, the Local Planning Authority may request a landfill gas investigation in accordance with the Town and Country Planning General Development Order, 1988.

Sources

Potential sources of hazardous gas are:

- Landfill sites
- Made ground, especially where significant depths are present
- Shallow mineworks associated with coal extraction
- Geological strata, including peat, organic silts, coal-bearing strata and limestone (reaction with acidic waters), granite (radon)
- Groundwater can sometimes act as a "carrier" for hazardous gas
- Leakages from pipelines or storage tanks
- Sewers, septic tanks and cess pits

Generation

Wherever biodegradable material is deposited, landfill gas (principally a mixture of methane and carbon dioxide) is likely to be generated by microbial activity. Carbon dioxide is an asphyxiant and toxic; methane is flammable and a mixture containing between 5% and 15% methane by volume in air is explosive. Landfill gas in the ground is unlikely itself to pose a significant risk, though it may damage vegetation. However, infiltration of landfill gas into confined spaces (e.g. cellars, services, etc) may give rise to considerable risk.

There is no typical figure for the length of time that landfill gas will be evolved, but at many sites significant gas generation continues for at least 15 years after the last deposit of waste.

Migration

Gas migration from a landfill site may occur in several ways. It may migrate through adjacent strata; the distance of migration being dependent on the pressure gradients, volume of gas and permeability of the strata. Where there are faults, cavities and fissures within the strata, gas may move considerable distances. Other migration pathways for gas include man-made features such as mine shafts, roadways and underground services.

Gas migration is influenced by a number of climatic factors, such as atmospheric pressure variations, water table level variations and the influence of a covering of snow or ice over the surface of the site and surrounding area.

Current Guidance

Guidance on landfill gas monitoring control at landfill sites is given two technical memoranda, Waste Management Paper Nos. 26 and 27 published by the Department of the Environment.

Waste Management Paper 27, 1991 recommends that no dwellings should be constructed within 50m of any landfill that has the capacity to produce large volumes of landfill gas. No garden should extend to within 10m of the landfilled waste. However, development closer to landfill has been permitted where a comprehensive gas risk assessment has been completed (typically based on a minimum of 6 to 12 month monitoring programme) and appropriate gas exclusion measures designed.

The current advice with regard to monitoring for landfill gas is that if the trigger value of 1% volume (20% LEL) for methane and 1.5% volume for carbon dioxide is exceeded then remedial/control measures will be required.

It should be noted that the guideline limit for carbon dioxide of 1.5% volume recommended in Waste Management paper No. 27 is the short term (10 minute) occupational exposure limit for carbon dioxide quoted by the Health and Safety Executive in their publication EH40. The long term (8 hour) occupational exposure limit for carbon dioxide is 0.5% volume.

Approved Document C to the Department of the Environment's Building Regulations 1992 requires what where there may be gaseous contamination of the ground but the level of methane is unlikely to exceed 1% by volume, the ground floor of any house or similar small building shall be constructed of suspended concrete and ventilated as described in BRE Digest Report "Construction of New Buildings on Gas Contaminated Land". The document also requires specific design measures to be taken if a level of 5% volume carbon dioxide exists or is exceeded within the ground.

Although the above guidance is still relevant it has been more recently updated within the following documen published by the Construction Industry Research and Information Association (CIRIA).

CIRIA Report 149	'Protecting Development from Methane' (1995)
CIRIA Report 150	'Methane Investigation Strategies' (1995)
CIRIA Report 151	'Interpreting Measurement of Gas in the Ground' (1995)
CIRIA Report 152	'Risk Assessment for Methane and other gases from the ground' (1995)

The above documents are intended to provide advice on how to investigate and deal with the gas contaminated ground with respect to development.

CIRIA Report 149 characterised sites based on the recorded methane/carbon dioxide concentration and emission rates recorded during a suitable gas investigation. Characteristic situation 1 is deemed to be the lowest risk scenario with the risk rating increasing up to 6. The characteristic situations are classified as follows:

Gassing regime in ground			
Methane (% by volume in air)	Carbon dioxide (% by volume in air)	Emission rate [1] (m/s)	Characteristic situation [2]
< 0.1	< 1.5	not detected	1
> 0.1 – 1	> 1.5 – 5	not detected	2
> 1 - 5	< 5	not detected	3
> 5 – 20	< 20	< 0.01	4
> 20	> 20	> 0.01 – 0.05	5
> 20	> 20	> 0.05	6

Notes:

1. Emission rate values measures as equivalent total gas flow velocity from a 50mm diameter borehole: for methods of measurement see Crowhurst and Manchester (1992).
2. Highest measures parameter used as determining factor.

CIRIA Report 151 (1995) identified that there is currently inadequate guidance on trigger concentrations for ground gases. The current emphasis on using gas concentrations for trigger values particularly in Waste Management Paper 27 and the Building Regulations, should be revised to consider gas pressures, borehole flow rates and estimated surface emission rates.

It was concluded that the most important aspect of relating the gas regime below or adjacent to a site, to the risk it poses to any development, is the surface emission rate i.e. how quickly the gas is coming out of the ground. The lower the surface emission rate the lower the risk. This is considered further in the DETR Partners in Technology Report 'Passive venting of soil gases beaneath buildings' (September 1997).

CIRIA Report 149 (1995), reference Table 28, reviewed over 100 case studies of development affeceted by gas to establish current UK practices for gas control. The report classified the gassing regimes fround within 6 Characteristic Situations. The highest measures parameter, either methane or carbon dioxide concentration and/or emission rate were used to define the Characteristic Situation for each case history site. The report then related the typical range of mitigation measures that has been adopted at each study site to the characteristic gas situation.

To achieve a more consistent design of protection measures Table 28 of CIRIA 149 was rewritten (Wilson and Card, 1999) in terms of borehole gas volume flow rate and gas concentrations, as reproduced in the table below. This was done to reflect the importance of recognising the gas surface emission rate.

Characteristic situations based on Gas Flux

Characteristic Situation	Limiting CH_4 Concentration (% v/v)	Limiting CO_2 Concentrations (% v/v)	Limiting Borehole Flow Velocity (m/s)	Limiting Borehole Gas Volume Flow (litre/hour)	
				CH_4	CO_2
1	< 0.1	< 0.1	< 0.005	< 0.035	< 0.035
2	< 1.0	< 1.5	< 0.005	< 0.35	< 0.5
3	< 5.0	< 5.0	< 0.005	< 1.75	< 1.75
4	< 20	< 20	< 0.01	< 14	< 14
5	> 20	> 20	< 0.05	< 70	< 70
6	> 20	> 20	< 0.05	> 70	> 70

s Monitoring Procedure

Sutcliffe Investigations adopt a standard gas monitoring procedure, in accordance with CIRIA guidance. This procedure involves the measurement, in the following order of:

- Atmospheric temperature, pressure and ambient oxygen concentration on site immediately prior to and on completion of monitoring.
- Gas emission rate.
- Methane, oxygen and carbon dioxide concentrations using and infra-red gas analyser.
- Standing water level using a dipmeter.

In addition, ground conditions at each sampling location are recorded together with prevailing weather conditions and any other observations such as any vandalism.

Where samples of gas are required for laboratory analysis, Gresham Tubes are used. Gas concentrations in the well are typically recorded immediately before and after retrieval of a sample.

Appendix B – Drawings

Liability shall not be taken
prior to commencing, this d
been so checked and verif

All dimensions are in millin

Do not scale.

revision	notes
A	Red line boundary amended

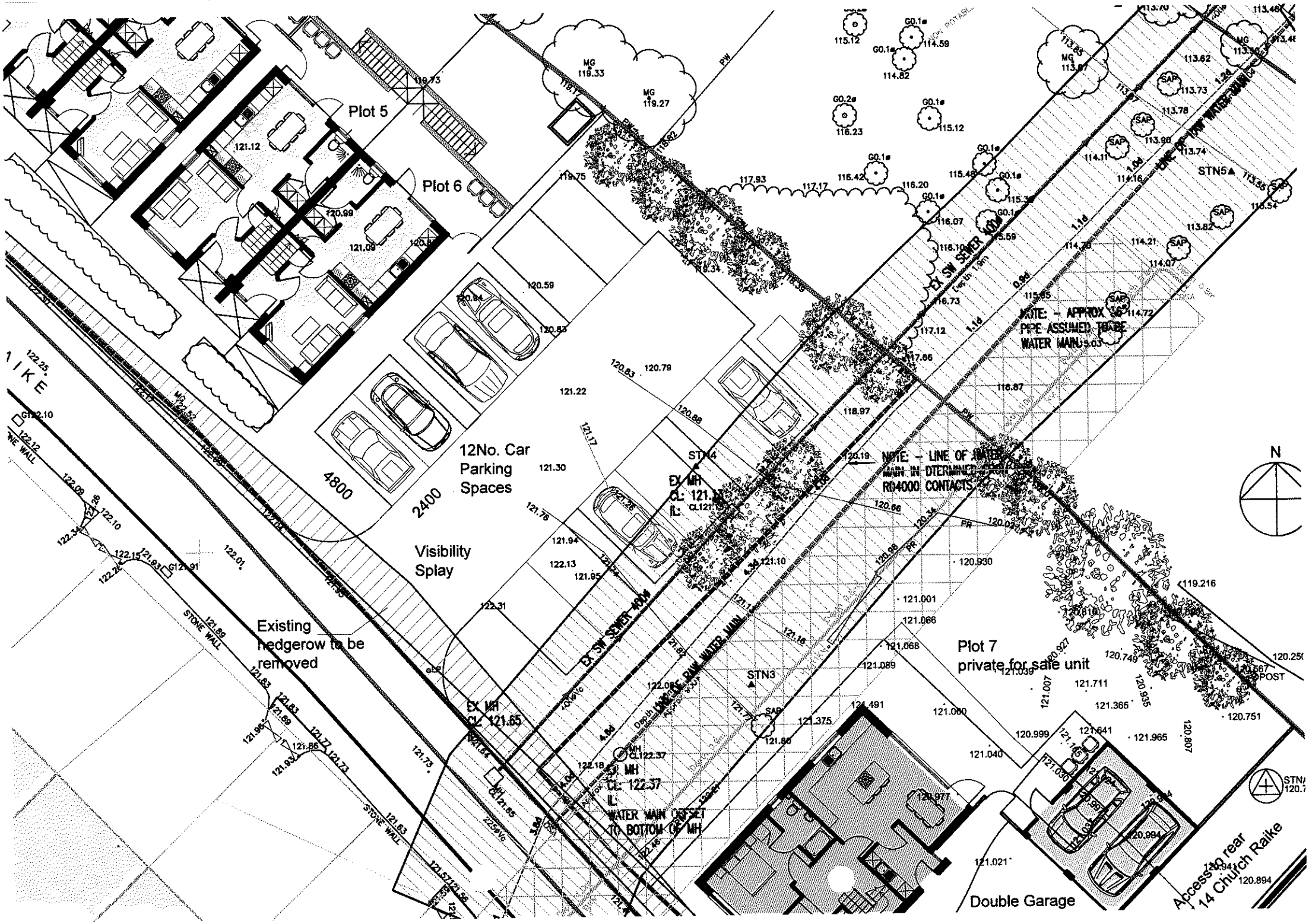
project
Proposed Residential De
Church Raike
Chipping

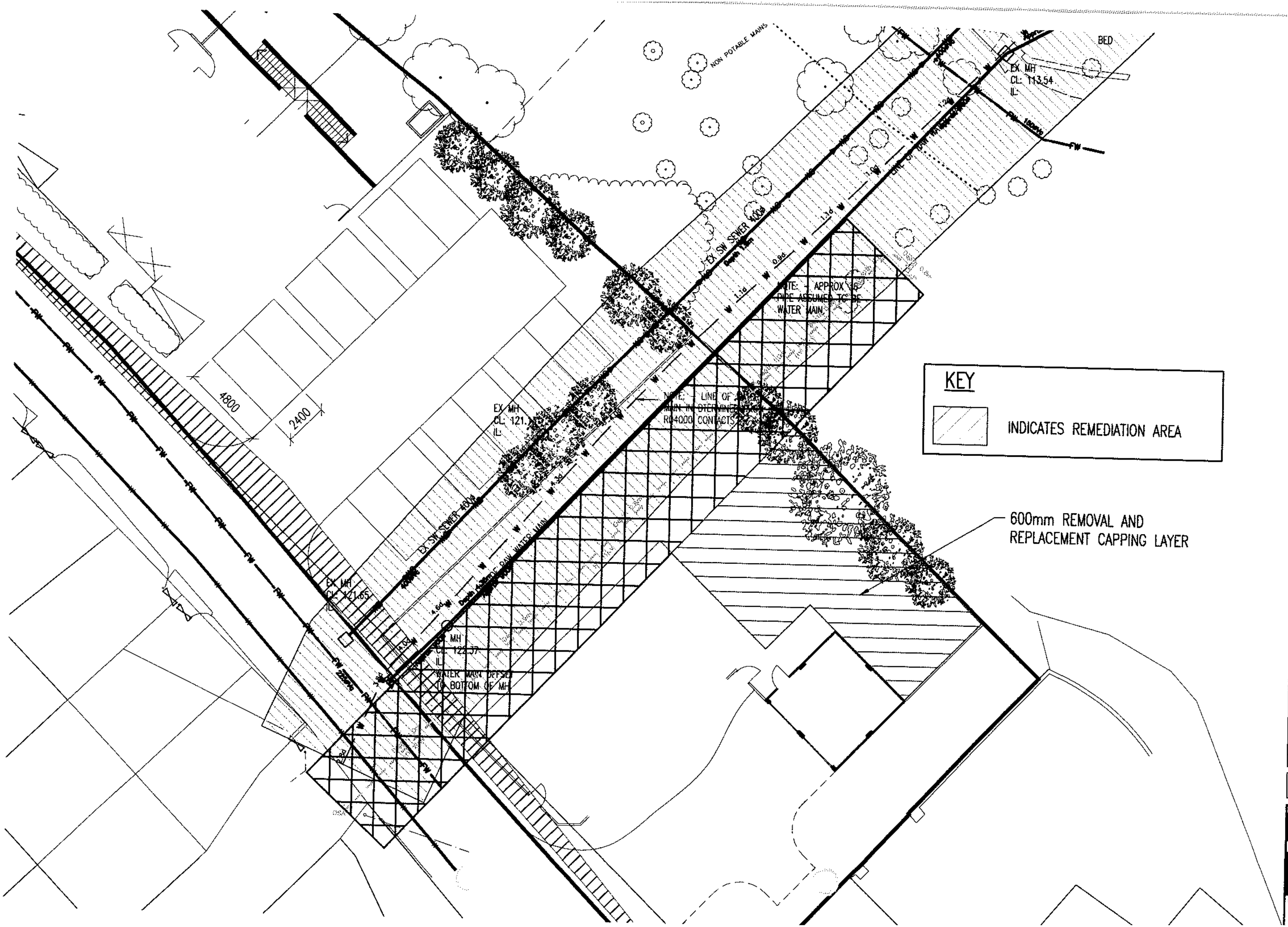
client
Liverpool Housing Trust

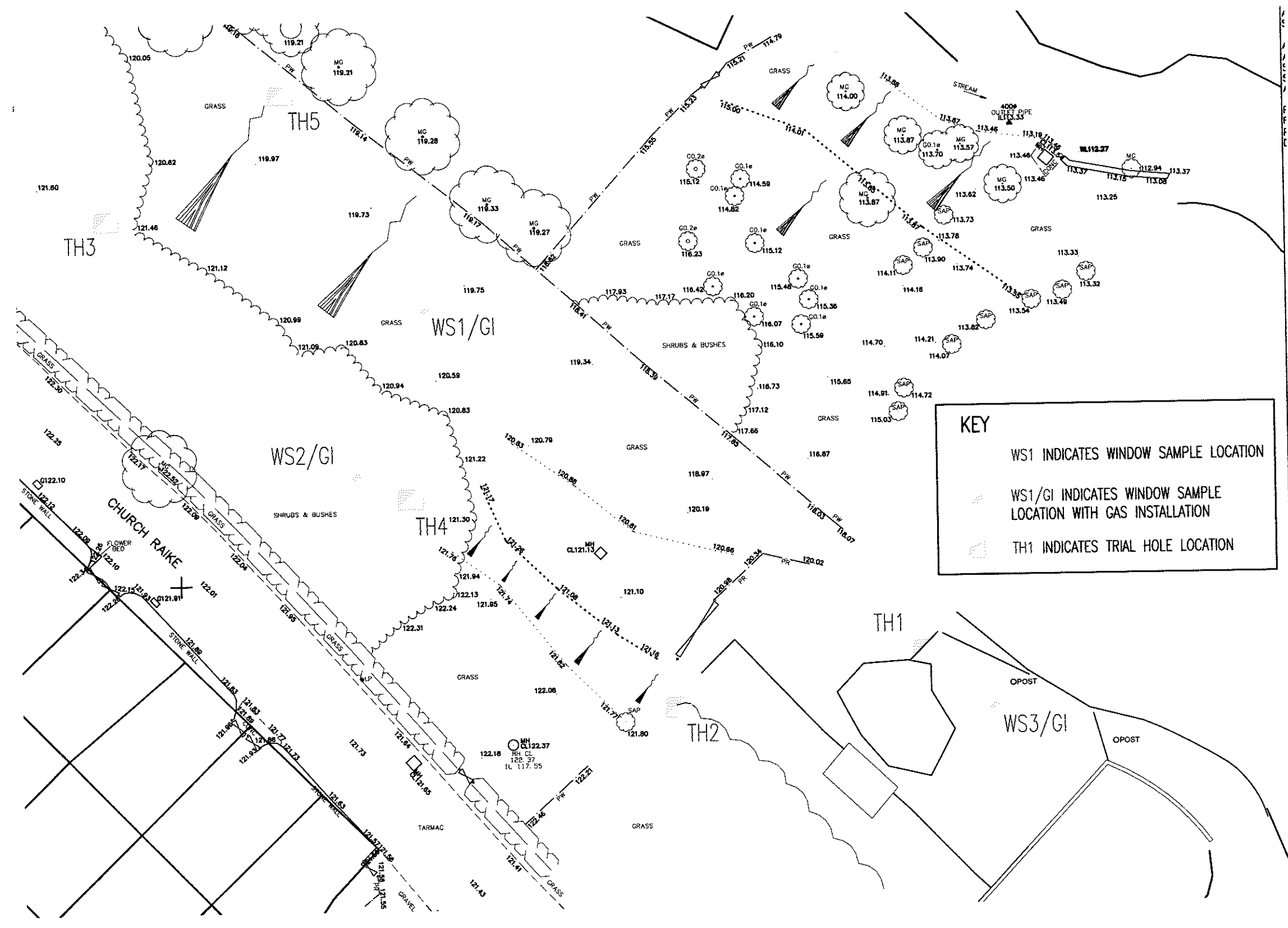
drawing title
Location Plan

status
Planning

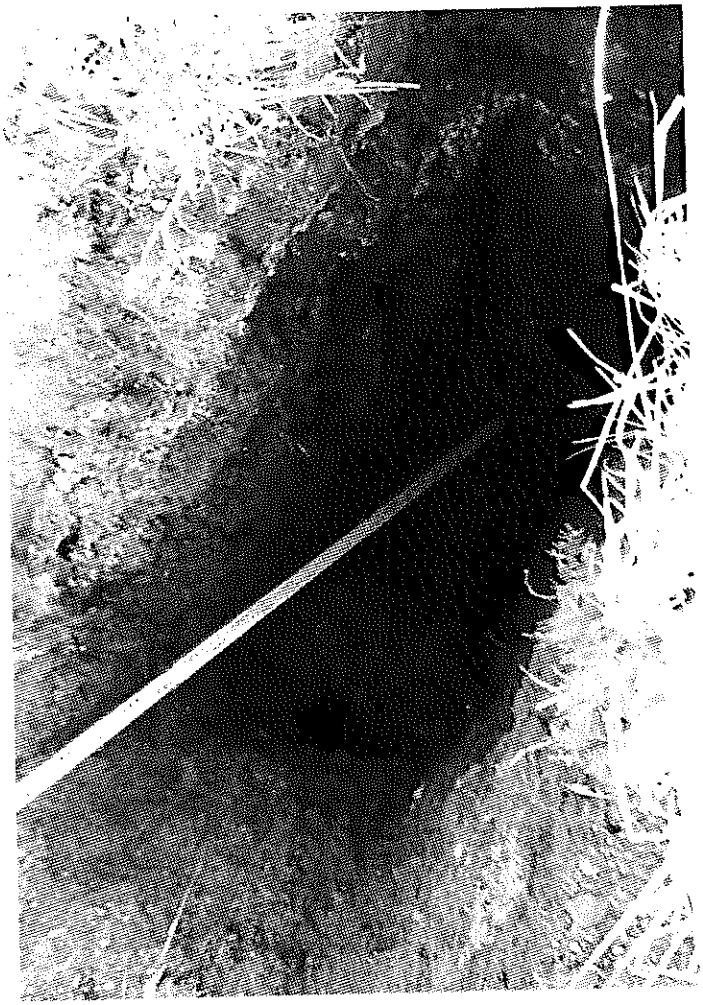
drawing no.	revision	sca
09-1441-P01	A	-

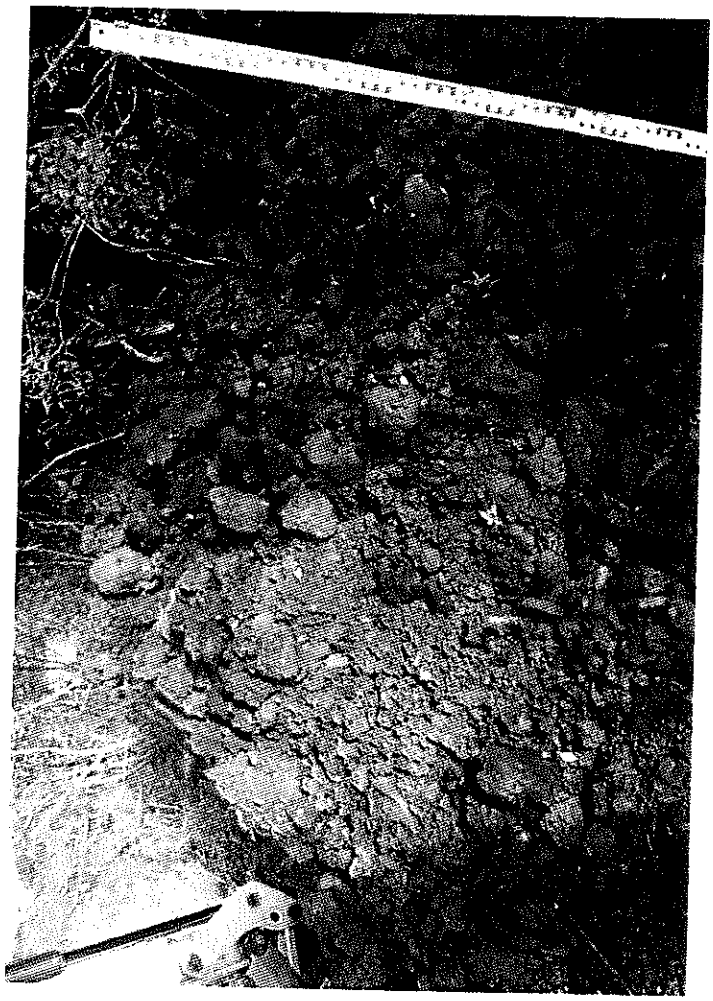

Plot 5
Plot 6
12No. Car Parking Spaces
4800
2400
Visibility Splay
Existing hedgerow to be removed
Plot 7 private for sale unit
Double Garage
Access to rear 14 Church Raike
EX SW SEWER 400ø
EX WATER MAIN
NOTE: - APPROX 16.0 PIPE ASSUMED TO BE WATER MAIN
NOTE: - LINE OF WATER MAIN IN DTERMINED RD4000 CONTACTS
EX MH CL: 121.65
EX MH CL: 122.37 IL: WATER MAIN OFFSET TO BOTTOM OF MH
STN3
STN4
STN5
STONE WALL
N

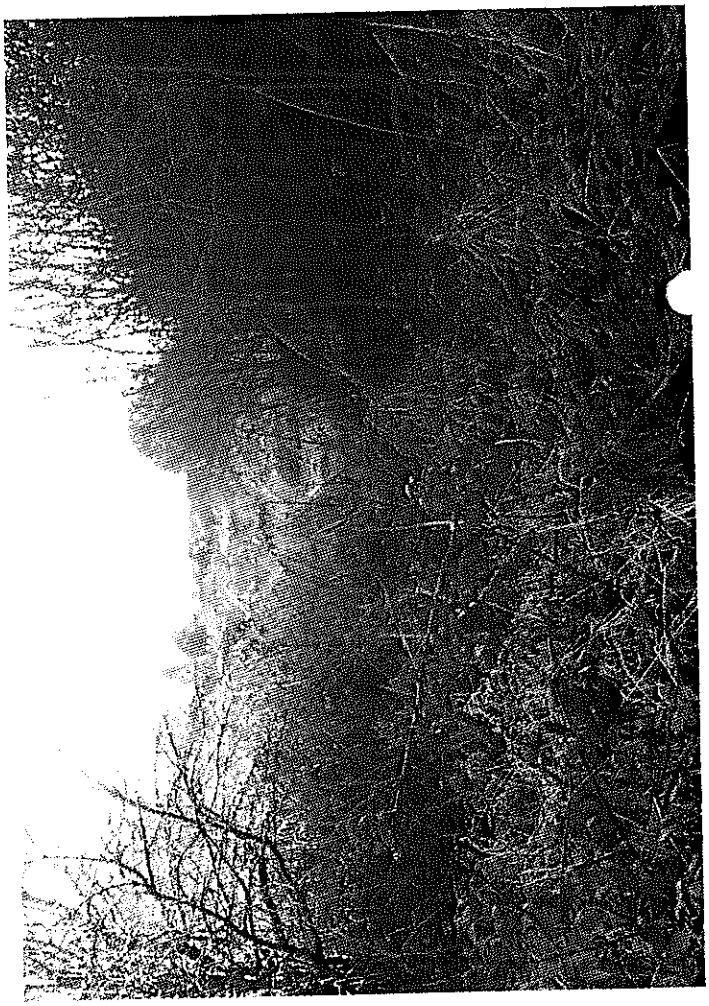

KEY
INDICATES REMEDIATION AREA
600mm REMOVAL AND REPLACEMENT CAPPING LAYER
EX SW SEWER 400Ø
EX MH
CL: 121.65
IL:
EX MH
CL: 121.
IL:
EX MH
CL: 113.54
IL:
WATER MAIN OFFSET TO BOTTOM OF MH
NOTE: - APPROX 36 PIPE ASSUMED TO BE WATER MAIN
4800
2400
NON POTABLE MAINS
BED

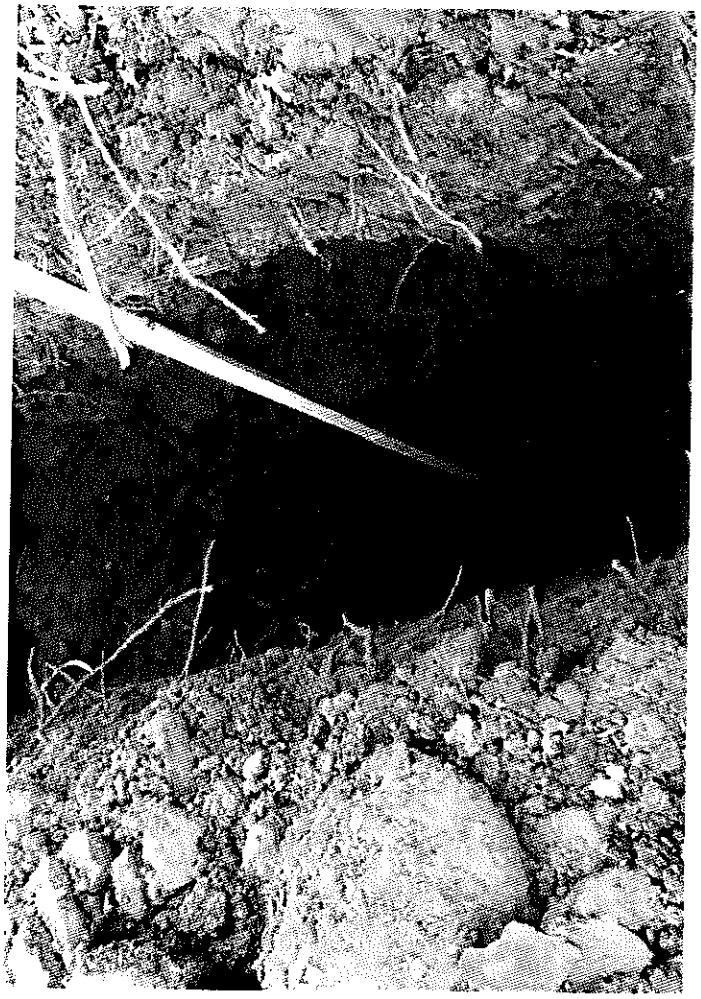

TH1
TH2
TH3
TH4
TH5
WS1/GI
WS2/GI
WS3/GI
KEY
WS1 INDICATES WINDOW SAMPLE LOCATION
WS1/GI INDICATES WINDOW SAMPLE LOCATION WITH GAS INSTALLATION
TH1 INDICATES TRIAL HOLE LOCATION
CHURCH RAIKE
GRASS
SHRUBS & BUSHES
TARMAC
GRAVEL
STONE WALL
FLOWER BED
STREAM
OUTLET PIPE
OPOST
SAP
MH
PW
PR

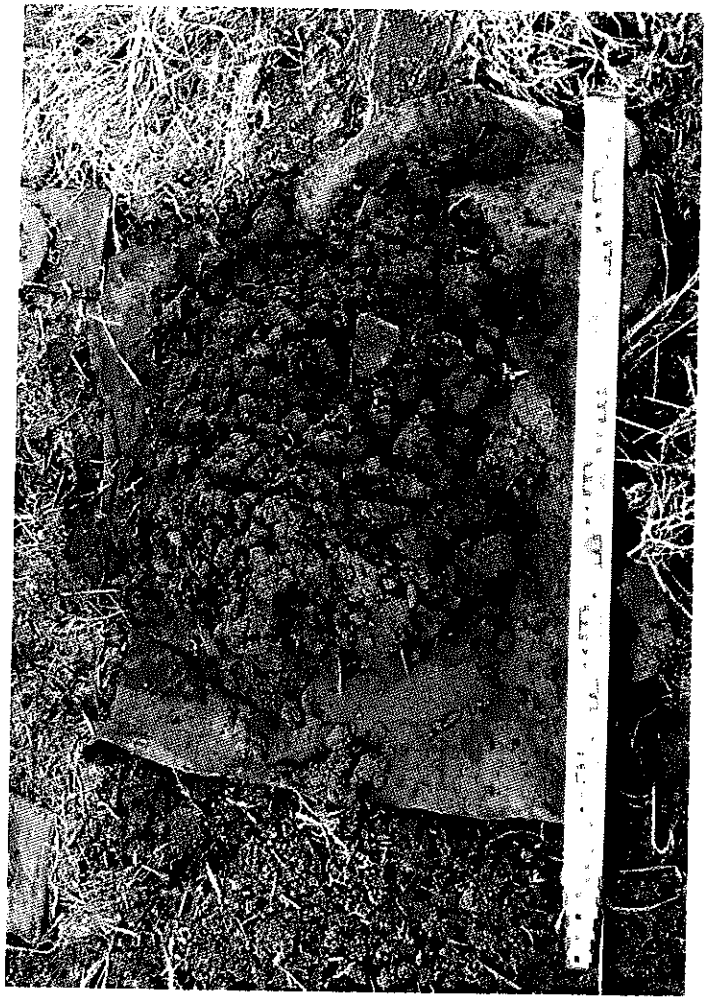
Appendix C – Photographs

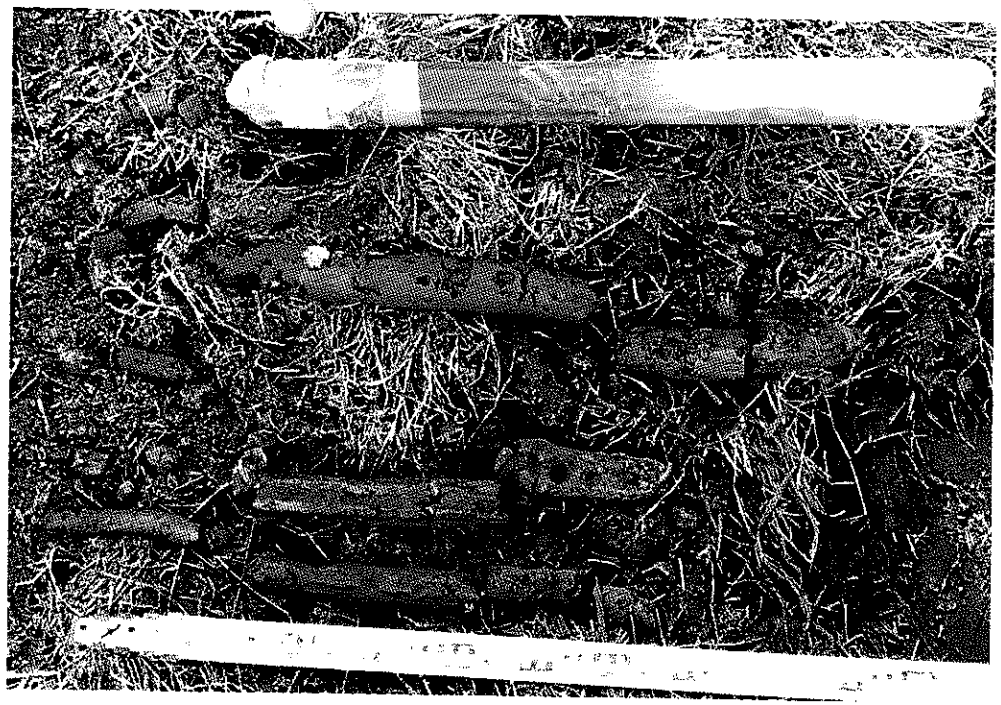


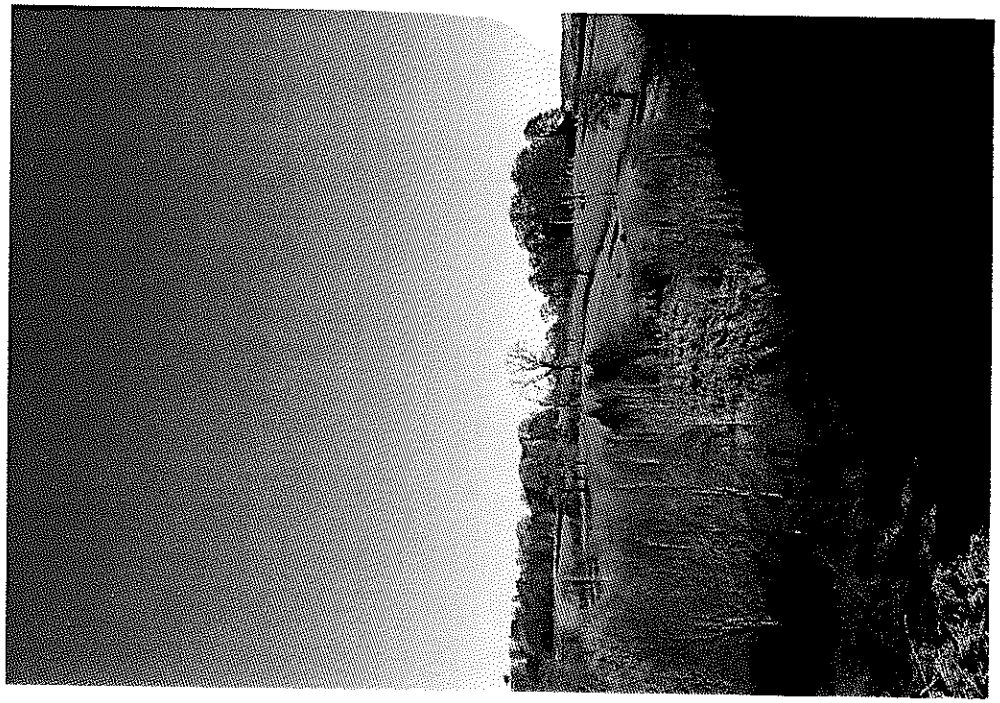


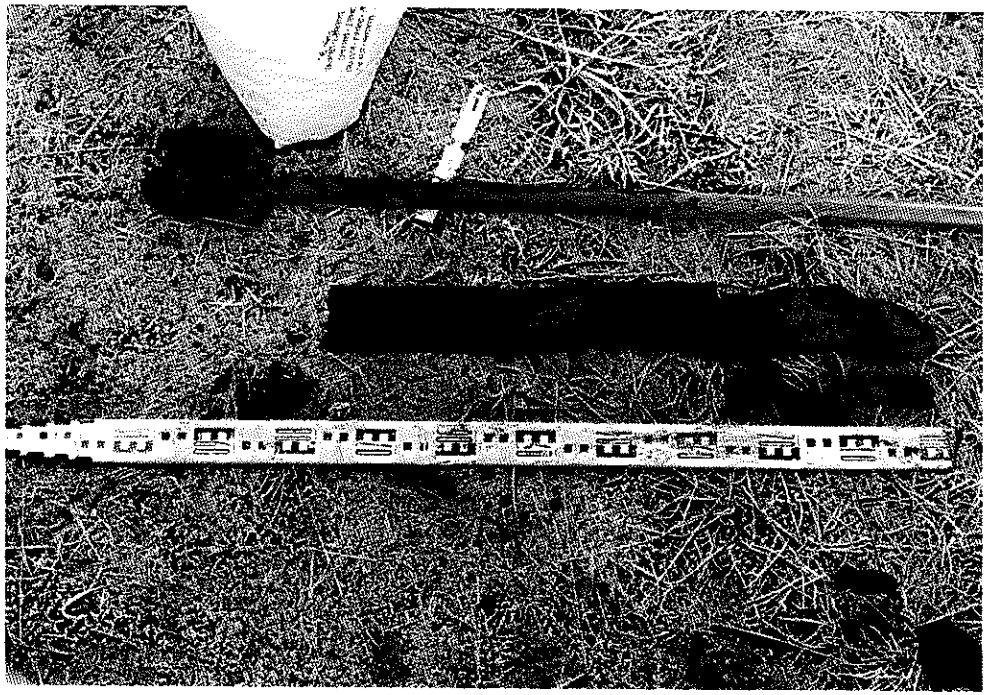












Appendix D – Geotechnical Assessment

Window Sample Logs

Sutcliffe Investigations

Site	Number
Church Raike	WS1

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Dando Terrier Rig.			LHT	26192LG
	Location See Location Plan.	**Dates** 10/12/2012	**Engineer** GF	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
					0.20 (0.20)	Dark brown SAND with fine and medium roots with rare sub angular gravel of limestone, sandstone and mudstone - TOPSOIL			
0.50-0.50	S1		P.I.D 0.0			Medium dense possible MADE GROUND comprising orangish brown silty gravelly cobbly SAND with rare half bricks. Gravels and cobbles are sub angular of sandstone and mudstone.			
1.00-1.00	N2		P.I.D 0.0						
1.00-1.45	SPT N= 10		1,3/5,3,1,1						
1.00-1.50	G3				2.20 (2.20)				
2.00-2.45	SPT N=7		2,1/1,1,2,3						
					2.40	Soft to firm dark brown sandy gravelly CLAY with sub angular cobbles and boulders of sandstone, mudstone and slate.			
3.00-3.45	SPT N=12		3,1/2,2,3,5						
4.00-4.45	SPT N= 17		2,7/7,4,3,3		3.05 (0.85)				
5.00-5.45	SPT N=17		3,3/4,4,4,5						
					5.45	Complete at 5.45m			

Remarks
Window Sample hole terminated at 5.45m bgl after SPT in firm CLAY.
Window Sample hole dry.

Scale (approx)	Logged By
1:50	GF

Figure No. 26192LG.L S1

Sutcliffe Investigations

Site	Number
Church Raike	WS2

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Dando Terrier Rig.			LHT	26192LG
	Location	**Dates**	**Engineer**	**Sheet**
	See Location Plan.	10/12/2012	GF	1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
					0.20 (0.20)	Dark brown SAND with fine and medium roots with rare sub angular gravel of limestone, sandstone and mudstone - TOPSOIL			
0.50-0.50	S1		P.I.D 0.0			Medium dense possible MADE GROUND comprising orangish brown silty gravelly cobbly SAND with rare half bricks. Gravels and cobbles are sub angular of sandstone and mudstone.			
1.00-1.45 1.00-1.80	SPT N=13 G2		1,1/2,2,4,5		1.63				
1.80-1.83	SPT 50/30 50/0		50/50		1.83				
						Complete at 1.83m			

Remarks
Window Sample hole dry.
Window Sample hole terminated at 1.83m bgl after SPT refusal on cobble / boulder after barrel had also refused.

Scale (approx)	Logged By
1:50	GF

Figure No.
26192LG.. S2

Sutcliffe Investigations

Site	Number
Church Raike	WS3

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Dando Terrier Rig.			LHT	26192LG
Location	**Dates**	**Engineer**		**Sheet**
See Location Plan.	10/12/2012	GF		1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.50-0.50	S1		P.I.D 0.0		(1.80)	MADE GROUND comprising dark brown slightlysilty gravelly cobbly SAND with rare sub angular fine brick fragments. Gravels and cobbles are angular to sub angular of sandstone and slate.			
1.00-1.45	SPT N=7		2,2/1,2,2,2						
1.20-1.20	D2		P.I.D 0.0						
					1.80				
2.00-2.45	SPT N=11		11,8/2,1,3,5			Medium dense very dark brown slightly silty gravelly cobbly bouldery SAND. Gravels, cobbles and boulders are sub rounded to sub angular of limestone, sandstone and slate. Slate fragments are veined with feldspar.			
2.00-3.00	G3				(1.65)				
3.00-3.45	SPT N=59		12,17/14,15,14,16						
					3.45				
						Complete at 3.45m			

Remarks
Window Sample hole terminated at 3.45m bgl after SPT refusal in gravelly cobbly bouldery SAND.
Window Sample hole dry.

Scale (approx)	Logged By
1:50	GF

Figure No.
26192LG.WL S3

Sutcliffe Investigations

Site	Trial Pit Number
Church Raike	TH1

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
JCB 3C with a 24inch toothed bucket.	1980mm 780mm		LHT	26192LG
	Location See Location Plan	**Dates** 10/12/2012	**Engineer** GF	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					0.50	MADE GROUND comprising light brown sandy GRAVEL with rare brick and glass fragments. Gravel is sub angular fine to coarse of limestone.		
0.60-0.60	S1		P.I.D 0.0		0.80	MADE GROUND comprising dark brown slightly silty very gravelly cobbly bouldery SAND with sub angular fine to coarse fragments of brick and concrete. Gravels, cobbles and boulders are sub angular of limestone, mudstone and flint.		
					1.30	Medium dense very dark brown slightly silty gravelly cobbly bouldery SAND. Gravels, cobbles and boulders are sub rounded to sub angular of limestone, sandstone and slate. Slate fragments are veined with feldspar.		
					2.60	Complete at 2.60m		

Plan

Remarks

Trial Hole walls stable.
Trial Hole dry.
Trial Hole terminated at 2.60m bgl in gravelly cobbly bouldery SAND after machine was struggling to dig through boulders.

Scale (approx)	Logged By	Figure No.
1:50	GF	26192LG.TH1

Sutcliffe Investigations

Site	Trial Pit Number
Church Raike	TH2

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
JCB 3C with a 24inch toothed bucket.	2000mm 800mm		LHT	26192LG
	Location See Location Plan.	**Dates** 10/12/2012	**Engineer** GF	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					0.50	Dark brown SAND with fine and medium roots with rare sub angular gravel of limestone, sandstone and mudstone - TOPSOIL		
0.40-0.40	S1		P.I.D 0.0		0.50	Brown very clayey gravelly cobbly SAND. Gravels and cobbles are sub angular to sub rounded fine to coarse of sandstone and mudstone.		
					1.00			
					1.50	Medium dense very dark brown slightly silty gravelly cobbly bouldery SAND. Gravels, cobbles and boulders are sub rounded to sub angular of limestone, sandstone and slate. Slate fragments are veined with feldspar.		
					1.20			
					2.70	Complete at 2.70m		

Plan

Remarks

Trial Hole walls stable.
Trial Hole dry.
Trial Hole terminated at 2.70m bgl in gravelly cobbly bouldery SAND after machine was struggling to dig through boulders.

Scale (approx)	Logged By	Figure No.
1:50	GF	26192LG.TH2

Sutcliffe Investigations

Excavation Method JCB 3C□ with a 24inch toothed bucket.	**Dimensions** 2080mm □810mm	**Ground Level (mOD)**	**Site** Church Raike	**Trial Pit Number** **TH3**
	Location See Location Plan.	**Dates** 10/12/2012	**Client** LHT	**Job Number** 26192LG
			Engineer GF	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					□0.10□ 0.10 □0.30□ 0.40	Dark brown SAND with fine and medium roots with rare sub angular gravel of limestone, sandstone and mudstone - T□PS□IL		
0.60-0.60	S1		P.I.D 0.0		□1.00□	MAD□ GR□□ND comprising light brown sandy GRA□□L with rare brick and glass fragments. Gravel is sub angular fine to coarse of limestone.		
					1.40	MAD□ GR□□ND comprising orangish brown silty gravelly cobbly SAND with rare half bricks. Gravels and cobbles are sub angular of sandstone and mudstone. LAND DRAIN at 1.40m bgl - DR□		
					□1.30□	Medium dense very dark brown slightly silty gravelly cobbly bouldery SAND. Gravels, cobbles and boulders are sub rounded to sub angular of limestone, sandstone and slate. Slate fragments are veined with feldspar.		
					2.70	Complete at 2.70m		

Plan

Remarks

Trial Hole walls stable.
Trial Hole dry.
Trial Hole terminated at 2.70m bgl in gravelly cobbly bouldery SAND after machine was struggling to dig through boulders.

Scale (approx)	Logged By	Figure No.
1:50	GF	26192LG.TH3

Sutcliffe Investigations

Site Church Raike			**Trial Pit Number** TH4
Excavation Method JCB 3C with a 24inch toothed bucket.	**Dimensions** 2100mm 820mm	**Ground Level (mOD)**	**Client** LHT	**Job Number** 26192LG
	Location See Location Plan.	**Dates** 10/12/2012	**Engineer** GF	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					0.20	Dark brown SAND with fine and medium roots with rare sub angular gravel of limestone, sandstone and mudstone - TOPSOIL		
0.50-0.50	S1		P.I.D 0.0		1.20	Medium dense brown silty gravelly cobbly SAND. Gravels and cobbles are sub angular to sub rounded fine to coarse of sandstone and slate.		
					1.40	Medium dense very dark brown slightly silty gravelly cobbly bouldery SAND. Gravels, cobbles and boulders are sub rounded to sub angular of limestone, sandstone and slate. Slate fragments are veined with feldspar.		
					2.30	Complete at 2.30m		

Plan

Remarks

Trial Hole walls unstable between 0.20m bgl and 1.40m bgl.
Trial Hole dry.
Trial Hole terminated at 2.30m bgl in gravelly cobbly bouldery SAND after machine was struggling to dig through boulders.

Scale (approx)	Logged By	Figure No.
1:50	GF	26192LG.TH4

Sutcliffe Investigations

Site Church Raike			**Trial Pit Number** TH5
Excavation Method JCB 3C□ with a 24inch toothed bucket.	**Dimensions** 2080mm □780mm	**Ground Level (mOD)**	**Client** LHT	**Job Number** 26192LG
	Location See Location Plan.	**Dates** 10/12/2012	**Engineer** GF	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					0.20□	Dark brown SAND with fine and medium roots with rare sub angular gravel of limestone, sandstone and mudstone - T□PS□IL		
0.50-0.50	S1		P.I.D 0.0		0.20			
					□1.50□	MAD□ GR□□ND comprising orangish brown silty gravelly cobbly SAND with rare half bricks. Gravels and cobbles are sub angular of sandstone and mudstone. LAND DRAIN at 1.00m bgl - DR□ initially but started dripping after 10mins.		
					1.70	Medium dense very dark brown slightly silty gravelly cobbly bouldery SAND. Gravels, cobbles and boulders are sub rounded to sub angular of limestone, sandstone and slate. Slate fragments are veined with feldspar.		
					□1.00□			
					2.70	Complete at 2.70m		

Plan

Remarks

Trial Hole terminated at 2.70m bgl in gravelly cobbly bouldery SAND after machine was struggling to dig through boulders.
Trial Hole dry.
Trial Hole walls unstable between 0.20m bgl a nd 1.70m bgl.

Scale (approx)	Logged By	Figure No.
1:50	GF	26192LG.TH5

Ground Gas Results

Pavement Testing Services Ltd
Unit 7, Cowling Business Park
Canal Side, CHORLEY, PR6 0QL
T: 01257 233 242
F: 01257 234 744
E: info@ptsinternational.co.uk

4076

TEST REPORT

Determination of Liquid and Plastic Limits

BS1377: Part 2: 1990

Client: Sutcliffes
Site: Church Raike
Location: Various
Date Sampled: 13/12/2012

Report No: 1219-S-01-A-04
Date received: 13/12/2012
Date tested: 04/01/2013
Date reported: 08/01/2013

Sample Ref.	Lab ref.	Sample Description	Sample Type	Sample Prep.	% Ret. 425µm sieve	Moisture Content %	Liquid Limit %	Plastic Limit %	Plasticity Index %
WS 1 1.00-1.50	3713	Brown sandy silty CLAY with fine to medium gravel	WS	N	29	16	47	21	26
WS 2 1.00-1.80	3714	Very wet brown sandy silty CLAY with occasional fine to medium gravel	WS	N	12	22	31	16	15
WS 3 2.00-3.00	3715	Black wet sandy silty CLAY with fine to medium gravel	WS	N	19	20	34	17	17

Legend: **D** = Disturbed, **B** = Bulk, **U** = Undisturbed

N = tested in natural condition, **A** = air dried before test, **W** = subject to wet sieving before test

NP = Non-plastic

Comments: Interpretations and opinions expressed herein are outside the scope of the UKAS Accreditation

Certified that the test was carried out in accordance with BS 1377: Part 2: 1990: Methods 3.0, 4.4 & 5

Signed:

( ) Mike Hayes (Laboratory Manager)
( ) D.Foster (Assistant Laboratory Manager)
(X) J.Hopkinson (Senior Technician)
( ) A.Crawford (Senior Technician)

Pavement Testing Services Ltd
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Canal Side, CHORLEY, PR6 0QL
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4076

TEST REPORT

Determination of Particle Size Distribution

Report No. 1319-S-01-A-01

Client:	Sutcliffe		
Site:	Church Raike		
Location:	WS1 1.0-1.5	PTS Ref:	3713
Date Sampled:	13/12/12	Client Ref.	WS1 1.0-1.5
Sampled from:	Window sample	Mass (kg):	4kg
Supplier:	Client	Source:	Site
Description:	Brown sandy silty CLAY with fine to medium gravel		

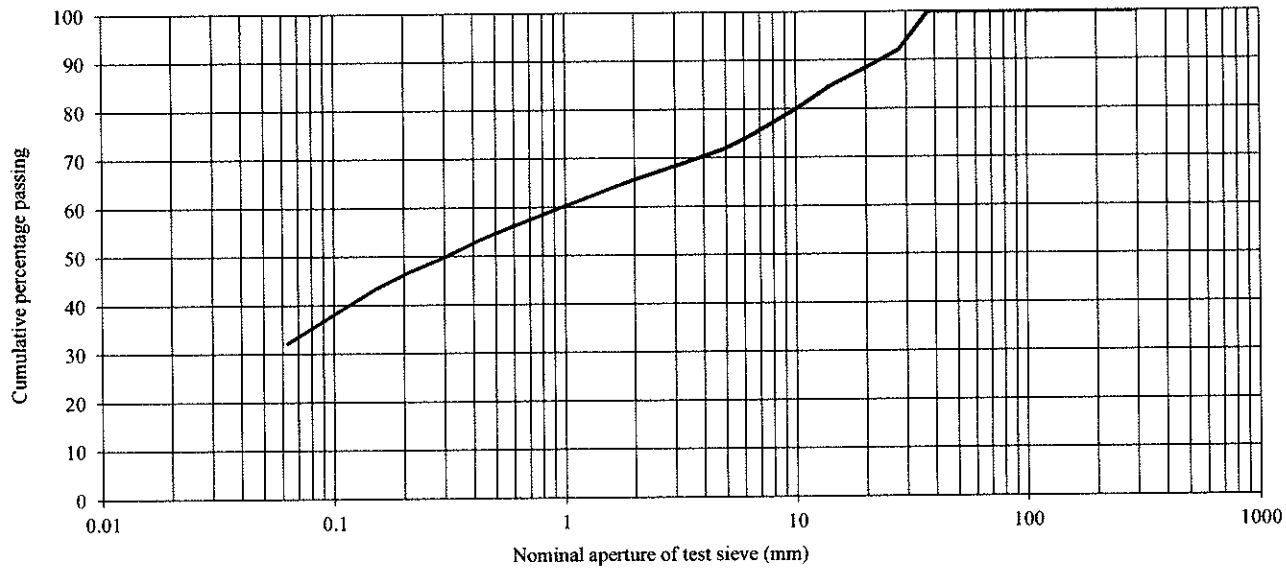
Material Specification:
Sampled by: Client
Date received: 13/12/12
Sample type: Bulk
Method of Preparation: BS 1377-1 & 2 : 1990

Remarks:

SIEVE ANALYSIS

BS Sieve (mm)	Passing (%)	Material Specification
300	100	
125	100	
90	100	
75	100	
37.5	100	
28	92	
20	88	
14	85	
10	80	
6.3	74	
5.0	72	
3.35	69	
2.00	66	
1.18	62	
0.600	56	
0.300	50	
0.212	47	
0.150	43	
0.063	32.1	

Sample Grading



Certified that the Particle Size Distribution was determined in accordance with BS 1377 - 2 : 1990, Method 9.2

Signed_____ ( ) M.Hayes (Laboratory Manager)
( ) D.Foster (Assistant Laboratory Manager)
(X) J.Hopkinson (Senior Technician)

Date Reported: 08/01/13

Pavement Testing Services Ltd
Unit 7, Cowling Business Park
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4076

TEST REPORT

Determination of Particle Size Distribution

Report No. 1319-S-01-A-02

Client:	Sutcliffe		
Site:	Church Raike		
Location:	WS2 1.0-1.8	PTS Ref:	3714
Date Sampled:	13/12/12	Client Ref.	WS2 1.0-1.8
Sampled from:	Window sample	Mass (kg):	4kg
Supplier:	Client	Source:	Site

Description: Very wet brown sandy silty CLAY with occasional fine to medium gravel

Material Specification:

Sampled by: Client

Date received: 13/12/12

Sample type: Bulk

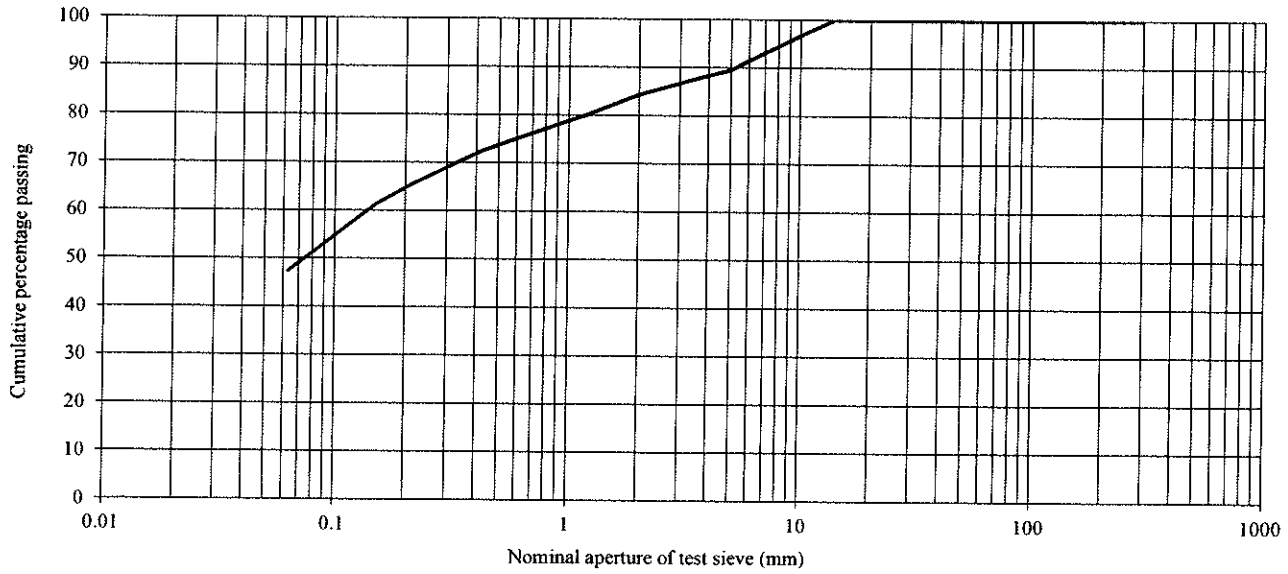
Method of Preparation: BS 1377-1 & 2 : 1990

Remarks:

SIEVE ANALYSIS

BS Sieve (mm)	Passing (%)	Material Specification
300	100	
125	100	
90	100	
75	100	
37.5	100	
28	100	
20	100	
14	100	
10	97	
6.3	92	
5.0	89	
3.35	87	
2.00	84	
1.18	80	
0.600	75	
0.300	69	
0.212	65	
0.150	61	
0.063	47.3	

Sample Grading



Certified that the Particle Size Distribution was determined in accordance with BS 1377 - 2 : 1990, Method 9.2

Signed_____ ( ) M.Hayes (Laboratory Manager)
( ) D.Foster (Assistant Laboratory Manager)
(X) J.Hopkinson (Senior Technician)

Date Reported: 08/01/13

Geotechnical Results

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Unit 7, Cowling Business Park
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4076

TEST REPORT

Determination of Particle Size Distribution

Report No. 1319-S-01-A-03

Client:	Sutcliffe		
Site:	Church Raike		
Location:	WS3 2.0-3.0	PTS Ref:	3715
Date Sampled:	13/12/12	Client Ref.	WS3 2.0-3.0
Sampled from:	Window sample	Mass (kg):	4kg
Supplier:	Client	Source:	Site
Description:	Black wet sandy silty CLAY with fine to medium gravel		

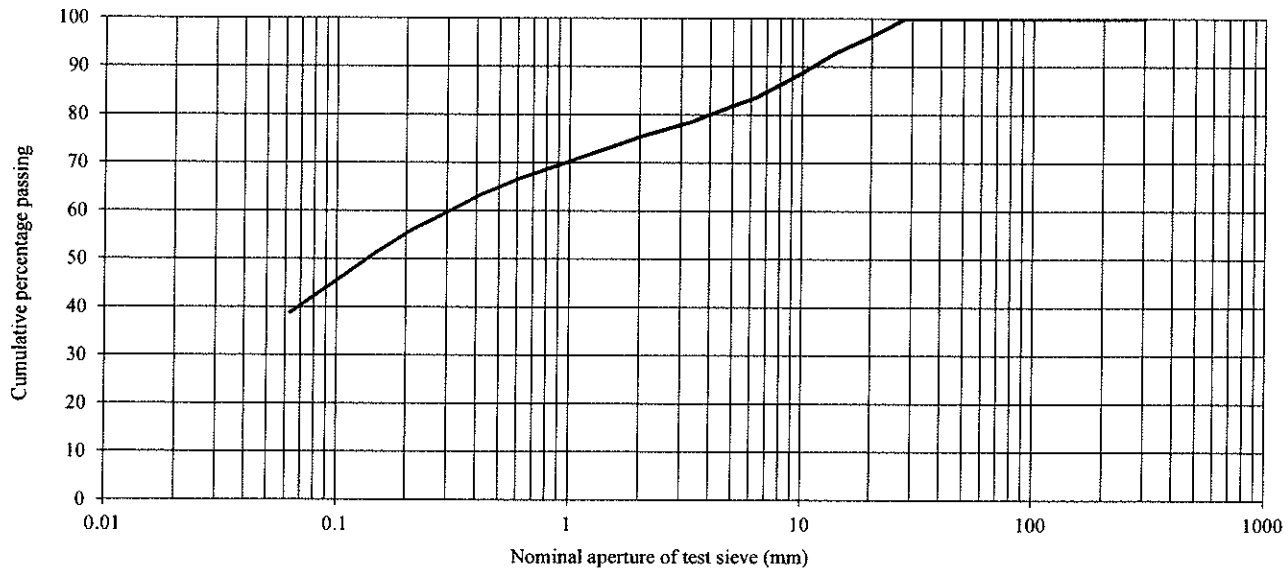
Material Specification:
Sampled by: Client
Date received: 13/12/12
Sample type: Bulk
Method of Preparation: BS 1377-1 & 2 : 1990

Remarks:

SIEVE ANALYSIS

BS Sieve (mm)	Passing (%)	Material Specification
300	100	
125	100	
90	100	
75	100	
37.5	100	
28	100	
20	96	
14	93	
10	89	
6.3	84	
5.0	82	
3.35	79	
2.00	75	
1.18	72	
0.600	66	
0.300	60	
0.212	56	
0.150	51	
0.063	38.7	

Sample Grading



Certified that the Particle Size Distribution was determined in accordance with BS 1377 - 2 : 1990, Method 9.2

Signed_____ ( ) M.Hayes (Laboratory Manager)
( ) D.Foster (Assistant Laboratory Manager)
(X) J.Hopkinson (Senior Technician)

Date Reported: 08/01/13

Appendix E – Contamination Results

ALcontrol Laboratories

Unit 7-8 Hawarden Business Park
Manor Road (off Manor Lane)
Hawarden
Deeside
CH5 3US
Tel: (01244) 528700
Fax: (01244) 528701
email: mkt@alcontrol.com
Website: www.alcontrol.com

Sutcliffe
18-20 Harrington Street
Liverpool
Merseyside
L2 9QA

Attention: Sara Hale

CERTIFICATE OF ANALYSIS

Date:	28 December 2012
Customer:	H_SUTCLIFF_LPL
Sample Delivery Group (SDG):	121212-89
Your Reference:	26192LG
Location:	Church Raike
Report No:	207060

We received 10 samples on Wednesday December 12, 2012 and 10 of these samples were scheduled for analysis which was completed on Friday December 28, 2012. Accredited laboratory tests are defined within the report, but opinions, interpretations and on-site data expressed herein are outside the scope of ISO 17025 accreditation.

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

All chemical testing (unless subcontracted) is performed at ALcontrol Hawarden Laboratories.

Approved By:

Sonia McWhan
Operations Manager

ALcontrol Laboratories

Validated

CERTIFICATE OF ANALYSIS

SDG:	121212-89	**Location:**	Church Raike	**Order Number:**	4595 / SH / 26192LG
Job:	H_SUTCLIFF_LPL-188	**Customer:**	Sutcliffe	**Report Number:**	207060
Client Reference:	26192LG	**Attention:**	Sara Hale	**Superseded Report:**	

Received Sample Overview

Lab Sample No(s)	Customer Sample Ref.	AGS Ref.	Depth (m)	Sampled Date
6650714	TH1		0.60	10/12/2012
6650715	TH2		0.40	10/12/2012
6650716	TH3		0.60	10/12/2012
6650717	TH4		0.50	10/12/2012
6650718	TH5		0.50	10/12/2012
6650719	WS1		0.50	11/12/2012
6650720	WS1		1.00	11/12/2012
6650721	WS2		0.50	11/12/2012
6650722	WS3		0.50	11/12/2012
6650723	WS3		1.20	11/12/2012

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

ALcontrol Laboratories

Validated

CERTIFICATE OF ANALYSIS

SDG:	121212-89	**Location:**	Church Raike	**Order Number:**	4595 / SH / 26192LG
Job:	H_SUTCLIFF_LPL-188	**Customer:**	Sutcliffe	**Report Number:**	207060
Client Reference:	26192LG	**Attention:**	Sara Hale	**Superseded Report:**	

SOLID

Results Legend

X Test

No Determination Possible

Lab Sample No(s)	6650714	6650715	6650716	6650717	6650718	6650719	6650720	6650721	6650722	6650723
Customer Sample Reference	TH1	TH2	TH3	TH4	TH5	WS1	WS1	WS2	WS3	WS3
AGS Reference										
Depth (m)	0.60	0.40	0.60	0.50	0.50	0.50	1.00	0.50	0.50	1.20
Container	250g Amber Jar (AL	400g Tub (ALE214)	250g Amber Jar (AL	400g Tub (ALE214)	250g Amber Jar (AL	400g Tub (ALE214)	60g VOC (ALE215)	250g Amber Jar (AL	400g Tub (ALE214)	60g VOC (ALE215)	250g Amber Jar (AL	400g Tub (ALE214)	250g Amber Jar (AL	400g Tub (ALE214)	60g VOC (ALE215)	250g Amber Jar (AL	400g Tub (ALE214)	60g VOC (ALE215)	250g Amber Jar (AL	400g Tub (ALE214)	60g VOC (ALE215)	250g Amber Jar (AL	400g Tub (ALE214)

% Stones Greater than 10mm	All	NDPs: 0 Tests: 10	X		X		X			X		X		X		X		X		X		X		
Anions by Kone (soil)	All	NDPs: 0 Tests: 10	X		X		X			X		X		X		X		X		X		X		
Anions by Kone (w)	All	NDPs: 0 Tests: 5				X		X					X				X				X			
Asbestos Identification (Soil)	All	NDPs: 0 Tests: 10		X		X		X			X		X			X		X			X			X
Boron Water Soluble	All	NDPs: 0 Tests: 10	X		X		X			X		X		X		X		X		X		X		
Chromium III	All	NDPs: 0 Tests: 10		X		X		X			X		X			X		X			X			X
Cyanide Comp[illegible]e/Total/Thiocyanate	All	NDPs: 0 Tests: 10		X		X		X			X		X			X		X			X			X
Dissolved Metals by ICP-MS	All	NDPs: 0 Tests: 5				X		X					X				X				X			
Dissolved Organic/Inorganic Carbon	All	NDPs: 0 Tests: 5				X		X					X				X				X			
Easily Liberated Sulphide	All	NDPs: 0 Tests: 10		X		X		X			X		X			X		X			X			X
Elemental Sulphur	All	NDPs: 0 Tests: 10	X		X		X			X		X		X		X		X		X		X		
EPH (DRO) (C10-C40) Aqueous (W)	All	NDPs: 0 Tests: 5				X		X					X				X				X			
EPH CWG (Aliphatic) GC (S)	All	NDPs: 0 Tests: 4					X					X				X				X				
EPH CWG (Aromatic) GC (S)	All	NDPs: 0 Tests: 4					X					X				X				X				
Free Sulphur	All	NDPs: 0 Tests: 5				X		X					X				X				X			

ALcontrol Laboratories

CERTIFICATE OF ANALYSIS

Validated

SDG:	121212-89	**Location:**	Church Raike	**Order Number:**	4595 / SH / 26192LG
Job:	H_SUTCLIFF_LPL-188	**Customer:**	Sutcliffe	**Report Number:**	207060
Client Reference:	26192LG	**Attention:**	Sara Hale	**Superseded Report:**	

SOLID

Results Legend

X Test

ND No Determination Possible

			Lab Sample No(s)	Customer Sample Reference	AGS Reference	Depth (m)	Container
			6650714	TH1		0.60	250g Amber Jar (AL
			6650715	TH2		0.40	400g Tub (ALE214)
			6650716	TH3		0.60	250g Amber Jar (AL
			6650717	TH4		0.50	400g Tub (ALE214)
			6650718	TH5		0.50	250g Amber Jar (AL
			6650719	WS1		0.50	400g Tub (ALE214)
			6650720	WS1		1.00	250g Amber Jar (AL
			6650721	WS2		0.50	400g Tub (ALE214)
			6650722	WS3		0.50	250g Amber Jar (AL
			6650723	WS3		1.20	400g Tub (ALE214)
GRO by GC-FID (S)	All	NDPs: 0 Tests: 4					60g VOC (ALE215)
GRO by GC-FID (W)	All	NDPs: 0 Tests: 5					400g Tub (ALE214)
Hexavalent Chromium (s)	All	NDPs: 0 Tests: 10					250g Amber Jar (AL
Hexavalent Chromium (w)	All	NDPs: 0 Tests: 5					400g Tub (ALE214)
Low Level Phenols by HPLC (W)	All	NDPs: 0 Tests: 5					250g Amber Jar (AL
Mercury Dissolved	All	NDPs: 0 Tests: 5					400g Tub (ALE214)
Metals by iCap-OES (Soil)	Arsenic	NDPs: 0 Tests: 10					250g Amber Jar (AL
	Cadmium	NDPs: 0 Tests: 10					400g Tub (ALE214)
	Chromium	NDPs: 0 Tests: 10					250g Amber Jar (AL
	Copper	NDPs: 0 Tests: 10					400g Tub (ALE214)
	Lead	NDPs: 0 Tests: 10					250g Amber Jar (AL
	Mercury	NDPs: 0 Tests: 10					400g Tub (ALE214)
	Nickel	NDPs: 0 Tests: 10					250g Amber Jar (AL
	Selenium	NDPs: 0 Tests: 10					400g Tub (ALE214)
	Zinc	NDPs: 0 Tests: 10					250g Amber Jar (AL

ALcontrol Laboratories

Validated

CERTIFICATE OF ANALYSIS

SDG:	121212-89	**Location:**	Church Raike	**Order Number:**	4595 / SH / 26192LG
Job:	H_SUTCLIFF_LPL-188	**Customer:**	Sutcliffe	**Report Number:**	207060
Client Reference:	26192LG	**Attention:**	Sara Hale	**Superseded Report:**	

SOLID

Results Legend

X Test

No Determination Possible

Lab Sample No(s)			6650714		6650715		6650716			6650717		6650718		6650719			6650720		6650721			6650722			6650723	
Customer Sample Reference			TH1		TH2		TH3			TH4		TH5		WS1			WS1		WS2			WS3			WS3	
AGS Reference																										
Depth (m)			0.60		0.40		0.60			0.50		0.50		0.50			1.00		0.50			0.50			1.20	
Container			250g Amber Jar (AL	400g Tub (ALE214)	250g Amber Jar (AL	400g Tub (ALE214)	250g Amber Jar (AL	400g Tub (ALE214)	60g VOC (ALE215)	250g Amber Jar (AL	400g Tub (ALE214)	250g Amber Jar (AL	400g Tub (ALE214)	250g Amber Jar (AL	400g Tub (ALE214)	60g VOC (ALE215)	250g Amber Jar (AL	400g Tub (ALE214)	250g Amber Jar (AL	400g Tub (ALE214)	60g VOC (ALE215)	250g Amber Jar (AL	400g Tub (ALE214)	60g VOC (ALE215)	250g Amber Jar (AL	400g Tub (ALE214)
NRA Leachate	All	NDPs: 0 Tests: 5				X		X							X					X			X			
PAH by GCMS	All	NDPs: 0 Tests: 10	X		X		X			X		X		X			X		X			X			X	
PAH Spec MS - Aqueous (W)	All	NDPs: 0 Tests: 5				X		X							X					X			X			
PCBs by GCMS	All	NDPs: 0 Tests: 1			X																					
pH	All	NDPs: 0 Tests: 10		X		X		X			X		X		X			X		X			X			X
pH Value	All	NDPs: 0 Tests: 5				X		X							X					X			X			
Phenols by HPLC (S)	All	NDPs: 0 Tests: 10		X		X		X			X		X		X			X		X			X			X
Sample description	All	NDPs: 0 Tests: 10	X		X		X			X		X		X			X		X			X			X	
Sulphide	All	NDPs: 0 Tests: 5				X		X							X					X			X			
Total Organic Carbon	All	NDPs: 0 Tests: 10	X		X		X			X		X		X			X		X			X			X	
Total Sulphate	All	NDPs: 0 Tests: 10	X		X		X			X		X		X			X		X			X			X	
TPH CWG GC (S)	All	NDPs: 0 Tests: 4					X							X					X			X				

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Validated

CERTIFICATE OF ANALYSIS

SDG:	121212-89	**Location:**	Church Raike	**Order Number:**	4595 / SH / 26192LG
Job:	H_SUTCLIFF_LPL-188	**Customer:**	Sutcliffe	**Report Number:**	207060
Client Reference:	26192LG	**Attention:**	Sara Hale	**Superseded Report:**	

Sample Descriptions

Grain Sizes

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

Lab Sample No(s)	Customer Sample Ref.	Depth (m)	Colour	Description	Grain size	Inclusions	Inclusions 2
6650714	TH1	0.60	Dark Brown	Sandy Loam	0.1 - 2 mm	Stones	Vegetation
6650715	TH2	0.40	Dark Brown	Sandy Loam	0.1 - 2 mm	Stones	Vegetation
6650716	TH3	0.60	Dark Brown	Sandy Clay Loam	0.1 - 2 mm	Stones	None
6650717	TH4	0.50	Dark Brown	Sandy Clay Loam	0.1 - 2 mm	Stones	None
6650718	TH5	0.50	Dark Brown	Sandy Loam	0.1 - 2 mm	Vegetation	Stones
6650719	WS1	0.50	Dark Brown	Sandy Loam	0.1 - 2 mm	Vegetation	Stones
6650720	WS1	1.00	Dark Brown	Sandy Clay Loam	0.1 - 2 mm	Stones	Vegetation
6650721	WS2	0.50	Dark Brown	Loamy Sand	0.1 - 2 mm	Stones	None
6650722	WS3	0.50	Dark Brown	Sandy Clay Loam	0.1 - 2 mm	Stones	None
6650723	WS3	1.20	Dark Brown	Sandy Clay Loam	0.1 - 2 mm	None	None

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

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

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

ALcontrol Laboratories

Validated

CERTIFICATE OF ANALYSIS

SDG:	121212-89	**Location:**	Church Raike	**Order Number:**	4595 / SH / 26192LG
Job:	H_SUTCLIFF_LPL-188	**Customer:**	Sutcliffe	**Report Number:**	207060
Client Reference:	26192LG	**Attention:**	Sara Hale	**Superseded Report:**	

Results Legend

#	ISO17025 accredited.
M	mCERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-48,+@	Sample deviation (see appendix)

Component	LOD/Units	Method	Customer Sample R	TH1	TH2	TH3	TH4	TH5	WS1
			Depth (m)	0.60	0.40	0.60	0.50	0.50	0.50
			Sample Type	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid
			Date Sampled	10/12/2012	10/12/2012	10/12/2012	10/12/2012	10/12/2012	11/12/2012
			Sample Time						
			Date Received	12/12/2012	12/12/2012	12/12/2012	12/12/2012	12/12/2012	12/12/2012
			SDG Ref	121212-89	121212-89	121212-89	121212-89	121212-89	121212-89
			Lab Sample No.(s)	6650714	6650715	6650716	6650717	6650718	6650719
			AGS Reference						
Moisture content ratio, Natural	%	PM024		16	70	20	14	24	29
Stones > 10 mm	%	TM008		39	3.14	25	25.3	26.1	5.94
Phenol	<0.01 mg/kg	TM062 (S)		<0.01 M	<0.01 M	<0.01 M	<0.01 M	<0.01 M	<0.01 M
Cresols	<0.01 mg/kg	TM062 (S)		<0.01 M	<0.01 M	<0.01 M	<0.01 M	<0.01 M	<0.01 M
Xylenols	<0.015 mg/kg	TM062 (S)		<0.015 M	<0.015 M	<0.015 M	<0.015 M	<0.015 M	<0.015 M
1-Naphthol	<0.01 mg/kg	TM062 (S)		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2,3,5-Trimethylphenol	<0.01 mg/kg	TM062 (S)		<0.01 M	<0.01 M	<0.01 M	<0.01 M	<0.01 M	<0.01 M
Phe[illegible]. Total Detected monohydric	<0.035 mg/kg	TM062 (S)		<0.035 M	<0.035 M	<0.035 M	<0.035 M	<0.035 M	<0.035 M
Carbon, Organic (diss.filt) NRA leach	<3000 µg/l	TM090			4890	4610			6060
Sulphide NRA leach	<10 µg/l	TM101			<10	<10			20
Organic Matter, Total	<0.35 %	TM132		2 #	6.86 #	1.55 #	1.78 #	2.1 #	2.36 #
pH	1 pH Units	TM133		8.31 M	7.59 M	8.03 M	7.6 M	7.95 M	6.06 M
Sulphur, Elemental	<10 mg/kg	TM136		<10 M	<10 M	<10 M	<10 M	<10 M	<10 M
Chromium, Hexavalent	<0.6 mg/kg	TM151		<0.6 #	<3 #	<1.2 #	<0.6 #	<3 #	<3 #
Chromium, Trivalent NRA leach	<30 µg/l	TM152			<30	<30			<30
Arsenic (diss.filt) NRA leach	<0.12 µg/l	TM152			2.58	0.517			1.07
Boron (diss.filt) NRA leach	<9.4 µg/l	TM152			<9.4	18.2			<9.4
Cadmium (diss.filt) NRA leach	<0.1 µg/l	TM152			<0.1	<0.1			<0.1
Chro[illegible]n (diss.filt) NRA leach	<0.22 µg/l	TM152			1.48	4.31			1.26
Copper (diss.filt) NRA leach	<0.85 µg/l	TM152			5.79	2.38			6.77
Lead (diss.filt) NRA leach	<0.02 µg/l	TM152			1.78	0.297			8.57
Nickel (diss.filt) NRA leach	<0.15 µg/l	TM152			1.4	1.12			2.37
Selenium (diss.filt) NRA leach	<0.39 µg/l	TM152			0.475	1.51			2.17
Zinc (diss.filt) NRA leach	<0.41 µg/l	TM152			7.14	1.52			7.42
Cyanide, Total	<1 mg/kg	TM153		<1 M	<1 M	<1 M	<1 M	<1 M	<1 M
EPH Range >C10 - C40 (aq) NRA leach	<46 µg/l	TM172			73.9	<46			<46
Sulphide, Easily liberated	<15 mg/kg	TM180		<15 & #	<15 & #	<15 & #	<15 & #	<15 & #	<15 #
Chromium, Trivalent	<0.9 mg/kg	TM181		8.38	19.7	12.8	12.1	17.1	14.8
Arsenic	<0.6 mg/kg	TM181		9.11 M	14.7 M	10 M	21.1 M	20.5 M	14.2 M
Cadmium	<0.02 mg/kg	TM181		0.885 M	1.68 M	1.61 M	3.23 M	1.73 M	1.36 M
Chromium	<0.9 mg/kg	TM181		8.38 M	19.7 M	12.8 M	12.1 M	17.1 M	14.8 M
Copper	<1.4 mg/kg	TM181		18.4 M	60.4 M	15.2 M	33.6 M	54.7 M	25.9 M

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CERTIFICATE OF ANALYSIS

SDG:	121212-89	**Location:**	Church Raike	**Order Number:**	4595 / SH / 26192LG
Job:	H_SUTCLIFF_LPL-188	**Customer:**	Sutcliffe	**Report Number:**	207060
Client Reference:	26192LG	**Attention:**	Sara Hale	**Superseded Report:**	

Results Legend

#	ISO17025 accredited.
M	mCERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-4&+@	Sample deviation (see appendix)

Component	LOD/Units	Method	Customer Sample R	TH1	TH2	TH3	TH4	TH5	WS1
			Depth (m)	0.60	0.40	0.60	0.50	0.50	0.50
			Sample Type	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid
			Date Sampled	10/12/2012	10/12/2012	10/12/2012	10/12/2012	10/12/2012	11/12/2012
			Sample Time	-	-	-	-	-	-
			Date Received	12/12/2012	12/12/2012	12/12/2012	12/12/2012	12/12/2012	12/12/2012
			SDG Ref	121212-89	121212-89	121212-89	121212-89	121212-89	121212-89
			Lab Sample No.(s)	6650714	6650715	6650716	6650717	6650718	6650719
			AGS Reference						
Lead	<0.7 mg/kg	TM181		20.5 M	129 M	40.7 M	32.7 M	48.1 M	56.5 M
Mercury	<0.14 mg/kg	TM181		<0.14 M	<0.14 M	<0.14 M	<0.14 M	<0.14 M	<0.14 M
Nickel	<0.2 mg/kg	TM181		14.4 M	28.3 M	15.3 M	47.9 M	38.5 M	15.5 M
Selenium	<1 mg/kg	TM181		<1 #	1.46 #	1.73 #	6.69 #	2.01 #	1.65 #
Zinc	<1.9 mg/kg	TM181		63.4 M	446 M	79.4 M	167 M	118 M	194 M
Mercury (diss.filt) NRA leach	<0.01 µg/l	TM183			0.0575	<0.01			0.0214
Sulphate NRA leach	<2000 µg/l	TM184			26500	18400			35400
Sulphate, Total	<48 mg/kg	TM221		906 M	533 M	329 M	690 M	202 M	274 M
Boron, water soluble	<1 mg/kg	TM222		<1 M	1.24 M	<1 M	<1 M	<1 M	<1 M
Cyanide, Total NRA leach	<50 µg/l	TM227			<50	<50			558
Chromium, Hexavalent NRA leach	<30 µg/l	TM241			<30	<30			<30
Water Soluble Sulphate as SO4 2:1 Extract	<0.008 g/l	TM243		0.155 M	0.0499 M	0.0413 M	0.0376 M	<0.008 M	<0.008 M
Catechol (low level) NRA leach	<0.5 µg/l	TM255			<0.5	<0.5			<0.5
Phenol (low level) NRA leach	<0.5 µg/l	TM255			5.86	0.9			0.56
Cresols (low level) NRA leach	<0.5 µg/l	TM255			0.53	<0.5			<0.5
Xylenols (low level) NRA leach	<0.5 µg/l	TM255			<0.5	<0.5			<0.5
1-Napthol (low level) NRA leach	<0.5 µg/l	TM255			<0.5	<0.5			<0.5
Sum of Detected Monohydric Phenols NRA	<0.5 µg/l	TM255			6.39	0.9			0.56
pH NRA leach	<1 pH Units	TM256			7.9	8.15			7.61
Sulphur, Free NRA leach	<50 µg/l	TM294			<75	<100			<75

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CERTIFICATE OF ANALYSIS

SDG:	121212-89	**Location:**	Church Raike	**Order Number:**	4595 / SH / 26192LG
Job:	H_SUTCLIFF_LPL-188	**Customer:**	Sutcliffe	**Report Number:**	207060
Client Reference:	26192LG	**Attention:**	Sara Hale	**Superseded Report:**	

Results Legend

#	ISO17025 accredited.
M	*m*CERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-4$,+$c	Sample deviation (see appendix)

Component	LOD/Units	Method	Customer Sample R	WS1	WS2	WS3	WS3		
			Depth (m)	1.00	0.50	0.50	1.20		
			Sample Type	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid		
			Date Sampled	11/12/2012	11/12/2012	11/12/2012	11/12/2012		
			Sample Time						
			Date Received	12/12/2012	12/12/2012	12/12/2012	12/12/2012		
			SDG Ref	121212-89	121212-89	121212-89	121212-89		
			Lab Sample No.(s)	6650720	6650721	6650722	6650723		
			AGS Reference						
Moisture content ratio, Natural	%	PM024		21	22	17	28		
Stones > 10 mm	%	TM008		18.2	30.1	28.3	0		
Phenol	<0.01 mg/kg	TM062 (S)		<0.01 M	<0.01 M	<0.01 M	<0.01 M		
Cresols	<0.01 mg/kg	TM062 (S)		<0.01 M	<0.01 M	<0.01 M	<0.01 M		
Xylenols	<0.015 mg/kg	TM062 (S)		<0.015 M	<0.015 M	<0.015 M	<0.015 M		
1-Naphthol	<0.01 mg/kg	TM062 (S)		<0.01	<0.01	<0.01	<0.01		
2,3,5-Trimethylphenol	<0.01 mg/kg	TM062 (S)		<0.01 M	<0.01 M	<0.01 M	<0.01 M		
Phe[illegible], Total Detected monohydric	<0.035 mg/kg	TM062 (S)		<0.035 M	<0.035 M	<0.035 M	<0.035 M		
Carbon, Organic (diss.filt) NRA leach	<3000 µg/l	TM090			<3000	11000			
Sulphide NRA leach	<10 µg/l	TM101			<10	<10			
Organic Matter, Total	<0.35 %	TM132		1.33 #	1.83 #	1.84 #	2.6 #		
pH	1 pH Units	TM133		7.29 M	7.61 M	7.93 M	7.88 M		
Sulphur, Elemental	<10 mg/kg	TM136		<10 M	<10 M	65.5 M	<10 M		
Chromium, Hexavalent	<0.6 mg/kg	TM151		<3 #	<0.6 #	<0.6 #	<0.6 #		
Chromium, Trivalent NRA leach	<30 µg/l	TM152			<30	<30			
Arsenic (diss.filt) NRA leach	<0.12 µg/l	TM152			1.38	5.07			
Boron (diss.filt) NRA leach	<9.4 µg/l	TM152			<9.4	31.3			
Cadmium (diss.filt) NRA leach	<0.1 µg/l	TM152			<0.1	0.144			
Chro[illegible]n (diss.filt) NRA leach	<0.22 µg/l	TM152			0.736	0.975			
Copper (diss.filt) NRA leach	<0.85 µg/l	TM152			2.18	2.73			
Lead (diss.filt) NRA leach	<0.02 µg/l	TM152			5.11	0.602			
Nickel (diss.filt) NRA leach	<0.15 µg/l	TM152			1.34	4.62			
Selenium (diss.filt) NRA leach	<0.39 µg/l	TM152			<0.39	1.4			
Zinc (diss.filt) NRA leach	<0.41 µg/l	TM152			7.9	1.11			
Cyanide, Total	<1 mg/kg	TM153		<1 M	<1 M	<1 M	<1 M		
EPH Range >C10 - C40 (aq) NRA leach	<46 µg/l	TM172			<46	<46			
Sulphide, Easily liberated	<15 mg/kg	TM180		<15 #	<15 #	<15 #	<15 #		
Chromium, Trivalent	<0.9 mg/kg	TM181		20.6	16.8	11.5	19.3		
Arsenic	<0.6 mg/kg	TM181		16.9 M	38 M	13.1 M	24.6 M		
Cadmium	<0.02 mg/kg	TM181		2.81 M	3.55 M	2.13 M	11.1 M		
Chromium	<0.9 mg/kg	TM181		20.6 M	16.8 M	11.5 M	19.3 M		
Copper	<1.4 mg/kg	TM181		26.7 M	28.5 M	31.4 M	64.3 M		

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CERTIFICATE OF ANALYSIS

SDG:	121212-89	**Location:**	Church Raike	**Order Number:**	4595 / SH / 26192LG
Job:	H_SUTCLIFF_LPL-188	**Customer:**	Sutcliffe	**Report Number:**	207060
Client Reference:	26192LG	**Attention:**	Sara Hale	**Superseded Report:**	

Results Legend

#	ISO17025 accredited.
M	mCERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-48+$@	Sample deviation (see appendix)

Component	LOD/Units	Method	Customer Sample R	WS1	WS2	WS3	WS3		
			Depth (m)	1.00	0.50	0.50	1.20		
			Sample Type	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid		
			Date Sampled	11/12/2012	11/12/2012	11/12/2012	11/12/2012		
			Sample Time	-	-	-	-		
			Date Received	12/12/2012	12/12/2012	12/12/2012	12/12/2012		
			SDG Ref	121212-89	121212-89	121212-89	121212-89		
			Lab Sample No.(s)	6650720	6650721	6650722	6650723		
			AGS Reference						
Lead	<0.7 mg/kg	TM181		38.7 M	23.2 M	37.3 M	71.1 M		
Mercury	<0.14 mg/kg	TM181		<0.14 M	<0.14 M	<0.14 M	<0.14 M		
Nickel	<0.2 mg/kg	TM181		34.7 M	58.3 M	25.8 M	67.8 M		
Selenium	<1 mg/kg	TM181		1.65 #	1.39 #	1.56 #	4.88 #		
Zinc	<1.9 mg/kg	TM181		189 M	145 M	136 M	298 M		
Mercury (diss.filt) NRA leach	<0.01 µg/l	TM183			<0.01	<0.01			
Sulphate NRA leach	<2000 µg/l	TM184			10600	33800			
Sulphate, Total	<48 mg/kg	TM221		137 M	67.4 M	517 M	279 M		
Boron, water soluble	<1 mg/kg	TM222		<1 M	<1 M	<1 M	<1 M		
Cyanide, Total NRA leach	<50 µg/l	TM227			<50	<50			
Chromium, Hexavalent NRA leach	<30 µg/l	TM241			<30	<30			
Water Soluble Sulphate as SO4 2:1 Extract	<0.008 g/l	TM243		0.0145 M	0.0161 M	0.0798 M	0.0191 M		
Catechol (low level) NRA leach	<0.5 µg/l	TM255			<0.5	<0.5			
Phenol (low level) NRA leach	<0.5 µg/l	TM255			<0.5	<0.5			
Cresols (low level) NRA leach	<0.5 µg/l	TM255			<0.5	<0.5			
Xylenols (low level) NRA leach	<0.5 µg/l	TM255			<0.5	<0.5			
1-Napthol (low level) NRA leach	<0.5 µg/l	TM255			<0.5	<0.5			
Sum of Detected Monohydric Phenols NRA	<0.5 µg/l	TM255			<0.5	<0.5			
pH NRA leach	<1 pH Units	TM256			6.55	8.02			
Sulphur, Free NRA leach	<50 µg/l	TM294			<75	<75			

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CERTIFICATE OF ANALYSIS

SDG:	121212-89	**Location:**	Church Raike	**Order Number:**	4595 / SH / 26192LG
Job:	H_SUTCLIFF_LPL-188	**Customer:**	Sutcliffe	**Report Number:**	207060
Client Reference:	26192LG	**Attention:**	Sara Hale	**Superseded Report:**	

GRO by GC-FID (W)

Results Legend		Customer Sample R	TH2
#	ISO17025 accredited.		
M	mCERTS accredited.		
aq	Aqueous / settled sample.		
diss.filt	Dissolved / filtered sample.		
tot.unfilt	Total / unfiltered sample.		
*	Subcontracted test.		
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery		
(F)	Trigger breach confirmed		
1-4&+§@	Sample deviation (see appendix)		
		Depth (m)	0.40
		Sample Type	Soil/Solid
		Date Sampled	10/12/2012
		Sample Time	-
		Date Received	12/12/2012
		SDG Ref	121212-89
		Lab Sample No.(s)	6650715
		AGS Reference	

Component	LOD/Units	Method	
GRO >C5-C12 NRA leach	<50 µg/l	TM245	<50
Methyl tertiary butyl ether (MTBE) NRA leach	<3 µg/l	TM245	<3
Benzene NRA leach	<7 µg/l	TM245	<7
Toluene NRA leach	<4 µg/l	TM245	<4
Ethylbenzene NRA leach	<5 µg/l	TM245	<5
m,p-Xylene NRA leach	<8 µg/l	TM245	<8
o-Xylene NRA leach	<3 µg/l	TM245	<3
Sum of detected Xylenes NRA leach	<11 µg/l	TM245	<11
Sum of detected BTEX NRA leach	<28 µg/l	TM245	<28
GRO >C5-C10 NRA leach	<10 µg/l	TM245	<10

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CERTIFICATE OF ANALYSIS

Validated

SDG:	121212-89	**Location:**	Church Raike	**Order Number:**	4595 / SH / 26192LG
Job:	H_SUTCLIFF_LPL-188	**Customer:**	Sutcliffe	**Report Number:**	207060
Client Reference:	26192LG	**Attention:**	Sara Hale	**Superseded Report:**	

PAH by GCMS

Results Legend	
#	ISO17025 accredited.
M	mCERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-48+5@	Sample deviation (see appendix)

Component	LOD/Units	Method	Customer Sample R	TH1	TH2	TH3	TH4	TH5	WS1
			Depth (m)	0.60	0.40	0.60	0.50	0.50	0.50
			Sample Type	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid
			Date Sampled	10/12/2012	10/12/2012	10/12/2012	10/12/2012	10/12/2012	11/12/2012
			Sample Time	-	-	-	-	-	-
			Date Received	12/12/2012	12/12/2012	12/12/2012	12/12/2012	12/12/2012	12/12/2012
			SDG Ref	121212-89	121212-89	121212-89	121212-89	121212-89	121212-89
			Lab Sample No.(s)	6650714	6650715	6650716	6650717	6650718	6650719
			AGS Reference						
Naphthalene-d8 % recovery**	%	TM218		94.5	103	97.5	102	101	105
Acenaphthene-d10 % recovery**	%	TM218		87.9	104	96.5	102	101	105
Phenanthrene-d10 % recovery**	%	TM218		88.5	103	95.9	100	100	103
Chrysene-d12 % recovery**	%	TM218		83	103	85.5	94.5	91.2	97.3
Perylene-d12 % recovery**	%	TM218		78.1	106	87.5	93.9	95	97.9
Naphthalene	<0.009 mg/kg	TM218		0.613 M	0.0991 M	<0.009 M	<0.009 M	<0.009 M	<0.009 M
Acenaphthylene	<0.012 mg/kg	TM218		0.443 M	0.397 M	<0.012 M	<0.012 M	<0.012 M	<0.012
Acenaphthene	<0.008 mg/kg	TM218		17.9 M	0.13 M	<0.008 M	<0.008 M	<0.008 M	<0.008 M
Fluorene	<0.01 mg/kg	TM218		14.3 M	0.108 M	<0.01 M	<0.01 M	<0.01 M	<0.01 M
Phenanthrene	<0.015 mg/kg	TM218		134 M	1.99 M	0.0214 M	0.0321 M	0.0337 M	<0.015 M
Anthracene	<0.016 mg/kg	TM218		36.3 M	0.671 M	<0.016 M	<0.016 M	<0.016 M	<0.016 M
Fluoranthene	<0.017 mg/kg	TM218		169 M	12.7 M	<0.017 M	<0.017 M	0.0792 M	0.0252 M
Pyrene	<0.015 mg/kg	TM218		124 M	10.9 M	0.0223 M	0.0252 M	0.0745 M	0.0221 M
Benz(a)anthracene	<0.014 mg/kg	TM218		55.5 M	6.44 M	0.0242 M	0.0225 M	0.0499 M	<0.014 M
Chrysene	<0.01 mg/kg	TM218		44.5 M	4.78 M	0.0173 M	0.022 M	0.0596 M	0.015 M
Benzo(b)fluoranthene	<0.015 mg/kg	TM218		36.7 M	6.21 M	0.0246 M	0.0282 M	0.0801 M	0.0229 M
Benzo(k)fluoranthene	<0.014 mg/kg	TM218		16.8 M	2.89 M	<0.014 M	<0.014 M	0.0266 M	<0.014 M
Benzo(a)pyrene	<0.015 mg/kg	TM218		39.4 M	6.49 M	<0.015 M	<0.015 M	0.0488 M	0.0202 M
Indeno(1,2,3-cd)pyrene	<0.018 mg/kg	TM218		17.6 M	3.53 M	<0.018 M	<0.018 M	0.0368 M	<0.018 M
Dibenzo(a,h)anthracene	<0.023 mg/kg	TM218		5.21 M	0.953 M	<0.023 M	<0.023 M	<0.023 M	<0.023 M
Benzo(g,h,i)perylene	<0.024 mg/kg	TM218		19.4 M	3.92 M	<0.024 M	<0.024 M	0.0518 M	<0.024 M
PAH, Total Detected USEPA 16	<0.118 mg/kg	TM218		731	62.2	<0.118	0.13	0.541	<0.118

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CERTIFICATE OF ANALYSIS

SDG:	121212-89	**Location:**	Church Raike	**Order Number:**	4595 / SH / 26192LG
Job:	H_SUTCLIFF_LPL-188	**Customer:**	Sutcliffe	**Report Number:**	207060
Client Reference:	26192LG	**Attention:**	Sara Hale	**Superseded Report:**	

PAH by GCMS

Results Legend

#	ISO17025 accredited.
M	mCERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-48,+$@	Sample deviation (see appendix)

Component	LOD/Units	Method	Customer Sample R	WS1	WS2	WS3	WS3		
			Depth (m)	1.00	0.50	0.50	1.20		
			Sample Type	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid		
			Date Sampled	11/12/2012	11/12/2012	11/12/2012	11/12/2012		
			Sample Time	-	-	-	-		
			Date Received	12/12/2012	12/12/2012	12/12/2012	12/12/2012		
			SDG Ref	121212-89	121212-89	121212-89	121212-89		
			Lab Sample No.(s)	6650720	6650721	6650722	6650723		
			AGS Reference						
Naphthalene-d8 % recovery**	%	TM218		102	102	100	96.6		
Acenaphthene-d10 % recovery**	%	TM218		101	103	100	94.1		
Phenanthrene-d10 % recovery**	%	TM218		101	101	100	94.8		
Chrysene-d12 % recovery**	%	TM218		89.4	94.2	91.4	85.1		
Perylene-d12 % recovery**	%	TM218		92	94	95.1	85.9		
Naphthalene	<0.009 mg/kg	TM218		<0.009 M	<0.009 M	0.0313 M	0.0126 M		
Acenaphthylene	<0.012 mg/kg	TM218		<0.012 M	<0.012 M	<0.012 M	<0.012 M		
Acenaphthene	<0.008 mg/kg	TM218		<0.008 M	<0.008 M	0.0501 M	<0.008 M		
Fluorene	<0.01 mg/kg	TM218		<0.01 M	<0.01 M	0.0456 M	<0.01 M		
Phenanthrene	<0.015 mg/kg	TM218		<0.015 M	<0.015 M	0.21 M	0.0444 M		
Anthracene	<0.016 mg/kg	TM218		<0.016 M	<0.016 M	0.0426 M	<0.016 M		
Fluoranthene	<0.017 mg/kg	TM218		<0.017 M	<0.017 M	0.213 M	<0.017 M		
Pyrene	<0.015 mg/kg	TM218		<0.015 M	<0.015 M	0.177 M	0.0196 M		
Benz(a)anthracene	<0.014 mg/kg	TM218		<0.014 M	<0.014 M	0.106 M	0.0284 M		
Chrysene	<0.01 mg/kg	TM218		<0.01 M	<0.01 M	0.0806 M	0.0185 M		
Benzo(b)fluoranthene	<0.015 mg/kg	TM218		<0.015 M	<0.015 M	0.137 M	0.0274 M		
Benzo(k)fluoranthene	<0.014 mg/kg	TM218		<0.014 M	<0.014 M	0.042 M	<0.014 M		
Benzo(a)pyrene	<0.015 mg/kg	TM218		<0.015 M	<0.015 M	0.0872 M	<0.015 M		
Indeno(1,2,3-cd)pyrene	<0.018 mg/kg	TM218		<0.018 M	<0.018 M	0.0538 M	<0.018 M		
Dibenzo(a,h)anthracene	<0.023 mg/kg	TM218		<0.023 M	<0.023 M	<0.023 M	<0.023 M		
Benzo(g,h,i)perylene	<0.024 mg/kg	TM218		<0.024 M	<0.024 M	0.0742 M	<0.024 M		
PAH, Total Detected USEPA 16	<0.118 mg/kg	TM218		<0.118	<0.118	1.35	0.151		

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CERTIFICATE OF ANALYSIS

SDG:	121212-89	**Location:**	Church Raike	**Order Number:**	4595 / SH / 26192LG
Job:	H_SUTCLIFF_LPL-188	**Customer:**	Sutcliffe	**Report Number:**	207060
Client Reference:	26192LG	**Attention:**	Sara Hale	**Superseded Report:**	

PAH Spec MS - Aqueous (W)

Results Legend	
#	ISO17025 accredited.
M	mCERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-4&+&@	Sample deviation (see appendix)

Component	LOD/Units	Method	Customer Sample R	TH2	TH3	WS1	WS2	WS3	
			Depth (m)	0.40	0.60	0.50	0.50	0.50	
			Sample Type	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid	
			Date Sampled	10/12/2012	10/12/2012	11/12/2012	11/12/2012	11/12/2012	
			Sample Time						
			Date Received	12/12/2012	12/12/2012	12/12/2012	12/12/2012	12/12/2012	
			SDG Ref	121212-89	121212-89	121212-89	121212-89	121212-89	
			Lab Sample No.(s)	6650715	6650716	6650719	6650721	6650722	
			AGS Reference						
Naphthalene (aq) NRA leach	<0.1 µg/l	TM178		0.12	15.6	0.118	0.179	21.7	
Acenaphthene (aq) NRA leach	<0.015 µg/l	TM178		0.0238	1.59	<0.015	0.0195	19.5	
Acenaphthylene (aq) NRA leach	<0.011 µg/l	TM178		<0.011	<1.1	<0.011	<0.011	<1.1	
Fluoranthene (aq) NRA leach	<0.017 µg/l	TM178		0.069	<1.7	<0.017	0.168	1.96	
Anthracene (aq) NRA leach	<0.015 µg/l	TM178		0.0152	<1.5	<0.015	<0.015	<1.5	
Phenanthrene (aq) NRA leach	<0.022 µg/l	TM178		0.0692	2.25	<0.022	0.0277	8.05	
Fluorene (aq) NRA leach	<0.014 µg/l	TM178		0.0145	<1.4	<0.014	0.015	8.49	
Chrysene (aq) NRA leach	<0.013 µg/l	TM178		0.0236	<1.3	<0.013	0.1	<1.3	
Pyrene (aq) NRA leach	<0.015 µg/l	TM178		0.0519	<1.5	<0.015	0.153	2.03	
Benzo(a)anthracene (aq) NRA leach	<0.017 µg/l	TM178		<0.017	<1.7	<0.017	0.0439	<1.7	
Benzo(b)fluoranthene (aq) NRA leach	<0.023 µg/l	TM178		<0.023	<2.3	<0.023	<0.023	<2.3	
Benzo(k)fluoranthene (aq) NRA leach	<0.027 µg/l	TM178		<0.027	<2.7	<0.027	<0.027	<2.7	
Benzo(a)pyrene (aq) NRA leach	<0.009 µg/l	TM178		<0.009	<0.9	<0.009	<0.009	<0.9	
Dibenzo(a,h)anthracene (aq) NRA leach	<0.016 µg/l	TM178		<0.016	<1.6	<0.016	<0.016	<1.6	
Benzo(g,h,i)perylene (aq) NRA leach	<0.016 µg/l	TM178		<0.016	<1.6	<0.016	<0.016	<1.6	
Indeno(1,2,3-cd)pyrene (aq) NRA leach	<0.014 µg/l	TM178		<0.014	<1.4	<0.014	<0.014	<1.4	
PAH, Total Detected USEPA 16 (aq) NRA	<0.247 µg/l	TM178		0.387	25.3	<0.247	0.707	65.9	

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CERTIFICATE OF ANALYSIS

SDG:	121212-89	**Location:**	Church Raike	**Order Number:**	4595 / SH / 26192LG
Job:	H_SUTCLIFF_LPL-188	**Customer:**	Sutcliffe	**Report Number:**	207060
Client Reference:	26192LG	**Attention:**	Sara Hale	**Superseded Report:**	

PCBs by GCMS

Results Legend		Customer Sample R	TH2
#	ISO17025 accredited.		
M	mCERTS accredited.		
aq	Aqueous / settled sample.	Depth (m)	0.40
diss.filt	Dissolved / filtered sample.	Sample Type	Soil/Solid
tot.unfilt	Total / unfiltered sample.	Date Sampled	10/12/2012
*	Subcontracted test.	Sample Time	
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery	Date Received	12/12/2012
		SDG Ref	121212-89
(F)	Trigger breach confirmed	Lab Sample No.(s)	6650715
1-4&+$@	Sample deviation (see appendix)	AGS Reference	

Component	LOD/Units	Method					
PCBs (vs Aroclor 1254)	<0.035 mg/kg	TM070	<0.035 #				

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CERTIFICATE OF ANALYSIS

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SDG:	121212-89	**Location:**	Church Raike	**Order Number:**	4595 / SH / 26192LG
Job:	H_SUTCLIFF_LPL-188	**Customer:**	Sutcliffe	**Report Number:**	207060
Client Reference:	26192LG	**Attention:**	Sara Hale	**Superseded Report:**	

TPH CWG (S)

Method Legend	
#	ISO17025 accredited.
M	mCERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-4&+5@	Sample deviation (see appendix)

Component	LOD/Units	Method	Customer Sample R	TH3	WS1	WS2	WS3		
			Depth (m)	0.60	0.50	0.50	0.50		
			Sample Type	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid		
			Date Sampled	10/12/2012	11/12/2012	11/12/2012	11/12/2012		
			Sample Time	-	-	-	-		
			Date Received	12/12/2012	12/12/2012	12/12/2012	12/12/2012		
			SDG Ref	121212-89	121212-89	121212-89	121212-89		
			Lab Sample No.(s)	6650716	6650719	6650721	6650722		
			AGS Reference						
GRO Surrogate % recovery**	%	TM089		115	108	99	93		
GRO >C5-C12	<0.044 mg/kg	TM089		<0.044	<0.044	<0.044	0.507		
Methyl tertiary butyl ether (MTBE)	<0.005 mg/kg	TM089		<0.005 #	<0.005 #	<0.005 #	<0.005 #		
Benzene	<0.01 mg/kg	TM089		<0.01 M	<0.01 M	<0.01 M	<0.01 M		
Toluene	<0.002 mg/kg	TM089		<0.002 M	<0.002 M	<0.002 M	<0.002 M		
Ethylbenzene	<0.003 mg/kg	TM089		<0.003 M	<0.003 M	<0.003 M	0.00351 M		
m,p-Xylene	<0.006 mg/kg	TM089		<0.006 M	<0.006 M	<0.006 M	<0.006 M		
o-Xylene	<0.003 mg/kg	TM089		<0.003 M	<0.003 M	<0.003 M	0.00351 M		
sum of detected mpo xylene by GC	<0.009 mg/kg	TM089		<0.009	<0.009	<0.009	<0.009		
sum of detected BTEX by GC	<0.024 mg/kg	TM089		<0.024	<0.024	<0.024	<0.024		
Aliphatics >C5-C6	<0.01 mg/kg	TM089		<0.01	<0.01	<0.01	<0.01		
Aliphatics >C6-C8	<0.01 mg/kg	TM089		<0.01	<0.01	<0.01	0.0246		
Aliphatics >C8-C10	<0.01 mg/kg	TM089		<0.01	<0.01	<0.01	0.0491		
Aliphatics >C10-C12	<0.01 mg/kg	TM089		<0.01	<0.01	<0.01	0.227		
Aliphatics >C12-C16	<0.1 mg/kg	TM173		4.38	2.83	5.55	8.95		
Aliphatics >C16-C21	<0.1 mg/kg	TM173		6.47	3.46	7.63	17.7		
Aliphatics >C21-C35	<0.1 mg/kg	TM173		47	13.6	16.3	42.2		
Aliphatics >C35-C44	<0.1 mg/kg	TM173		6.01	3.69	3.61	6.2		
Total Aliphatics >C12-C44	<0.1 mg/kg	TM173		63.9	23.5	33.1	75.1		
Aromatics >EC5-EC7	<0.01 mg/kg	TM089		<0.01	<0.01	<0.01	<0.01		
Aromatics >EC7-EC8	<0.01 mg/kg	TM089		<0.01	<0.01	<0.01	<0.01		
Aromatics >EC8-EC10	<0.01 mg/kg	TM089		<0.01	<0.01	<0.01	0.0433		
Aromatics >EC10-EC12	<0.01 mg/kg	TM089		<0.01	<0.01	<0.01	0.151		
Aromatics >EC12-EC16	<0.1 mg/kg	TM173		<0.1	2.3	3.05	1.19		
Aromatics >EC16-EC21	<0.1 mg/kg	TM173		<0.1	2.63	3.2	7.88		
Aromatics >EC21-EC35	<0.1 mg/kg	TM173		18.9	18.1	11.4	30.9		
Aromatics >EC35-EC44	<0.1 mg/kg	TM173		1.87	5.89	3.54	4.31		
Aromatics >EC40-EC44	<0.1 mg/kg	TM173		<0.1	2.33	1.25	<0.1		
Total Aromatics >EC12-EC44	<0.1 mg/kg	TM173		20.8	28.9	21.2	44.3		
Total Aliphatics >C5-35	<0.1 mg/kg	TM173		57.9	19.9	29.5	69.2		
Total Aromatics >C5-35	<0.1 mg/kg	TM173		18.9	23	17.7	40.2		
Total Aliphatics & Aromatics >C5-35	<0.1 mg/kg	TM173		76.8	42.9	47.1	109		

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CERTIFICATE OF ANALYSIS

SDG:	121212-89	**Location:**	Church Raike	**Order Number:**	4595 / SH / 26192LG
Job:	H_SUTCLIFF_LPL-188	**Customer:**	Sutcliffe	**Report Number:**	207060
Client Reference:	26192LG	**Attention:**	Sara Hale	**Superseded Report:**	

TPH CWG (S)

Results Legend

#	ISO17025 accredited.
M	mCERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
^	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-4&+5@	Sample deviation (see appendix)

Component	LOD/Units	Method	Customer Sample R	TH3	WS1	WS2	WS3		
			Depth (m)	0.60	0.50	0.50	0.50		
			Sample Type	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid		
			Date Sampled	10/12/2012	11/12/2012	11/12/2012	11/12/2012		
			Sample Time						
			Date Received	12/12/2012	12/12/2012	12/12/2012	12/12/2012		
			SDG Ref	121212-89	121212-89	121212-89	121212-89		
			Lab Sample No.(s)	6650716	6650719	6650721	6650722		
			AGS Reference						
Total Aliphatics & Aromatics >C5-C44	<0.1 mg/kg	TM173		84.7	52.4	54.3	120		

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CERTIFICATE OF ANALYSIS

SDG:	121212-89	**Location:**	Church Raike	**Order Number:**	4595 / SH / 26192LG
Job:	H_SUTCLIFF_LPL-188	**Customer:**	Sutcliffe	**Report Number:**	207060
Client Reference:	26192LG	**Attention:**	Sara Hale	**Superseded Report:**	

TPH CWG (W)

Results Legend

#	ISO17025 accredited.
M	mCERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-4&+&@	Sample deviation (see appendix)

Component	LOD/Units	Method	Customer Sample R	TH3	WS1	WS2	WS3		
			Depth (m)	0.60	0.50	0.50	0.50		
			Sample Type	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid		
			Date Sampled	10/12/2012	11/12/2012	11/12/2012	11/12/2012		
			Sample Time	-	-	-	-		
			Date Received	12/12/2012	12/12/2012	12/12/2012	12/12/2012		
			SDG Ref	121212-89	121212-89	121212-89	121212-89		
			Lab Sample No.(s)	6650716	6650719	6650721	6650722		
			AGS Reference						
GRO >C5-C12 NRA leach	<50 µg/l	TM245		<50	<50	<50	<50		
Methyl tertiary butyl ether (MTBE) NRA leach	<3 µg/l	TM245		<3	<3	<3	<3		
Benzene NRA leach	<7 µg/l	TM245		<7	<7	16	<7		
Toluene NRA leach	<4 µg/l	TM245		<4	<4	5	<4		
Ethylbenzene NRA leach	<5 µg/l	TM245		<5	<5	<5	<5		
m,p-Xylene NRA leach	<8 µg/l	TM245		<8	<8	<8	<8		
o-Xylene NRA leach	<3 µg/l	TM245		<3	<3	<3	<3		
Sum of detected Xylenes NRA leach	<11 µg/l	TM245		<11	<11	<11	<11		
Sum of detected BTEX NRA leach	<28 µg/l	TM245		<28	<28	<28	<28		
GRO >C5-C10 NRA leach	<10 µg/l	TM245		<10	<10	12	<10		

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CERTIFICATE OF ANALYSIS

SDG:	121212-89	**Location:**	Church Raike	**Order Number:**	4595 / SH / 26192LG
Job:	H_SUTCLIFF_LPL-188	**Customer:**	Sutcliffe	**Report Number:**	207060
Client Reference:	26192LG	**Attention:**	Sara Hale	**Superseded Report:**	

Asbestos Identification - Soil

		Date of Analysis	Analysed By	Comments	Amosite (Brown) Asbestos	Chrysotile (White) Asbestos	Crocidolite (Blue) Asbestos	Fibrous Actinolite	Fibrous Anthophyllite	Fibrous Tremolite	Non-Asbestos Fibre
Cust. Sample Ref. Depth (m) Sample Type Date Sampled Date Received SDG Original Sample Method Number	TH1 0.60 SOLID 10/12/2012 00:00:00 121212-89 6650714 TM048	27/12/12	Kevin Bowron	-	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected
Cust. Sample Ref. Depth (m) Sample Type Date Sampled Date Received SDG Original Sample Method Number	TH2 0.40 SOLID 10/12/2012 00:00:00 121212-89 6650715 TM048	27/12/12	Chris Swindells	-	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected
Cust. Sample Ref. Depth (m) Sample Type Date Sampled Date Received SDG Original Sample Method Number	TH3 0.60 SOLID 10/12/2012 00:00:00 121212-89 6650716 TM048	27/12/12	Chris Swindells	-	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected
Cust. Sample Ref. Depth (m) Sample Type Date Sampled Date Received SDG Original Sample Method Number	TH4 0.50 SOLID 10/12/2012 00:00:00 121212-89 6650717 TM048	27/12/12	Kevin Bowron	-	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected
Cust. Sample Ref. Depth (m) Sample Type Date Sampled Date Received SDG Original Sample Method Number	TH5 0.50 SOLID 10/12/2012 00:00:00 121212-89 6650718 TM048	27/12/12	Chris Swindells	-	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected

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CERTIFICATE OF ANALYSIS

SDG:	121212-89	**Location:**	Church Raike	**Order Number:**	4595 / SH / 26192LG
Job:	H_SUTCLIFF_LPL-188	**Customer:**	Sutcliffe	**Report Number:**	207060
Client Reference:	26192LG	**Attention:**	Sara Hale	**Superseded Report:**	

		Date of Analysis	Analysed By	Comments	Amosite (Brown) Asbestos	Chrysotile (White) Asbestos	Crocidolite (Blue) Asbestos	Fibrous Actinolite	Fibrous Anthophyllite	Fibrous Tremolite	Non-Asbestos Fibre
Cust. Sample Ref. Depth (m) Sample Type Date Sampled Date Received SDG Original Sample Method Number	WS1 0.50 SOLID 11/12/2012 00:00:00 121212-89 6650719 TM048	27/12/12	Chris Swindells	-	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected
Cust. Sample Ref. Depth (m) Sample Type Date Sampled Date Received SDG Original Sample Method Number	WS1 1.00 SOLID 11/12/2012 00:00:00 121212-89 6650720 TM048	27/12/12	Chris Swindells	-	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected
Cust. Sample Ref. Depth (m) Sample Type Date Sampled Date Received SDG Original Sample Method Number	WS2 0.50 SOLID 11/12/2012 00:00:00 121212-89 6650721 TM048	27/12/12	Chris Swindells	-	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected
Cust. Sample Ref. Depth (m) Sample Type Date Sampled Date Received SDG Original Sample Method Number	WS3 0.50 SOLID 11/12/2012 00:00:00 121212-89 6650722 TM048	27/12/12	Chris Swindells	-	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected
Cust. Sample Ref. Depth (m) Sample Type Date Sampled Date Received SDG Original Sample Method Number	WS3 1.20 SOLID 11/12/2012 00:00:00 121212-89 6650723 TM048	27/12/12	Chris Swindells	-	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected

CERTIFICATE OF ANALYSIS

SDG:	121212-89	**Location:**	Church Raike	**Order Number:**	4595 / SH / 26192LG
Job:	H_SUTCLIFF_LPL-188	**Customer:**	Sutcliffe	**Report Number:**	207060
Client Reference:	26192LG	**Attention:**	Sara Hale	**Superseded Report:**	

Table of Results - Appendix

Method No	Reference	Description	Wet/Dry Sample ¹	Surrogate Corrected
ASB_PREP				
PM001		Preparation of Samples for Metals Analysis		
PM023	Leaching test method for the Assessment of Contaminated Land: Interim NRA Guidance. National Rivers Authority R & D note 301. (1994).	Leaching Procedure for NRA Leachates		
PM024	Modified BS 1377	Soil preparation including homogenisation, moisture screens of soils for Asbestos Containing Material		
TM008	BS 1377:Part 1977	Particle size distribution of solid samples		
TM048	HSG 248, Asbestos: The analysts' guide for sampling, analysis and clearance procedures	Identification of Asbestos in Bulk Material		
TM061	Method for the Determination of EPH,Massachusetts Dept.of EP, 1998	Determination of Extractable Petroleum Hydrocarbons by GC-FID (C10-C40)		
TM062 (S)	National Grid Property Holdings Methods for the Collection & Analysis of Samples from National Grid Sites version 1 Sec 3.9	Determination of Phenols in Soils by HPLC		
TM070	Modified: US EPA Method 8250 & 625	Determination of Total Polychlorinated Biphenyls (PCBs) as Aroclor 1254 by GC-MS in Soils		
TM089	Modified: US EPA Methods 8020 & 602	Determination of Gasoline Range Hydrocarbons (GRO) and BTEX (MTBE) compounds by Headspace GC-FID (C4-C12)		
TM090	Method 5310, AWWA/APHA, 20th Ed., 1999 / Modified: US EPA Method 415.1 & 9060	Determination of Total Organic Carbon/Total Inorganic Carbon in Water and Waste Water		
TM101	Method 4500B & C, AWWA/APHA, 20th Ed., 1999	Determination of Sulphide in soil and water samples using the Kone Analyser		
TM132	In - house Method	ELTRA CS800 Operators Guide		
TM133	BS 1377: Part 3 1990;BS 6068-2.5	Determination of pH in Soil and Water using the GLpH pH Meter		
TM136	Method 17.10, Second Site property, March 2003	Determination of Sulphur by HPLC		
TM151	Method 3500D, AWWA/APHA, 20th Ed., 1999	Determination of Hexavalent Chromium using Kone analyser		
TM152	Method 3125B, AWWA/APHA, 20th Ed., 1999	Analysis of Aqueous Samples by ICP-MS		
TM153	Method 4500A,B,C, I, M AWWA/APHA, 20th Ed., 1999	Determination of Total Cyanide, Free (Easily Liberatable) Cyanide and Thiocyanate using the Skalar SANS+ System Segmented Flow Analyser		
TM172	Analysis of Petroleum Hydrocarbons in Environmental Media – Total Petroleum Hydrocarbon Criteria	EPH in Waters		
TM173	Analysis of Petroleum Hydrocarbons in Environmental Media – Total Petroleum Hydrocarbon Criteria	Determination of Speciated Extractable Petroleum Hydrocarbons in Soils by GC-FID		
TM178	Modified: US EPA Method 8100	Determination of Polynuclear Aromatic Hydrocarbons (PAH) by GC-MS in Waters		
TM180	Sulphide in waters and waste waters 1991 ISBN 01 175 7186 SCA rec. 2007 (unpublished)'	The Determination Of Easily Liberated Sulphide In Soil Samples by Ion Selective Electrode Technique		
TM181	US EPA Method 6010B	Determination of Routine Metals in Soil by iCap 6500 Duo ICP-OES		
TM183	BS EN 23506:2002, (BS 6068-2.74:2002) ISBN 0 580 38924 3	Determination of Trace Level Mercury in Waters and Leachates by PSA Cold Vapour Atomic Fluorescence Spectrometry		
TM184	EPA Methods 325.1 & 325.2,	The Determination of Anions in Aqueous Matrices using the Kone Spectrophotometric Analysers		
TM218	Microwave extraction – EPA method 3546	Microwave extraction - EPA method 3546		
TM221	Inductively Coupled Plasma - Atomic Emission Spectroscopy. An Atlas of Spectral Information: Winge, Fassel, Peterson and Floyd	Determination of Acid extractable Sulphate in Soils by IRIS Emission Spectrometer		
TM222	In-House Method	Determination of Hot Water Soluble Boron in Soils (10:1 Water:soil) by IRIS Emission Spectrometer		
TM227	Standard methods for the examination of waters and wastewaters 20th Edition, AWWA/APHA Method 4500.	Determination of Total Cyanide, Free (Easily Liberatable) Cyanide and Thiocyanate		
TM241	Methods for the Examination of Waters and Associated Materials; Chromium in Raw and Potable Waters and Sewage Effluents 1980.	The Determination of Hexavalent Chromium in Waters and Leachates using the Kone Analyser		
TM243		Mixed Anions In Soils By Kone		
TM245	By GC-FID	Determination of GRO by Headspace in waters		
TM255		Determination of Low Level Phenols in Waters and Leachates by HPLC		
TM256	The measurement of Electrical Conductivity and the Laboratory determination of pH Value of Natural, Treated and Wastewaters. HMSO, 1978. ISBN 011 751428 4.	Determination of pH in Water and Leachate using the GLpH pH Meter		
TM294		Determination of Free Sulphur in liquids by HPLC		
TM321		Organic matter Content of Soil By Titration		

ALcontrol Laboratories

Validated

CERTIFICATE OF ANALYSIS

SDG:	121212-89	**Location:**	Church Raike	**Order Number:**	4595 / SH / 26192LG
Job:	H_SUTCLIFF_LPL-188	**Customer:**	Sutcliffe	**Report Number:**	207060
Client Reference:	26192LG	**Attention:**	Sara Hale	**Superseded Report:**	

[1] Applies to Solid samples only. DRY indicates samples have been dried at 35°C. NA = not applicable.

ALcontrol Laboratories

Validated

CERTIFICATE OF ANALYSIS

SDG:	121212-89	**Location:**	Church Raike	**Order Number:**	4595 / SH / 26192LG
Job:	H_SUTCLIFF_LPL-188	**Customer:**	Sutcliffe	**Report Number:**	207060
Client Reference:	26192LG	**Attention:**	Sara Hale	**Superseded Report:**	

Test Completion Dates

Lab Sample No(s)	6650714	6650715	6650716	6650717	6650718	6650719	6650720	6650721	6650722	6650723
Customer Sample Ref.	TH1	TH2	TH3	TH4	TH5	WS1	WS1	WS2	WS3	WS3
AGS Ref.										
Depth	0.60	0.40	0.60	0.50	0.50	0.50	1.00	0.50	0.50	1.20
Type	SOLID	SOLID	SOLID	SOLID	SOLID	SOLID	SOLID	SOLID	SOLID	SOLID
% Stones Greater than 10mm	18-Dec-2012	18-Dec-2012	18-Dec-2012	18-Dec-2012	18-Dec-2012	18-Dec-2012	18-Dec-2012	18-Dec-2012	18-Dec-2012	18-Dec-2012
Anions by Kone (soil)	19-Dec-2012	19-Dec-2012	18-Dec-2012	19-Dec-2012	19-Dec-2012	19-Dec-2012	19-Dec-2012	19-Dec-2012	18-Dec-2012	18-Dec-2012
Anions by Kone (w)		18-Dec-2012	18-Dec-2012			18-Dec-2012		18-Dec-2012	18-Dec-2012	
Asbestos Identification (Soil)	27-Dec-2012	27-Dec-2012	27-Dec-2012	27-Dec-2012	27-Dec-2012	27-Dec-2012	27-Dec-2012	27-Dec-2012	27-Dec-2012	27-Dec-2012
Boron Water Soluble	20-Dec-2012	20-Dec-2012	19-Dec-2012	20-Dec-2012	19-Dec-2012	20-Dec-2012	20-Dec-2012	20-Dec-2012	19-Dec-2012	19-Dec-2012
Chromium III	20-Dec-2012	20-Dec-2012	19-Dec-2012	20-Dec-2012	19-Dec-2012	20-Dec-2012	20-Dec-2012	20-Dec-2012	19-Dec-2012	19-Dec-2012
Cyanide Comp/Free/Total/Thiocyanate	19-Dec-2012	19-Dec-2012	19-Dec-2012	19-Dec-2012	18-Dec-2012	19-Dec-2012	19-Dec-2012	19-Dec-2012	19-Dec-2012	18-Dec-2012
Dissolved Metals by ICP-MS		18-Dec-2012	18-Dec-2012			18-Dec-2012		18-Dec-2012	18-Dec-2012	
Dissolved Organic/Inorganic Carbon		19-Dec-2012	19-Dec-2012			19-Dec-2012		19-Dec-2012	19-Dec-2012	
Easily Liberated Sulphide	19-Dec-2012	19-Dec-2012	18-Dec-2012	19-Dec-2012	18-Dec-2012	19-Dec-2012	19-Dec-2012	19-Dec-2012	18-Dec-2012	18-Dec-2012
Elemental Sulphur	20-Dec-2012	20-Dec-2012	20-Dec-2012	20-Dec-2012	20-Dec-2012	20-Dec-2012	20-Dec-2012	20-Dec-2012	20-Dec-2012	20-Dec-2012
EPH (DRO) (C10-C40) Aqueous (W)		19-Dec-2012	19-Dec-2012			19-Dec-2012		19-Dec-2012	19-Dec-2012	
EPH CWG (Aliphatic) GC (S)			20-Dec-2012			20-Dec-2012		20-Dec-2012	20-Dec-2012	
EPH CWG (Aromatic) GC (S)			20-Dec-2012			20-Dec-2012		20-Dec-2012	20-Dec-2012	
Free Sulphur		18-Dec-2012	18-Dec-2012			18-Dec-2012		18-Dec-2012	18-Dec-2012	
GRO [illegible]C-FID (S)			18-Dec-2012			19-Dec-2012		19-Dec-2012	18-Dec-2012	
GRO [illegible]C-FID (W)		18-Dec-2012	18-Dec-2012			18-Dec-2012		18-Dec-2012	18-Dec-2012	
Hexavalent Chromium (s)	19-Dec-2012	19-Dec-2012	18-Dec-2012	19-Dec-2012	18-Dec-2012	19-Dec-2012	19-Dec-2012	19-Dec-2012	18-Dec-2012	18-Dec-2012
Hexavalent Chromium (w)		18-Dec-2012	18-Dec-2012			18-Dec-2012		18-Dec-2012	18-Dec-2012	
Low Level Phenols by HPLC (W)		19-Dec-2012	19-Dec-2012			19-Dec-2012		19-Dec-2012	19-Dec-2012	
Mercury Dissolved		18-Dec-2012	18-Dec-2012			18-Dec-2012		18-Dec-2012	18-Dec-2012	
Metals by iCap-OES (Soil)	20-Dec-2012	20-Dec-2012	20-Dec-2012	20-Dec-2012	20-Dec-2012	20-Dec-2012	20-Dec-2012	20-Dec-2012	20-Dec-2012	20-Dec-2012
NRA Leachate		14-Dec-2012	14-Dec-2012			14-Dec-2012		14-Dec-2012	14-Dec-2012	
PAH by GCMS	19-Dec-2012	20-Dec-2012	19-Dec-2012	20-Dec-2012	19-Dec-2012	20-Dec-2012	19-Dec-2012	20-Dec-2012	19-Dec-2012	19-Dec-2012
PAH Spec MS - Aqueous (W)		19-Dec-2012	19-Dec-2012			19-Dec-2012		19-Dec-2012	19-Dec-2012	
PCBs by GCMS		20-Dec-2012								
pH	18-Dec-2012	18-Dec-2012	18-Dec-2012	18-Dec-2012	18-Dec-2012	18-Dec-2012	18-Dec-2012	18-Dec-2012	18-Dec-2012	18-Dec-2012
pH Value		18-Dec-2012	18-Dec-2012			18-Dec-2012		18-Dec-2012	18-Dec-2012	
Phenols by HPLC (S)	19-Dec-2012	19-Dec-2012	19-Dec-2012	19-Dec-2012	19-Dec-2012	19-Dec-2012	19-Dec-2012	19-Dec-2012	19-Dec-2012	19-Dec-2012
Sample description	17-Dec-2012	17-Dec-2012	17-Dec-2012	17-Dec-2012	17-Dec-2012	17-Dec-2012	18-Dec-2012	17-Dec-2012	17-Dec-2012	17-Dec-2012
Sulphide		18-Dec-2012	18-Dec-2012			18-Dec-2012		18-Dec-2012	18-Dec-2012	
Total Organic Carbon	28-Dec-2012	28-Dec-2012	28-Dec-2012	28-Dec-2012	28-Dec-2012	28-Dec-2012	28-Dec-2012	28-Dec-2012	28-Dec-2012	28-Dec-2012
Total Sulphate	20-Dec-2012	20-Dec-2012	19-Dec-2012	20-Dec-2012	19-Dec-2012	20-Dec-2012	20-Dec-2012	20-Dec-2012	19-Dec-2012	19-Dec-2012
TPH CWG GC (S)			20-Dec-2012			20-Dec-2012		20-Dec-2012	20-Dec-2012	

SDG:	121212-89	**Location:**	Church Raike	**Order Number:**	4595 / SH / 26192LG
Job:	H_SUTCLIFF_LPL-188	**Customer:**	Sutcliffe	**Report Number:**	207060
Client Reference:	26192LG	**Attention:**	Sara Hale	**Superseded Report:**	

Appendix

General

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

2. Samples will be run in duplicate upon request, but an additional charge may be incurred.

3. If sufficient sample is received a sub sample will be retained free of charge for 30 days after analysis is completed (e-mailed) for all sample types unless the sample is destroyed on testing. The prepared soil sub sample that is analysed for asbestos will be retained for a period of 2 months after the analysis date. All bulk samples will be retained for a period of 6 months after the analysis date. All samples received and not scheduled will be disposed of one month after the date of receipt unless we are instructed to the contrary. Once the initial period has expired, a storage charge will be applied for each month or part thereof until the client cancels the request for sample storage. ALcontrol Laboratories reserve the right to charge for samples received and stored but not analysed.

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

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

6. When requested, the individual sub sample scheduled will be analysed in house for the presence of asbestos fibres and asbestos containing material by our documented in house method TM048 based on HSG 248 (2005), which is accredited to ISO17025. If a specific asbestos fibre type is not found this will be reported as "Not detected". If no asbestos fibre types are found all will be reported as "Not detected" and the sub sample analysed deemed to be clear of asbestos. If an asbestos fibre type is found it will be reported as detected (for each fibre type found). Testing can be carried out on asbestos positive samples, but, due to Health and Safety considerations, may be replaced by alternative tests or reported as No Determination Possible. The quantity of asbestos present is not determined unless specifically requested.

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

8. If appropriate preserved bottles are not received preservation will take place on receipt. However, the integrity of the data may be compromised.

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

10. Metals in water are performed on a filtered sample, and therefore represent dissolved metals -total metals must be requested separately.

11. Results relate only to the items tested.

12. LODs for wet tests reported on a dry weight basis are not corrected for moisture content.

13. **Surrogate recoveries** -Most of our organic methods include surrogates, the recovery of which is monitored and reported. For EPH, MO, PAH, GRO and VOCs on soils the result is not surrogate corrected, but a percentage recovery is quoted. Acceptable limits for most organic methods are 70 -130 %.

14. **Product analyses** -Organic analyses on products can only be semi-quantitative due to the matrix effects and high dilution factors employed.

15. Phenols monohydric by HPLC include phenol, cresols (2-Methylphenol, 3-Methylphenol and 4-Methylphenol) and Xylenols (2,3 Dimethylphenol, 2,4 Dimethylphenol, 2,5 Dimethylphenol, 2,6 Dimethylphenol, 3,4 Dimethyphenol, 3,5 Dimethylphenol).

16. Total of 5 speciated phenols by HPLC includes Phenol, 2,3,5-Trimethyl Phenol, 2-Isopropylphenol, Cresols and Xylenols (as detailed in 15).

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

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

19. Mercury results quoted on soils will not include volatile mercury as the analysis is performed on a dried and crushed sample.

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

21. For all leachate preparations (NRA, DIN, TCLP, BSEN 12457-1, 2, 3) volatile loss may occur, as we do not employ zero headspace extraction.

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

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

Sample Deviations

1	**Container with Headspace provided for volatiles analysis**
2	**Incorrect container received**
3	**Deviation from method**
4	**Holding time exceeded before sample received**
5	**Sampled on date not provided**
*	**Sample holding time exceeded in laboratory**
@	**Sample holding time exceeded due to sampled on date**
&	**Sample Holding Time exceeded - Late arrival of instructions.**

Asbestos

Identification of Asbestos in Bulk Materials & Soils

The results for identification of asbestos in bulk materials are obtained from supplied bulk materials which have been examined to determine the presence of asbestos fibres using Alcontrol Laboratories (Hawarden) in-house method of transmitted/polarised light microscopy and central stop dispersion staining, based on HSG 248 (2005).

The results for identification of asbestos in soils are obtained from a homogenised sub sample which has been examined to determine the presence of asbestos fibre sing Alcontrol Laboratories (Hawarden) in-house method of transmitted/polaris light microscopy and central stop dispersion staining, based on HSG 248 (2005).

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

Visual Estimation Of Fibre Content

Estimation of fibre content is not permitted as part of our UKAS accredited test other than: -

Trace -Where only one or two asbestos fibres were identified.

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

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

Appendix F – Statistical Analysis

its	SGV	RESIDENTIAL WITH PLANT UPTAKE				LQM			121212-89 6650714	121212-89 6650715	121212-89 6650716	121212-89 6650717	121212-89 6650718	121212-89 6650719	121212-89 6650720	121212-89 6650721	121212-89 6650722	121212-89 6650723
		Atkins Atrisk 1% SOM	Additional Values for 1% SOM (mg/kg) See notes	Atkins Atrisk 6% SOM	Additional Values for 6% SOM (mg/kg) See notes	SOM 1%	SOM 2.5%	SOM 5%	TH1 0.60	TH2 0.40-	TH3 0.60-	TH4 0.50-	TH5 0.50-	WS1 0.50-	WS1 1.00-	WS2 0.50-	WS3 0.50-	WS3 1.20-
/kg	32	32		32					9.11	14.7	10	21.1	20.5	14.2	16.9	38	13.1	24.6
/kg							291		<1	1.24	<1	<1	<1	<1	<1	<1	<1	<1
/kg		10		10			3		0.885	1.68	1.61	3.23	1.73	1.36	2.81	3.55	2.13	11.1
/kg		12800		12900			627		8.38	19.7	12.8	12.1	17.1	14.8	20.6	16.8	11.5	19.3
/kg		14.2		14.5			4.3		<0.6	<3	<1.2	<0.6	<3	<3	<3	<0.6	<0.6	<0.6
/kg		3970		4020			2330		18.4	60.4	15.2	33.6	54.7	25.9	26.7	28.5	31.4	64.3
/kg		276		342					20.5	129	40.7	32.7	48.1	56.5	38.7	23.2	37.3	71.1
/kg	170	170		170					<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14
/kg	130	130		130					14.4	28.3	15.3	47.9	38.5	15.5	34.7	58.3	25.8	67.8
/kg	350	350		350					<1	1.46	1.73	6.69	2.01	1.65	1.65	1.39	1.56	4.88
/kg		16900		17200			3750		63.4	446	79.4	167	118	194	189	145	136	298
/kg		34		34					<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
/kg		162		420		210	390	780	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
									2	6.86	1.55	1.78	2.1	2.36	1.33	1.83	1.84	2.6
									906	533	329	690	202	274	137	67.4	517	279
/l									0.155	0.0499	0.0413	0.0376	<0.008	<0.008	0.0145	0.0161	0.0798	0.0191
/kg									<15	<15	<15	<15	<15	<15	<15	<15	<15	<15
nits									8.31	7.59	8.03	7.6	7.95	6.06	7.29	7.61	7.93	7.88
/kg									<10	<10	<10	<10	<10	<10	<10	<10	65.5	<10
/kg		30.1		259		30	55	110	N/S	N/S	<0.01	N/S	N/S	<0.01	N/S	<0.01	<0.01	N/S
/kg		69.8		14700	769	73	160	370	N/S	N/S	<0.01	N/S	N/S	<0.01	N/S	<0.01	0.0246	N/S
/kg		9.79		144		19	46	110	N/S	N/S	<0.01	N/S	N/S	<0.01	N/S	<0.01	0.0491	N/S
/kg		1390	49.9	4140	297	93	230	540	N/S	N/S	<0.01	N/S	N/S	<0.01	N/S	<0.01	0.227	N/S
/kg		5100	21	5260	126	740	1700	3000	N/S	N/S	4.38	N/S	N/S	2.83	N/S	5.55	8.95	N/S
/kg		145000		145000		45000	64000	76000	N/S	N/S	53.47	N/S	N/S	17.06	N/S	23.93	59.09	N/S
/kg						45000	64000	76000	N/S	N/S	6.01	N/S	N/S	3.69	N/S	3.61	6.2	N/S
/kg		0.0493		0.33		65	130	280	N/S	N/S	<0.01	N/S	N/S	<0.01	N/S	<0.01	<0.01	N/S
/kg		86.9		610		120	270	611	N/S	N/S	<0.01	N/S	N/S	<0.01	N/S	<0.01	<0.01	N/S
/kg		14.8		177		27	65	151	N/S	N/S	<0.01	N/S	N/S	<0.01	N/S	<0.01	0.0433	N/S
/kg		57.3		389		69	160	346	N/S	N/S	<0.01	N/S	N/S	<0.01	N/S	<0.01	0.151	N/S
/kg		142		687		140	310	593	N/S	N/S	<0.1	N/S	N/S	2.3	N/S	3.05	1.19	N/S
/kg		272		804		250	480	770	N/S	N/S	<0.1	N/S	N/S	2.63	N/S	3.2	7.88	N/S
/kg		888		1220		890	1100	1230	N/S	N/S	18.9	N/S	N/S	18.1	N/S	11.4	30.9	N/S
/kg						890	1100	1230	N/S	N/S	1.87	N/S	N/S	5.89	N/S	3.54	4.31	N/S
/kg	0.33	0.0493		0.33					N/S	N/S	<0.01	N/S	N/S	<0.01	N/S	<0.01	<0.01	N/S
/kg	610	86.9		610					N/S	N/S	<0.002	N/S	N/S	<0.002	N/S	<0.002	<0.002	N/S
/kg	350	38.2		350					N/S	N/S	<0.003	N/S	N/S	<0.003	N/S	<0.003	0.00351	N/S
/kg	240	17.9		240					N/S	N/S	<0.006	N/S	N/S	<0.006	N/S	<0.006	<0.006	N/S
/kg	230	17.2		230					N/S	N/S	<0.006	N/S	N/S	<0.006	N/S	<0.006	<0.006	N/S
/kg	250	18.9		250					N/S	N/S	<0.003	N/S	N/S	<0.003	N/S	<0.003	0.00351	N/S
/kg		0.585		8.71		1.5	3.7	8.7	0.613	0.0991	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	0.0313	0.0126
/kg						170	400	850	0.443	0.397	<0.012	<0.012	<0.012	<0.012	<0.012	<0.012	<0.012	<0.012
/kg		588	157	2130	937	210	480	1000	17.9	0.13	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	0.0501	<0.008
/kg		615	125	1930	746	160	380	780	14.3	0.108	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.0456	<0.01
/kg						92	200	380	134	1.99	0.0214	0.0321	0.0337	<0.015	<0.015	<0.015	0.21	0.0444
/kg		8270	3.48	18300	20.9	2300	4900	9200	36.3	0.671	<0.016	<0.016	<0.016	<0.016	<0.016	<0.016	0.0426	<0.016
/kg		822	18.9	2160	113	[illegible]	460	670	169	12.7	<0.017	<0.017	0.0792	0.0252	<0.017	<0.017	0.213	<0.017
/kg		563	2.2	1550	13.2	[illegible]	1000	1600	124	10.9	0.0223	0.0252	0.0745	0.0221	<0.015	<0.015	0.177	0.0196
/kg		4.52	1.71	8.54		3.1	4.7	5.9	55.5	6.44	0.0242	0.0225	0.0499	<0.014	<0.014	<0.014	0.106	0.0284
/kg		585	0.44	927	2.64	6	8	9.3	44.5	4.78	0.0173	0.022	0.0596	0.015	<0.01	<0.01	0.0806	0.0185

Job Name: Church Raike
Job Number: LG26192

		LEACHATES		121212-89	121212-90	121212-91	121212-92	121212-93
CAS Number	Units	Site Specific Guidelines		6650715	6650716	6650719	6650721	6650722
Sample Ref				TH2	TH3	WS1	WS2	WS3
Determinand Name		EQS	UK DWS	0.4	0.6	0.5	0.5	0.5
Leachate Prep □10:1 Std NRA□□								
Arsenic □Soluble□□	□g/l	50	10	2.58	0.517	1.07	1.38	5.07
Boron □Soluble□	mg/l	2000	1000	□0.0094	0.0182	□0.0094	□0.0094	0.0031
Cadmium □Soluble□	□g/l	5	5	□0.1	□0.1	□0.1	□0.1	0.144
Chromium □Soluble□	□g/l	5 to 250	50	1.48	4.31	1.26	0.736	0.975
Copper □Soluble□	□g/l	1 to 28	2000	5.79	2.38	6.77	2.18	2.73
Lead □Soluble□	□g/l	4 to 250	25	1.78	0.297	8.57	5.11	0.602
Mercury □Soluble□	□g/l	1	1	0.0575	□0.01	0.0214	□0.01	□0.01
Nickel □Soluble□	□g/l	50 to 200	50	1.4	1.12	2.37	1.34	4.62
Selenium □Soluble□□	□g/l		10	0.475	1.51	2.17	□0.39	1.4
Sulphur □Free□	mg/l			□75	□100	□75	□75	□75
□inc □Soluble□	□g/l	8 to 500	5000	7.14	1.52	7.42	7.9	1.11
Cyanide □Total□□	mg/l		50	□0.05	□0.05	0.558	□0.05	□0.05
Phenols □Total□	mg/l			0.00586	0.0009	0.00056	□0.0005	□0.0005
Sulphate as S□3	mg/l	400	250	26.5	18.4	35.4	10.6	33.8
Sulphide as S	□g/l	0.25		□10	□10		□10	□10
pH	pH units			7.9	8.15	7.61	6.55	8.02
□PH □C10 - C40				73.9	□46	□46	□46	□46
□□ PAH S□T□ □□								
naphthalene□	□g/l	5		0.12		0.118	0.179	21.7
acenaphthylene□	□g/l			0.0238	1.59	□0.015	0.0195	19.5
acenaphthene□	□g/l			□0.011	□1.1	□0.011	□0.011	□1.1
fluorene□	□g/l			0.0145	□1.4	□0.014	0.015	8.49
phenanthrene□	□g/l			0.0692	2.25	□0.022	0.0277	8.05
anthracene□	□g/l	0.02		0.0152	□1.5	□0.015	□0.015	□1.5
fluoranthene□	□g/l			0.069	□1.7	□0.017	0.168	1.96
pyrene□	□g/l			0.0519	□1.5	□0.015	0.153	2.03
ben□□a□anthracene□	□g/l			□0.017	□1.7	□0.017	0.0439	□1.7
chrysene□	□g/l			0.0236	□1.3	□0.013	0.1	□1.3
ben□□b□fluoranthene□	□g/l			□0.023	□2.3	□0.023	□0.023	□2.3
ben□□k□fluoranthene□	□g/l			□0.027	□2.7	□0.027	□0.027	□2.7
ben□□a□pyrene□	□g/l	0.03	0.01	□0.009	□0.9	□0.009	□0.009	□0.9
diben□□ah□anthracene□	□g/l			□0.016	□1.6	□0.016	□0.016	□1.6
ben□□ghi□perylene□	□g/l			□0.016	□1.6	□0.016	□0.016	□1.6
indeno□123cd□pyrene□	□g/l			□0.014	□1.4	□0.014	□0.014	□1.4
□□ TPH S□T□ □□								
ben□ene	□g/l			□7	□7	□7	16	□7
toluene	□g/l			□4	□4	□4	5	□4
ethylben□ene	□g/l			□5	□5	□5	□5	□5
o-□ylene	□g/l			□3	□3	□3	□3	□3
m,p-□ylene	□g/l			□8	□8	□8	□8	□8

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□asting	Northing	Sample ID	Arsenic □Total□	Boron □Soluble□	Cadmium □Total□	Chromium III	Chromium □I	Copper □Total□	Lead □Total□	Mercury □Total□	Nickel □Total□	Selenium □Total□	□inc □Total□	Cyanide □Total□	Phenols □Total□
			mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
		TH1 0.60	9.11	□1	0.885	8.38	□0.6	18.4	20.5	□0.14	14.4	□1	63.4	□1	□0.01
		TH2 0.40-	14.7	1.24	1.68	19.7	□3	60.4	129	□0.14	28.3	1.46	446	□1	□0.01
		TH3 0.60-	10	□1	1.61	12.8	□1.2	15.2	40.7	□0.14	15.3	1.73	79.4	□1	□0.01
		TH4 0.50-	21.1	□1	3.23	12.1	□0.6	33.6	32.7	□0.14	47.9	6.69	167	□1	□0.01
		TH5 0.50-	20.5	□1	1.73	17.1	□3	54.7	48.1	□0.14	38.5	2.01	118	□1	□0.01
		WS1 0.50-	14.2	□1	1.36	14.8	□3	25.9	56.5	□0.14	15.5	1.65	194	□1	□0.01
		WS2 0.50-	38	□1	3.55	16.8	□0.6	28.5	23.2	□0.14	58.3	1.39	145	□1	□0.01
		WS3 0.50-	13.1	□1	2.13	11.5	□0.6	31.4	37.3	□0.14	25.8	1.56	136	□1	□0.01
		WS3 1.20-	24.6	□1	11.1	19.3	□0.6	64.3	71.1	□0.14	67.8	4.88	298	□1	□0.01

Client/client ref: LHT
Project ref: LG26192
Site ref: Church Raike
Data description: MADE GROUND
Contaminants: METALS
Test scenario: Planning
Date: 10.01.2013
User details: SR

	Arsenic (Total) (mg/kg)	Boron (Soluble) (mg/kg)	Cadmium (Total) (mg/kg)	Chromium III (mg/kg)	Chromium VI (mg/kg)	Copper (Total) (mg/kg)	Lead (Total) (mg/kg)	Mercury (Total) (mg/kg)	Nickel (Total) (mg/kg)	Selenium (Total) (mg/kg)	Zinc (Total) (mg/kg)	Cyanide (Total) (mg/kg)	Phenols (Total) (mg/kg)
	32	291	10	12800	14.2	3970	276	170	130	350	16900	34	162
	Atkins 1	L M	Atkins 1	Atkins 1	Atkins 1	Atkins 1	Atkins 1	Atkins 1	Atkins 1	Atkins 1	Atkins 1	Atkins 1	Atkins 1
	9	9	9	9	9	9	9	9	9	9	9	9	9
	18.3677778	1.02666667	3.03055556	14.72	1.46666667	36.9333333	51.0111111	0.14	34.6444444	2.48555556	182.977778	1	0.01
	9.01786252	0.08	3.14571379	3.82244686	1.16619038	18.2540406	33.2761718	0	19.7436136	1.94362491	120.252919	0	0
	0	8	0	0	9	0	0	9	0	1	0	9	9
	Half detection limit	Detection limit	Half detection limit	Half detection limit	Detection limit	Half detection limit	Half detection limit	Detection limit	Half detection limit	Detection limit	Half detection limit	Detection limit	Detection limit
	[redacted]	[redacted]	[redacted]	No	No	No	[redacted]	No	No	[redacted]	[redacted]	No	No
	Normal	Non-normal	Non-normal	Normal	Non-normal	Normal	Non-normal	Single value	Normal	Non-normal	Normal	Single value	Single value
	Auto: One-sample t	Auto: Chebychev	Auto: Chebychev	Auto: One-sample t	Auto: Chebychev	Auto: One-sample t	Auto: Chebychev	Auto: Chebychev	Auto: One-sample t	Auto: Chebychev	Auto: One-sample t	Auto: Chebychev	Auto: Chebychev
	Planning: is true mean lower than critical concentration (μ < Cc)?						95%	Use Normal distribution to test for outliers					
	-4.535073203	-10874	-6.646610181	-10034.3684	-32.75622976	-646.386393	-20.28378355	N/A	-14.48907341	-536.3912192	-417.0465651	N/A	N/A
	23.957494	1.14290397	7.60117173	17.0893412	3.161102	48.2480885	99.3602678	0.14	46.8825104	5.30957707	257.516471	1	0.01
	100%	100%	98%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	evidence level	evidence level	evidence level	evidence level	evidence level	evidence level	evidence level	evidence level	evidence level	evidence level	evidence level	evidence level	evidence level
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	○ Y	○ Y	○ Y	○ Y	○ Y	○ Y	◉ Y	○ Y	○ Y	○ Y	○ Y	○ Y	○ Y

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Easting	Northing	Sample ID	benzene	toluene	ethylbenzene	m-xylene	p-xylene	o-xylene
			mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
		TH1 0.60						
		TH2 0.40-						
		TH3 0.60-	<0.01	<0.002	<0.003	<0.006	<0.006	<0.003
		TH4 0.50-						
		TH5 0.50-						
		WS1 0.50-	<0.01	<0.002	<0.003	<0.006	<0.006	<0.003
		WS2 0.50-	<0.01	<0.002	<0.003	<0.006	<0.006	<0.003
		WS3 0.50-	<0.01	<0.002	0.00351	<0.006	<0.006	0.00351
		WS3 1.20-						

Client/client ref: LHT
Project ref: LG26192
Site ref: Church Raike
Data description: Made Ground
Contaminant s: BT
Test scenario: Planning
Date: 10.01.2013
User details: SR

benzene (mg/kg)	toluene (mg/kg)	ethylbenzene (mg/kg)	m-xylene (mg/kg)	p-xylene (mg/kg)	o-xylene (mg/kg)				
0.0493	86.9	38.2	17.9	17.2	18.9				
Atkins Atrisk 1	Atkins Atrisk 1	Atkins Atrisk 1	Atkins Atrisk 1	Atkins Atrisk 1	Atkins Atrisk 1				
4	4	4	4	4	4	0	0	0	0
0.01	0.002	0.0031275	0.006	0.006	0.0031275	No Data	No Data	No Data	No Data
0	0	0.000255	0	0	0.000255				
4	4	3	4	4	3				
Detection limit	Detection limit	Detection limit	Detection limit	Detection limit	Detection limit	Half detection limit	Half detection limit	Half detection limit	Half detection limit
No	No	[illegible]	No	No	[illegible]				
Single value	Single value	Non-normal	Single value	Single value	Non-normal				
Auto: Chebychev	Auto: Chebychev	Auto: Chebychev	Auto: Chebychev	Auto: Chebychev	Auto: Chebychev	Auto	Auto	Auto	Auto

Planning: is true mean lower than critical concentration (μ < Cc)?

						95%	Use Normal distribution to test for outliers		
N/A	N/A	-299583.3137	N/A	N/A	-148210.7647				
0.01	0.002	0.00368326	0.006	0.006	0.00368326				
100%	100%	100%	100%	100%	100%				
evidence level	evidence level	evidence level	evidence level	evidence level	evidence level				
μ < Cc	μ < Cc	μ < Cc	μ < Cc	μ < Cc	μ < Cc				
○ Y	○ Y	○ Y	○ Y	○ Y	○ Y	◉ Y	○ Y	○ Y	○ Y

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Easting	Northing	Sample ID	naphthalene	acenaphthylene	acenaphthene	fluorene	phenanthrene	anthracene	fluoranthene	pyrene	benzo(a)anthracene	chrysene	benzo(b)fluoranthene	benzo(k)fluoranthene	benzo(a)pyrene	dibenzo(ah)anthracene	benzo(ghi)perylene	indeno(123cd)pyrene
			mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
		TH1 0.60	0.613	0.443	17.9	14.3	134	36.3	169	124	55.5	44.5	36.7	16.8	39.4	5.21	19.4	17.6
		TH2 0.40-	0.0991	0.397	0.13	0.108	1.99	0.671	12.7	10.9	6.44	4.78	6.21	2.89	6.49	0.953	3.92	3.53
		TH3 0.60-	<0.009	<0.012	<0.008	<0.01	0.0214	<0.016	<0.017	0.0223	0.0242	0.0173	0.0246	<0.014	<0.015	<0.023	<0.024	<0.018
		TH4 0.50-	<0.009	<0.012	<0.008	<0.01	0.0321	<0.016	<0.017	0.0252	0.0225	0.022	0.0282	<0.014	<0.015	<0.023	<0.024	<0.018
		TH5 0.50-	<0.009	<0.012	<0.008	<0.01	0.0337	<0.016	0.0792	0.0745	0.0499	0.0596	0.0801	0.0266	0.0488	<0.023	0.0518	0.0368
		WS1 0.50-	<0.009	<0.012	<0.008	<0.01	<0.015	<0.016	0.0252	0.0221	<0.014	0.015	0.0229	<0.014	0.0202	<0.023	<0.024	<0.018
		WS2 0.50-	<0.009	<0.012	<0.008	<0.01	<0.015	<0.016	<0.017	<0.015	<0.014	<0.01	<0.015	<0.014	<0.015	<0.023	<0.024	<0.018
		WS3 0.50-	0.0313	<0.012	0.0501	0.0456	0.21	0.0426	0.213	0.177	0.106	0.0806	0.137	0.042	0.0872	<0.023	0.0742	0.0538
		WS3 1.20-	0.0126	<0.012	<0.008	<0.01	0.0444	<0.016	<0.017	0.0196	0.0284	0.0185	0.0274	<0.014	<0.015	<0.023	<0.024	<0.018

Client/client ref: LHT
Project ref: LG26182
Site ref: Church Raike
Data description: MADE GROUND
Contaminant/s: PAH's
Test scenario: Planning
Date: 10.01.2013
User details: SR

	naphthalene (mg/kg)	acenaphthylene (mg/kg)	acenaphthene (mg/kg)	fluorene (mg/kg)	phenanthrene (mg/kg)	anthracene (mg/kg)	fluoranthene (mg/kg)	pyrene (mg/kg)	benzo(a)anthracene (mg/kg)	chrysene (mg/kg)	benzo(b)fluoranthene (mg/kg)	benzo(k)fluoranthene (mg/kg)	benzo(a)pyrene (mg/kg)	dibenzo(ah)anthracene (mg/kg)	benzo(ghi)perylene (mg/kg)	indeno(123cd)pyrene (mg/kg)
	0.585 Atkins 10	170 LCM 10	588 Atkins 10	615 Atkins 10	92 LCM 10	8270 Atkins 10	822 Atkins 10	563 Atkins 10	4.52 Atkins 10	585 Atkins 10	7.75 Atkins 10	84.4 Atkins 10	0.818 Atkins 10	0.838 Atkins 10	96.2 Atkins 10	7.31 Atkins 10
	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
	0.089	0.10266667	2.01423333	1.61262222	15.1512889	4.12328889	20.2317111	15.0284111	[redacted]	5.50033333	4.80502222	2.20317778	[redacted]	0.70266667	2.61844444	2.36784444
	0.19869709	0.18027826	5.95730193	4.75788017	44.5729111	12.0681916	55.9448649	41.0215962	18.3435354	14.7089552	12.1330542	5.55651101	13.0302217	1.71800568	6.42291997	5.82844944
	5	7	6	6	2	6	4	1	2	1	1	5	4	7	5	5
	Detection limit	Detection limit	Detection limit	Detection limit	Detection limit	Detection limit	Detection limit	Detection limit	Detection limit	Detection limit	Detection limit	Detection limit	Detection limit	Detection limit	Detection limit	Detection limit
	[redacted]	No	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal
	Auto: Chebychev	Auto: Chebychev	Auto: Chebychev	Auto: Chebychev	Auto: Chebychev	Auto: Chebychev	Auto: Chebychev	Auto: Chebychev	Auto: Chebychev	Auto: Chebychev	Auto: Chebychev	Auto: Chebychev	Auto: Chebychev	Auto: Chebychev	Auto: Chebychev	Auto: Chebychev
	Planning: is true mean lower than critical concentration (μ < Cc)?						95%	Use Normal distribution to test for outliers								
	-7.488786173	-2827.25165	-295.0928657	-386.7609248	-5.172337357	-2054.782543	-42.99435851	-40.07437347	0.391036943	-118.1932353	-0.728170597	-44.3866399	0.991136881	-0.236320523	-43.70981861	-2.543809777
	0.37770017	0.3646049	10.6899924	8.52566183	79.9142273	21.6579648	101.517425	74.6314086	33.563539	26.8719497	22.4339413	10.2751481	24.0553844	3.19887104	11.9507308	10.8363851
	98%	100%	100%	100%	96%	100%	100%	100%	0%	100%	35%	100%	0%	5%	100%	87%
	evidence level	evidence level	evidence level	evidence level	evidence level	evidence level	evidence level	evidence level	evidence level	evidence level	evidence level	evidence level	evidence level	evidence level	evidence level	evidence level
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	μ ≥ Cc	[redacted]	μ ≥ Cc	[redacted]	μ ≥ Cc	μ ≥ Cc	[redacted]	μ ≥ Cc
	○ Y	○ Y	○ Y	○ Y	○ Y	○ Y	○ Y	○ Y	● Y	○ Y	○ Y	○ Y	○ Y	○ Y	○ Y	○ Y

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Project details

Easting	Northing	Sample ref.	benzo[a]anthracene	benzo[b]fluoranthene	benzo[a]pyrene	dibenz[ah]anthracene	indeno[123-cd]pyrene
			mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
		TH1 0.60					
		TH2 0.40-	6.44	6.21		0.953	3.53
		TH3 0.60-	0.0242	0.0246	<0.015	<0.023	<0.018
		TH4 0.50-	0.0225	0.0282	<0.015	<0.023	<0.018
		TH5 0.50-	0.0499	0.0801	0.0488	<0.023	0.0368
		WS1 0.50-	<0.014	0.0229	0.0202	<0.023	<0.018
		WS2 0.50-	<0.014	<0.015	<0.015	<0.023	<0.018
		WS3 0.50-	0.106	0.137	0.0872	<0.023	0.0538
		WS3 1.20-	0.0284	0.0274	<0.015	<0.023	<0.018

Client/client ref: LHT
Project ref: 26192LG
Site ref: Church Raike
Data description: MAD□ GR□□ND
Contaminant□ PAH □□TU□RS
Test scenario: Planning
Date: 10.01.12
□ser details: SR

benzo(a)anthracene (mg/kg)	benzo(b)fluoranthene (mg/kg)	benzo(e)pyrene (mg/kg)	dibenzo(ah)anthracene (mg/kg)	Indeno(123cd)pyrene (mg/kg)					
4.52	7.75	0.818	0.838	7.31					
Atkins 1□	Atkins 1□	Atkins 1□	Atkins 1□	Atkins 1□					
8	8	7	8	8	0	0	0	0	0
0.837375	0.81815	0.03088571	0.13925	0.463825	No Data	No Data	No Data	No Data	No Data
2.26400534	2.17903092	0.02773634	0.32880465	1.2389915					
2	1	4	7	5					
Detection limit	Detection limit	Detection limit	Detection limit	Detection limit	Half detection limit	Half detection limit	Half detection limit	Half detection limit	Half detection limit
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]					
Non-normal	Non-normal	Non-normal	Non-normal	Non-normal					
Auto: Chebychev	Auto: Chebychev	Auto: Chebychev	Auto: Chebychev	Auto: Chebychev	Auto	Auto	Auto	Auto	Auto

Planning: is true mean lower than critical concentration (μ < Cc)? | 95% | Use Normal distribution to test for outliers

-4.600711953	-8.997684429	-75.0823063	-6.010752688	-15.62876501					
4.32644156	4.17626218	0.07658159	0.645972	2.37323914					
95%	99%	100%	97%	100%					
evidence level	evidence level	evidence level	evidence level	evidence level					
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]					
○ Y	○ Y	○ Y	○ Y	○ Y	○ Y	◉ Y	○ Y	○ Y	○ Y

Back to data | Go to outlier test | Go to normality test | Show individual summary

Appendix G – Risk Assessment

RISK ASSESSMENT METHODOLOGY

GENERAL

The purpose of this appendix is to describe in detail the concepts underlying the risk based approach to assessing potentially contaminated land, introduce the roles of key legislation and describe the qualitative methodology adopted for evaluating and characterising risk.

Current best practice in the UK promotes a risk-based approach to dealing with both soil and groundwater contamination. The principal aim of the approach is to ensure protection of human health and the environment in a thorough, transparent and cost-effective manner.

Fundamental to the risk-based approach is the concept that for 'Contaminated Land' to be designated, as a consequence of historic activities, a pathway for contamination must be shown to exist between a source of contamination and a receptor. The combined presence of a source, pathway and a receptor is described as a 'pollutant linkage'.

The concepts associated with a contaminant source, pathway and receptor are defined in DETR Circular 02/2000 'Contaminated Land Environmental Protection Act 1990: Part II A'. A ***source*** of contamination may be considered as a 'substance which is in, on or under land that has the potential to cause harm or to cause pollution of controlled waters'. A ***receptor*** can be considered as either 'a living organism, a group of living organisms, an ecological system or a piece of property which is being, or could be harmed, by a contaminant or controlled waters which are being, or could be, polluted by a contaminant'. A ***pathway*** may be considered as one or more routes by, or through, which a receptor is being, or could be, exposed to or affected, by a contaminant. Typical pathways may include migration in groundwater, surface water run-off or infiltration, inhalation, dermal contact and ingestion.

The risks posed by an identified pollutant linkage can often be mitigated by removing the source of contamination, treating the source of contamination, blocking the relevant pathway(s) or by protecting the receptor.

PRINCIPLES OF RISK EVALUATION

The risk evaluation methodology presented below is qualitative in nature, and is therefore a subjective method. It is based upon guidance presented in CIRIA publication referenced C552, 'Contaminated land risk assessment - A guide to good practice', 2001 and involves the classification of the following.

The magnitude of the potential **consequence** (severity) of risks occurring (Table 1).

The magnitude of the **probability** (likelihood) of the risk occurring (Table 2).

These are then considered in conjunction to give a risk matrix (Table 3)

Table 1 - Classification of consequence

Classification	Definition	Examples
Severe	Short-term (acute) risk to human health likely to result in "significant harm" as defined by the Environmental 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, or organism forming part of such 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 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/ services 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 human 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. Discolouration of concrete.

Table 2 - 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 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 3 - 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 4 - 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 works 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, it is 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.

Table 5 - Response action likely to be required in relation to estimated risk

KEY

- Mitigation and remedial measures required
- Mitigation and remedial measures likely
- Remedial measures unlikely
- Remedial measures not required

RISK ASSESSMENT FOR THE WATER ENVIRONMENT

The risk assessment has been developed to provide a greater level of standardisation. It includes relevant elements from TAG (Transport Analysis Guidance)(Table 1 relating to the features described as river, floodplain, groundwater and stillwaters, including their attributes/services and selected/modified indicators of (uality and possible measures. Two additional columns have been added for (grading(and (importance level(. These columns e(pand on the limited number of e(amples provided in TAG Table 2. Table 1 has been developed with reference to TAG, Highways Agency(s (New Approach to Appraisal((NATA(, the ((ater Framework Directive and other sources as referenced in the table.

Table 1 here relies on easily available data to avoid unnecessary data collection. Should inade(uate data be available a (worst case(should be assumed. The table is designed to act as a guide to determining importance and to raise the level of compatibility in predicting the significance of impacts on the water environment.

(nce Table 1 has been used to determine the importance of the environmental attributes that may be affected by a particular development project, Tables 3 and 4 of TAG (nit 3.3.11 can be used to estimate the significance of potential impacts. These tables are reproduced here as Tables 2 and 3 respectively. Table 2 provides a methodology for determining impact magnitude. Table 3 is a matri(that allows the significance of the impact to be calculated based on the impact magnitude and the importance of the attribute. The significance of impacts can range from (nsignificant(to (ery significant(.

Table 1: Water features, their attributes, indicators of quality, grading and importance (adapted from Table 1 of TAG unit 3.3.11)

Feature	Attribute / Service	Indicator of Quality	Measure	Grading	Importance Level
River	(ater Supply	Chemical water (uality	(nvironment Agency(s Chemical General (uality Assessment (G(A(	A B C-D (-F	(ery High High Medium Low
		Industrial / agricultural abstractions	Location and volume of abstraction	All abstractions within 2km downstream: (1000m3/day 500-1000m3/day 50-499m3/day (50m3/day	(ery High High Medium Low
		Drinking water supply	Classification defined within The Surface (aters (Abstraction for Drinking (ater((Classification(Regulations 1996. No 3001[2]	Classification: D(1 or D(2 within critical travel time for pollution downstream D(3 within critical time downstream Not designated	(ery High High Medium - Low
	Biodiversity[3]	Biological (ater (uality	(nvironment Agency(s Biological G(A[1]	A B C-D (-F	(ery High High Medium Low
		Fisheries (uality	Fisheries status as defined within the Freshwater Fish Directive 78/659/((C	Designated salmonid fishery Designated cyprinid fishery (ndesignated fishery Not a fishery	(ery High High Medium Low

Feature	Attribute / Service	Indicator of Quality	Measure	Grading	Importance Level
River	Transport and dilution of waste product	Surface □ ater / effluent discharges	Type of discharges with reference to the □C Dangerous Substances Directive □76/464/□□C and Daughter Directives□	All discharges within 2km up or downstream: List I List II □ther discharge / no discharge	 □ery High - High Medium Medium - Low
	Recreation	Riverside access	Presence / absence of route and importance	National trail / cycleway Regional trail Definitive footpath / bridleway No route	□ery High High Medium Low
		Presence of clubs/ recreation use	Presence / absence	Club recreation use present No club / recreation use	□ery High - High - Medium Low
	Conveyance of flow and material	Presence of water courses	Si□e of watercourses[5]	Main River □ 10m wide Main River □ 10m wide □rdinary watercourse □5m wide □ther	□ery High High Medium Low
Floodplain	Flood defence	Importance in relation to flood defence	Status of flood plain area	Designated washland Active floodplain □□lsting defended area Does not flood	□ery High High Medium Low
			Return period	□ □ie more fre□uent then□1 in 25 years □ 1 in 25 years □1 in 100 years □urban□ □1 in 50 years □1 in 200 years	□ery High High Medium Medium Low
Groundwater	□ ater supply	Industrial / agricultural abstractions	Location and volume of abstraction	All abstraction points within □one of influence of development: □1000m3/day □500-1000m3/day 50-499m3/day □50m3/day	 □ery High High Medium Low
		Drinking water supply	Presence of potable public supply or private water supply within □ one of influence of development	Public supply Private water supply □ 10m3/day or serves □50 people[6] □ther private water supply No supply	□ery High High Medium Low
		Groundwater vulnerability	Source protection status	□ ithin □one 1,2 or 3 of a source protection □one Not within a source protection □one	□ery High High Medium Low
			Classification of a□uifer vulnerability	Major a□uifer with H soils or I soils or □ soils. Minor a□uifer with H soils or □ soils Major a□uifer with L soils. Minor a□uifer with L soils or non a□uifer	□ery High High Medium Low
	Conveyance of flood flows	Acceptance potential of flood flows	Soil type / groundwater table levels[8]	Gravels with low water table □□1m below infiltration point□ Sands with low water table All soil types with high water table Clay	□ery High High Medium Low
Stillwaters □lakes and ponds□	Biodiversity[3]	Biological water □uality	Classification system to be developed under the □ ater Framework Directive for ecological status / potential		
		Fisheries □uality	Fisheries status as defined within the Freshwater Fish Directive 78/659/□□C	Designated salmonid fishery Designated cyprinid fishery □ndesignated fishery Not a fishery	□ery High-high High - medium Medium - low Low
	□ ater supply	□se for abstraction	Presence / absence	Abstraction No abstraction	□ery High - High □ Medium[9] Low
	Recreation	Presence of clubs / recreation use	Presence / absence	Club recreation use present No club / recreation use	□ery High - High - Medium[4] Low

Notes to Table 1

1 If the river is unclassified and hence has no G□A grade, the □uality can be measured or assumptions can be made based on the grade of the nearest classified stretch.

2 An importance level of high or very high must also be awarded if the water feature provides more than 10m3/day of drinking water, or serves more than 50 people, which is the definition used in the □ ater Framework Directive to define drinking water protected areas.

3 Conservation value is not included, as this should be included within an ecology/nature conservation assessment.

4 This re□uired judgement on a case by case basis because the importance of use by people is being assessed, and they are sensitive to being categorised as unimportant. Careful assessment is thus re□uired, using as much data as possible eg on the facilities, their scale and fre□uency of use, membership levels and economic value.

5 An importance level of □Medium□or greater must also be awarded if a river has a catchment greater than 10km2, as this means that it will be classified as a water body under the □ ater Framework Directive. □ther measures are available for describing the ability of watercourses to convey flow and material □such as the carrying capacity of the channel for flood flows□and could if necessary be substituted.

6 Based on criteria given within the □ ater Frame □ ork Directive for features to be designated as drinking water protected areas.

7 Adapted from NRA Policy and Practice for the Protection of Groundwater, Groundwater □ulnerability Sheets, NRA 1994. Because soil information in urban areas is less reliable and based on fewer observations than in rural areas, the worst case is assumed and such land is classified as being high of leaching potential. H □ high, I □ Intermediate, L □ Low and □ □ □nclassified leaching potential.

8 This uses a coarse basis of permeability together with the ability of the e□isting ground conditions to accept additional flows. For e□ample, gravels in a river floodplain are unlikely to have a high acceptance potential because of raised water table due to river flows. Sands above a relatively dry substrata would have a high potential, however caution is re□uired in areas such as chalk with highly fluctuating groundwater levels.

9 Depends on use of water, volume abstracted etc. An importance level of □High□or □□ery high□mus be awarded if the water feature provides more than 10m3/day of drinking water, or serves more than 50 people, which is the definition used in the □ ater Framework Directive to define drinking water protected areas.

Table 2: Criteria for determining impact magnitude (reproduced from Table 3 of TAG unit 3.3.11)

Magnitude	Criteria	Example
Major	Results in loss of attribute	• Loss of □C designated Salmonid fishery • Compromise employment source • Pollution of potable source of abstraction • Change in G□A grade of river reach • Loss of flood storage / increased flood risk
Moderate	Results in impact on integrity of attribute or loss of art of attribute	• Loss in productivity of a fishery • Contribution of a significant proportion of the effluent in the receiving river, but insufficient to change its G□A grade • Reduction in the economic value of the feature
Minor	Results in minor impact on attribute	• Measurable change in attribute, but of limited si□e and/or proportion
Negligible	Results in an impact on attribute but of insufficient magnitude to affect the use / integrity	• Discharges to watercourse but no significant loss in □uality, fishery productivity or biodiversity • No significant impact on the economic value of the feature • No increase in flood risk

Table 3: Significance Criteria of Potential Impacts
(Reproduced from Table 4 of TAG unit 3.3.11)

Magnitude of Potential impact	Importance of Attribute			
	Very High	High	Medium	Low
Major	ery Significant	ery Significant	Significant	Low Significant
Moderate	ery Significant	Significant	Low Significant	Insignificant
Minor	Significant	Low Significant	Insignificant	Insignificant
Negligible	Low Significant	Insignificant	Insignificant	Insignificant

Table 4: Proposed impact assessment summary table

Feature	Attribute / Service	Importance Level	Magnitude of Impact	Significance of Impact
River	ater Supply	ery High	Minor	Significant

References

1 The Highways Agency et al, Design Manual for Roads and Bridges, ol 11. nvironmental Assessment, 1993.
2 D TR Guidance on the New Approach to Appraisal, 1998.
3 Department for Transport, Transport Analysis Guidance TAG 2003