

<b>CLIENT:</b>	Jones Homes (Yorkshire) Limited
<b>PROJECT:</b>	Land at Primrose Lane, Liversedge
<b>SUBJECT:</b>	Proposed Additional Phase 2 Investigations
<b>JOB NO:</b>	LD11143
<b>DATE:</b>	17 <sup>th</sup> January 2025
<b>PREPARED BY:</b>	Jonathan Currie (Wardell Armstrong, Associate Director)
<b>CHECKED BY:</b>	Verity Curtis (Principal Geoenvironmental Engineer)

## INTRODUCTION

This Technical Note has been prepared by Wardell Armstrong (WA) to provide a proposed scope of additional Phase 2 Ground Investigation (GI) works to address those outstanding comments raised by Kirklees Council Environmental Health (KCEH), pursuant to Local Planning Authority number 2023/62/91116/E, for the proposed development of 77 No. dwellings at land off Primrose Lane, Hightown, Liversedge (the Site).

It is intention for the proposed scope of Phase 2 GI works to be agreed with KCEH prior to their commencement on Site on the 27<sup>th</sup> January 2025.

## BACKGROUND

Comments were originally received from KCEH in letters dated 5<sup>th</sup> June 2023 (Ref: WK/202314249), 7<sup>th</sup> August 2023 (Ref: WK/202321391) and 27<sup>th</sup> February 2024 (Ref: WK/202404236) in relation to the Site Investigation (SI), Generic Quantitative Risk Assessment (GQRA) and ground gas risk assessments prepared by Michael D Joyce Associates LLP (MDJA), as well as supplementary investigations completed by WA.

Following the submission of a series of correspondence and technical notes prepared by Wardell Armstrong (the most recent is enclosed at Appendix A), many of the original queries raised by KCEH have been addressed, which has allowed them to remove their objections to the planning application and provide pragmatic planning condition recommendations to the case officer for review.

From a review of the most recent correspondence from KCEH and the Strategic Planning Committee Report dated 05<sup>th</sup> December 2024, the planning condition approach appears to have been agreed, but the following additional intrusive contaminated land investigation works are required in the immediate short term:

- The installation of additional ground gas monitoring wells, further ground gas monitoring and the completion of a comprehensive ground and mine gas risk assessment to assess

all potential gas sources and migration pathways, including those from the proposed piling activities in the north of the site.

- The undertaking of additional calorific value testing for the colliery spoil within the northern woodland area and clarification as to whether the previously proposed mitigation (i.e. calorific values greater than 7MJ/kg being located at least 1m from ignition sources and beneath a 1m thick inert layer in gardens and landscaped areas) needs to extend into this area.
- The submission of a supplementary/updated Phase 2 Intrusive Site Investigation Report.
- While not explicitly mentioned in the reviewed correspondence, it is recommended by WA that groundwater sampling and subsequent laboratory testing is undertaken to allow for a controlled waters risk assessment to be undertaken.

Please note that if our understanding of the required works is incorrect, we would need to be advised prior to the commencement of the SI works.

## Scope of Services

The following scope of works is proposed to address the KCEH's requirements for additional intrusive SI in regard to the outstanding contaminated land concerns and to address the WA identified information gaps identified from the previous investigations undertaken at the Site. Exploratory holes have been proposed as shown in Drawing No. LD11143-001 as enclosed at Appendix B.

Exploratory holes are proposed to provide further ground, groundwater, and ground gas information and seek to provide general site coverage, as well as targeting specific site features and proposed building locations etc. in accordance with the most recently provided site development plan.

Generally, the scope of **Pre-Site Investigation Works** would likely be as follows:

- Production of Risk Assessment Method Statements (RAMS)/Construction Design and Management (CDM) documentation, setting up contracts, procurement of subcontractors, lead in times etc.
- WA would seek to appoint a competent drilling contractor to adopt the Principal Contractor (PC) role for these works and liaise with them to ensure that all the necessary duties are undertaken and the relevant documentation is completed to ensure compliance with CDM 2015 Regulations.
- Utility survey to clear exploratory hole locations and to identify on site utilities (if any).

The general scope of the **GI Works** will likely be as follows:

- 6 No. hand excavated inspection pits (0.3m x 0.3m) within the woodland area on a c. 50m x 50m grid and to a maximum depth of 1.00m below existing ground level, to obtain additional soil samples for subsequent calorific value laboratory testing. The hand excavated pits would be logged and photographed in accordance with best practice guidance. If the ground conditions are not suitable for hand excavation, then an alternative methodology would likely be required, but we would advise accordingly if this was the case.
- 14 No. additional windowless sample boreholes to depths of c. 5m and on a c. 50m grid to establish the thickness, extent and characteristics of the Made Ground beneath the Site, and to allow for the installation of new ground gas and groundwater monitoring wells in areas where gaps have been identified (e.g. close to the recorded mine entries and where piled foundations may be required) and to allow for the subsequent collection of groundwater samples for laboratory testing. The rationale for each position as per the proposed exploratory hole plan is as follows:
  - ✓ WS101 to target the former reservoir where cohesive Made Ground deposits different to those elsewhere at the site were encountered.
  - ✓ WS102 to provide general site coverage.
  - ✓ WS103 to target the southernmost Mining Remediation Authority (MRA) mine entry reference 419424-014.
  - ✓ WS104 to target the former colliery area, area of deep Made Ground and MRA mine entry reference 419424-020.
  - ✓ WS105 to provide general site coverage.
  - ✓ WS106 to target the former colliery area and the area of deep Made Ground.
  - ✓ WS107 to provide general site coverage.
  - ✓ WS108 to target the former colliery area, area of deep Made Ground and the general area between MRA mine entries 419424-020 and 004.
  - ✓ WS109 to provide general site coverage.
  - ✓ WS110 to target the former colliery area, area of deep Made Ground and MRA mine entries 419424-020 and 006.
  - ✓ WS111 to target an area of limited investigation.

- ✓ WS112 to provide general site coverage.
- ✓ WS113 to target the former colliery area, area of deep Made Ground and MRA mine entries 419424-004 and 005.
- ✓ WS114 to target the former colliery area, area of deep Made Ground and MRA mine entry 419424-005.
- Environmental/chemical sampling and subsequent laboratory testing of soils and groundwaters, so that the risks to human health and controlled waters can be updated/further quantified. Samples will be obtained in accordance with best practice<sup>1</sup> and/or in line with the general guidance outlined within the enclosed WA technical procedure notes (Appendix C). Samples would be submitted under chain of custody to a suitably accredited UKAS and MCERTS laboratory for a suite of potential contaminants appropriate to the Sites previous uses as follows:
  - ✓ Groundwater parameters will be obtained using an Aquaread probe. Testing suites would include for dissolved metals, manganese, redox potential, dissolved mercury, cyanide, Polycyclic Aromatic Hydrocarbons (PAH), Total Petroleum Hydrocarbons Criteria Working Group (TPH CWG), sulphate, sulphide, phenols and Benzene, Toluene, Ethylbenzene and Xylenes (BTEX) etc. Additional Semi volatile Organic Compounds (SVOC) and Volatile Organic Compounds (VOC) testing will be undertaken if elevated Photo Ionisation Detector (PID) readings are detected within soils. Further details can be found within the enclosed proposed testing suites (Appendix D).
  - ✓ If any additional visual and/or olfactory evidence of contamination is encountered then additional soils testing would include for metals, cyanide, hexavalent chromium, TPH, PAH, phenols, BTEX, sulphate, sulphide, pH etc. SVOC and VOC testing will primarily be undertaken where elevated PID readings have been detected or based on visual and olfactory evidence. Further details can be found within the enclosed proposed testing suites (Appendix D).
- During sampling of soils, a PID would be used for the duration of the site works to screen for potential VOC's. Should these compounds be detected then additional testing for these determinands would be undertaken. Our generic proposed testing suites for these determinands are enclosed.

---

<sup>1</sup> BS 10175:2011+A2:2017 Investigation of potentially contaminated sites. Code of practice.  
BS ISO 18400-105:2017 Soil quality. Sampling. Packaging, transport, storage and preservation of samples.  
BS ISO 18400-106 Soil quality – Sampling – Part 106: Quality control and quality assurance

- Installation of 14 No. additional ground gas and groundwater monitoring wells at various depths and intersecting features of interest as outlined above, to allow for the monitoring of ground gases and groundwater. Where possible the response zones for gas monitoring wells will be located above groundwater in accordance with best practice<sup>2</sup>. The additional monitoring wells can also be used to obtain samples of groundwater where groundwater is encountered.
- Full time supervision by suitably qualified and experienced WA geo-environmental engineers.

The general scope of **post GI works** will be as follows:

- In accordance with best practice guidance<sup>2</sup>, 9 No. additional ground gas monitoring visits over a period of 6 months would be undertaken from the newly installed monitoring wells and any accessible/suitable previous monitoring wells to establish the groundwater profile and to allow for a comprehensive ground and mine gas risk assessment to be undertaken, so the requirement for any ground gas protection measures can be established.
- Development of the newly installed monitoring wells (if water is present), followed by a single round of groundwater sampling in accordance with best practice<sup>3</sup> and/or in line with the general guidance outlined within the enclosed WA technical procedure notes (Appendix C). Three samples would be obtained and submitted for subsequent environmental laboratory testing to quantify the risk to controlled waters and establish groundwater characteristics. Those monitoring wells installed as part of the previous WA Shallow Coal Mine Investigation were noted to contain groundwater and sampling is initially proposed from these monitoring wells. Depending on the findings, then a further round of groundwater sampling may be required.

---

<sup>2</sup> Ciria C665: 2007 Assessing risks posed by hazardous ground gases to buildings.

BS8485: 2015+A1:2019 Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings

Ground Gas Handbook: 2009 Steve Wilson, Geoff Card & Sarah Haines.

<sup>3</sup> BS 10175:2011+A2:2017 Investigation of potentially contaminated sites. Code of practice.

BS EN ISO 5667-3 Water quality. Sampling. Preservation and handling of water samples.

BS ISO 5667-14:2014 Water quality sampling. Guidance on quality assurance and quality control of environmental water sampling and handling.

BS EN ISO 5667-14 Water Quality – Sampling – Part 14: Guidance on quality assurance and quality control of environmental water sampling and handling.

Environment Agency Guidance on Monitoring of Landfill Leachate, Groundwater and Surface Water

The **Reporting** elements will comprise the following:

- The provision of detailed engineers logs in accordance with BS 5930:2015+A1:2020 Code of Practice for Ground Investigations.
- Preparation of an LCRM/NPPF compliant Phase 2 GI Report that would include the factual findings of the additional intrusive GI, a summary and review of the previous investigations and ground gas monitoring, and subsequent assessments of ground conditions to allow for a Generic Quantitative Risk Assessment (GQRA) to be undertaken for those identified receptors (human health, controlled waters, buildings/infrastructure) and to include for a ground gas and mine gas risk assessment.

All GI works will be conducted in general accordance with BS5930 (2015) along with other relevant guidance and in accordance with the CDM Regulations 2015. A site-specific Construction Phase Plan (CPP) will also be produced. A utility clearance survey will be undertaken of the proposed exploratory hole locations in addition to a hand excavated service inspection pit to 1.2m bgl for each borehole position.

### **Potential Additional Works / Reporting**

Following completion of and/or depending on the outcome of the above assessments, the following further contamination land related works may be required:

- Should the findings of the Phase 2 Report indicate a potentially unacceptable risk to sensitive receptors from contamination present at the site, then a Detailed Quantitative Risk Assessment (DQRA) may be required. Should the DQRA identify that remedial works are required to deal with unacceptable contamination present at the site, then an Options Appraisal would also be required followed by a Remediation Strategy.
- A DQRA for methane and carbon dioxide may be required if certain thresholds are met during the ground gas monitoring period. We would advise if this were the case and prepare a separate proposal for these works.

The above list is not exhaustive and is ultimately dependent on the findings of the updated Phase 2 report.

### **AGREEMENT**

We trust that the above scope of works is acceptable and are confident that this is a pragmatic approach to address those outstanding issues, which will allow the development to proceed safely. If you have any queries, please do not hesitate to contact us.

Enc.

Appendix A – WA Technical Note dated 4<sup>th</sup> December 2024

Appendix B – LD11143-001 Proposed Exploratory Hole Plan

Appendix C – WA Technical Procedure Notes

Appendix D – Proposed Soil and Groundwater Seepage Testing Suites

**APPENDIX A**

<b>CLIENT:</b>	Jones Homes (Yorkshire) Limited
<b>PROJECT:</b>	Land at Primrose Lane, Liversedge
<b>SUBJECT:</b>	Technical Response to Kirklees Council Environmental Health's Comments
<b>JOB NO:</b>	LD11143
<b>DATE:</b>	4 <sup>th</sup> December 2024
<b>PREPARED BY:</b>	Verity Curtis (Wardell Armstrong, Principal Geoenvironmental Engineer)
<b>CHECKED BY:</b>	Jon Currie (Wardell Armstrong, Associate Director)

## INTRODUCTION AND BACKGROUND

This Technical Note (TN) has been prepared by Wardell Armstrong (WA) to address the comments raised by Kirklees Council Environmental Health (KCEH) pursuant to Local Planning Authority number 2023/62/91116/E for the proposed development of 77 No. dwellings at land off Primrose Lane, Hightown, Liversedge (the Site).

Comments were received from KCEH in letters dated 5<sup>th</sup> June 2023 (Ref: WK/202314249), 7<sup>th</sup> August 2023 (Ref: WK/202321391) and 27<sup>th</sup> February 2024 (Ref: WK/202404236) in relation to the Site Investigation (SI), Generic Quantitative Risk Assessment (GQRA) and ground gas risk assessments prepared by Michael D Joyce Associates LLP (MDJA), as well as supplementary investigations completed by WA.

The comments raised by KCEH in relation to the land contamination and ground/mine gas issues at the Site are as follows:

- *The ground conditions in the woodland area to the north of the site are unknown yet form part of the application site. In the absence of full site information, we consider part of the site characterisation incomplete.*
- *Given the type of made ground identified and historic land use on-site and to the west, we expect the calorific value of the made ground soils to be established. Additional information and/or clarification is necessary.*
- *We request additional commentary on the sampling methodology to detail the rationale behind the chosen samples sent for analysis.*
- *We understand that soils will have to be imported, and a cover system is recommended in the northern area of the site. However, the report also suggests the possible re-use of site won subsoils. However, we require additional testing to confirm the sub-soils soils suitability for re-use as no subsoils appear to have been tested to date.*

- *Details regarding the response zone and targeted source/s is missing. This information must be included and be fully justified.*
- *The ground gas monitoring is limited to events >1000 mb. Justification is necessary for this approach as this does not appear to be in accordance with best practice guidance.*
- *Piling is necessary on part of the site (northern section and the area of the suspected backfilled quarry). We consider the report to lack an assessment on the piling activities and possible ground gas pathways/migration. A more detailed ground gas assessment is necessary.*

This TN aims to provide a comprehensive response to the comments listed above and, where possible, demonstrate that these concerns have been fully addressed. Where comments cannot be addressed at this stage, proposed further works are detailed, which could be addressed via standard contaminated land planning conditions placed on the planning application.

## **EXTENT OF GROUND INVESTIGATIONS AND REPORTING UNDERTAKEN TO DATE**

Extensive Ground Investigations (GI) and reporting have been undertaken for the Site. These investigations have allowed for a comprehensive assessment of the subsurface conditions, and to accurately quantify the associated risks.

### **Extent of Reporting and Risk Assessments**

The results of the GIs along with other desk-based information have been documented in a series of detailed technical reports which include:

- Michael D Joyce Associates LLP (MDJA): “Phase 1 Geo-environmental and Geotechnical Assessment (Desk Study)” (report no. 4146), dated July 2021.
- MDJA: “Preliminary Phase 2 Ground Investigation” (report no. 4157), dated Sept. 2021.
- MDJA: “Primrose Lane, Liversedge – Ground Gas Risk Assessment” (ref: ADJ/DJM/11274), dated April 2022.
- WA: Coal Mining Risk Assessment (CMRA), Primrose Lane, Liversedge, dated July 2022.
- Terra Dat: Geophysical Survey to Map Potential Mineshafts – Primrose Lane, Liversedge (ref: Geophysical Survey Report 8085) – dated August 2022.
- WA: Shallow Coal Mining Investigation, Land at Primrose Lane, Liversedge, dated May 2023

- WA: Technical Response to Coal Authority Objections dated September 2024.

The reports prepared by WA have been carried out in accordance with best practice and relevant industry standards and were informed by the previous third-party reports. This integration has ensured that the findings and subsequent assessments are robust and provide a comprehensive understanding of the Sites ground conditions.

## **Extent of Ground Investigations**

The scope of the GI works carried out at the Site has been extensive and has included several stages of work that were undertaken between 2021 and 2023. Each stage of investigation has been built upon the previous stages and the overall extent of the works are summarised below:

- 6 No. rotary boreholes (BH) were drilled at strategically selected locations across the Site to depths up to 30.0m below ground level (bgl). These boreholes were logged in detail (where core was recovered) to establish the depths and nature of any shallow coal seams and/or coal mine workings beneath the Site, along with establishing the competency of the overlying strata.
- 37 No. trial pits (TP) were excavated to depths up to 4.5m bgl to establish the thickness, extent, and characteristics of shallow Made Ground and shallow weathered bedrock and to provide direct observations of any shallow or outcropping coal seams.
- 5 No. trial trenches (TT) were excavated to depths up to 4.0m bgl to confirm the presence or absence of the shafts that had been identified within the developable area of the Site, and to establish the depth and width of the shafts at the level of competent rock head.
- 25 No. window sample (WS) boreholes were drilled to depths up to 5.45m bgl to obtain further information about the shallow ground conditions and establish the depth to competent rockhead.
- A comprehensive suite of geophysical surveys were conducted across the entire developable area to help identify potential anomalies associated with former mining activities, with a focus on being located unrecorded mine entries.
- 6 No. ground gas and groundwater monitoring visits were undertaken by MDJA between 24<sup>th</sup> August 2021 and 08<sup>th</sup> November 2021 at 13 No. locations across the Site to enable ground gas risk assessment to be undertaken and to establish the groundwater regime beneath the Site.

- Environmental testing undertaken by both WA and MDJA, in total, comprised 49 No. soil samples that were tested for asbestos, soil organic matter, pH, sulphate, total cyanide, metals, phenols and speciated Polycyclic Aromatic Hydrocarbons (PAHs). Additionally, 4 No. samples were tested for speciated Total Petroleum Hydrocarbons (TPH) and Benzene, Toluene, Ethylbenzene and Xylene (BTEX), and 1 No. sample for a combined pesticide and herbicide suite. Further details can be found within Table 1 on page 11 where the sampling and testing has been discussed in more detail.

Full copies of the exploratory hole logs and testing results are provided within the reports listed above. All the exploratory hole positions undertaken at the Site are shown within Figure 1 below.

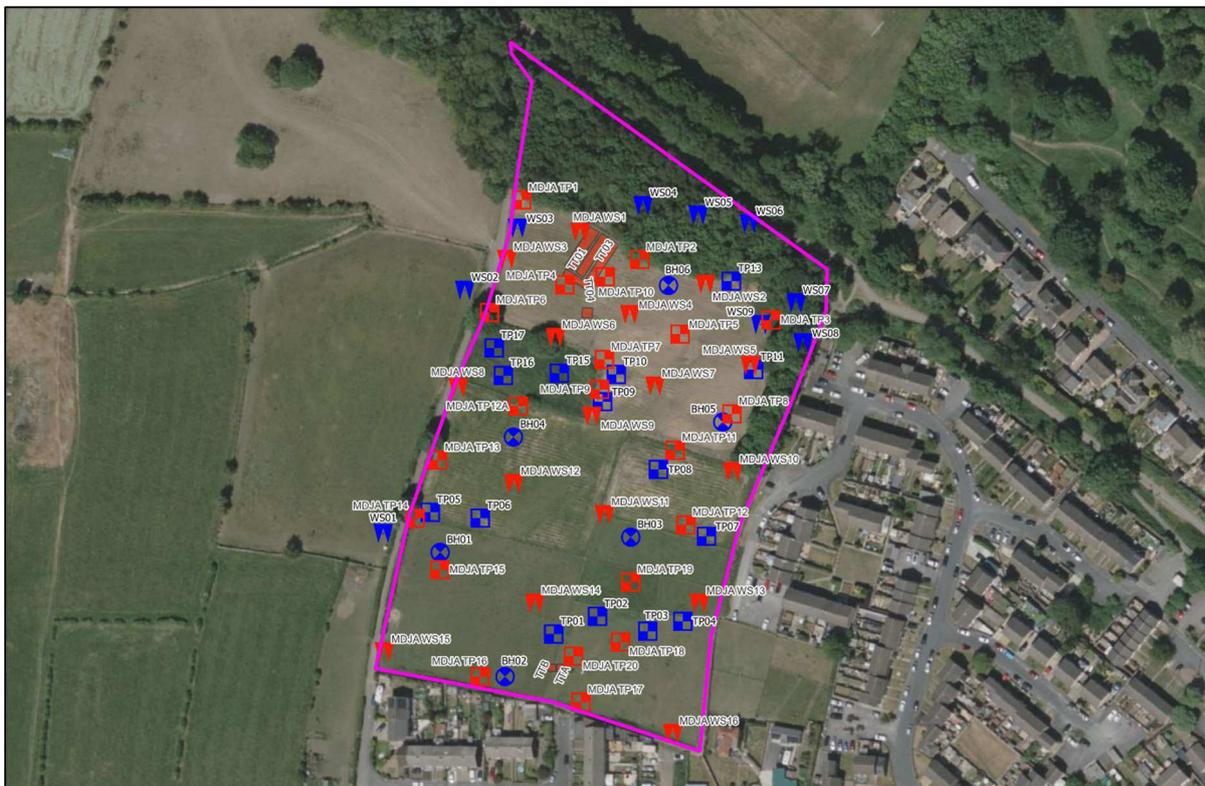


Figure 1: Aerial image showing exploratory hole locations and the extent of the previous investigations at the Site. Blue locations are WA exploratory holes and red locations are third-party exploratory hole locations.<sup>1</sup>

## SUMMARY OF PAST LAND USE

The earliest available map from 1854 shows the Site as undeveloped. However, by 1892, the northern half of the Site is recorded to have become occupied by Stanley Colliery, which

<sup>1</sup> Image is for illustrative purposes only. BING imagery reproduced under license and for illustrative purposes only. Boundaries are indicative. Aerial imagery shown for context purposes only. Drawing uses third-party data. No reliance can be provided for this data and WA cannot be held responsible for any errors within this data.

included two mine shafts and an air shaft, along with several buildings, a railway network, a small rectangular reservoir and a row of workers cottages, as shown in Figure 2 below.

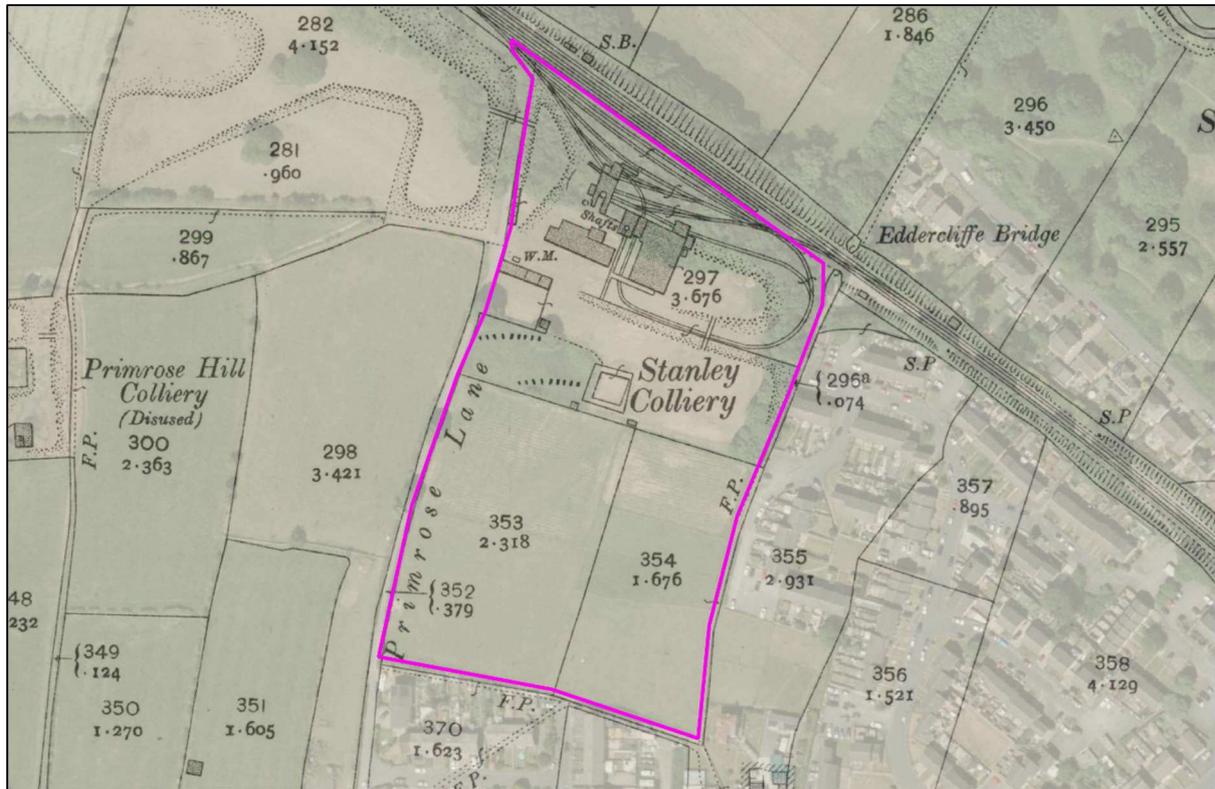


Figure 2: Overlay of historical mapping dated c. 1922 showing the former Stanley Colliery with associated buildings and shafts.<sup>2</sup>

By 1933, the colliery is indicated to have ceased operations and by 1938 most structures are indicated to have been demolished and the shafts no longer recorded. By 1969, the only remaining features are the outline of former spoil heaps.

Notably, the southern half of the Site appears to have remained undeveloped. Following the demolition of the colliery, the northern section of the Site also appears to have remained undeveloped to the present day, although it is understood to have been used for grazing by the current landowner.

MDJA noted within their Phase 2 report that a backfilled quarry was also encountered within the south eastern section of the site. This suggests that unrecorded quarrying and backfilling may have also been undertaken at the Site. WA have reviewed the MDJA trial pit data from this area of the Site and the location correlates closely to the shaft that was present in the

<sup>2</sup> Image is for illustrative purposes only. Historical imagery reproduced with the permission of the National Library of Scotland under Creative Commons Attribution (CC-BY) licence. BING imagery reproduced under license and for illustrative purposes only. Boundaries are indicative. Aerial imagery shown for context purposes only. Drawing uses third-party data. No reliance can be provided for this data and WA cannot be held responsible for any errors within this data.

south eastern part of the site. The Made Ground recorded in this area by MDJA is logged as reworked natural ground and as such may represent part of the spoil excavated from the adjacent shaft rather than representing a backfilled quarry.

## SUMMARY OF GROUND CONDITIONS

The ground and groundwater conditions encountered at the Site are summarised in the sections below. For detailed descriptions please refer to the specific GI reports listed in the previous sections.

### Geological Overview

British Geological Survey (BGS) mapping indicates that the Site is characterised by an absence of drift deposits and is underlain by solid geology of the Pennine Lower Coal Measures Formation, which has a shallow rock dip to the northeast.

As shown in Figure 3 below, the Top Lousey and Trub coal seams are conjectured to outcrop across the southern and central sections of the Site respectively, although the outcrop locations are noted to differ between the various sources that have been reviewed. No faults are indicated to be present at the Site.



Figure 3: Extract from BGS 1:50,000 scale geological map showing the Lower Pennine Coal Measures Formation

*with prominent sandstone outcrops in green and typical coal measures strata in grey. The diagonal hatched area depicts an area of Made Ground. Conjectured coal seam outcrops are shown by the dashed black lines.<sup>3</sup>*

## Ground Conditions Summary

Previous GIs at the Site indicate that ground conditions vary significantly between the northern and southern sections. Typical ground conditions are as follows:

- In the northern portion of the site, a thin layer topsoil was encountered from ground level to depths of between 0.05m and 0.35m bgl. In the southern portion of the site, topsoil and subsoil was encountered from ground level to a maximum depth of 0.40m bgl.
- The northern part of the Site predominantly consists of granular Made Ground that mainly comprises colliery spoil with some demolition and infill materials related to the former colliery. This Made Ground extends to depths of between 1.2m and in excess of 4.5m bgl. In localised areas, particularly around the former reservoir, more cohesive Made Ground materials were also encountered. Made Ground was also encountered within the south eastern section of the site within an area that MDJA believe may be an unrecorded backfilled quarry. This area is in the vicinity of a mine shaft and could potentially be colliery spoil excavated from the adjacent shaft as this has been logged as a reworked natural material.
- Across the remainder of the Site, and beneath the Made Ground in the north, residually weathered coal measures strata were encountered. The thickness of this stratum ranges from 0.3m to 6.2m, with the thickness increasing towards the north. It typically comprises a soft to stiff clay with lithorelicts of mudstone, though it occasionally occurs as an angular gravel of extremely weak mudstone or sandstone.
- The superficial strata and weathered bedrock strata are underlain by the Lower Pennine Coal Measures Formation, which typically comprised sequences of extremely weak to medium strong mudstone, very weak to weak sandstone, and weak ferruginous siltstone.
- Intact coal was encountered within 7 No. exploratory hole locations at depths of between 2.0m and 18.2m bgl. These coals were recorded as being between 0.2m and 0.8m thick and are believed to correspond to the Top Lousey and Trub Coal seams that are conjectured to outcrop at the Site.

---

<sup>3</sup> This drawing is for illustrative purposes only. BGS Geology 50k: Contains British Geological Survey materials © UKRI [2024] and provided under the Open Government License v3. BING imagery reproduced under license. Aerial imagery shown for context purposes. Drawing uses third-party data. No reliance can be provided for this data and WA cannot be held responsible for any errors within this data.

Significant obstructions related to the former colliery buildings were encountered in the northern section of the Site and this included brick walls, concrete footings, floor slabs, drains, and other oversized materials.

## **Groundwater**

Groundwater was generally absent and where water strikes were encountered these were primarily associated with land drains and other relict man-made features. However, perched groundwater was encountered in shallow monitoring wells at depths ranging from 1.3m to 3.4m bgl.

## **DISCUSSION TO ADDRESS KCEH OUTSTANDING COMMENTS**

### **1. Woodland Area Ground Conditions and Contamination Assessment**

With regard to the woodland area in the northernmost part of the Site, a total of 5 No. WS boreholes (WA WS04 to WS08 – see Appendix A) have been carried out to depths of between 3.00m and 5.45m bgl. These exploratory holes encountered similar ground conditions to those located in the wider former colliery area (i.e. Made Ground overlying natural Clay) that occupies the northern portion of the Site.

Made Ground was present in all the WS positions located in the woodland area and was encountered between ground level to depths ranging between 1.30m bgl and 4.50m bgl. It generally comprised a dark grey, sandy, clayey Gravel of mudstone, siltstone and sandstone. Occasional fragments of brick and glass were recorded in the upper layer of the Made Ground in WS04 and WS06. Additionally, Made Ground including suspected clinker, brick and ceramic were encountered in WS04 between 1.10m and 1.55m bgl.

Other than the presence of suspected clinker at WS04 between 1.10m and 1.50m bgl, no visual or olfactory evidence of contamination was recorded in the Made Ground located in the woodland area.

4 No. soil samples were obtained from the above WS boreholes and these were tested for asbestos, soil organic matter, pH, sulphate, total cyanide, metals, phenols and speciated PAHs. The soil analysis results from the woodland area have been screened to assess the potential risk to human health from this material.

The area of woodland is to remain as an area of informal public open space adjacent to the proposed residential development. As such, the soil analysis results have been screened against a Public Open Space – Residential End Use. Suitable for Use Levels (S4UL) have been applied and where S4UL are not available, Category 4 Screening Levels (C4SL) and SoBRA

acute Generic Assessment Criteria (GAC) have been used where appropriate. An initial screening exercise has been undertaken using 1% SOM as a conservative approach. All SOM values from this material are in excess of 1% with an average SOM value of 9.15%.

The human health assessment for potential risk to human health from the Made Ground located in the adjacent woodland indicates that there are no concentrations present above the applicable soil screening values (see Appendix B).

Only a limited number of samples (4 No.) have been tested from the Made Ground/Colliery Spoil within the woodland area. As such, a review of the chemical data obtained from the wider site from comparable material adjacent to the woodland area has been undertaken in order to assess the range of contaminant concentrations present within this material and whether the concentrations within the woodland area can be considered representative.

A further 12 No. soil samples from the Colliery Spoil material across the wider site have undergone chemical analysis and these have also been screened against a Public Open Space – Residential End Use (see Appendix B). These soil samples contain potential contaminant concentrations at similar levels to those within the woodland area and again, no concentrations are present above the applicable soil screening values.

WA therefore consider that the Made Ground/Colliery Spoil within the woodland area in the northernmost part of the Site has been characterised and is unlikely to constitute an unacceptable risk to human health based on the proposed end use.

## **2. Calorific Value of the Made Ground Soils**

The calorific value of the Colliery Spoil/Made Ground was assessed as part of the WA Shallow Coal Mining Investigation dated May 2023 to evaluate the potential combustibility of the Colliery Spoil and ascertain the suitability of the material for reuse.

Calorific value testing was conducted on 2 No. samples of the Colliery Spoil material taken from TP11 and Trial Trench No. 4. The test results are included in Appendix C and show that the sample from TP11 had a calorific value of <1 MJ/kg, while the sample from Trial Trench No. 4 had a value of 7 MJ/kg.

The WA May 2023 reported recommended that materials with a calorific value >7 MJ/kg should be kept a minimum of 1m away from any potential sources of ignition and should not be left exposed for long periods of time to minimise the risk of combustion. When used in areas of private gardens or soft landscaping a 1m thick layer of inert material should be present to prevent accidental ignition.

The WA May 2023 report also recommended that further calorific value testing should be undertaken during earthworks where colliery spoil is intended to be reused as fill material, so that the material placed in the upper 1 m, or within 1m of a potential ignition source does not exceed 7 MJ/kg.

### 3. Sampling Methodology/Rationale Behind the Chosen Samples Sent for Analysis

Combining the WA and MDJA investigation data, 49 No. soil samples have been obtained and generally tested from areas where potentially contaminative sources have been identified, at regular depth intervals, changes of strata, where visual and/or olfactory evidence of contamination has been noted, at discrete horizons recognised as having the potential to retain contaminants, and from background/baseline areas for comparison and to increase the chances of unrecorded contamination being detected.

This approach has ensured that the samples selected for chemical analysis provide adequate spatial coverage across the Site (both laterally and vertically). Between the two datasets testing has also been undertaken across a range of depths that varies between ground level and 4.00m bgl.

The combined total of 49 No. soil samples have also been chemically tested for a suite of potential contaminants that reflects the historical and current potentially contaminative land uses of the site (colliery, railway and agricultural land), as outlined in their respective DoE industry profiles

A summary of the testing is included in Table 1 below and copies of the laboratory testing certificates are included within the MDJA: Preliminary Phase 2 Ground Investigation and the WA Shallow Coal Mining Investigation Reports.

Table 1: Summary of Soil Chemical Analysis			
Substances	WA Soil Samples 2023	MDJA Soil Samples 2021	Total Soil Samples
General inorganics	28	21	49
Cyanide	28	19	47
Asbestos ID	28	19	47
Asbestos Quantification	3	0	3
Total Phenols	28	19	47
Speciated PAHs and Total PAHs	28	19	47
Metals/Metalloids	28	19	47
Total Petroleum Hydrocarbons Criteria Working Group (TPH CWG)	4	0	4
Soil Organic Matter (SOM)	28	0	28

Table 1: Summary of Soil Chemical Analysis			
Substances	WA Soil Samples 2023	MDJA Soil Samples 2021	Total Soil Samples
Benzene, Toluene, Ethylbenzene and Xylene (BTEX)	4	0	4
Pesticides	0	1	1

All the WA samples were obtained by a suitably qualified geoenvironmental engineer in accordance with best practice and/or in line with the general guidance outlined within internal WA technical procedure notes. The soil samples were collected, transferred to the laboratory under chain of custody and analysed to ensure traceability and reliability of analytical results. All testing was undertaken in approved UKAS and MCERTS accredited laboratories. Based on the laboratory Quality Assurance data, the analytical results were considered acceptable for interpretative use.

As stated in the MDJA report, all MJDA sampling was undertaken under the full time direction of a Chartered Engineer. All the recovered soil samples were screened on site for any visual or olfactory evidence of contamination including the presence of VOCs. Samples were selected from the trial pits and window sample boreholes on the basis of those which were most likely to be contaminated and those which gave the most appropriate indication of the spread of any contaminants. The samples were stored in both glass and plastic containers and kept in cooled conditions. Testing was carried out by Chemtech Limited to UKAS accredited procedures in accordance with MCERTS performance standards.

This comprehensive approach has provided a sound basis for an assessment of the potential presence of unacceptable concentrations of contaminants and to determine whether the material is suitable for reuse given the proposed end use of the Site.

#### 4. Testing to Confirm Sub-Soil Suitability for Re-use

As detailed in the sections above, a combined total of 49 No. soil samples have been chemically tested across the Site from various strata and depths and WA consider this provides a representative dataset to adequately characterise the geochemical conditions present at the Site.

WA have completed a screening exercise of all the available chemical data from both the WA and MDJA investigations for the Site. The soil present within the proposed area of residential development has been screened against S4UL and, where not available, C4SL for a residential with plant uptake end use.

The outcome of this screening exercise indicates that there are isolated exceedances of the S4UL for arsenic, beryllium, chromium (III), lead and dibenzo(ah)anthracene.

There were also 3 No. soil samples that returned a positive identification for chrysotile asbestos, within Trial Trench 03 at 2.50m bgl, Trial Trench 05 between 3.80m and 4.00m bgl and within a stockpile located in the northern part of the Site. However, with the exception of the stockpile sample, these soils are located at depth and within an area where filling is proposed so their excavation and reuse as part of the proposed development is considered unlikely.

It is acknowledged that MDJA have described both topsoil and subsoil within their logs. While 13 No. samples of topsoil have been tested, no testing has been undertaken for what has been described as subsoil. However, this subdivision is misleading as during the WA investigation only topsoil underlain by residually weathered bedrock was recorded. The subsoil likely relates to the deeper topsoil stratum and 4 No. samples of the deeper topsoil (or subsoil) were obtained and tested at depths of between 0.30m and 0.60m bgl. Exceedences of arsenic, beryllium and dibenzo(ah)anthracene were recorded.

Regardless, it is considered that site won material would be suitable for reuse, although in some cases where elevated concentrations of contaminants/asbestos fibres are present, this would need to be at depth beneath a clean cover system to ensure the source-pathway-receptor linkage is adequately broken.

It is recommended that all material that is to be reused on Site is retested at an appropriate frequency for the volume of material involved during the earthworks cut and fill exercise to confirm that the material is suitable for reuse at the required depth. Furthermore, it is anticipated that the earthworks would be undertaken in accordance with an Earthworks Specification based on Series 600 and a Material Management Plan (MMP); both of which would ensure rigorous classification of materials to determine acceptability and include stringent validation criteria.

It is acknowledged that importation of additional clean topsoil and subsoil may be required onsite should adequate volumes not be obtained during the soil strip and cut and fill exercise, but again suitable testing or certification would be undertaken and/or provided respectively to confirm the material is suitable for use.

The assessment regarding the woodland area, which will continue to be used as informal public open space adjacent to the residential development, has been discussed earlier in this

technical note and concluded that there was not considered to be an unacceptable risk to human health and as such no remedial measures are envisaged.

## 5. Ground Gas Assessment

MDJA completed 6 No. gas monitoring visits over an 11-week period in 2021 and monitored 13 No. gas monitoring installations that had been installed within their window sample boreholes.

These 2021 MDJA visits were all completed under high pressure conditions ranging from 1002mb to 1029mb with both falling and rising pressure trends preceding the monitoring visits.

No methane, carbon monoxide or flow were detected during the MDJA gas monitoring visits. Carbon dioxide concentrations were recorded between 0.2% and 3.1%.

Using the MDJA gas monitoring data, this results in a Gas Screening Value (GSV) of 0.0031, which is equivalent to NHBC Green category or Characteristic Situation (CS) 1. Neither of these categories require gas protection measures to be installed.

WA installed a selection of exploratory hole positions during their 2023 ground investigation however, subsequent gas monitoring at these positions was not completed at the request of Jones Homes.

WA recently visited the Site on 25<sup>th</sup> November 2024 to complete a supplementary gas monitoring visit of existing MDJA and WA installations. None of the MDJA monitoring installations could be located as flush covers are presumed to have been used and only one of the WA installations could be located and/or could be successfully monitored from. Pressure conditions were below 999mb however, there was a rising pressure trend preceding the visit.

WA BH05 was the only position that could be monitored. This is located within the north eastern section of the proposed residential development area, and screens the Made Ground and underlying natural material between 1m and 4m bgl. No methane or carbon monoxide were detected, but a peak carbon dioxide concentration of 6.6% and a steady flow rate of 0.3l/hr was recorded. These levels result in a GSV of 0.0198, which is again NHBC Green category or CS 1, which do not require gas protection measures. However, there could be justification to increase to CS 2 based on a carbon dioxide concentration of greater than 5%.

It should be noted that no gas monitoring was undertaken by MDJA under worst case conditions (i.e. atmospheric pressure below 999mb and falling pressure conditions).

Additionally, it is unclear where the response zones are located within the MDJA monitoring installations and therefore, which strata is being monitored, as there is no installation data included on the MDJA exploratory hole logs.

The MDJA Phase 2 Report text states that installations comprised 0.5m of sealed plain pipe with the remainder being slotted pipework. Normally 1m of sealed plain pipe would be used at the top of a monitoring installation especially in grassed locations to ensure that the installation is fully sealed from the atmosphere and not drawing in outside air during monitoring.

Under the suggested frequency and duration of gas monitoring used in the ground gas guidance documents, the MDJA gas monitoring regime (6 visits over 11 weeks) for a high sensitivity end use (residential end use) assumes that there is a very low gas generation potential at the site.

While the MDJA ground gas risk assessment suggests that ground gas protection measures are unlikely to be required, this conclusion appears overly optimistic given the Sites coal mining legacy, which would typically necessitate the inclusion of ground gas protection measures as a precautionary approach. Additionally, the ground gas regime could change due to subsidence or collapse of any coal mine workings or following remedial works and site development—especially if new pathways for gas migration are created such as during piling for foundations.

Given the uncertainties that exist from the gas monitoring completed to date (i.e. lack of monitoring under worst case conditions, uncertainties regarding the response zone locations and lack of monitoring undertaken in the vicinity of the mine shafts), it would be prudent to conduct further ground gas monitoring at the site.

A comprehensive ground and mine gas risk assessment should be carried out to assess all potential gas sources and migration pathways including piling to determine whether additional protective measures are required.

## **CONCLUSIONS AND PROPOSED ACTIONS**

WA conclude that there is sufficient existing data to resolve KCEH outstanding queries relating to the ground conditions within the woodland area, calorific value, sampling methodology and the suitability of site won soil for reuse. This existing data will be used to produce the required LCRM/NPPF compliant documentation (i.e. updated Phase 2 Report) required to discharge any associated planning conditions that are placed on the proposed development.

Further ground/mine gas monitoring and assessment is required to fully understand the potential gas risk at the Site and the nature of any gas protection measures required. However, there does not appear to be any reason to suggest that the risk is such that the development of the Site would not be able to be completed safely once further assessment has been undertaken.

It is hoped that any residual matters and/or those identified outstanding matters can be conditioned as part of the planning process, rather than being used to uphold the current objection.

Granting planning permission is essential for the development to move forward, allowing Jones Homes to purchase the Site and undertake the required additional works and/or remedial actions.

In conclusion, this technical note outlines a comprehensive and pragmatic approach to addressing the issues that have been raised by KCEH. We are confident that the objection from KCEH can now be resolved, allowing the development to proceed safely and enabling the Site to be granted planning permission. Continued collaboration with all stakeholders will ensure that any emerging issues are addressed promptly, and that the development can move forward.

Encs.

Appendix A – Window Sample Borehole Logs from Woodland Area

Appendix B – WA Chemical Screening Exercise for Woodland Area

Appendix C – WA Calorific Value Testing Laboratory Results

Appendix D – WA November 2024 Gas Monitoring Record

**APPENDIX A**



# Windowless Sample Borehole Log

BOREHOLE REFERENCE  
**WS04**  
Sheet 1 of 2

Project Name: Primrose Lane	Client: Jones Homes (Yorkshire) Ltd	Date: 23/03/2023
Location: Liversedge, West Yorkshire	Contractor: DMW Drilling Ltd	Co-ords: E419719.00 N424217.00
Project No. : LD10488	Drilling Equipment: Global	Level : 84.70m AoD

Logged By GP	Checked By EH	Approved By VC	SPT Energy Ratio 71%	Final Depth 5.45
-----------------	------------------	-------------------	-------------------------	---------------------

Instal. / Backfill	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	Scale
		Depth (m)	Type	Results					
					0.30	84.40		MADE GROUND: Soft to firm brown slightly gravelly silty organic CLAY. Rootlets. Gravel is fine and medium angular of dark mudstone and brick. COHESIVE MADE GROUND	1
					1.10	83.60		MADE GROUND: Very dark grey slightly clayey fine and medium subangular to subrounded GRAVEL of mudstone. Occasional rootlets. GRANULAR MADE GROUND	
		1.00	SPT(C)	N=10 (2,2/2,2,3,3)	1.55	83.15		MADE GROUND: Very dark grey slightly sandy subangular to subrounded fine to coarse GRAVEL of clinker, mudstone and siltstone. Occasional brick and ceramic. GRANULAR MADE GROUND	
		2.00	SPT(C)	N=8 (2,3/3,2,1,2)	2.08	82.62		MADE GROUND: Yellowish grey slightly sandy CLAY. COHESIVE MADE GROUND	
		2.50	ES					MADE GROUND: Light grey subangular fine to coarse GRAVEL of mudstone and siltstone. GRANULAR MADE GROUND	
		3.00	SPT(C)	N=9 (1,2/2,2,2,3)					
		4.00	SPT(C)	N=12 (2,2/3,3,3,3)	3.80	80.90		Firm yellowish grey CLAY. COHESIVE NATURAL, WEATHERED	4

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation				Installation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Top	Base	Inclination	Orientation	Top	Base	Pipe Type	Diameter
		1,00m	100mm												

Remarks  
Terminated due to SPT refusal.



# Windowless Sample Borehole Log

BOREHOLE REFERENCE  
**WS04**  
Sheet 2 of 2

Project Name: Primrose Lane	Client: Jones Homes (Yorkshire) Ltd	Date: 23/03/2023
Location: Liversedge, West Yorkshire	Contractor: DMW Drilling Ltd	Co-ords: E419719.00 N424217.00
Project No. : LD10488	Drilling Equipment: Global	Level : 84.70m AoD

Logged By GP	Checked By EH	Approved By VC	SPT Energy Ratio 71%	Final Depth 5.45
-----------------	------------------	-------------------	-------------------------	---------------------

Instal. / Backfill	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	Scale
		Depth (m)	Type	Results					
		5.00	SPT(C)	N=7 (3,3/2,1,2,2)			Firm yellowish grey CLAY. COHESIVE NATURAL, WEATHERED	5	
					5.45	79.25	End of Borehole at 5.45m	6	
								7	
								8	
								9	

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation				Installation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Top	Base	Inclination	Orientation	Top	Base	Pipe Type	Diameter
		1.00m	100mm												

**Remarks**  
Terminated due to SPT refusal.



# Windowless Sample Borehole Log

BOREHOLE REFERENCE  
**WS05**  
Sheet 1 of 1

Project Name: Primrose Lane	Client: Jones Homes (Yorkshire) Ltd	Date: 23/03/2023
Location: Liversedge, West Yorkshire	Contractor: DMW Drilling Ltd	Co-ords: E419742.00 N424213.00
Project No. : LD10488	Drilling Equipment: Global	Level : 84.05m AoD

Logged By GP	Checked By EH	Approved By VC	SPT Energy Ratio 71%	Final Depth 4.45
-----------------	------------------	-------------------	-------------------------	---------------------

Instal. / Backfill	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	Scale
		Depth (m)	Type	Results					
		0.00 - 0.20	ES				MADE GROUND: Very dark grey clayey fine and medium sub-angular GRAVEL of orangic mudstone . Rootlets. GRANULAR MADE GROUND	1	
		0.80	ES						
		1.00	SPT(C)	N=13 (1,2/4,3,3,3)	1.00	83.05	MADE GROUND: Very dark grey organic SILT. Rootlets. COHESIVE MADE GROUND		
		1.10			1.10	82.95	MADE GROUND: Very dark brown sandy slightly organic fine and medium GRAVEL of sandstone and mudstone. GRANULAR MADE GROUND		
		2.00	SPT(C)	N=12 (2,3/3,3,3,3)	2.20	81.85	MADE GROUND: Pale grey slightly sandy slightly clayey fine to coarse sub-rounded to angular GRAVEL of mudstone and siltstone. GRANULAR MADE GROUND		
	3.00	SPT(C)	N=8 (3,1/2,2,2,2)	3.80	80.25	Firm pale yellowish brown slightly sandy gravelly CLAY. Gravel is fine and medium sub-rounded of coal and various lithologies. COHESIVE NATURAL, WEATHERED	4		
	4.00	SPT(C)	N=11 (2,4/3,2,3,3)	4.45	79.60		End of Borehole at 4.45m		

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation				Installation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Top	Base	Inclination	Orientation	Top	Base	Pipe Type	Diameter
		1.00m	100mm									0.00m 1.00m	1.00m 4.00m	PLAIN SLOTTED	

**Remarks**  
Terminated due to the lead length kicking off on a probable cobble obstruction.



# Windowless Sample Borehole Log

BOREHOLE REFERENCE  
**WS06**  
Sheet 1 of 1

Project Name: Primrose Lane	Client: Jones Homes (Yorkshire) Ltd	Date: 21/03/2023
Location: Liversedge, West Yorkshire	Contractor: DMW Drilling Ltd	Co-ords: E419763.00 N424209.00
Project No. : LD10488	Drilling Equipment: Global	Level : 83.40m AoD

Logged By LT	Checked By EH	Approved By VC	SPT Energy Ratio 71%	Final Depth 3.00
-----------------	------------------	-------------------	-------------------------	---------------------

Instal. / Backfill	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	Scale
		Depth (m)	Type	Results					
		0.40	ES				MADE GROUND: Dark grey very clayey medium and coarse angular to sub-angular of mudstone GRAVEL with occasional fragments of glass and brick cobbles. GRANULAR MADE GROUND		
		1.20	SPT(C)	N=24 (2,1/1,2,9,12)	1.00	82.40	MADE GROUND: Very soft black occasionally grey gravelly SILT. Gravel is typically, of mudstone and possibly carbonaceous material. COHESIVE MADE GROUND	1	
		2.00	SPT(C)	N=9 (2,2/3,2,2,2)	2.00	81.40	MADE GROUND: Weak light grey subangular fine to coarse GRAVEL of mudstone and siltstone. GRANULAR MADE GROUND	2	
					3.00	80.40	End of Borehole at 3.00m	3	

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation				Installation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Top	Base	Inclination	Orientation	Top	Base	Pipe Type	Diameter

**Remarks**  
Terminated due to being told to stand-down by a representative of SusTrans.



# Windowless Sample Borehole Log

BOREHOLE REFERENCE  
**WS07**  
Sheet 1 of 1

Project Name: Primrose Lane	Client: Jones Homes (Yorkshire) Ltd	Date: 21/03/2023
Location: Liversedge, West Yorkshire	Contractor: DMW Drilling Ltd	Co-ords: E419782.00 N424176.00
Project No. : LD10488	Drilling Equipment: Global	Level : 83.05m AoD

Logged By EH	Checked By EH	Approved By VC	SPT Energy Ratio 71%	Final Depth 4.80
-----------------	------------------	-------------------	-------------------------	---------------------

Instal. / Backfill	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	Scale
		Depth (m)	Type	Results					
		0.30	ES				MADE GROUND: Dark grey very clayey medium and coarse angular to sub-angular of mudstone and siltstone GRAVEL. GRANULAR MADE GROUND	1 2 3 4	
		0.60	D						
		0.80 – 1.20	B						
		1.20	SPT(C)	N=8 (2,1/2,3,2,1)	1.20	81.85	MADE GROUND: Very soft black occasional grey gravelly SILT. COHESIVE MADE GROUND		
		1.50 – 2.00	ES						
		2.00	SPT(C)	N=6 (2,1/2,1,2,1)	2.00	81.05	MADE GROUND: Weak light grey fine to coarse GRAVEL of angular siltstone. GRANULAR MADE GROUND		
		2.70	D						
		3.00 – 3.45 3.00	D SPT(C)	N=12 (2,3/3,3,3,3)					
		4.00	SPT(C)	N=44 (5,5/9,10,11,14)			Firm yellowish brown, mottled grey, CLAY. COHESIVE NATURAL, WEATHERED		
		4.60	SPT(C)	50 (25,0 for 0mm/26,24 for 50mm)	4.50	78.55			
				4.80	78.25	End of Borehole at 4.80m			

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation				Installation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Top	Base	Inclination	Orientation	Top	Base	Pipe Type	Diameter
												0.00m	1.00m	PLAIN	
												1.00m	4.00m	SLOTTED	

Remarks  
Terminated due to SPT refusal.



# Windowless Sample Borehole Log

BOREHOLE REFERENCE  
**WS08**  
Sheet 1 of 2

Project Name: Primrose Lane	Client: Jones Homes (Yorkshire) Ltd	Date: 21/03/2023
Location: Liversedge, West Yorkshire	Contractor: DMW Drilling Ltd	Co-ords: E419785.00 N424160.00
Project No. : LD10488	Drilling Equipment: Global	Level : 84.05m AoD

Logged By LT	Checked By EH	Approved By VC	SPT Energy Ratio 71%	Final Depth 5.22
-----------------	------------------	-------------------	-------------------------	---------------------

Instal. / Backfill	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	Scale
		Depth (m)	Type	Results					
		0.20	B		1.30	82.75		MADE GROUND: Dark grey very clayey fine to coarse angular to sub-angular of mudstone GRAVEL. GRANULAR MADE GROUND	1
		0.30	ES						
		0.50	D						
		0.70 – 1.20	B						
		1.20	SPT(S)	N=9 (2,1/2,2,2,3)					
		1.60 – 2.00	D						
		2.00	SPT(S)	N=29 (3,3/6,7,8,8)					
		2.50	D						
		3.00 – 3.45	D						
		3.00	SPT(S)	N=20 (4,4/4,5,6,5)					
				2.10	81.95		Firm light brown mottled with orange and grey sandy CLAY. Occasional roots. COHESIVE NATURAL, WEATHERED	2	
				3.00	81.05		Stiff light brown mottled with grey sandy gravelly silty CLAY. Gravel is fine to coarse angular of sandstone and mudstone. Sand is fine. COHESIVE NATURAL, WEATHERED	3	
				3.70	80.35		Extremely weak very thinly laminated dark grey organic MUDSTONE occasional orangish brown staining and occasional laminae of coal with pyrite inclusions. PLCM BEDROCK	4	
				4.40	79.65		Extremely weak thinly banded light grey SILTSTONE occasional orangish brown staining. PLCM BEDROCK		

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation				Installation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Top	Base	Inclination	Orientation	Top	Base	Pipe Type	Diameter

Remarks  
Terminated due to SPT refusal.



# Windowless Sample Borehole Log

BOREHOLE REFERENCE  
**WS08**  
Sheet 2 of 2

Project Name: Primrose Lane	Client: Jones Homes (Yorkshire) Ltd	Date: 21/03/2023
Location: Liversedge, West Yorkshire	Contractor: DMW Drilling Ltd	Co-ords: E419785.00 N424160.00
Project No. : LD10488	Drilling Equipment: Global	Level : 84.05m AoD

Logged By LT	Checked By EH	Approved By VC	SPT Energy Ratio 71%	Final Depth 5.22
-----------------	------------------	-------------------	-------------------------	---------------------

Instal. / Backfill	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	Scale
		Depth (m)	Type	Results					
		4.80	SPT(S)	50 (13,12 for 65mm/21,26,3 for 0mm)	5.22	78.83	XXXXXXXXXX XXXXXXXXXX XXXXXXXXXX XXXXXXXXXX XXXXXXXXXX XXXXXXXXXX XXXXXXXXXX XXXXXXXXXX XXXXXXXXXX XXXXXXXXXX	5	
							Extremely weak thinly banded light grey SILTSTONE occasional orangish brown staining. PLCM BEDROCK		
							End of Borehole at 5.22m		
								6	
								7	
								8	
								9	

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation				Installation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Top	Base	Inclination	Orientation	Top	Base	Pipe Type	Diameter

Remarks  
Terminated due to SPT refusal.

**APPENDIX B**

Liversedge - HH Screen Woodland Area				WA Chemical Analysis										MDJA Chemical Analysis																																																																													
				Woodland				Colliery		Colliery		Colliery		Colliery		Colliery		Colliery		Colliery																																																																							
				Colliery spoil	Colliery spoil	Colliery spoil	Colliery spoil	Colliery spoil	Colliery spoil	Colliery spoil	Colliery spoil	Colliery spoil / reworked clay	Colliery spoil / MG	Colliery spoil / MG	Colliery spoil / MG	Colliery spoil / MG	Colliery spoil / MG	Colliery spoil / MG	Colliery spoil / MG	Colliery spoil / MG																																																																							
Concentration less than screening value				WS04				WS05		WS06 E51		TP11		TP13		Trial Trench No 3		414429-020 Trial Trench		No2		TP1		TP2		TP4		TP6		WS3		WS4		WS6		WS7																																																							
Concentration greater than screening value				2.50				0.00-0.20		0.80		0.00-0.25		0.90-1.00		0.50-0.50		1.00-1.20		2.50-2.50		0.05m		0.2m		0.2m		0.1m		0.1m		0.3m		0.15m		0.1m																																																							
Customer Sample ID				Method				Units				LOD																																																																															
Depth																																																																																											
Analysis				Test																																																																																							
Sample Description				Colour				PM024				No units																																																																															
				Description				PM024				No units																																																																															
				Inclusion 1)				PM024				No units																																																																															
				Inclusion 2)				PM024				No units																																																																															
				Moisture Content Ratio (% of as received sample)				PM024				%																																																																															
Asbestos				Asbestos Quantification - Gravimetric - %				TM304				%				<0.001																																																																											
				Date of Analysis				TM048				No units																																																																															
				Analysed By				TM048				No units																																																																															
				Asbestos Quantification - PCOM Evaluation - %				TM304				%				<0.001																																																																											
				Additional Asbestos Components (Using TM048)				TM304				No units																																																																															
				Analysts Comments				TM304				No units																																																																															
				Asbestos Quantification - Total - %				TM304				%				<0.001																																																																											
				Chrysotile (White) Asbestos				TM048				No units				presence				Not Detected																																																																							
				Amosite (Brown) Asbestos				TM048				No units				presence				Not Detected																																																																							
				Crocidolite (Blue) Asbestos				TM048				No units				presence				Not Detected																																																																							
				Asbestos Anthophyllite				TM048				No units				presence				Not Detected																																																																							
				Asbestos Tremolite				TM048				No units				presence				Not Detected																																																																							
				Asbestos Actinolite				TM048				No units				presence				Not Detected																																																																							
				Non-Asbestos Fibre				TM048				No units				presence				Not Detected																																																																							
				Comments				TM048				No units																																																																															
Carbon				Soil Organic Matter (SOM)				TM132				%				<0.35				1.15				7.96				10.6				16.9				5.69				22.1				34.1				24.7																																											
Inorganics				Water Soluble Sulphate as SO4:2:1 Extract				TM243				g/l				<0.004				0.0379				0.0113				0.017				0.0178				0.0063				<0.004				0.0289				0.0596																																											
				pH				TM133				pH Units				<1				<5.5 >9.5				Prof judgement				8.38				7.91				8.69				8.69				8.71				8.54				5.51				7.34				7.2				7.8				7.2				8				5.7				7.1				7.3				7.5			
				Sulphate, Total				TM221				mg/kg				<48				155				185				383				285				82				187				5450				3580																																											
				Sulphide, Easily liberated				TM180				mg/kg				<15				<15				<15				<15				<15				<15				<15				<15				<15																																											
				Cyanide, Total				TM153				mg/kg				<1				24				SoBRA acute GAC child				<1				<1				<1				<1				<1				<1				<1				<1				<1																															
Metals - (Solids)				Chromium, Hexavalent				TM151				mg/kg				<0.6				8				POS Resi - S4UL				<0.6				<0.6				<0.6				<0.6				<0.6				<0.6				<0.6				<0.6				<0.6																															
				Boron, water soluble				TM222				mg/kg				<1				21,000				POS Resi - S4UL				<1				<1				<1				2.1				<1				3.45				<1				2.41																																			
				Arsenic				TM181				mg/kg				<0.6				79				POS Resi - S4UL				8.09				6.28				14.6				20.1				4.67				10.3				32.8				35.9				11				20				20				6.4				29				4.3				29				10			
				Beryllium				TM181				mg/kg				<0.01				2.2				POS Resi - S4UL				1.49				1.62				1.75				1.96				1.58				1.48				1.19				1.46																																			
				Cadmium				TM181				mg/kg				<0.02				120				POS Resi - S4UL				0.702				0.681				1.11				<0.02				<0.02				0.0424				0.485				0.0537				<0.2				<0.2				<0.2				<0.2				<0.2				<0.2											
				Chromium				TM181				mg/kg				<0.9				1,500				POS Resi - S4UL				7.1				11.5				<0.9				<0.9				6.29				6.96				7.84																																							
				Copper				TM181				mg/kg				<1.4				12,000				POS Resi - S4UL				32.5				45.1				42.6				59.9				38				47.1				51.2				57.4				35				48				50				41				51				39				51				48			
				Lead				TM181				mg/kg				<0.7				630				POS Resi - S4UL				16.7				24.5				27.8				89.6				18				30.7				29.3				42.7				22				30				31				25				25				28				33							
				Mercury				TM181				mg/kg				<0.1				120				POS Resi - S4UL				<0.1				<0.1				<0.1				<0.1				<0.1				<0.1				<0.1				<0.1				<0.1				<0.1				<0.1				<0.1																			
				Nickel				TM181				mg/kg				<0.2				230				POS Resi - S4UL				48.8				56.4				49.6				48.1				43.3				49.3				28.4				37				43				43				44				52				36				56				45				60			
				Selenium				TM181				mg/kg				<1				1,100				POS Resi - S4UL				<1				1.16				1.58				2.81				2.94				2.28				<1				<1				1.1				1.2				1.2				1.4				1.4				1.5				1.3				1.8			
				Vanadium				TM181				mg/kg				<0.2				2,000				POS Resi - S4UL				16.6				14.3				8.06				24.1				25.6				2.6				23.8				29.4																																			
				Zinc				TM181				mg/kg				<1.9				81,000				POS Resi - S4UL				108				113				106				99.2				98				104				59.4				102				83				100				105				98				68				105				82				118			
Phenols				Phenol				TM062 (S)				mg/kg				<0.01				440				POS Resi - S4UL				<0.01				<0.01				<0.01				<0.01				<0.01				<0.01				<0.01				<0.01				<0.01																															
				Cresols				TM062 (S)				mg/kg				<0.01												<0.01				<0.01				0.0108				<0.01				<0.01				<0.01				<0.01				<0.01																																			
				Xylenols				TM062 (S)				mg/kg				<0.015												<0.015				<0.015				0.0108				<0.015				<0.015				<0.015				<0.015				<0.015																																			
				Phenols, Total Detected monohydric				TM062 (S)				mg/kg				<0.035				440				POS Resi - S4UL				<0.035				<0.035				<0.035				<0.035				<0.035				<0.035				<0.035				<0.035				<0.035																															
Polyaromatic Hydrocarbons (PAHs)				Naphthalene-d8 % recovery**				TM218				%												82.9				82.1				81.1				88.7				91.9				89.6				89.7				84.2																																							
				Acenaphthene-d10 % recovery**				TM218				%												84.2				86.1				84.5				90.7				96				96.4				91.2				92.3																																							
				Phenanthrene-d10 % recovery**				TM218				%												83.1				82.9				80.6				96.4				102				106				92.5				104																																							
				Chrysene-d12 % recovery**				TM218				%												77.8				72.4				71				89.1				108				105				89.6				96.3																																							
				Perylene-d12 % recovery**				TM218				%												78.8				71.7				70.3				87.8				98.1				90.9				81.7				77.4																																							
				Naphthalene				TM218				mg/kg				<0.009				4,900				POS Resi - S4UL				0.0325				0.0513				0.116				0.291				0.0557				0.0256				0.219				0.0593				0.11				0.12				0.13				0.06				0.26				0.11				0.21				0.13			
				Acenaphthylene				TM218				mg/kg				<0.012				15,000				POS Resi - S4UL				<0.012				<0.012				0.0458				<0.012				0.0134				<0.012				<0.012				<0.012				<0.012				<0.012				<0.012				<0.012				<0.012															
				Acenaphthene				TM218				mg/kg				<0.008				15,000				POS Resi - S4UL				<0.008				<0.008				0.00977				0.0746				<0.008				<0.008				0.0146				0.0615				<0.02				<0.02				<0.02				<0.02				<0.02				<0.02											
				Fluorene				TM218				mg/kg				<0.01				9,900				POS Resi - S4UL				<0.01				<0.01				0.0205				0.0964				<0.01				<0.01				0.0214				0.0744				<0.02				<0.02				<0.02				<0.02				<0.02															
				Phenanthrene				TM218				mg/kg				<0.015				3,100				POS Resi - S4UL				0.0745				0.118				0.299				1.52				0.131				0.112				0.651				1.14				0.32				0.38				0.33				0.14				0.6				0.25				0.56				0.29			
				Anthracene				TM218				mg/kg				<0.016				74,000				POS Resi - S4UL				<0.016				<0.016				0.0314				0.29				<0.016				0.0176				0.0264				0.189				0.03				0.04				0.02				<0.02				<0.02				0.08				0.02							
				Fluoranthene				TM218				mg/kg				<0.017				3,100				POS Resi - S4UL				<0.017				0.0238				0.262				2.1				0.025				0.12				0.208				1.03				0.21				0.24				0.14				0.07				0.12				0.05				0.32				0.06			
				Pyrene				TM218				mg/kg				<0.015				7,400				POS Resi - S4UL				<0.015				0.0254				0.255				1.83				0.0261				0.12				0.183				0.904				0.17				0.25				0.12				0.06				0.12				0.04				0.34				0.06			
				Benzo(a)anthracene				TM218				mg/kg				<0.014				29				POS Resi - S4UL				<0.014				<0.014				0.138				1.17				<0.014				0.0609				0.0894				0.401				0.11				0.15				0.07				0.02				0.04				<0.02				0.21				0.02			
				Chrysene				TM218				mg/kg				<0.01				57				POS Resi - S4UL				<0.01				0.0187				0.129				1.17				0.0241				0.0791				0.178				0.481				0.11				0.16				0.08				0.04				0.06				0.03				0.2				0.06			
				Benzo(b)fluoranthene				TM218				mg/kg				<0.015				7.1				POS Resi - S4UL				<0.015				0.0203				0.18				1.22				0.0187				0.148				0.135				0.419				0.18				0.25				0.12				0.06				0.08				0.04				0.32				0.06			
				Benzo(k)fluoranthene				TM218				mg/kg				<0.014				190				POS Resi - S4UL				<0.014				0.0595				0.517				<0.014				0.055				0.0369				0.148																																							

**APPENDIX C**



# LABORATORY REPORT



**Contract Number: PSL23/2252**

Report Date: 02 May 2023  
Client's Reference: LD10488  
Client Name: Wardell Armstrong  
Sir Henry Doulton House  
Forge Lane  
Etruria  
Stoke on Trent  
ST1 5BD

**For the attention of: Elliot Heatherington**

Contract Title: Primrose Lane, Liversedge  
Date Received: 31/3/2023  
Date Commenced: 31/3/2023  
Date Completed: 02/5/2023

**Notes: Opinions and Interpretations are outside the UKAS Accreditation**

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

Checked and Approved Signatories:

L Knight  
(Assistant Laboratory Manager)

R Berriman  
(Associate Director)

S Royle  
(Laboratory Manager)

A Watkins  
(Managing Director)

S Eyre  
(Senior Technical Coordinator)

T Watkins  
(Senior Technician)

5 – 7 Hexthorpe Road,  
Hexthorpe,  
Doncaster,  
DN4 0AR  
Tel: 01302 768098  
Email: rberriman@prosoils.co.uk  
awatkins@prosoils.co.uk

Page 1 of

# SUMMARY OF LABORATORY SOIL DESCRIPTIONS

Hole Number	Sample Number	Sample Type	Top Depth m	Base Depth m	Description of Sample
TP01		B	1.50		Brown slightly gravelly slightly sandy CLAY.
TP01		B	3.00		Brown slightly sandy clayey GRAVEL.
TP05		B	1.00		Brown slightly gravelly slightly sandy CLAY.
TP06		B	2.10		Brown slightly gravelly slightly sandy CLAY.
TP06		B	2.80		Dark brown very sandy very silty GRAVEL.
TP07		B	0.80		Brown mottled grey slightly gravelly sandy CLAY.
TP07		B	3.50		Brown mottled grey highly weathered MUDSTONE
TP08		B	1.60	2.00	Dark grey GRAVEL.
TP08		B	2.60	3.00	Grey highly weathered MUDSTONE.
TP10		B	0.90	1.00	Brown slightly gravelly sandy CLAY.
TP10		B	1.80	2.00	Grey mottled brown very gravelly sandy CLAY.
TP11		B	1.00	1.10	Grey highly weathered MUDSTONE.
TP15		B	2.20		MADE GROUND brown gravelly sandy clay.
TP17		B	2.00		Brown highly weathered MUDSTONE.
TP17		B	3.50		Brown highly weathered MUDSTONE.
Trial Trench No.3		B	1.20		MADE GROUND grey clayey very sandy gravel.
Trial Trench No.3		B	2.50		MADE GROUND dark grey very sandy clayey gravel.
Trial Trench No.4		B	1.60		MADE GROUND dark brown very sandy clayey gravel.
Trial Trench No.5		B	1.40	1.50	MADE GROUND dark grey very sandy clayey gravel.



Primrose Lane, Liversedge

**Contract No:**

**PSL23/2252**

**Client Ref:**

**LD10488**

# SUMMARY OF SOIL CLASSIFICATION TESTS

(BS1377 : PART 2 : 1990)

Hole Number	Sample Number	Sample Type	Top Depth m	Base Depth m	Moisture Content % Clause 3.2	Particle Density Mg/m <sup>3</sup> Clause 8.2	Liquid Limit % Clause 4.3/4	Plastic Limit % Clause 5.3	Plasticity Index % Clause 5.4	Passing .425mm %	Remarks
TP01		B	1.50		13						
TP01		B	3.00		8.4	2.75					
TP05		B	1.00		20	2.69	46	22	24	96	Intermediate Plasticity CI
TP06		B	2.10		20						
TP06		B	2.80		26	2.74					
TP07		B	0.80		27		49	24	25	90	Intermediate Plasticity CI
TP07		B	3.50		12	2.67					
TP08		B	1.60	2.00	22						
TP08		B	2.60	3.00	10						
TP10		B	0.90	1.00	22	2.65					
TP10		B	1.80	2.00	28		47	24	23	72	Intermediate Plasticity CI
TP11		B	1.00	1.10	7.8						
TP15		B	2.20		27						
TP17		B	2.00		28						
TP17		B	3.50		13						
Trial Trench No.3		B	1.20		17						
Trial Trench No.3		B	2.50		16	2.40					
Trial Trench No.4		B	1.60		22	2.25					
Trial Trench No.5		B	1.40	1.50	12						

SYMBOLS : NP : Non Plastic

\* : Liquid Limit and Plastic Limit Wet Sieved.



Primrose Lane, Liversedge

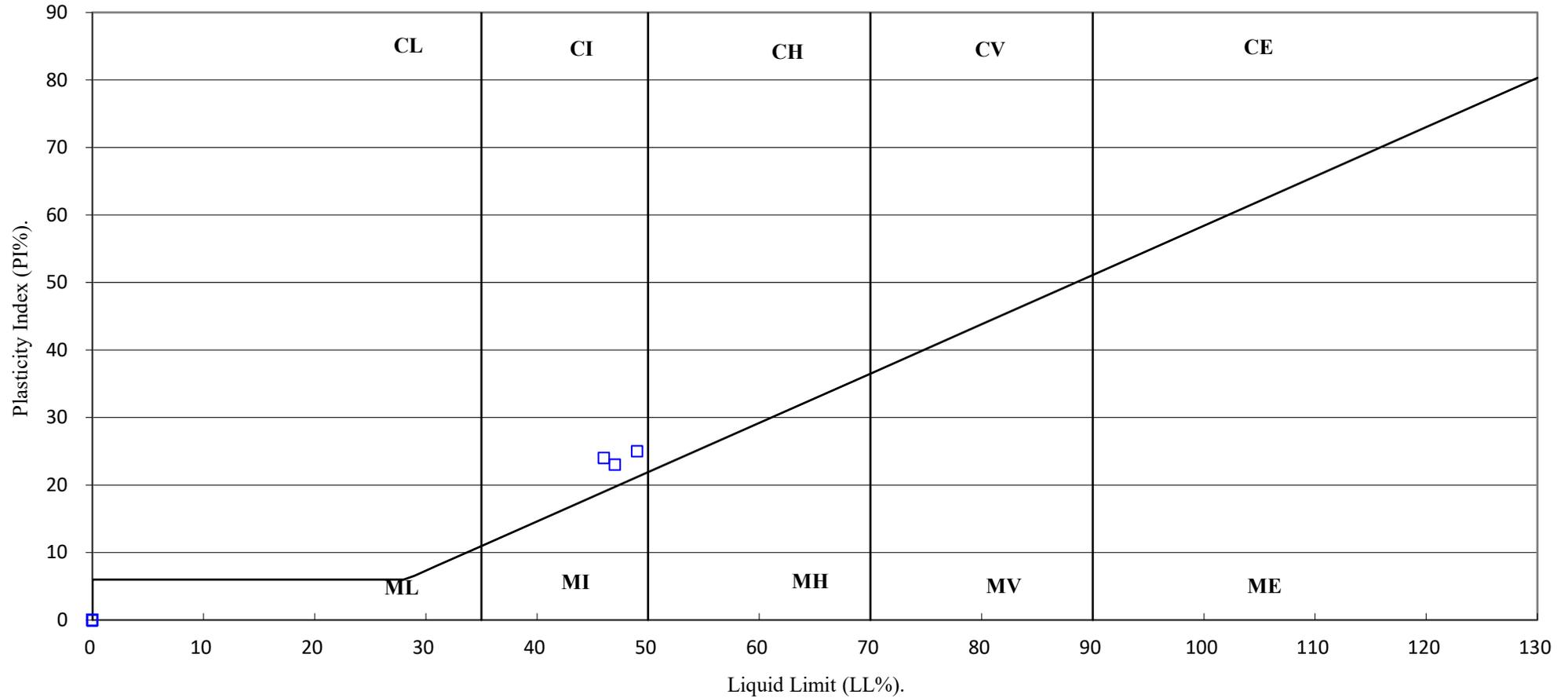
Contract No:

PSL23/2252

Client Ref:

LD10488

# PLASTICITY CHART FOR CASAGRANDE CLASSIFICATION.



Primrose Lane, Liversedge

Contract No:

PSL23/2252

Client Ref:

LD10488

# PARTICLE SIZE DISTRIBUTION TEST

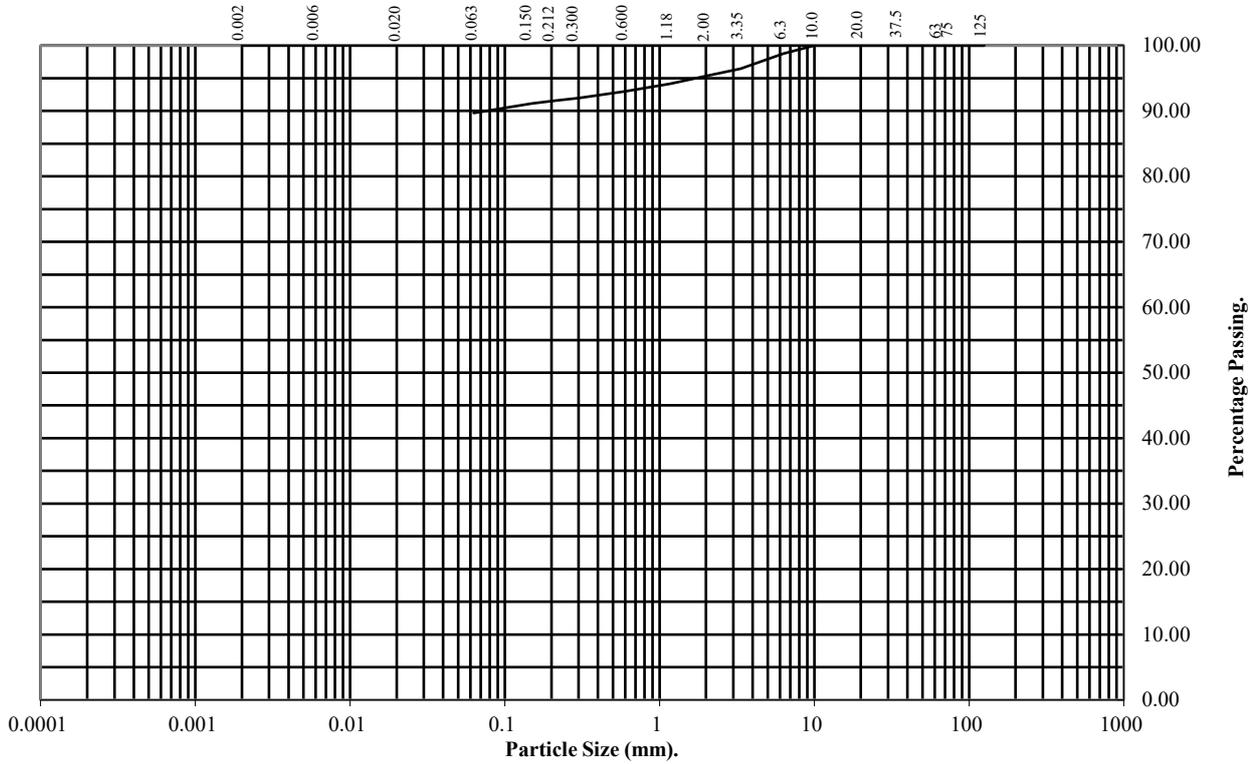
BS1377 : Part 2 : 1990

Wet Sieve, Clause 9.2

Hole Number: **TP01** Top Depth (m): **1.50**

Sample Number: Base Depth(m):

Sample Type: **B**



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
63	100
37.5	100
20	100
10	100
6.3	99
3.35	96
2	95
1.18	94
0.6	93
0.3	92
0.212	92
0.15	91
0.063	90

Soil Fraction	Total Percentage
Cobbles	0
Gravel	5
Sand	5
Silt/Clay	90

**Remarks:**  
See Summary of Soil Descriptions



Primrose Lane, Liversedge

<b>Contract No:</b>
<b>PSL23/2252</b>
<b>Client Ref:</b>
<b>LD10488</b>

# PARTICLE SIZE DISTRIBUTION TEST

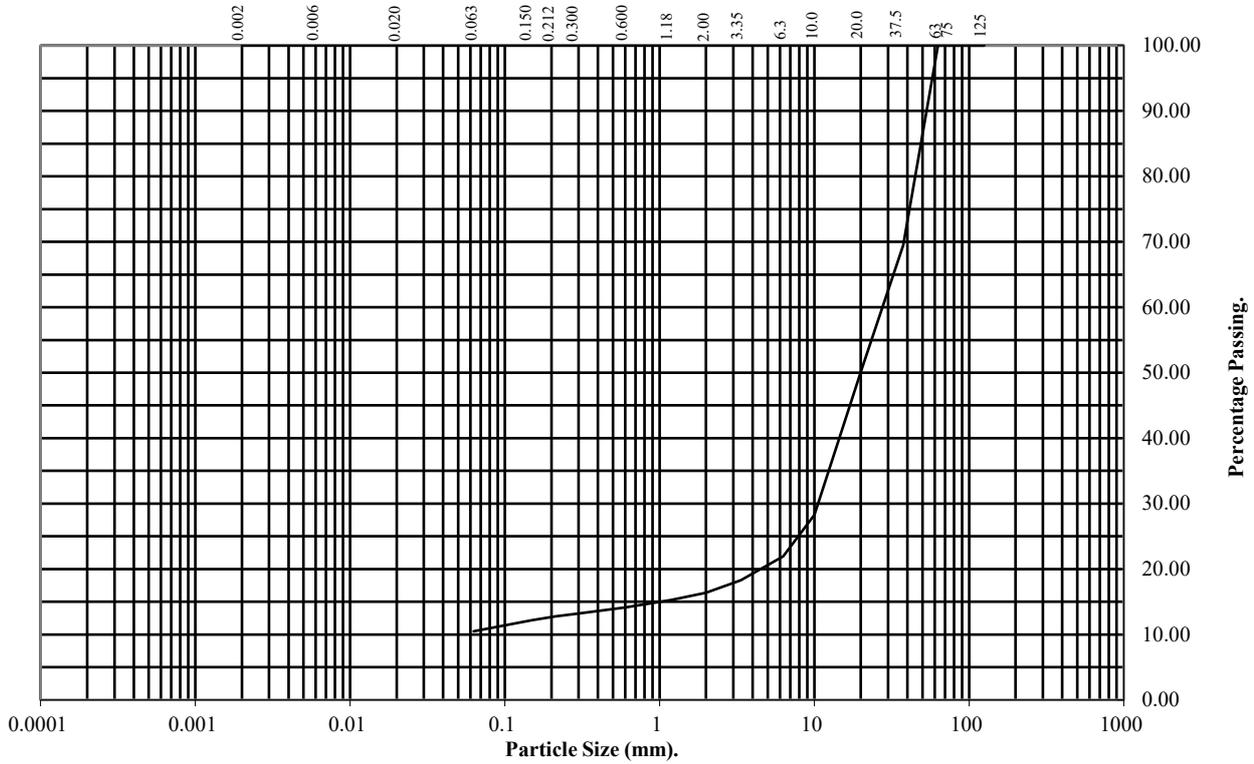
BS1377 : Part 2 : 1990

Wet Sieve, Clause 9.2

Hole Number: **TP01** Top Depth (m): **3.00**

Sample Number: Base Depth(m):

Sample Type: **B**



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
63	100
37.5	69
20	50
10	28
6.3	22
3.35	18
2	16
1.18	15
0.6	14
0.3	13
0.212	13
0.15	12
0.063	10

Soil Fraction	Total Percentage
Cobbles	0
Gravel	84
Sand	6
Silt/Clay	10

**Remarks:**  
See Summary of Soil Descriptions



Primrose Lane, Liversedge

<b>Contract No:</b>
<b>PSL23/2252</b>
<b>Client Ref:</b>
<b>LD10488</b>

# PARTICLE SIZE DISTRIBUTION TEST

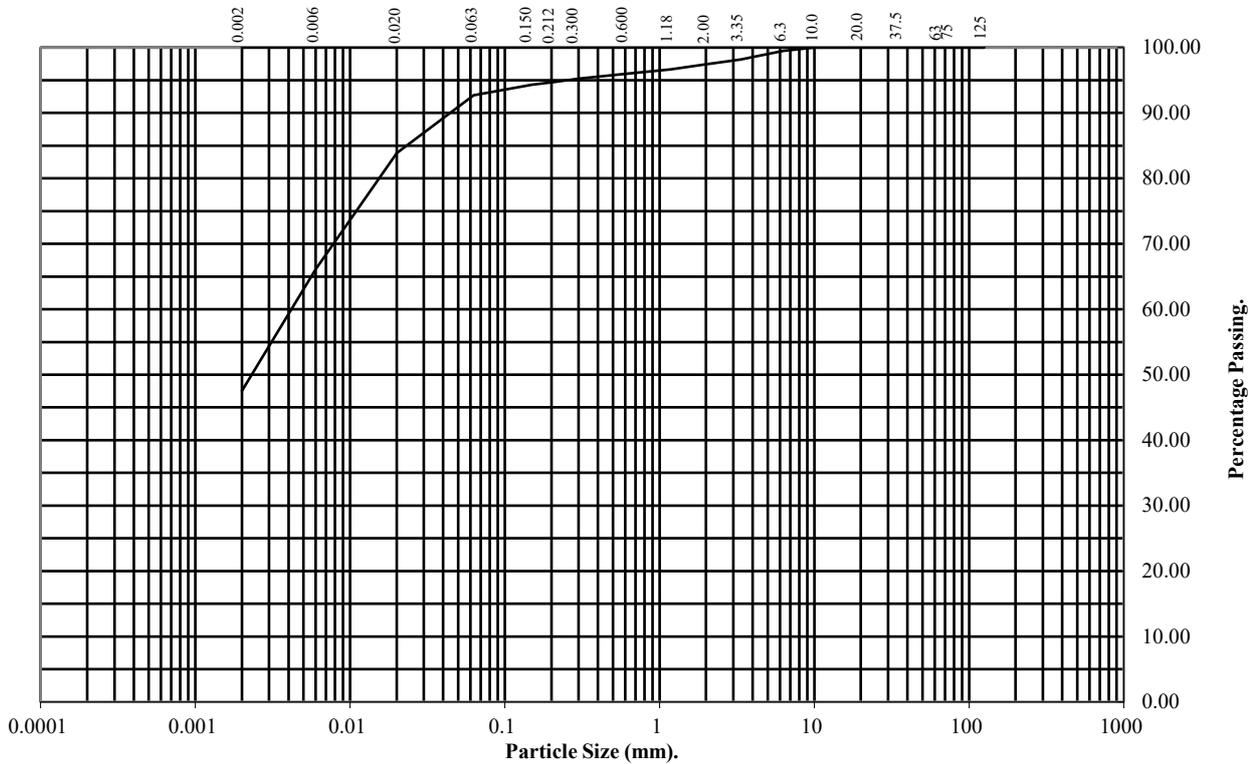
BS1377 : Part 2 : 1990

Wet Sieve & Pipette Analysis, Clause 9.2 & 9.4

Hole Number: **TP05** Top Depth (m): **1.00**

Sample Number: Base Depth(m):

Sample Type: **B**



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
63	100
37.5	100
20	100
10	100
6.3	99
3.35	98
2	97
1.18	97
0.6	96
0.3	95
0.212	95
0.15	94
0.063	93

Particle Diameter	Percentage Passing
0.02	84
0.006	66
0.002	48

Soil Fraction	Total Percentage
Cobbles	0
Gravel	3
Sand	4
Silt	45
Clay	48

**Remarks:**  
See Summary of Soil Descriptions



Primrose Lane, Liversedge

Contract No:  
**PSL23/2252**  
Client Ref:  
**LD10488**

# PARTICLE SIZE DISTRIBUTION TEST

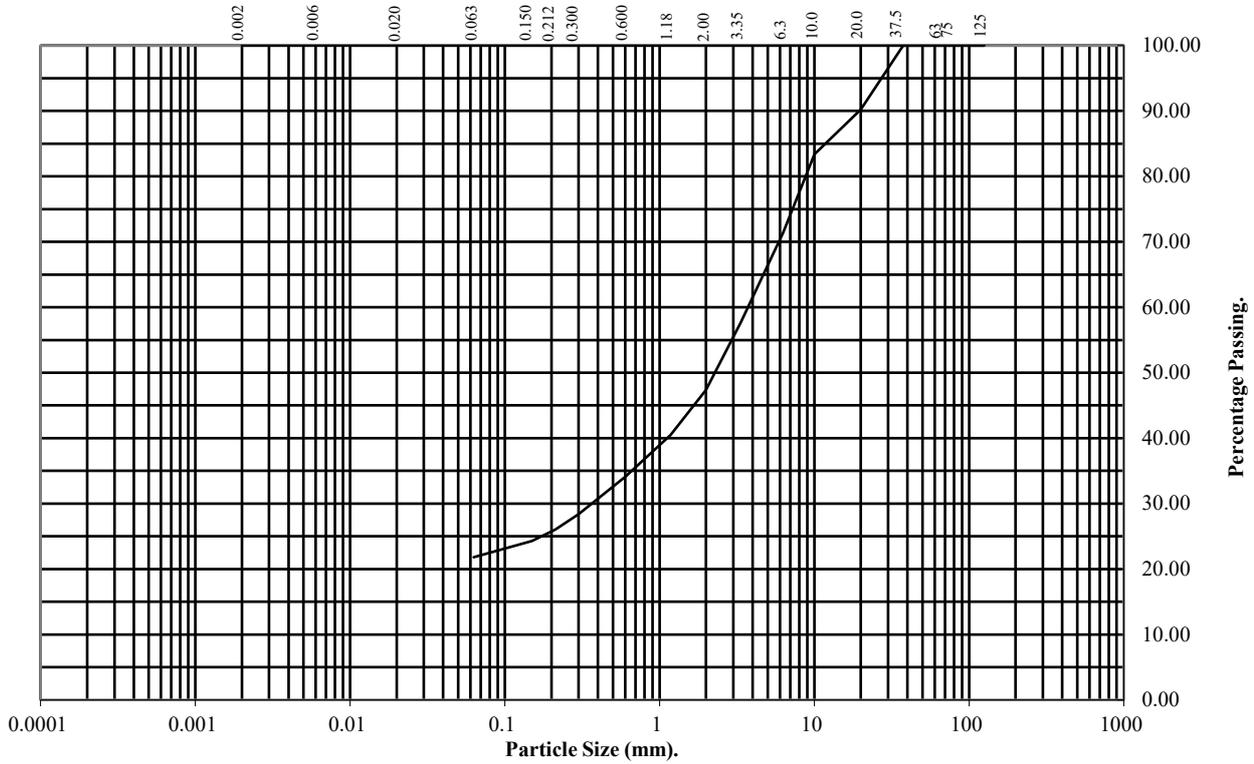
BS1377 : Part 2 : 1990

Wet Sieve, Clause 9.2

Hole Number: **TP06** Top Depth (m): **2.80**

Sample Number: Base Depth(m):

Sample Type: **B**



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
63	100
37.5	100
20	90
10	83
6.3	71
3.35	58
2	47
1.18	40
0.6	34
0.3	28
0.212	26
0.15	24
0.063	22

Soil Fraction	Total Percentage
Cobbles	0
Gravel	53
Sand	25
Silt/Clay	22

**Remarks:**  
See Summary of Soil Descriptions



Primrose Lane, Liversedge

Contract No:  
**PSL23/2252**  
Client Ref:  
**LD10488**

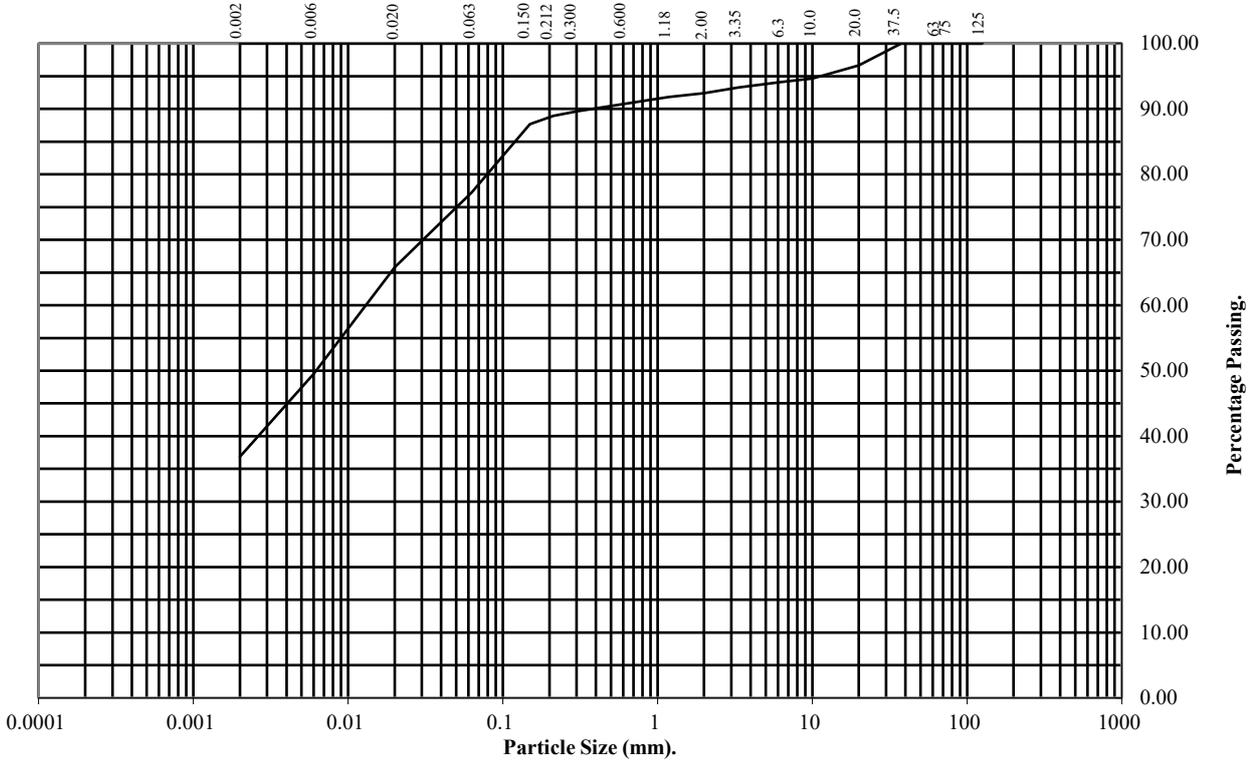
# PARTICLE SIZE DISTRIBUTION TEST

**BS1377 : Part 2 : 1990**  
Wet Sieve & Pipette Analysis, Clause 9.2 & 9.4

**Hole Number:** TP07 **Top Depth (m):** 0.80

**Sample Number:** **Base Depth(m):**

**Sample Type:** B



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
63	100
37.5	100
20	97
10	95
6.3	94
3.35	93
2	92
1.18	92
0.6	91
0.3	90
0.212	89
0.15	88
0.063	77

Particle Diameter	Percentage Passing
0.02	66
0.006	50
0.002	37

Soil Fraction	Total Percentage
Cobbles	0
Gravel	8
Sand	15
Silt	40
Clay	37

**Remarks:**  
See Summary of Soil Descriptions



Primrose Lane, Liversedge

<b>Contract No:</b>
<b>PSL23/2252</b>
<b>Client Ref:</b>
<b>LD10488</b>

# PARTICLE SIZE DISTRIBUTION TEST

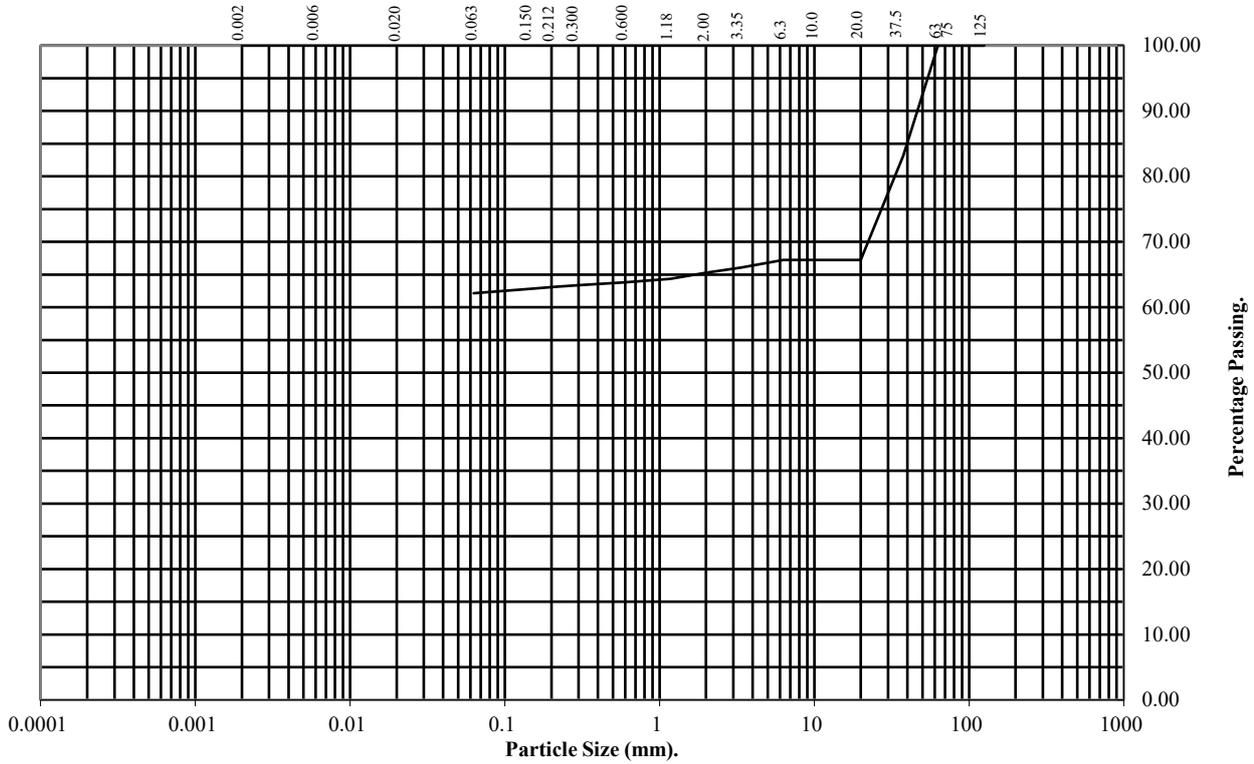
BS1377 : Part 2 : 1990

Wet Sieve, Clause 9.2

Hole Number: **TP07** Top Depth (m): **3.50**

Sample Number: Base Depth(m):

Sample Type: **B**



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
63	100
37.5	83
20	67
10	67
6.3	67
3.35	66
2	65
1.18	64
0.6	64
0.3	63
0.212	63
0.15	63
0.063	62

Soil Fraction	Total Percentage
Cobbles	0
Gravel	35
Sand	3
Silt/Clay	62

**Remarks:**  
See Summary of Soil Descriptions



Primrose Lane, Liversedge

<b>Contract No:</b>
<b>PSL23/2252</b>
<b>Client Ref:</b>
<b>LD10488</b>



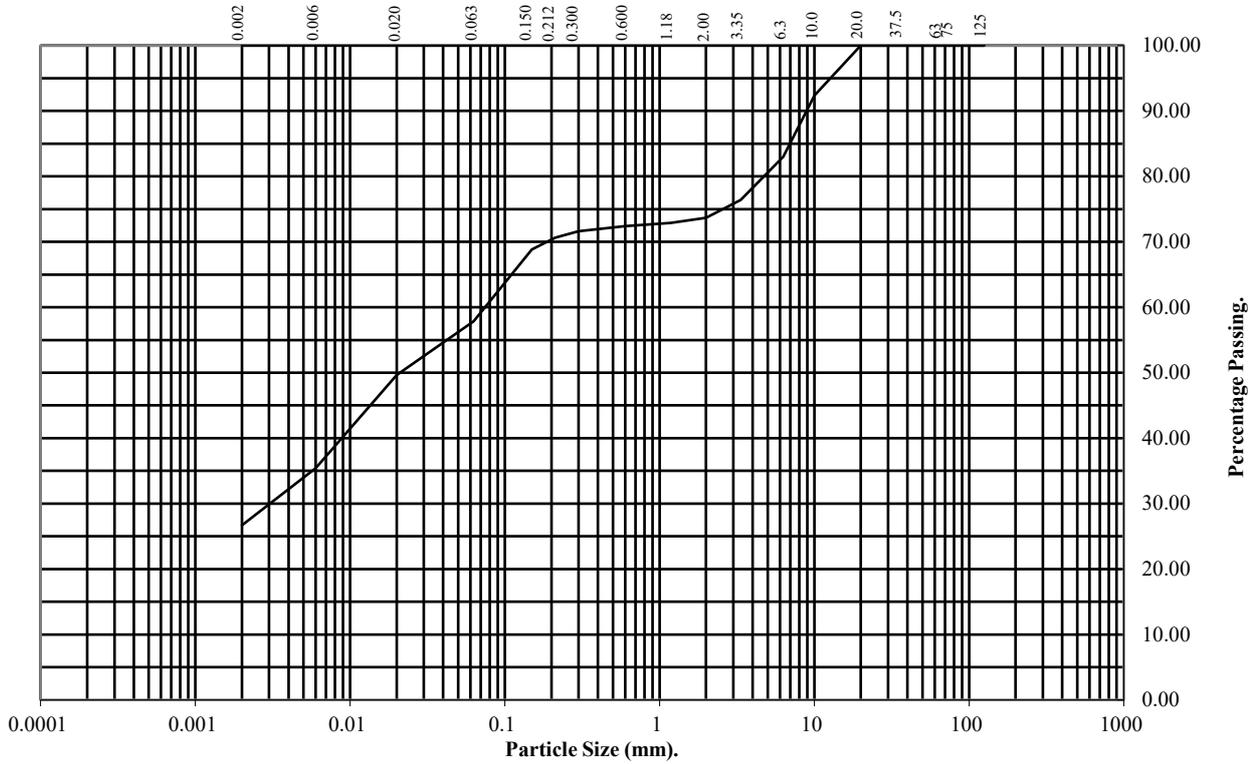
# PARTICLE SIZE DISTRIBUTION TEST

**BS1377 : Part 2 : 1990**  
Wet Sieve & Pipette Analysis, Clause 9.2 & 9.4

**Hole Number:** TP10 **Top Depth (m):** 1.80

**Sample Number:** **Base Depth(m):** 2.00

**Sample Type:** B



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
63	100
37.5	100
20	100
10	92
6.3	83
3.35	76
2	74
1.18	73
0.6	72
0.3	72
0.212	71
0.15	69
0.063	58

Particle Diameter	Percentage Passing
0.02	50
0.006	35
0.002	27

Soil Fraction	Total Percentage
Cobbles	0
Gravel	26
Sand	16
Silt	31
Clay	27

**Remarks:**  
See Summary of Soil Descriptions



Primrose Lane, Liversedge

<b>Contract No:</b>
<b>PSL23/2252</b>
<b>Client Ref:</b>
<b>LD10488</b>

# PARTICLE SIZE DISTRIBUTION TEST

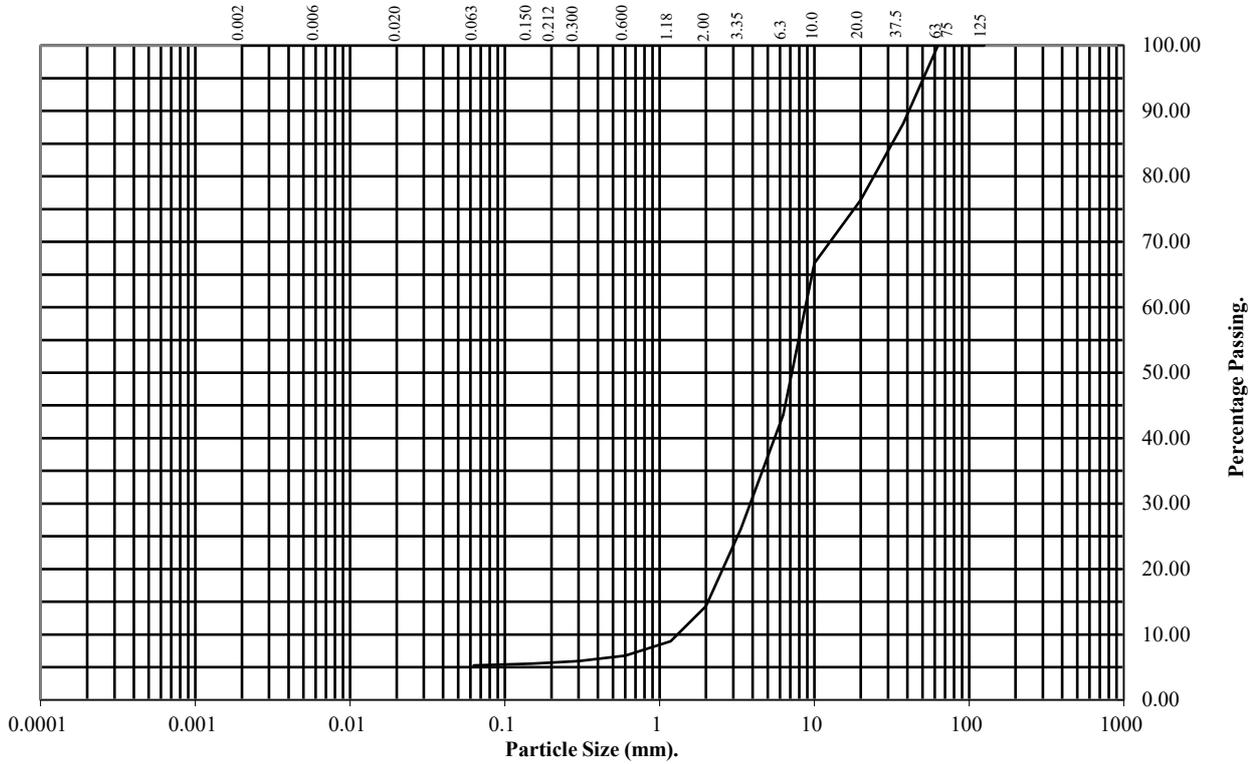
BS1377 : Part 2 : 1990

Wet Sieve, Clause 9.2

**Hole Number:** TP11 **Top Depth (m):** 1.00

**Sample Number:** **Base Depth(m):** 1.10

**Sample Type:** B



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
63	100
37.5	88
20	76
10	67
6.3	44
3.35	26
2	14
1.18	9
0.6	7
0.3	6
0.212	6
0.15	6
0.063	5

Soil Fraction	Total Percentage
Cobbles	0
Gravel	86
Sand	9
Silt/Clay	5

**Remarks:**  
See Summary of Soil Descriptions



Primrose Lane, Liversedge

<b>Contract No:</b>
<b>PSL23/2252</b>
<b>Client Ref:</b>
<b>LD10488</b>

# PARTICLE SIZE DISTRIBUTION TEST

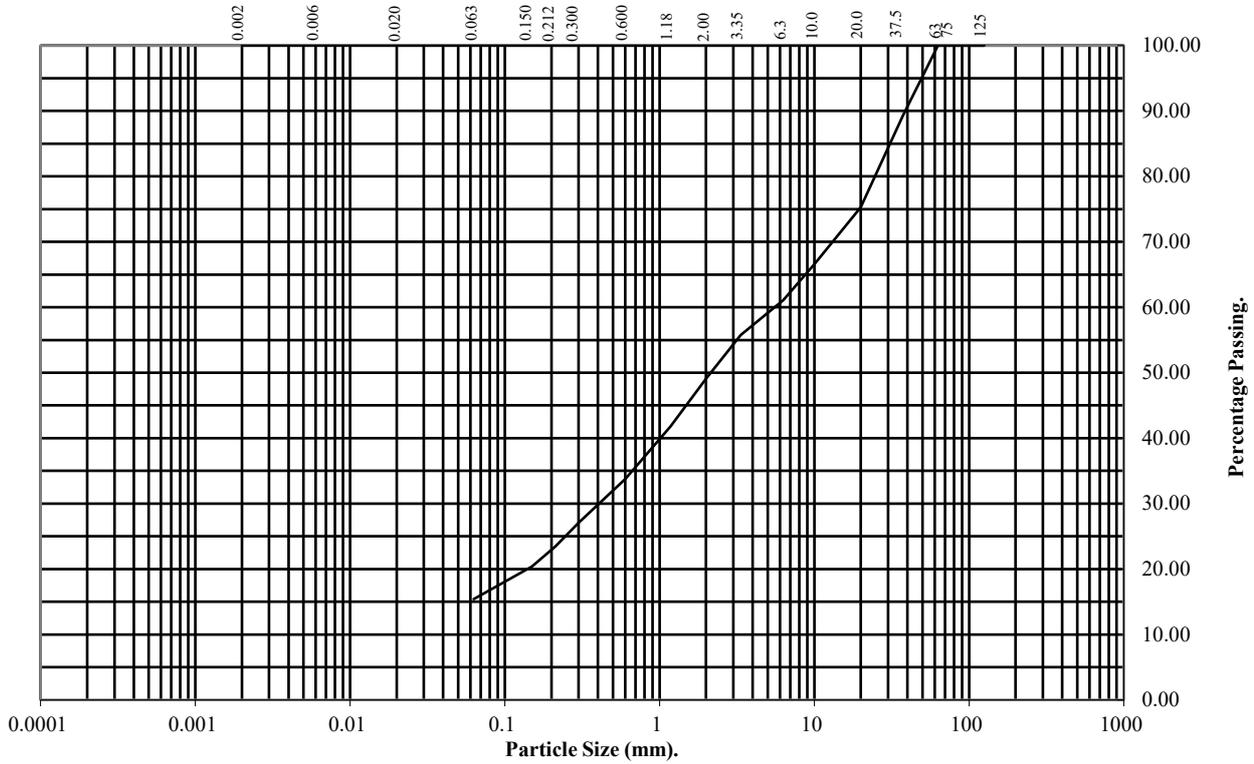
**BS1377 : Part 2 : 1990**

Wet Sieve, Clause 9.2

**Hole Number:** Trial Trench No.3      **Top Depth (m):** 2.50

**Sample Number:**      **Base Depth(m):**

**Sample Type:** B



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
63	100
37.5	89
20	75
10	67
6.3	61
3.35	56
2	49
1.18	42
0.6	34
0.3	27
0.212	23
0.15	20
0.063	15

Soil Fraction	Total Percentage
Cobbles	0
Gravel	51
Sand	34
Silt/Clay	15

**Remarks:**  
See Summary of Soil Descriptions



Primrose Lane, Liversedge

<b>Contract No:</b>
<b>PSL23/2252</b>
<b>Client Ref:</b>
<b>LD10488</b>

# PARTICLE SIZE DISTRIBUTION TEST

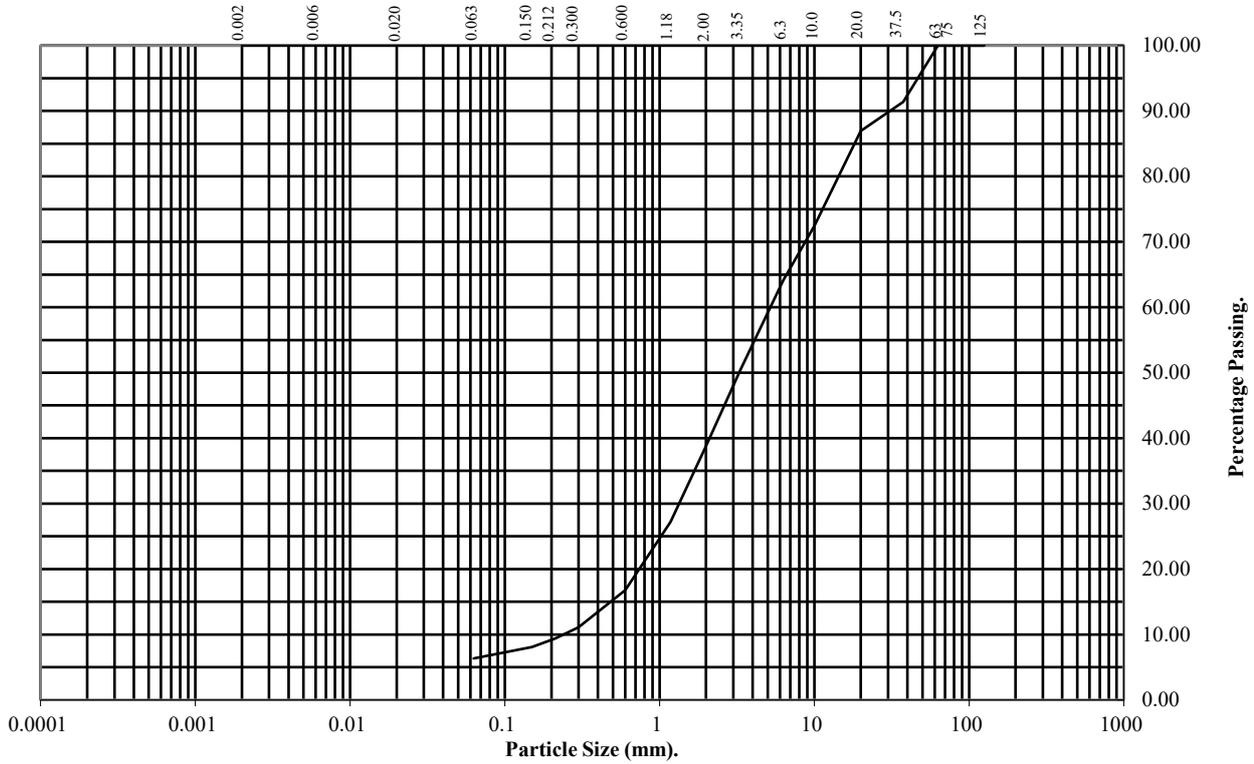
BS1377 : Part 2 : 1990

Wet Sieve, Clause 9.2

Hole Number: **Trial Trench No.4**      Top Depth (m): **1.60**

Sample Number:      Base Depth(m):

Sample Type: **B**



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
63	100
37.5	91
20	87
10	72
6.3	64
3.35	51
2	39
1.18	27
0.6	17
0.3	11
0.212	9
0.15	8
0.063	6

Soil Fraction	Total Percentage
Cobbles	0
Gravel	61
Sand	33
Silt/Clay	6

**Remarks:**  
See Summary of Soil Descriptions



Primrose Lane, Liversedge

<b>Contract No:</b>
<b>PSL23/2252</b>
<b>Client Ref:</b>
<b>LD10488</b>

# PARTICLE SIZE DISTRIBUTION TEST

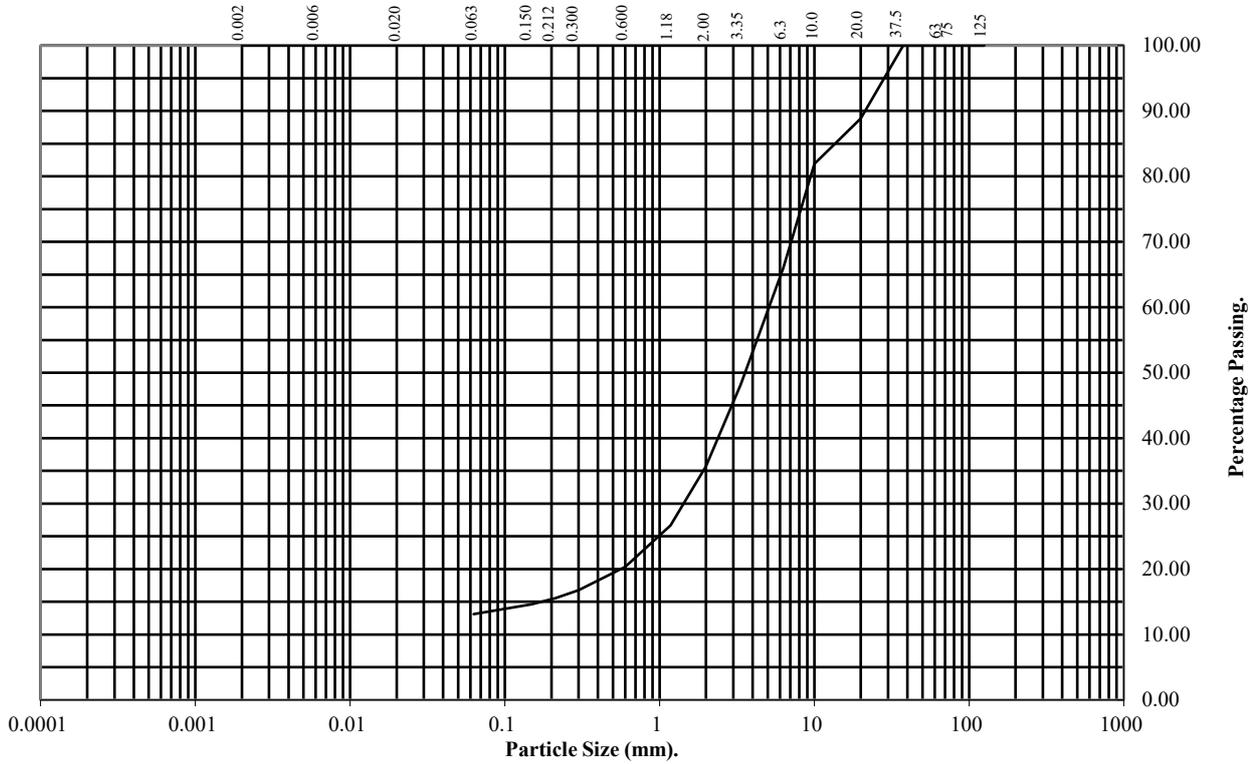
**BS1377 : Part 2 : 1990**

Wet Sieve, Clause 9.2

**Hole Number:** Trial Trench No.5      **Top Depth (m):** 1.40

**Sample Number:**      **Base Depth(m):** 1.50

**Sample Type:** B



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
63	100
37.5	100
20	89
10	82
6.3	66
3.35	48
2	36
1.18	27
0.6	20
0.3	17
0.212	16
0.15	15
0.063	13

Soil Fraction	Total Percentage
Cobbles	0
Gravel	64
Sand	23
Silt/Clay	13

**Remarks:**  
See Summary of Soil Descriptions



Primrose Lane, Liversedge

<b>Contract No:</b>
<b>PSL23/2252</b>
<b>Client Ref:</b>
<b>LD10488</b>

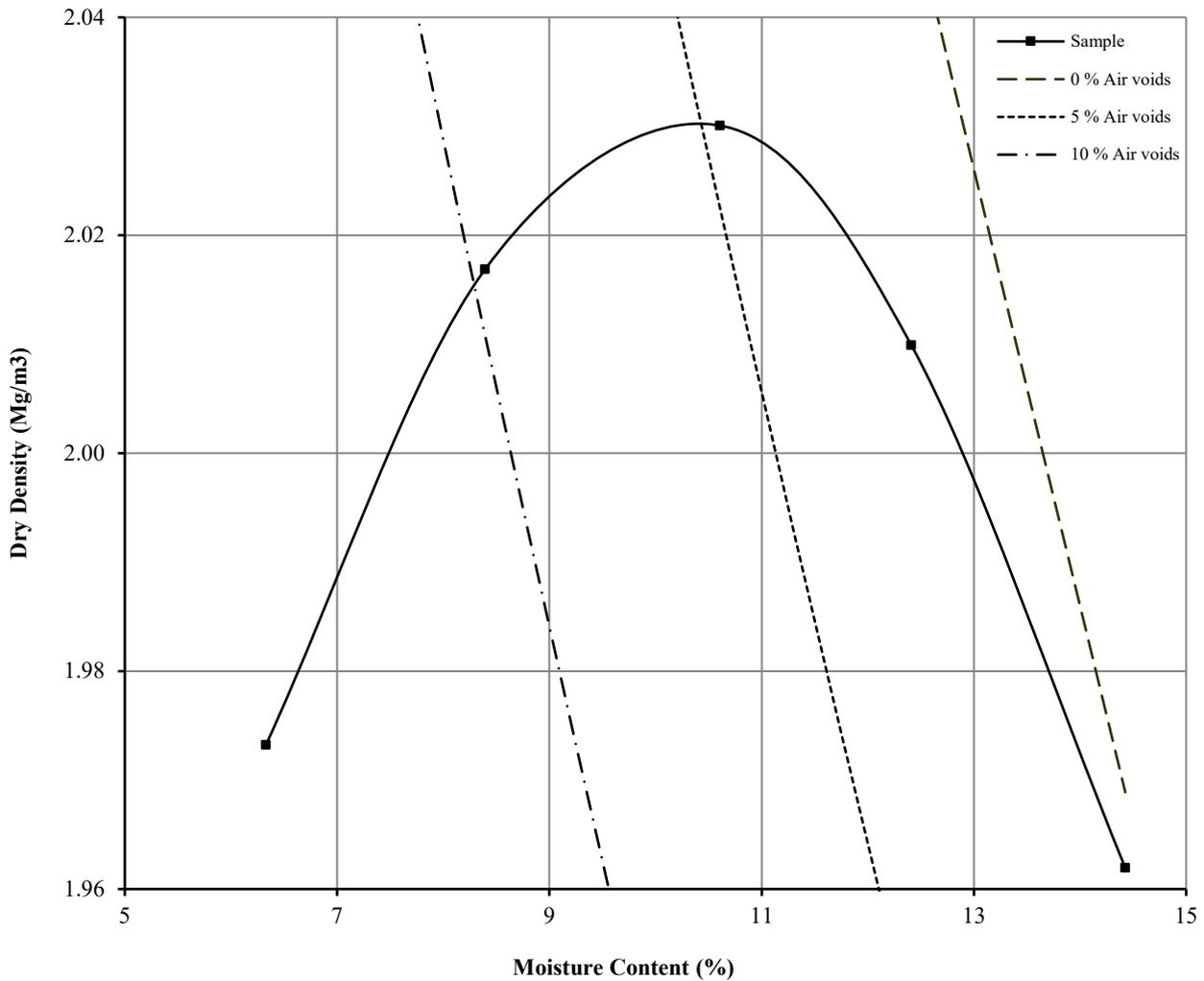
# DRY DENSITY / MOISTURE CONTENT RELATIONSHIP

Non compliance with BS 1377 : Part 4 : Clause 3.4 : 1990

Hole Number: TP01 Top Depth (m) : 3.00

Sample Number: Base Depth (m) :

Sample Type: B



Initial Moisture Content:	8.4	Method of Compaction:	2.5kg	Separate Samples
Particle Density (Mg/m <sup>3</sup> ):	2.75	Measured	Material Retained on 37.5 mm Test Sieve (%):	31
Maximum Dry Density (Mg/m <sup>3</sup> ):	2.03		Material Retained on 20.0 mm Test Sieve (%):	19
Optimum Moisture Content (%):	11			
Remarks See summary of soil descriptions				

 	<b>Primrose Lane, Liversedge</b>	<b>Contract</b>
		<b>PSL23/2252</b>
		<b>Client Ref</b>
		<b>LD10488</b>

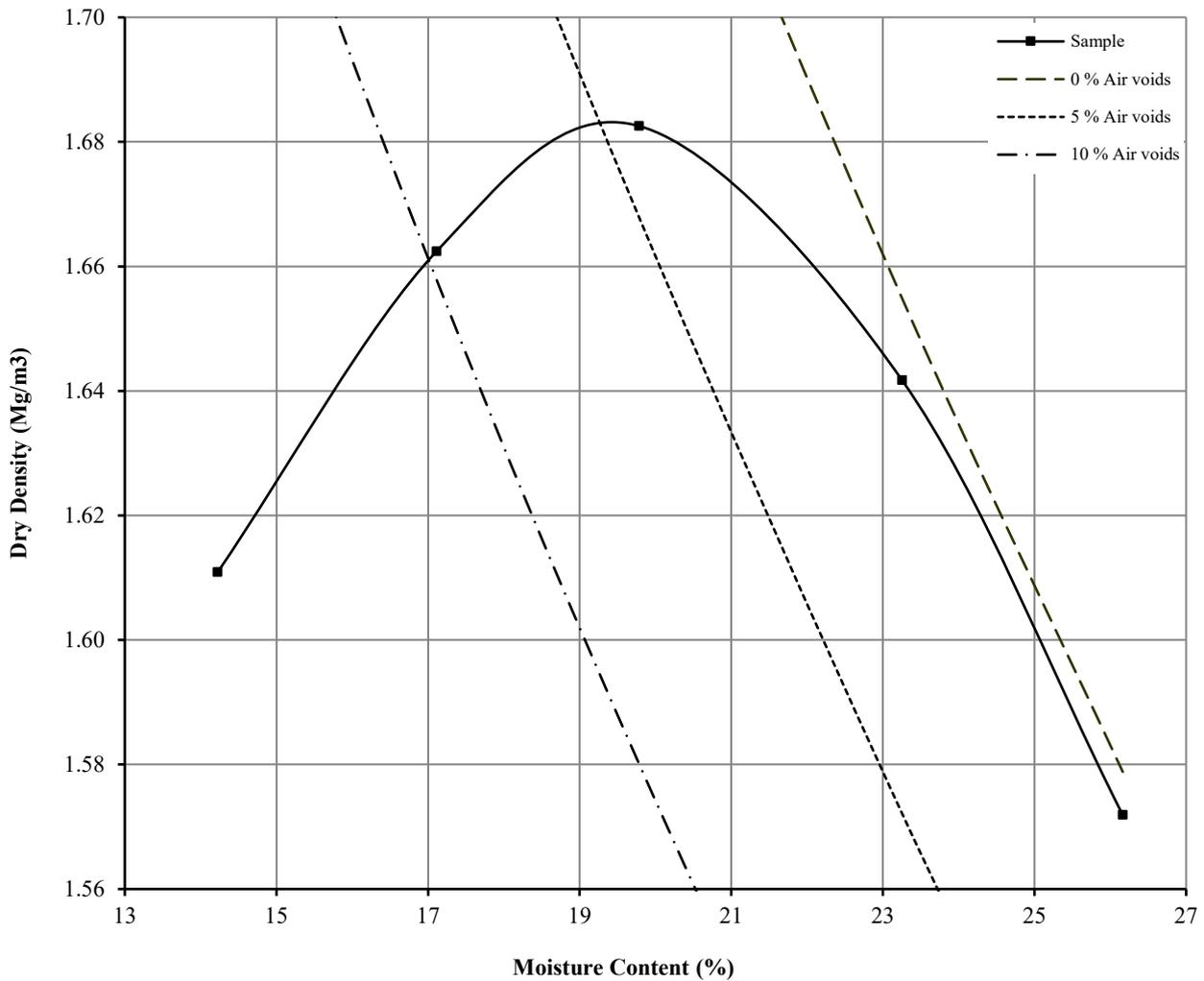
# DRY DENSITY / MOISTURE CONTENT RELATIONSHIP

BS 1377 : Part 4 : Clause 3.3 : 1990

Hole Number: TP05 Top Depth (m) : 1.00

Sample Number: Base Depth (m) :

Sample Type: B



Initial Moisture Content:	20	Method of Compaction:	2.5kg	Separate Samples
Particle Density (Mg/m <sup>3</sup> ):	2.69	Measured	Material Retained on 37.5 mm Test Sieve (%):	0
Maximum Dry Density (Mg/m <sup>3</sup> ):	1.68	Material Retained on 20.0 mm Test Sieve (%):	0	
Optimum Moisture Content (%):	20			
Remarks See summary of soil descriptions				

 	<p style="text-align: center;"><b>Primrose Lane, Liversedge</b></p>	<b>Contract</b>
		<b>PSL23/2252</b>
		<b>Client Ref</b>
		<b>LD10488</b>

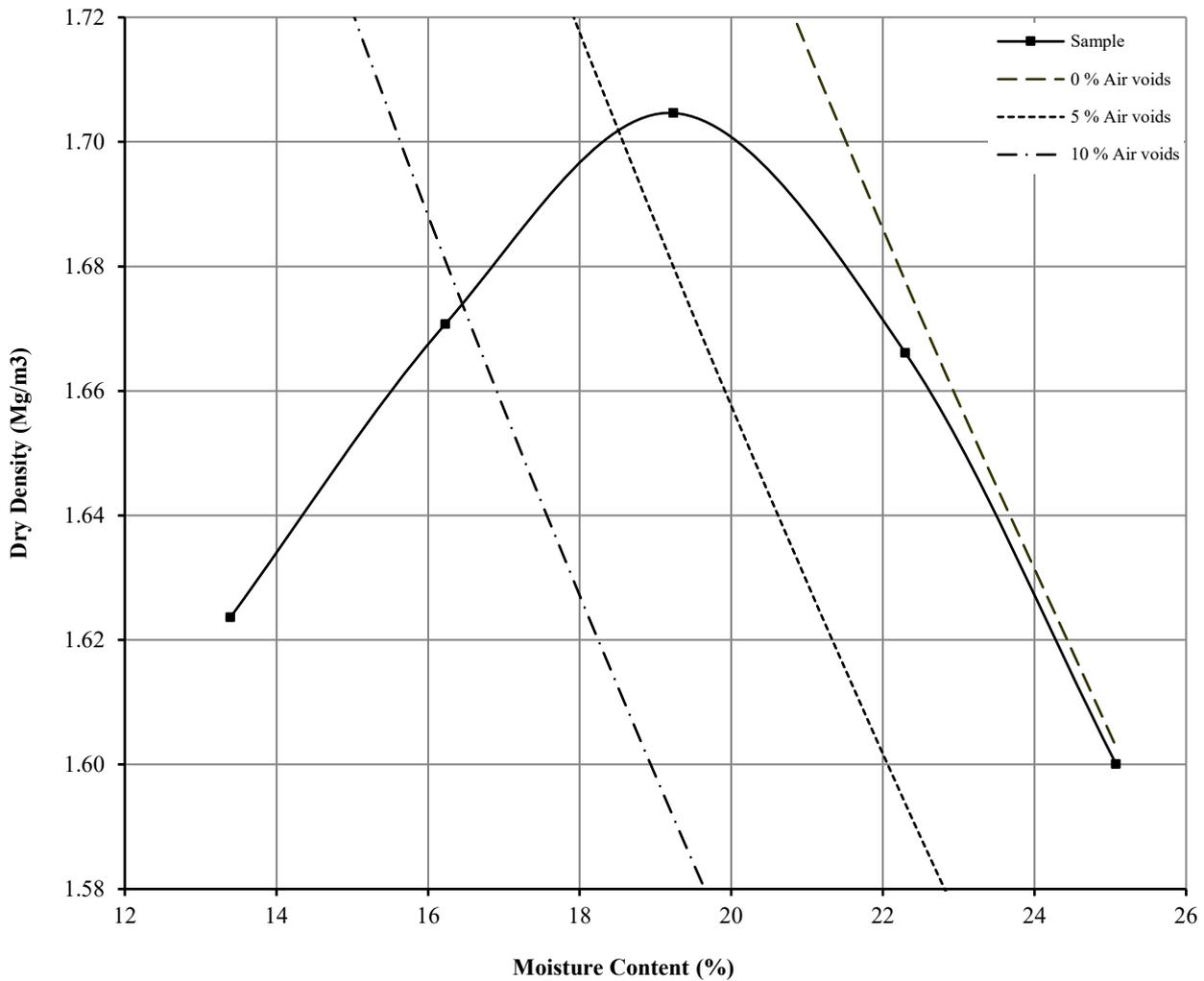
# DRY DENSITY / MOISTURE CONTENT RELATIONSHIP

BS 1377 : Part 4 : Clause 3.3 : 1990

Hole Number: TP06 Top Depth (m) : 2.10

Sample Number: Base Depth (m) :

Sample Type: B



Initial Moisture Content:	19	Method of Compaction:	2.5kg	Separate Samples
Particle Density (Mg/m <sup>3</sup> ):	2.68	Assumed	Material Retained on 37.5 mm Test Sieve (%):	0
Maximum Dry Density (Mg/m <sup>3</sup> ):	1.70	Material Retained on 20.0 mm Test Sieve (%):	0	
Optimum Moisture Content (%):	19			
Remarks See summary of soil descriptions				

 	<b>Primrose Lane, Liversedge</b>	<b>Contract</b>
		<b>PSL23/2252</b>
		<b>Client Ref</b>
		<b>LD10488</b>

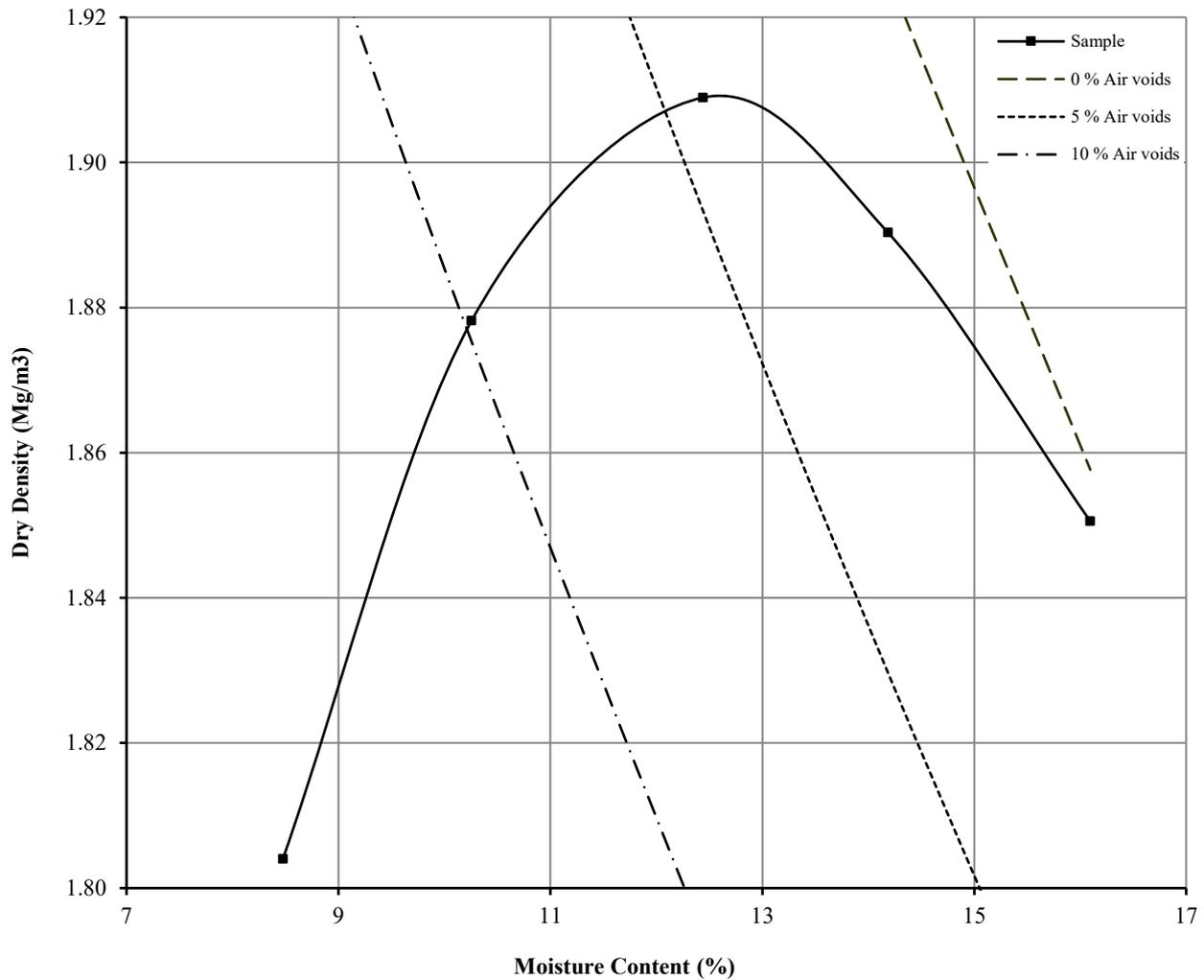
# DRY DENSITY / MOISTURE CONTENT RELATIONSHIP

BS 1377 : Part 4 : Clause 3.3 : 1990

Hole Number: TP08 Top Depth (m) : 2.60

Sample Number: Base Depth (m) : 3.00

Sample Type: B



Initial Moisture Content:	10	Method of Compaction:	2.5kg	Separate Samples
Particle Density (Mg/m <sup>3</sup> ):	2.65	Assumed	Material Retained on 37.5 mm Test Sieve (%):	0
Maximum Dry Density (Mg/m <sup>3</sup> ):	1.91	Material Retained on 20.0 mm Test Sieve (%):	0	
Optimum Moisture Content (%):	12			
Remarks See summary of soil descriptions				

 	<b>Primrose Lane, Liversedge</b>	<b>Contract</b>
		<b>PSL23/2252</b>
		<b>Client Ref</b>
		<b>LD10488</b>

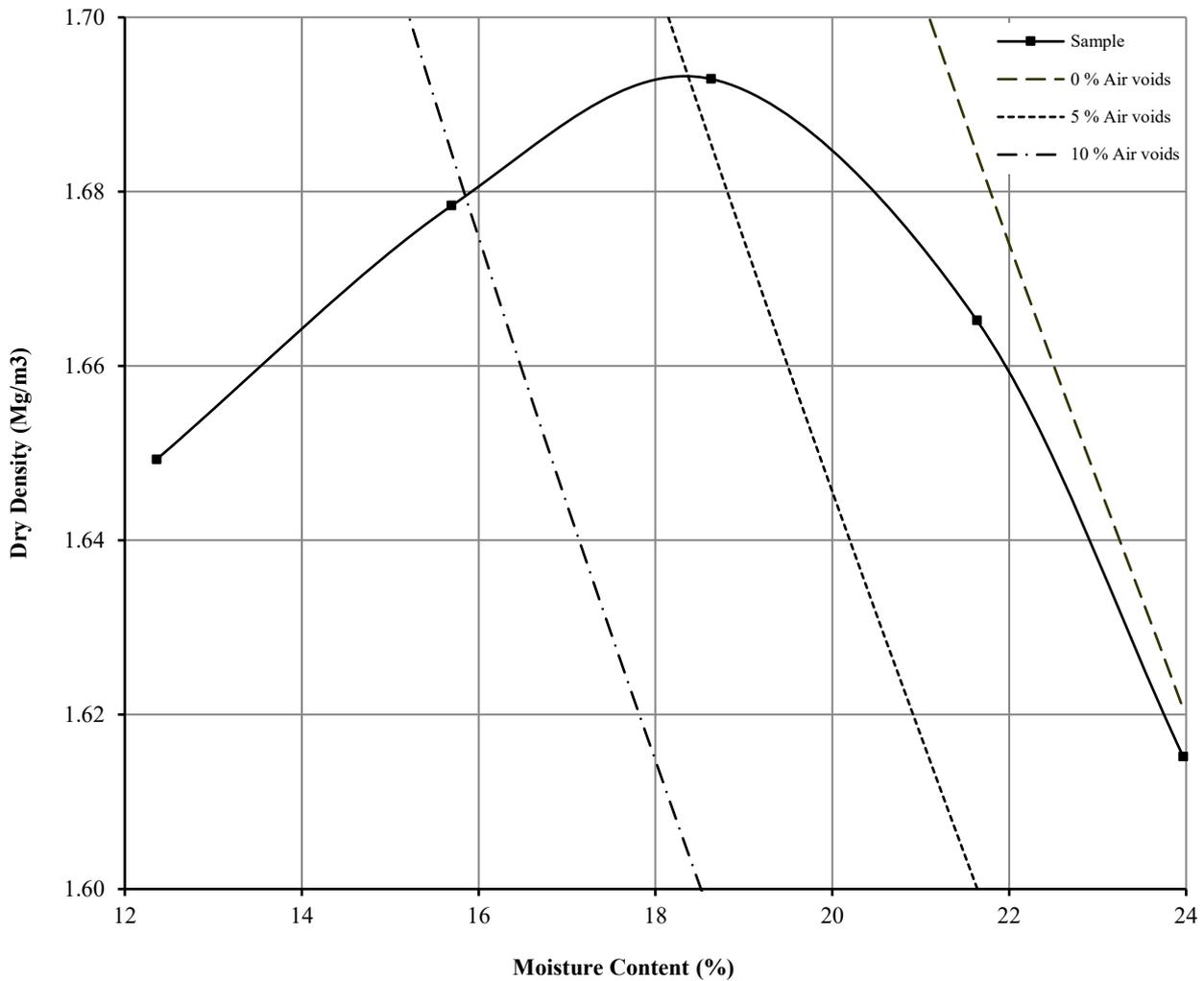
# DRY DENSITY / MOISTURE CONTENT RELATIONSHIP

BS 1377 : Part 4 : Clause 3.3 : 1990

Hole Number: TP10 Top Depth (m) : 0.90

Sample Number: Base Depth (m) : 1.00

Sample Type: B



Initial Moisture Content:	22	Method of Compaction:	2.5kg	Separate Samples
Particle Density (Mg/m <sup>3</sup> ):	2.65	Measured	Material Retained on 37.5 mm Test Sieve (%):	0
Maximum Dry Density (Mg/m <sup>3</sup> ):	1.69		Material Retained on 20.0 mm Test Sieve (%):	0
Optimum Moisture Content (%):	19			
Remarks See summary of soil descriptions				

 	<b>Primrose Lane, Liversedge</b>	<b>Contract</b>
		<b>PSL23/2252</b>
		<b>Client Ref</b>
		<b>LD10488</b>

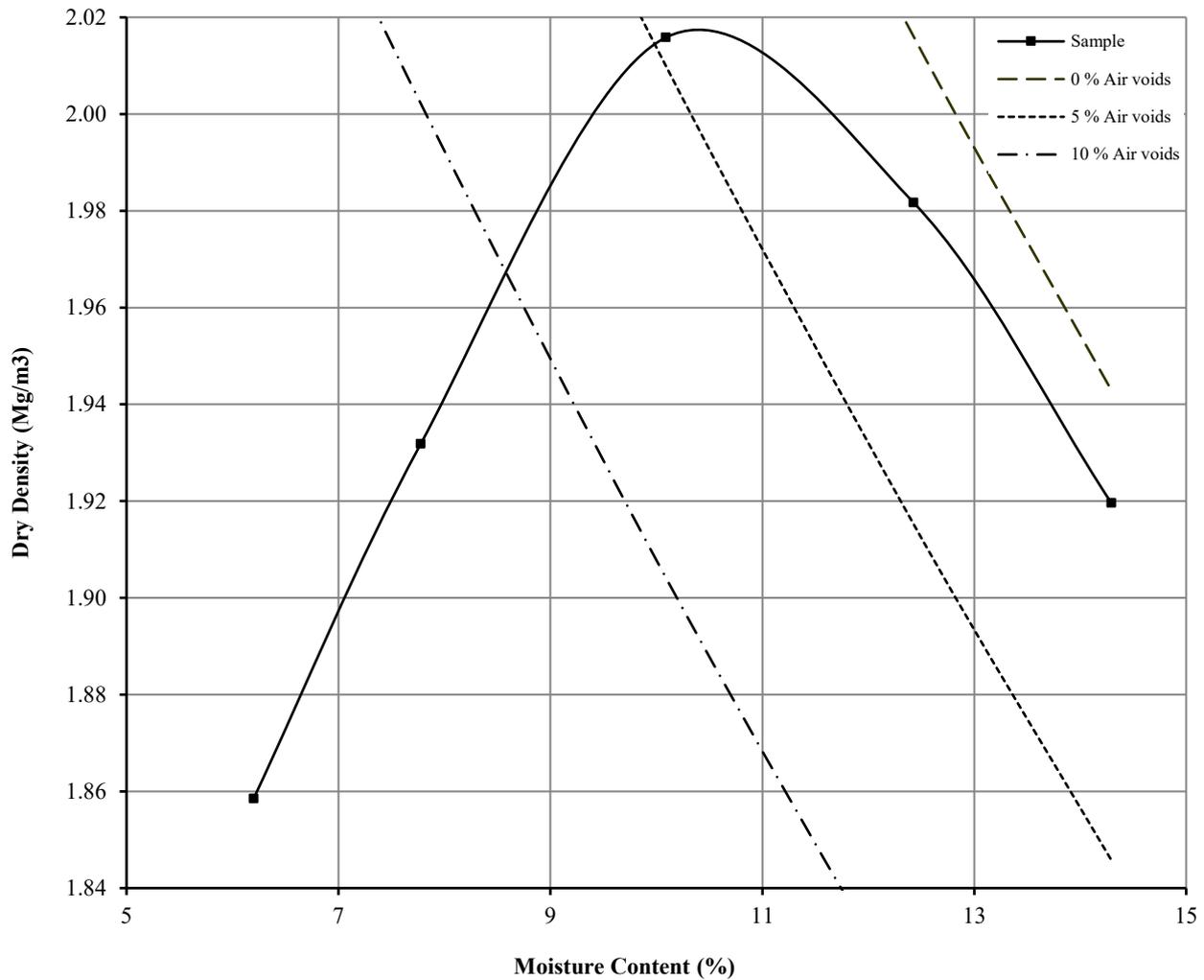
# DRY DENSITY / MOISTURE CONTENT RELATIONSHIP

Non compliance with BS 1377 : Part 4 : Clause 3.4 : 1990

Hole Number: TP11 Top Depth (m) : 1.00

Sample Number: Base Depth (m) : 1.10

Sample Type: B



Initial Moisture Content:	7.8	Method of Compaction:	2.5kg	Separate Samples
Particle Density (Mg/m <sup>3</sup> ):	2.69	Assumed	Material Retained on 37.5 mm Test Sieve (%):	12
Maximum Dry Density (Mg/m <sup>3</sup> ):	2.02		Material Retained on 20.0 mm Test Sieve (%):	12
Optimum Moisture Content (%):	10			
Remarks See summary of soil descriptions				

 	Primrose Lane, Liversedge	Contract
		PSL23/2252
		Client Ref
		LD10488

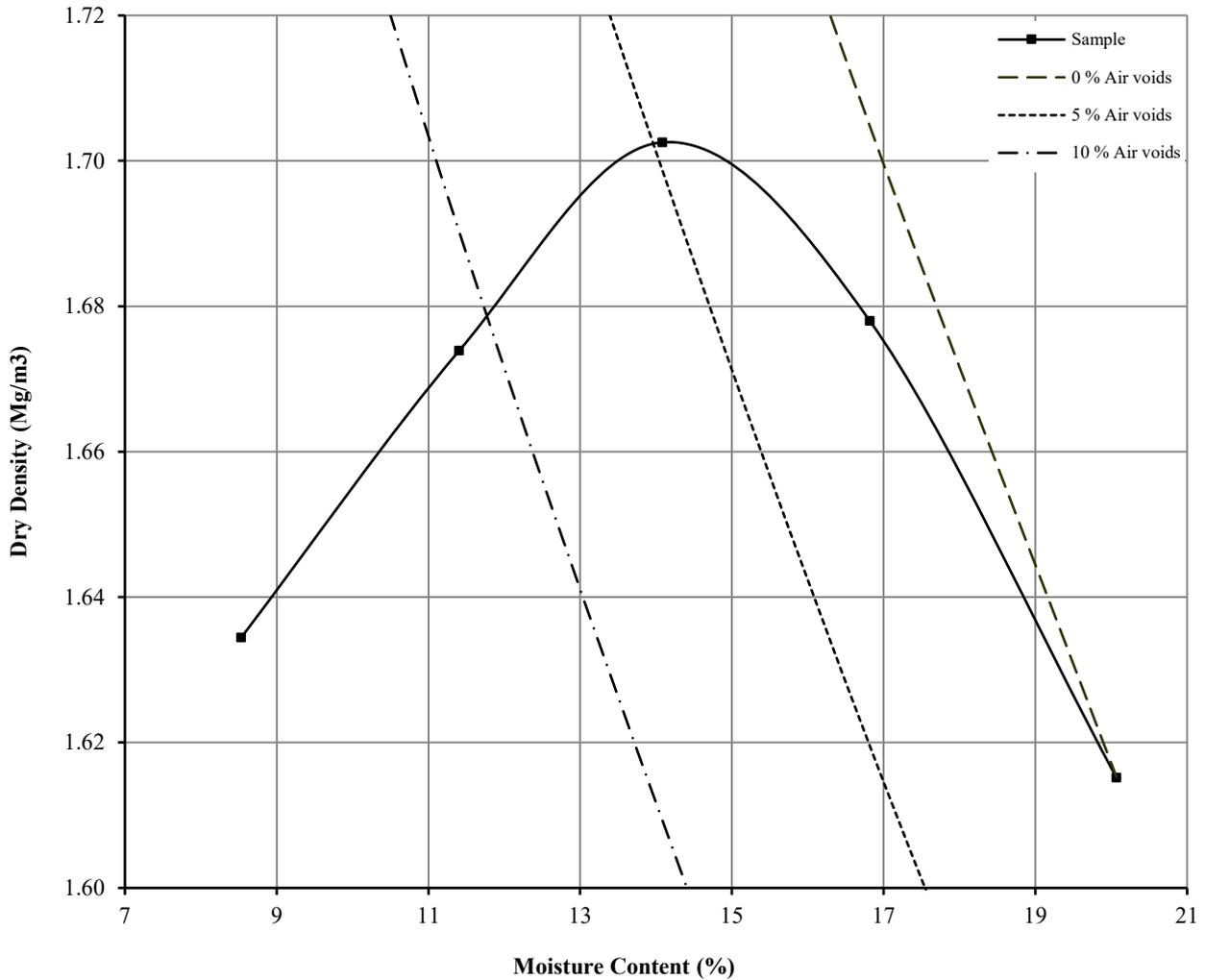
# DRY DENSITY / MOISTURE CONTENT RELATIONSHIP

Non compliance with BS 1377 : Part 4 : Clause 3.4 : 1990

Hole Number: Trial Trench No.3 Top Depth (m) : 1.20

Sample Number: Base Depth (m) :

Sample Type: B



Initial Moisture Content:	17	Method of Compaction:	2.5kg	Separate Samples
Particle Density (Mg/m <sup>3</sup> ):	2.39	Assumed	Material Retained on 37.5 mm Test Sieve (%):	19
Maximum Dry Density (Mg/m <sup>3</sup> ):	1.70	Material Retained on 20.0 mm Test Sieve (%):	10	
Optimum Moisture Content (%):	14			
Remarks See summary of soil descriptions				

 	<b>Primrose Lane, Liversedge</b>	<b>Contract</b>
		<b>PSL23/2252</b>
		<b>Client Ref</b>
		<b>LD10488</b>

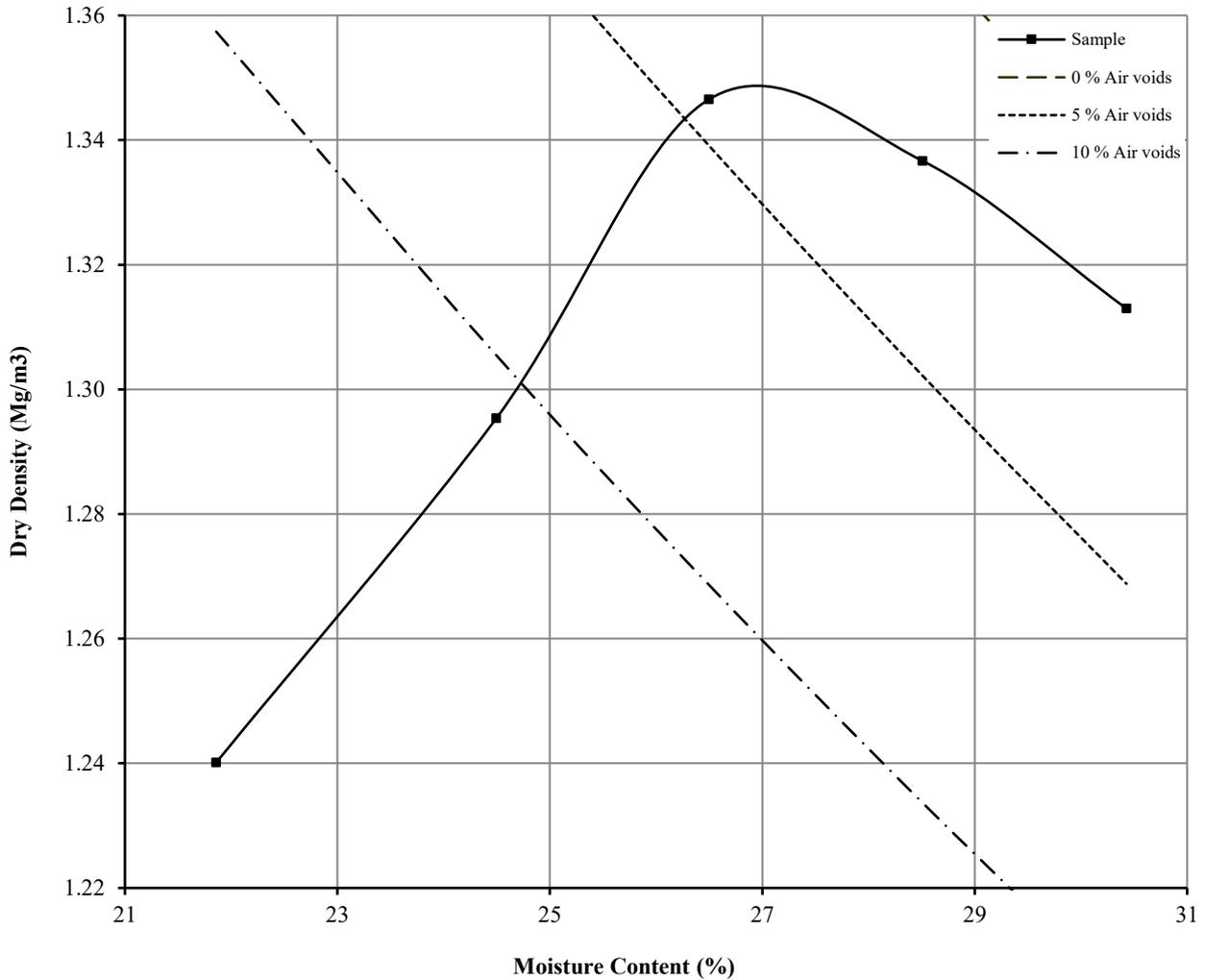
# DRY DENSITY / MOISTURE CONTENT RELATIONSHIP

BS 1377 : Part 4 : Clause 3.4 : 1990

Hole Number: Trial Trench No.4 Top Depth (m) : 1.60

Sample Number: Base Depth (m) :

Sample Type: B



Initial Moisture Content:	22	Method of Compaction:	2.5kg	Separate Samples
Particle Density (Mg/m <sup>3</sup> ):	2.25	Measured	Material Retained on 37.5 mm Test Sieve (%):	9
Maximum Dry Density (Mg/m <sup>3</sup> ):	1.35		Material Retained on 20.0 mm Test Sieve (%):	4
Optimum Moisture Content (%):	26			
Remarks See summary of soil descriptions				

 	<p style="text-align: center;"><b>Primrose Lane, Liversedge</b></p>	<b>Contract</b>
		<b>PSL23/2252</b>
		<b>Client Ref</b>
		<b>LD10488</b>

# MOISTURE CONDITION VALUE

BS1377 : Part 4 : 1990 Clause 5.4

Hole Number: TP01 Top Depth (m): 3.00

Sample Number: Base Depth (m):

Sample Type: B

Material Retained on the 20mm BS Test Sieve (%):	50
Interpretation based on steepest straight line intercept with 5mm change in penetration.	

## MCV Determination



Blows (N)	Penetration (mm)	n to 4n (mm)
1	65.2	12.8
2	58.8	12.7
3	55.0	14.3
4	52.4	13.0
6	48.5	10.9
8	46.1	9.8
12	40.7	5.8
16	39.4	5.7
24	37.6	4.6
32	36.3	
48	34.9	
64	33.7	
96	33.0	
128		
192		
256		

### Test Results.

Moisture Content (%)	8.4
MCV	11.1



Primrose Lane, Liversedge

Contract No:  
PSL23/2252  
Client Ref:  
LD10488

# MOISTURE CONDITION VALUE

BS1377 : Part 4 : 1990 Clause 5.4

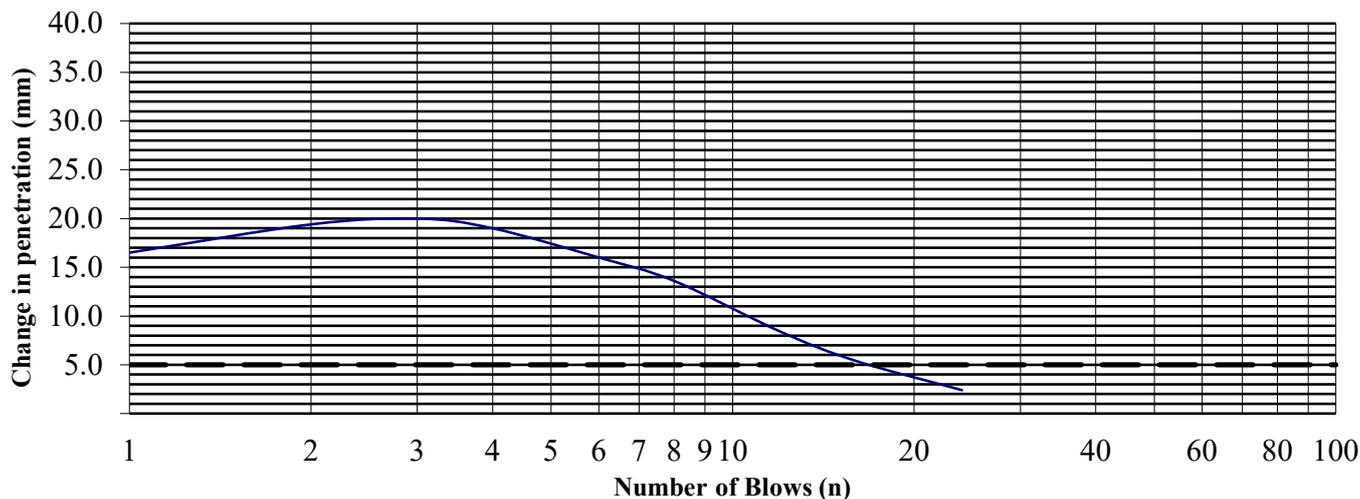
Hole Number: TP05 Top Depth (m): 1.00

Sample Number: Base Depth (m):

Sample Type: B

Material Retained on the 20mm BS Test Sieve (%):	0
Interpretation based on steepest straight line intercept with 5mm change in penetration.	

## MCV Determination



Blows (N)	Penetration (mm)	n to 4n (mm)
1	79.2	16.5
2	72.0	19.4
3	66.9	20.0
4	62.7	19.0
6	56.3	16.0
8	52.6	13.6
12	46.9	8.4
16	43.7	5.4
24	40.3	2.4
32	39.0	
48	38.5	
64	38.3	
96	37.9	
128		
192		
256		

### Test Results.

Moisture Content (%)	20
MCV	12.3



Primrose Lane, Liversedge

Contract No:  
PSL23/2252  
Client Ref:  
LD10488

# MOISTURE CONDITION VALUE

BS1377 : Part 4 : 1990 Clause 5.4

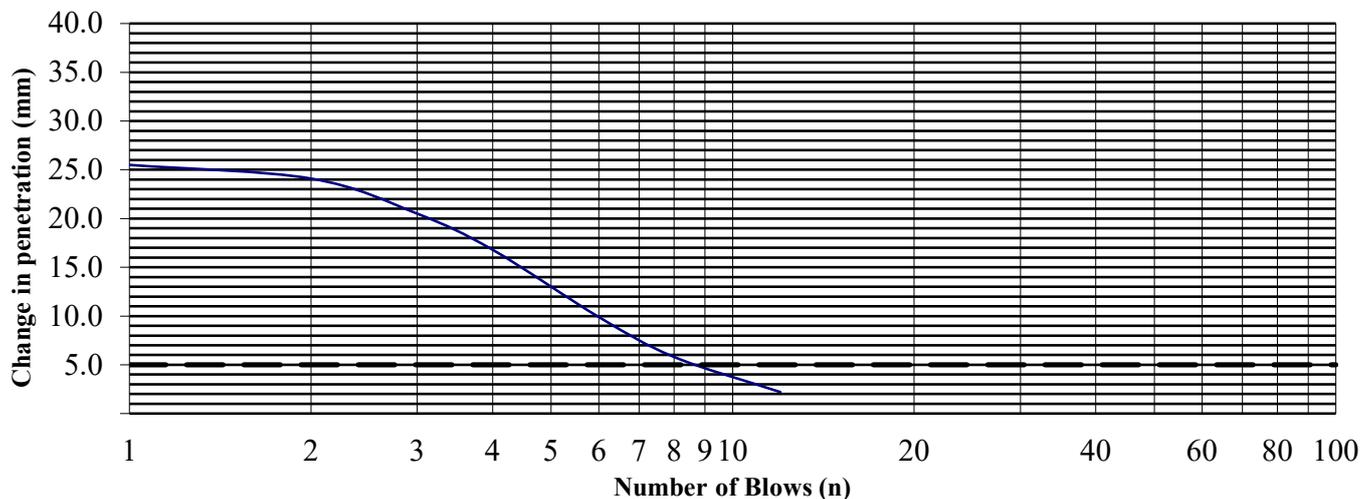
Hole Number: TP06 Top Depth (m): 2.10

Sample Number: Base Depth (m):

Sample Type: B

Material Retained on the 20mm BS Test Sieve (%):	0
Interpretation based on steepest straight line intercept with 5mm change in penetration.	

## MCV Determination



Blows (N)	Penetration (mm)	n to 4n (mm)
1	81.5	25.5
2	68.9	24.1
3	61.5	20.5
4	56.0	16.8
6	49.0	9.9
8	44.8	5.8
12	41.0	2.2
16	39.2	
24	39.1	
32	39.0	
48	38.8	
64		
96		
128		
192		
256		

## Test Results.

Moisture Content (%)	19
MCV	9.4



Primrose Lane, Liversedge

Contract No:  
PSL23/2252  
Client Ref:  
LD10488

# MOISTURE CONDITION VALUE

BS1377 : Part 4 : 1990 Clause 5.4

Hole Number: TP08 Top Depth (m): 2.60

Sample Number: Base Depth (m): 3.00

Sample Type: B

Material Retained on the 20mm BS Test Sieve (%):	0
Interpretation based on steepest straight line intercept with 5mm change in penetration.	

## MCV Determination



Blows (N)	Penetration (mm)	n to 4n (mm)
1	71.0	17.3
2	62.7	17.1
3	57.3	15.4
4	53.7	14.2
6	48.8	11.7
8	45.6	9.9
12	41.9	7.7
16	39.5	6.2
24	37.1	4.4
32	35.7	
48	34.2	
64	33.3	
96	32.7	
128		
192		
256		

## Test Results.

Moisture Content (%)	10
MCV	13.1



Primrose Lane, Liversedge

Contract No:  
PSL23/2252  
Client Ref:  
LD10488

# MOISTURE CONDITION VALUE

BS1377 : Part 4 : 1990 Clause 5.4

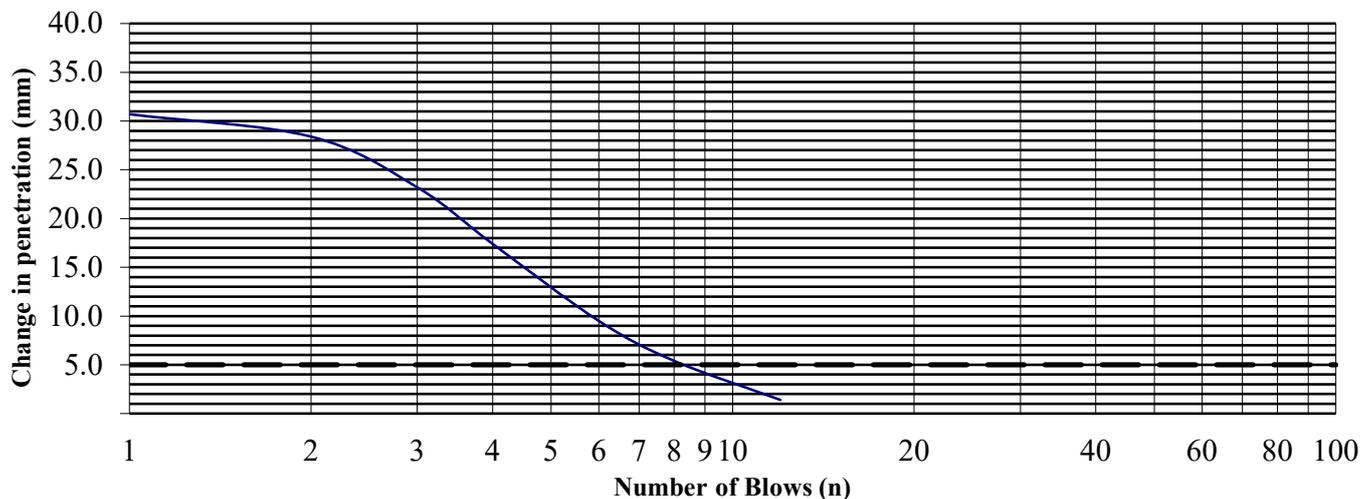
Hole Number: TP10 Top Depth (m): 0.90

Sample Number: Base Depth (m): 1.00

Sample Type: B

Material Retained on the 20mm BS Test Sieve (%):	0
Interpretation based on steepest straight line intercept with 5mm change in penetration.	

## MCV Determination



Blows (N)	Penetration (mm)	n to 4n (mm)
1	88.9	30.7
2	74.1	28.4
3	64.8	23.2
4	58.2	17.4
6	49.9	9.5
8	45.7	5.4
12	41.6	1.4
16	40.8	
24	40.4	
32	40.3	
48	40.2	
64		
96		
128		
192		
256		

### Test Results.

Moisture Content (%)	22
MCV	9.2



Primrose Lane, Liversedge

Contract No:  
PSL23/2252  
Client Ref:  
LD10488

# MOISTURE CONDITION VALUE

BS1377 : Part 4 : 1990 Clause 5.4

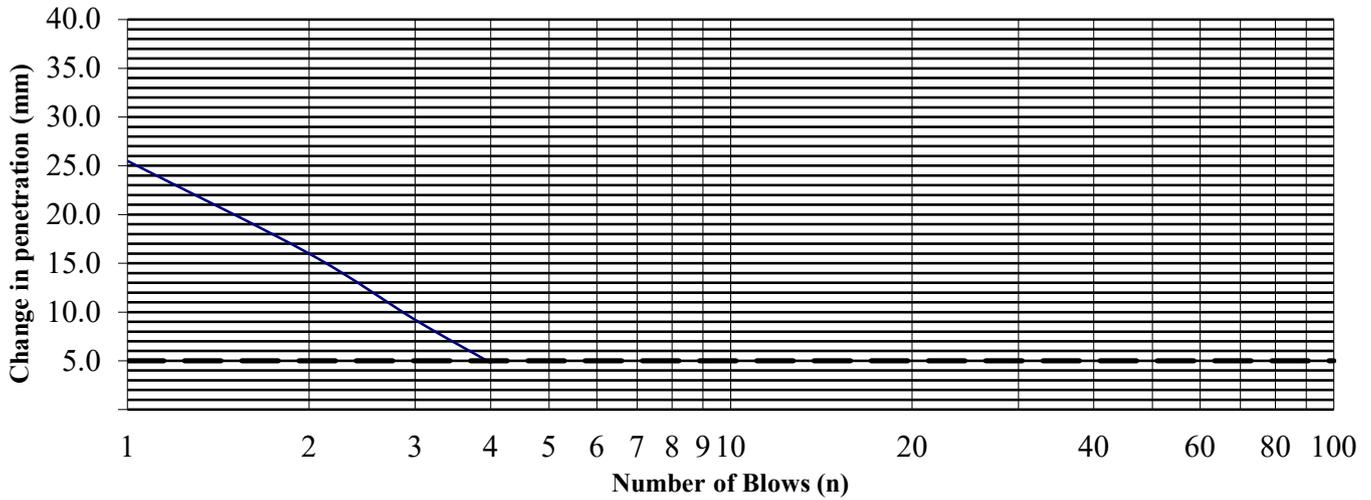
Hole Number: Trial Trench No.3 Top Depth (m): 1.20

Sample Number: Base Depth (m):

Sample Type: B

Material Retained on the 20mm BS Test Sieve (%):	29
Interpretation based on steepest straight line intercept with 5mm change in penetration.	

## MCV Determination



Blows (N)	Penetration (mm)	n to 4n (mm)
1	76.5	25.5
2	62.5	16.0
3	55.5	9.2
4	51.0	4.8
6	47.3	
8	46.5	
12	46.3	
16	46.2	
24		
32		
48		
64		
96		
128		
192		
256		

### Test Results.

Moisture Content (%)	17
MCV	5.9



Primrose Lane, Liversedge

Contract No:  
PSL23/2252  
Client Ref:  
LD10488

# MOISTURE CONDITION VALUE

BS1377 : Part 4 : 1990 Clause 5.4

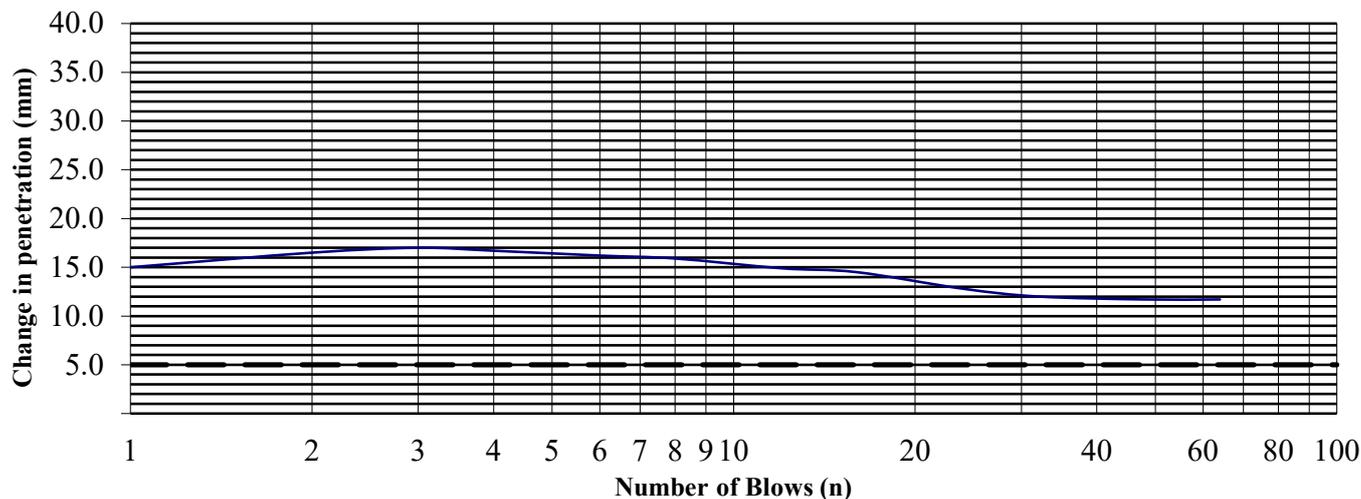
Hole Number: Trial Trench No.4 Top Depth (m): 1.60

Sample Number: Base Depth (m):

Sample Type: B

Material Retained on the 20mm BS Test Sieve (%):	13
Interpretation based on steepest straight line intercept with 5mm change in penetration.	

## MCV Determination



Blows (N)	Penetration (mm)	n to 4n (mm)
1	119.1	15.0
2	112.1	16.5
3	107.6	17.0
4	104.1	16.7
6	99.0	16.2
8	95.6	15.9
12	90.6	14.9
16	87.4	14.5
24	82.8	12.8
32	79.7	12.0
48	75.7	11.7
64	72.9	11.7
96	70.0	
128	67.7	
192	64.0	
256	61.2	

### Test Results.

Moisture Content (%)	22
MCV	>20



Primrose Lane, Liversedge

Contract No:  
PSL23/2252  
Client Ref:  
LD10488







# DETS

## Certificate of Analysis

*Certificate Number* 23-09285

*Issued:* 25-Apr-23

*Client* Professional Soils Laboratory Ltd  
5/7 Hexthorpe Road  
Hexthorpe  
DN4 0AR

*Our Reference* 23-09285

*Client Reference* PSL23/2252

*Order No* (not supplied)

*Contract Title* Primrose Lane, Liversedge

*Description* 11 Soil samples.

*Date Received* 19-Apr-23

*Date Started* 19-Apr-23

*Date Completed* 25-Apr-23

*Test Procedures* Identified by prefix DETSn (details on request).

*Notes* Opinions and interpretations are outside the laboratory's scope of ISO 17025 accreditation. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.

*Approved By*

Kirk Bridgewood  
General Manager



## Summary of Chemical Analysis Soil Samples

Our Ref 23-09285

Client Ref PSL23/2252

Contract Title Primrose Lane, Liversedge

Lab No	2158499	2158500	2158501	2158502	2158503	2158504	2158505	2158506	2158507	2158508	2158509
Sample ID	TP01	TP05	TP07	TP08	TP10	TP11	TP15	TP17	Canal Trench No.3	Canal Trench No.4	Canal Trench No.5
Depth	1.50	1.00	0.80	2.60-3.00	0.90-1.00	1.00-1.10	2.20	2.00	2.50	1.60	1.40-1.50
Other ID											
Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
Sampling Date	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s
Sampling Time	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s

Test	Method	LOD	Units										
<b>Metals</b>													
Magnesium Aqueous Extract (2:1)	DETSC 2076*	10	mg/l			< 10			< 10			< 10	< 10
<b>Inorganics</b>													
pH	DETSC 2008#		pH	5.0	5.6	6.1	4.9	6.6	7.7	6.5	4.6	7.9	7.8
Ash Content	DETS 069*	0.1	%						89				82
Calorific Value	DETSC 5008	1	MJ/kg						< 1.0				7.0
Organic matter	DETSC 2002#	0.1	%	1.9	4.6	0.2	6.5	2.2		0.4	2.0	11	1.8 1.0
Chloride Aqueous Extract (2:1)	DETSC 2055	1	mg/l			7.6			4.3			11	8.8
Nitrate Aqueous Extract as NO3 (2:1)	DETSC 2055	1	mg/l			< 1.0			< 1.0			3.7	6.7
Sulphate Aqueous Extract as SO4 (2:1)	DETSC 2076#	10	mg/l			22			13			55	140
Sulphur as S, Total	DETSC 2320	0.01	%			< 0.01			0.04			0.14	0.04
Sulphate as SO4, Total	DETSC 2321#	0.01	%	0.01	0.04	0.02	0.08	0.02	0.02	0.07	0.12	0.16	0.11

## Information in Support of the Analytical Results

Our Ref 23-09285  
 Client Ref PSL23/2252  
 Contract Primrose Lane, Liversedge

### Containers Received & Deviating Samples

Lab No	Sample ID	Date Sampled	Containers Received	Holding time exceeded for tests	Inappropriate container for tests
2158499	TP01 1.50 SOIL		PT 1L	Sample date not supplied, Total Sulphate ICP (30 days), Organic Matter (Manual) (28 days), pH + Conductivity (7 days)	
2158500	TP05 1.00 SOIL		PT 1L	Sample date not supplied, Total Sulphate ICP (30 days), Organic Matter (Manual) (28 days), pH + Conductivity (7 days)	
2158501	TP07 0.80 SOIL		PT 1L	Sample date not supplied, Anions 2:1 (30 days), Total Sulphur ICP (7 days), Total Sulphate ICP (30 days), Metals ICP Prep (182 days), Organic Matter (Manual) (28 days), pH + Conductivity (7 days)	
2158502	TP08 2.60-3.00 SOIL		PT 1L	Sample date not supplied, Total Sulphate ICP (30 days), Organic Matter (Manual) (28 days), pH + Conductivity (7 days)	
2158503	TP10 0.90-1.00 SOIL		PT 1L	Sample date not supplied, Total Sulphate ICP (30 days), Organic Matter (Manual) (28 days), pH + Conductivity (7 days)	
2158504	TP11 1.00-1.10 SOIL		PT 1L	Sample date not supplied, Anions 2:1 (30 days), Calorific Value (365 days), Total Sulphur ICP (7 days), Total Sulphate ICP (30 days), Metals ICP Prep (182 days), pH + Conductivity (7 days)	
2158505	TP15 2.20 SOIL		PT 1L	Sample date not supplied, Total Sulphate ICP (30 days), Organic Matter (Manual) (28 days), pH + Conductivity (7 days)	
2158506	TP17 2.00 SOIL		PT 1L	Sample date not supplied, Total Sulphate ICP (30 days), Organic Matter (Manual) (28 days), pH + Conductivity (7 days)	
2158507	Canal Trench No.3 2.50 SOIL		PT 1L	Sample date not supplied, Anions 2:1 (30 days), Total Sulphur ICP (7 days), Total Sulphate ICP (30 days), Metals ICP Prep (182 days), Organic Matter (Manual) (28 days), pH + Conductivity (7 days)	
2158508	Canal Trench No.4 1.60 SOIL		PT 1L	Sample date not supplied, Anions 2:1 (30 days), Calorific Value (365 days), Total Sulphur ICP (7 days), Total Sulphate ICP (30 days), Metals ICP Prep (182 days), Organic Matter (Manual) (28 days), pH + Conductivity (7 days)	
2158509	Canal Trench No.5 1.40-1.50 SOIL		PT 1L	Sample date not supplied, Organic Matter (Manual) (28 days)	

Key: P-Plastic T-Tub

DETS cannot be held responsible for the integrity of samples received whereby the laboratory did not undertake the sampling. In this instance samples received may be deviating. Deviating Sample criteria are based on British and International standards and laboratory trials in conjunction with the UKAS note 'Guidance on Deviating Samples'. All samples received are listed above. However, those samples that have additional comments in relation to hold time, inappropriate containers etc are deviating due to the reasons stated. This means that the analysis is accredited where applicable, but results may be compromised due to sample deviations. If no sampled date (soils) or date+time (waters) has been supplied then samples are deviating. However, if you are able to supply a sampled date (and time for waters) this will prevent samples being reported as deviating where specific hold times are not exceeded and where the container supplied is suitable.

## Information in Support of the Analytical Results

*Our Ref* 23-09285  
*Client Ref* PSL23/2252  
*Contract* Primrose Lane, Liversedge

### Soil Analysis Notes

Inorganic soil analysis was carried out on a dried sample, crushed to pass a 425 $\mu$ m sieve, in accordance with BS1377.  
Organic soil analysis was carried out on an 'as received' sample. Organics results are corrected for moisture and expressed on a dry weight basis.  
The Loss on Drying, used to express organics analysis on an air dried basis, is carried out at a temperature of 28°C +/-2°C.

### Disposal

From the issue date of this test certificate, samples will be held for the following times prior to disposal :-  
Soils - 1 month, Liquids - 2 weeks, Asbestos (test portion) - 6 months

End of Report

**APPENDIX D**



**APPENDIX B**



DO NOT SCALE FROM THIS DRAWING

Legend

-  Approximate Site Boundary
-  Proposed Windowless Sample Hole Locations
-  Proposed Hand Pits
-  Mine Entry Location
-  MDJA 2021 Exploratory Hole Locations
-  MDJA Windowless Sample Hole Locations
-  WA 2023 Exploratory Hole Locations
-  WA Windowless Sample Hole Locations
-  WA 2023 Exploratory Hole Locations
-  WA Borehole Locations

Notes

Image is for illustrative purposes only. BING imagery reproduced under license and for illustrative purposes only. Boundaries are indicative. Aerial imagery shown for context purposes only. Drawing uses third-party data. No reliance can be provided for this data and WA cannot be held responsible for any errors within this data.



REVISION	DETAILS	DATE	DRN	CHKD	APPD
----------	---------	------	-----	------	------

CLIENT

**JONES HOMES (YORKSHIRE) LTD**

PROJECT

**LAND OFF PRIMROSE LANE,  
LIVERSEGE - ADDITIONAL PHASE 2  
INVESTIGATIONS**

DRAWING TITLE

**PROPOSED EXPLORATORY HOLE  
LOCATION PLAN**

DRG No.	LD11143-001	REV	DRAFT
DRG SIZE	A3	SCALE	1:1,250
		DATE	16/01/25
DRAWN BY	JC	CHECKED BY	VC
		APPROVED BY	MP




**APPENDIX C**

## TECHNICAL PROCEDURE NOTE

<b>Subject:</b> Ground Gas On-site Monitoring Protocol	<b>No.:</b> T-GEE-03
	<b>Authority:</b> M C Hassall
<b>Category:</b> Ground & Environmental Engineering	<b>Status:</b> Mandatory
<b>Relevance:</b> Ground Engineering / Environmental Waste	<b>Reviewed:</b> 2 October 2017

The purpose of the protocol is to ensure that there is a consistent approach and methodology for gas monitoring in the event that:

- Different members of staff attend site to undertake monitoring on separate occasions
- We are requested to provide a protocol to the Client / Local Authority to demonstrate how monitoring is undertaken.

There are two documents forming this Technical Practice Note and they are the Ground Gas Onsite Monitoring Protocol Method Statement (13 pages) and a one page guidance note on what should be considered before going to and when on site.

### INTRODUCTION

Gas monitoring provides essential input to a gaseous hazard and risk assessment in respect of the safe development of a site. In particular, gas monitoring is used to determine whether a gaseous hazard is present on site and to provide an indication of the potential severity of any emissions at the surface and into structures. However, it should always be remembered that the data obtained represents a snapshot in time. An assessment of the full potential for harm must also consider what changes could happen in the future to possibly exacerbate a problem. Before such extrapolations are attempted, however, the characteristics of the gas regimes in the ground should be reasonably well understood.

This method statement details the technical procedures for undertaking gas monitoring of boreholes that have been installed as part of the site investigation process.

The technical procedures in this document have been developed in accordance with the guidance and recommendations given in the following documents:

- Waste Management Paper No.4;
- Waste Management Paper No.27;
- Environment Agency, November 2002 Guidance on the Management of Landfill Gas;
- Institution of Wastes Management, 1998: The Monitoring of Landfill Gas;
- Health and Safety at Work Act 1974;
- Personal Protective Equipment Regulations 1992;
- Management of Health and Safety Regulations 1999;
- B.S. 5930:1999: Code of Practice for Site Investigation;
- B.S. 10175:2001: Code of Practice for the Investigation of Potentially Contaminated Sites;
- CIRIA Special Report103 Volume III: Site Investigation and Assessment;
- CIRIA Report 130: Methane: its occurrence and hazards in construction;
- CIRIA Report 131: The Measurement of Methane and other gases from the Ground;
- CIRIA Report 149: Protecting Development from Methane;

- CIRIA Report 150: Methane Investigation Strategies;
- CIRIA Report 151: Interpreting measurements of gas in the ground;
- CIRIA Report 152: Risk Assessment for ethane and other gases from the ground;
- CIRIA Report 659: Assessing risks posed by hazardous ground gases to buildings.

The procedure for monitoring ground gases has been designed to:

- Produce gas monitoring results by a method which is logical, consistent and is repeatable;
- Allow meaningful comparisons between the results of monitoring visits undertaken on different dates.

## **TRAINING and HEALTH & SAFETY**

Only appropriately competent and experienced personnel will undertake gas monitoring. They will be suitably trained, have undergone a health and safety induction and be equipped with the appropriate personal protective equipment (PPE).

The Wardell Armstrong Generic Risk Assessment for Out of Office Activities, Wardell Armstrong “site specific” risk assessment(s) and any Client “site specific” health and safety rules will be completed and complied with, as appropriate.

Personnel carrying out the monitoring may be exposed to potentially contaminated waters and hazardous ground gases on a regular basis and shall be provided with appropriate PPE. These personnel shall also receive appropriate training and instruction so that they:

- *Follow approved sampling protocols;*
- *Are aware of the hazards of potentially contaminated waters and ground gases (and the condensate derived from them); and*
- *Are aware of the limitations of gas measuring instruments.*

All work will be carried out in a safe manner, using only certified equipment, and the working area maintained to ensure the safe and efficient operation of the equipment.

Prior to commencing any monitoring, the personnel will be informed of any relevant environmental issues and mitigation measures and will carry out the monitoring in accordance with such measures. This includes reference to the borehole environment (gas concentrations) prior to sampling. Where high levels of explosive gases (e.g. methane) are present within the borehole, consideration must be given to the possibility of fire/explosion if non-intrinsically safe equipment is used in the vicinity (e.g. Waterra pump, mobile phone, PID).

A methane concentration above the explosive limit within the borehole may dilute with air outside the borehole and become explosive.

Consideration is to be given to monitoring locations in confined/enclosed spaces where explosive/asphyxiant gases may accumulate. Likely/known hazardous substances which may be present within a borehole/water body (eg. Weils Disease, phenols, solvents, etc) are to be made known to sampling personnel and appropriate PPE (respirators/vapour masks) is to be provided to mitigate the risks posed.

## PRE-SAMPLING PROCEDURES

Monitoring personnel should make a number of preliminary checks the day before or immediately prior to carrying out a monitoring visit as follows:

- i) Check the requirements of the monitoring visit that are likely to include the following:
  - The number and location of boreholes or sampling points to be tested.
  - Undertake flow measurements.
  - Are samples for confirmatory gas analysis to be taken?
  - Decide on a monitoring route.
- ii) Check that equipment is clean, visually in good order and operable.
- iii) Check the landfill gas monitoring instrument(s) to ensure that it is within its calibration date.
- iv) Check the battery life of each instrument is sufficient for the sampling round. Check that the equipment filter is fitted and clean – if not then replace it.
- v) Take a dip meter for checking the depth of water in boreholes.
- vi) Take all necessary protective equipment (including gloves) and ensure that any cuts on the hands or forearms have been covered with waterproof plasters. The equipment should include a first aid kit.
- vii) Take a notebook or data recording device.
- viii) Ensure that the sampler has the means to gain access to the monitoring points which require sampling (e.g. keys, spanners, screwdrivers, etc).
- ix) If a sample(s) of gas is to be taken ensure that the appropriate sample container(s) is carried and that it is clearly labelled and that the operator has been trained in the correct procedures for obtaining a gas sample.
- x) Make sure that the equipment is booked out to the job number.

## CALIBRATION and QA CHECKS

In order to ensure that meaningful and accurate measurements are made, equipment needs to be regularly serviced and calibrated. One person should be nominated from each office who will ensure that dates for instrument calibration are recorded along with the results of monthly and six monthly analyses. The service interval and frequency of calibration varies as to the type of measuring equipment and the duty cycle of the equipment.

Monitoring results and laboratory analyses should be verifiable and repeatable. Consequently stringent Quality Assurance (QA) procedures must be applied to ensure the integrity of any data. Check the calibration of the instrument with a can of calibration gas and record the results of the test on a monthly basis. If the results are outside the recommended limits the equipment must be returned to the manufacturer or authorised service agency for re-calibration and/or service.

The equipment should be regularly checked and sent to the manufacturer for calibration in accordance with the manufacturer's instructions.

The collection and analysis of QA samples provides a means to determine whether or not sampling or analytical procedures have significantly affected analytical results. Without an effective QA sampling programme, it may not be possible to distinguish whether monitoring is measuring real changes in the system or simply recording variations caused by sampling and analytical procedures.

## **VALIDATION (QA) PROCEDURE**

The reliability of portable instruments should be checked from time to time by carrying out confirmatory analysis in the laboratory. Every six months, samples of gas should be taken, using a Gresham Tube, from two boreholes selected at random and possibly from different sites. If the gas concentrations cannot be measured continuously whilst the sample is being taken they should be measured before and after the sample has been obtained. In the laboratory the following determinands will be measured using a gas chromatograph:

- Methane
- Carbon dioxide
- Oxygen.

## **NEAR SURFACE GAS TESTING**

A spike or near-surface probe test may be warranted on any brown-field development site as part of a preliminary site investigation programme. A spike test, however, will only provide limited information. If no hazardous gas concentrations are detected during spike testing it does not necessarily follow that the site may not be affected by gas, the result merely indicates that at the time sampled and at the depth penetrated no hazardous gases were present. Deduction of the absence of a potential gas hazard requires information additional to the spike test that would usually come from a desk study. Spike testing is only indicative. A positive result should be followed by further work to ascertain the nature of any identified hazard. A cable avoidance tool should be used and statutory undertakers plans consulted to ensure no buried power cables or services are accidentally penetrated. A note should be made of the condition of the ground, for example, is fill material frozen or waterlogged.

Should initial findings indicate the need for further shallow probing, consider placing plastic sampling pipes in hand-augered holes to facilitate monitoring on successive occasions. Alternatively, perforated pipe can be placed in any geotechnical investigation points prior to backfilling. Cavities such as drainage grids, pipes and other services should routinely be tested whenever appropriate as this can be useful for post construction monitoring if required.

## **MONITORING PROCEDURE at BOREHOLES**

It is very important that any sample taken from a gas monitoring borehole should be representative of the gases in the ground. Gases present in the borehole may not be representative of the ground atmosphere on the day of sampling since they have become stratified or 'stagnant'. It is therefore imperative that sufficient time is allowed for sampling each borehole to enable fresh gases to be drawn into the borehole. The period of pumping should be at least 2 minutes up to a maximum of 5 minutes or until a steady reading is recorded.

It is also important that air is not drawn into the borehole during the sampling process. For this reason the borehole should be fitted with a removable but airtight cap which contains an integral gas sampling tap.

It is also important to ensure that water is not drawn into the gas meter. A water trap filter should be attached to the tube to reduce the possibility of this happening. Failure to ensure that water is not drawn into the instrument will result in extensive damage to the equipment.

## **FLOW MEASUREMENT**

Flow measurements should be made at each borehole. Irrespective of relative pressure. It is intended that all WA offices have compatible flow meters that can be attached to the monitoring instrument(s). Without flow measurements, it is not possible to accurately determine the gas precautions required to protect subsequent developments. Instruction manuals are available from the Geotechnical Instruments web site [www.geotech.co.uk](http://www.geotech.co.uk) for use of the flow pod with various gas monitoring units eg. GA 94A, however, there is no current literature available from the manufacturer for use with the GA2000.

*The information on flow measurement is only valid for the Geotechnical GA2000 and was obtained from the technical department of Geotechnical instruments (U.K.) Ltd.*

The flow unit should be connected to the GA2000 meter via the communications port (next to the charging port) prior to switching the meter on.

*To calibrate* - Once the meter is turned on calibrate the unit to zero using the 'Zero channel(s)' option.

*To zero the flow reading*, select 'Field calibration' from the main menu then select the 'Calibration menu' by pressing the return button (↵). A new menu will appear, from this, select zero channel(s) and then choose the item to be zeroed i.e. Flow. It was advised that this should be carried out each time sampling was performed however no firm guidance was given on this e.g. between boreholes or between sampling sets.

When carrying out this procedure both inlet and outlet pipes should be open to the atmosphere and protected from the wind as this can affect the flow.

*To sample* - Connect the inlet tube to the headworks' of the borehole/probe hole etc. and leave the outlet tube in the open, protected from the wind.

While in the main screen press the 'enter' key and then 1 to store the data and the flow screen appears.

Set parameters to the required values i.e. duration of sample (5 minutes) and sampling intervals (10 seconds).

Press the enter key to begin sampling. There is a counter at the bottom of the screen that indicates sampling duration. Once the set duration for sampling is complete the meter automatically stores the reading using its data logging facilities and reverts to the main screen.

To view the (average) reading for flow, select from the main menu 'View Data' scroll through the data until the last reading is shown (indicated at the top of the display).

The flow reading is located underneath the pressure readings. Sometimes the reading is not initially displayed however by pressing key 5 it will appear.

Press 1 to return to the main screen.

## Sampling Procedure

- i) At the start of the monitoring visit note the atmospheric pressure and current weather condition (atmospheric pressure should be logged by the analyser). These two items should be written onto the Site Event Log on that visit.
- ii) Note the time that the borehole is monitored and at each borehole check the appearance and condition of the cover and note any damage or unusual occurrence (such as odour, pooling / bubbling of water, cracks or fissures in the ground, distressed vegetation etc). Damage should be reported to the Client as soon as possible and arrangements for repair or replacement recommended if appropriate.
- iii) Switch on the gas meter(s) and take a sample of air to 'zero' the meter. Ensure that the reading is zero for methane and carbon dioxide and is approximately 21% for oxygen.
- iv) Measure the gas pressure within the borehole first by connecting the pressure meter to the sampling tap by means of a piece of (rubber) tubing and note the reading obtained.
- v) Connect the gas analyser to the sampling tap and pump a sample of gas from the borehole through the analyser.
- vi) Watch the gas level indicator continuously for changes and pump from the borehole for at least 2 minutes, or longer until a stable reading is obtained.
- vii) Note the following peak readings and also note whether the readings stabilise after the peak reading has been obtained or whether they fluctuate or decrease:

Flammable Gas	- highest reading
Hydrogen Sulphide	- highest reading
Carbon Monoxide	- highest reading
Carbon Dioxide	- highest reading
Oxygen	- lowest reading
- viii) Disconnect the analyser and pump air through the machine to return it to 'zero'. Ensure that the gas tap is closed and covers are locked/tagged so as to be secure.
- ix) Proceed to the next borehole and repeat the procedure outlined in ii) to viii) above.
- x) Before leaving site, make a note in the Site Diary/Site Event Log to record the date of the monitoring round.
- xi) Compare the previous results with those taken on the current visit and note any significant variation. Also note operations on and adjacent to site as they could provide an indication as to any variation in results, i.e. excavations, drilling etc.
- xii) Download the monitoring results and process them in the computer software package and place copies on file.

## WEATHER

If a series of monitoring visits are proposed, at least one should be made when barometric pressure is falling (rapidly if possible). At such times the maximum pressure gradient between a source or reservoir in the ground and the surface will be created, gas flows will be at their highest and atmospheric gases are most likely to have been displaced from soils giving the best chance of detecting any hazardous gases. Every Wardell Armstrong office should have a barograph to assist in the selection of appropriate times for monitoring. All monitoring records should include a note of the atmospheric pressure and trend at the time of sampling.

## RESULTS

The results should be tabulated, graphed and the sample locations cross-referenced to a suitable site plan. Graphs for methane, carbon dioxide, oxygen, flow and atmospheric pressure should be prepared. The monitored results can be compared with critical values, such as Gas Screening Values as stated in CIRIA C659.

The spatial relevance of data is ascertained by correlating persistently high gas concentration areas with particular surface or former surface (from OS maps) features and the nature of the ground as determined from borehole or trial pit investigations.

The results should be recorded on a proforma and presented either in a factual report or interpreted as part of a gas hazard and risk assessment in respect of a particular development.

Do not attempt to convert methane LEL readings to volume percent concentration (or vice versa) if a sample is oxygen deficient as the result may be incorrect.

## APPLICATIONS

Gas monitoring programmes should be designed to assess features of a site pertinent to the engineering and safety objectives. Tests should be recommended which minimise the ambiguity of interpretation thus aiding the decision making processes of the client and various interested parties.

### Limitations of Monitoring Equipment

- i) Catalytic Oxidation detectors require a minimum percentage of oxygen to be present in the sample. Thus in a catalytic oxidation instrument treat LEL readings with suspicion at oxygen concentrations of less than 12%. The 100% gas range of the instrument is unaffected by the presence of oxygen but is inaccurate at the low end of the scale.
- ii) Flame Ionisation Detectors are very sensitive but are not intrinsically safe. They must NOT be taken into buildings unless the internal atmosphere has been checked with an instrument using catalytic oxidation.
- iii) The pellisters used in flammable gas detectors are prone to poisoning by a wide range of chemicals many of which may be present in trace amounts in landfill gas. It is for this reason that gas instruments should be regularly calibrated.
- iv) Some gases interfere with the performances of the gas detectors. Hydrogen can significantly increase the response of catalytic oxidation and thermal conductivity meters to methane. Carbon dioxide, on the other hand, can depress the response of the meter to methane.

- v) Where the concentrations of gases present in a sample appear strange (e.g. low oxygen, low methane, low carbon dioxide) it may be appropriate to take a gas sample for confirmatory analysis in the laboratory.
- vi) Infra-red detectors can be affected by hydrocarbon vapours unless fitted with a vapour screen. The engineer responsible for the work should inform the person undertaking the monitoring if such vapours are anticipated F(L).

## **GAS PRESSURE**

The difference in pressure between that in a borehole and the atmosphere is termed relative pressure. This pressure is measured using the GA2000. The gas pressure in a borehole may be higher than atmospheric for various reasons eg:

- rising water level pressurising the gas;
- atmospheric pressure lower than when the borehole sample tap was last opened for testing (and allowed to reach equilibrium with atmospheric pressure);
- gas being generated or released under pressure;
- rise in gas or groundwater temperature in the borehole (unusual).

A lower pressure than atmospheric (i.e. a negative pressure) could be due to:

- falling groundwater level;
- suction effects of a landfill gas extraction scheme or, in the case of abandoned mine workings a mine ventilation fan;
- atmospheric pressure higher than when the borehole was last tested.

Atmospheric effects can theoretically explain pressure differences up to an extreme of say 1000Pa (10mb). Groundwater fluctuations can exert greater effects.

## **PERMEABILITY**

Permeable ground will disperse gas if exposed at the surface and act as a reservoir and mitigation pathway if capped with clay or covered by development structures. If a borehole can retain pressures different from atmospheric this indicates a low permeability between the test interval and the surface. If pressure differences are not evident and the borehole contains mostly air then either the borehole seal, sampling tube or sampling valve is leaking, or the ground is highly permeable.

Pressure retention can be tested by connecting a pump to the sample valve, pressurising the borehole and measuring pressure decay with an instrument.

## **GAS FLOW**

Positive pressure in a borehole indicates a potential for a flow of gas to occur. However, only sustainable flows are significant. After sampling a borehole for gas composition and relative pressure, the tap can be left open to test whether positive pressure persists; measure pressure versus time at intervals. Thus, an indication of the extent of the gas reservoir obtained. An immediate loss of pressure on opening the borehole valve indicates a low reservoir volume and probably low permeability ground. Persistent flows from a borehole can be measured with a pitot tube and a pressure gauge or a flow meter. However, results will be influenced by the internal resistance of the measurement apparatus and are therefore relative.

Some practitioners determine steady-state gas compositions in boreholes after leaving the valve open for about an hour. Disappearance of the cumulated gas initially detected is indicative of a negligible gas flow, although rising atmospheric pressure will cause a similar effect. If methane at a high concentration is only detected when first opening the sampling valve, layering of a limited quantity of the low density gas is probably occurring in the borehole. We do not recommend this as a standard method.

Borehole flushing tests can be used to determine gas flow rates into monitoring boreholes. During stable barometric conditions flush the borehole with a high volume capacity pump, available from most outdoor leisure shops: alternatively a large plastic bin bag can be used and check that any gases have been fully displaced with air throughout the length of the borehole using a monitoring instrument. Measure gas concentrations over time. Data gathered over say one hour will be normally sufficient to determine whether the experiment needs extending over hours or days. A rapid build-up (minutes) of gas indicates a relatively free flow. The flow rates for methane and carbon dioxide should be calculated in terms of  $m^3/hr$  (l/hr).

Insertion of a gas sampling tube to different depths in the borehole (taking care not to dip it into water) may enable the positions of gas migration horizons to be determined. The lithology can then be identified from the borehole log or from trial pit logs. Note that prolonged gas sampling, using an instrument with an internal pump, in an open borehole will gradually remove the gas and allow air to flow in to take its place.

## **SURFACE GAS FLUX**

In designing gas protection measures for a building, a measure of gas flow through to the surface is required. This is usually assessed using borehole gas monitoring data interpreted in the light of prevailing ground conditions and projected ground treatment. Although WA does not undertake Surface Gas Flux .it may sometimes be helpful if required to attempt direct measurement of the gas flow to the surface through the ground. A simple approach involves placing weighted plastic sheets of known area at selected locations and measuring the gas concentrations accumulated over a period of a few days. A more robust measurement can be achieved with a mat of synthetic void former which can be buried just below the surface to prevent disturbance. Sample tubes are taped within the mat to facilitate circulation of the trapped atmosphere through a non-reactive gas monitor (i.e. an infra-red device). If ground is left uncovered for too long then the ground gas environment itself may change leading to erroneous results.

In many instances, gas flow in fills and made ground will be indeterminately low. However, this type of test will help to ensure an appropriate technical response to perceived gas problems.

## **IN SITU GAS SERVICES**

The presence of in situ gas sources such as localised waste deposits and rotting timber are generally deduced from the results of gas testing and trial pit excavation or borehole logs. Where important conclusions hinge on the interpretation, confirmation may be obtained by sealing fragments of the suspect material in a gas-tight desorption vessel and measuring the gas concentrations evolved over a period of time.

## **GAS COMPOSITION**

Remember that Pellistor based instruments used for measuring LEL's will not indicate correct flammable gas concentrations in oxygen deficient atmospheres, neither will a portable FID (flame ionisation detector) function (as it requires oxygen to sustain the detector flame).. Such problems do not beset infra-red instruments. With all types of instruments, beware of cross-sensitivity between gases especially if heavy hydrocarbons may be present. If there is any doubt take a sample of as high concentration as practicable in a Gresham tube for a laboratory check analysis.

# Ground Gas On-site Monitoring Protocol

## Guidance Note – Methodology to be considered when going to site

WA gas monitoring protocols must be read and understood.

### **Before going to site it is good practice to:**

- Check local pressure trends.
- Check sampling requirements, previous concentrations/flows/samples/QA samples.
- Check logs for borehole depths and any past readings.
- Check that all equipment is within the calibration test date.
- Calibrate the instrument using in house calibration gases.
- Take tools necessary to access boreholes.

### **At the Borehole**

1. Do not open gas tap.
2. Calibrate i.e. zero readings for flow pod. Ensure outlet & inlet tubes are sheltered from the wind during calibration.
3. Keep monitoring equipment switched on between boreholes. If a sleep function turns monitoring equipment off ensure flow pod is recalibrated as in step 2.
4. Note site, job number, date, site personnel, weather conditions, atmospheric pressure, borehole condition, presence of any odours, bubbling of water, cracks, fissures or diminished vegetation. Make a note of site activities undertaken by others.
5. Ensure meter (GA2000 or similar) shows atmospheric conditions ie 0.0 for CH<sub>4</sub> and CO<sub>2</sub> and ~ 21%v/v O<sub>2</sub> bearing in mind the accuracy of the instrument ( $\pm 0.2$  %v/v CO<sub>2</sub>).
6. Attach the Gas meter, open the gas valve and read the relative borehole pressure.
  - The GA2000 is only accurate to 1dp and often jumps around a lot, therefore, take a rough average and round the figure up.
7. Close gas tap.
8. Attach flow pod inlet tube to the borehole leaving the gas tap open.
9. Ensure flow pod is set to record an average reading over 5 minutes sampling at 10s intervals unless otherwise stated by project manager:
  - Ensure the outlet pipe is sheltered from the wind during sampling
10. Turn pump on for a minimum of 2 minutes. Record peak readings for CH<sub>4</sub>, CO<sub>2</sub>, H<sub>2</sub>S, CO and lowest readings of O<sub>2</sub>
  - If the peak is only temporary then record the steady reading as well.
  - If gas concentrations are still rising/falling after 2 minutes of pumping continue to pump until the reading settles and note the length of pumping time.
11. Record results in field notebook
  - Concentrations % v/v
  - Flow l/h
12. Dip measurements should always be taken when gas monitoring (depth to liquid) but after gas measurements have been made.
  - Measure the depth to the base of the borehole on each monitoring visit
13. If water samples are being taken then protective gloves should be changed between boreholes to prevent cross contamination.

## Spike Survey

- Always use CAT before hammering spike holes.
- Drive spike into ground to a depth ~ 1m (if ground will not allow penetration to this depth note approximate depth achieved).
- Insert a perforated tube attached to the gas analyser into the hole made by the spike and sample the gas (see step 10) at the borehole.
- Note the relative pressure, atmospheric pressure, site personal that are present, unusual events, date, weather conditions, site description.
- Note ground conditions i.e. frozen, waterlogged.

<b>TECHNICAL PROCEDURE NOTE</b>	
<b>Subject:</b> Soil Sample Collection and Analysis	<b>No.:</b> T-GEE-10
	<b>Authority:</b> M C Hassall
<b>Category:</b> Ground & Environmental Engineering	<b>Status:</b> Mandatory
<b>Relevance:</b> Ground Engineering/Environmental/Waste	<b>Reviewed:</b> 3 November 2017

The purpose of this document is to provide general guidance in obtaining soil samples for chemical analysis. It is indicated that such guidance ensures that there is consistency in obtaining samples thereby ensuring, as far as is reasonably practicable, that results are reliable.

This protocol is Mandatory but should issues subsequently arise that require the protocol to be revised then please send comments in the first instance to the Service Director for Ground Engineering (currently S S Hake).

## INTRODUCTION

### General

This document details the technical procedures for soil sample collection and analysis.

The technical procedures in this document have been developed in accordance with the guidance and recommendations given in the following documents:

- British Standard 5930:2015 "Code of Practice for Site Investigations".
- British Standard 10175:2013 "Investigation of potentially contaminated sites - Code of Practice".
- BS ISO10381-2:2002 "Soil Quality - Sampling", Part 2: "Guidance on Sampling Technique".
- CIRIA SP101-111 "Remedial Treatment for Contaminated Land", Volume III: "Site Investigation and Assessment" 1995.
- CL:AIRE / CIEH May 2008, "Guidance on Comparing Soil Contamination Data with a Critical Concentration".
- DETR CLR4:1994 "Sampling Strategies for contaminated land".
- Environment Agency, 2000 "Technical Aspects of Site Investigation" Volumes I and II, R&D Technical Report P5-065/TR.
- Environment Agency, 2000 "Secondary Model Procedure for the Development of Appropriate Soil Sampling Strategies for Land Contamination", R&D Technical Report P5-066/TR.
- Environment Agency, NHBC and CIEH, 2008 "Guidance for the Safe Development of Housing on Land Affected by Contamination", R&D Publication 66.
- Environment Agency, April 2005 "Guidance on Sampling and Testing of Wastes to meet Landfill Waste Acceptance Criteria Procedures".
- Environment Agency, Version 2, March 2012 "MCERTS Performance Standard for Laboratories Undertaking Chemical Testing of Soils".
- Environment Agency, 2004 "Model Procedures for the Management of Land Contamination", Contaminated Land Report (CLR) 11.
- Ferguson, C, "Statistical Basis for Special Sampling of Contaminated Land", Ground Engineering, June 1992, 25(5), 34-38.

- Health and Safety at Work Act 1974.
- Management of Health and Safety Regulations 1999 and
- Personal Protective Equipment Regulations 1992.

## Health Safety and Environment

Only competent and experienced personnel will undertake the monitoring and sampling. They will be suitably trained, have undergone a H&S Induction and be equipped with the appropriate personnel protective equipment (PPE).

The Wardell Armstrong Generic Risk Assessment for Out of Office Activities, any Wardell Armstrong "site specific" risk assessment and any Client "site specific" health and safety rules will be complied with.

The presence of all existing underground services will need to be established. Service plans, if available, should be consulted and the appropriate avoidance tools must be used which may include the CAT electronic sensor equipment.

Personnel carrying out the sampling and analysis may be exposed to potentially contaminated soils, waters and hazardous ground gases on a regular basis and shall be provided with appropriate PPE.

These personnel shall also receive appropriate training and instruction so that they:

- Can follow approved sampling protocols.
- Are aware of the hazards of potentially contaminated soils, waters and ground gases/vapours (and the condensate derived from them) and
- Take appropriate precautions when sampling so as to obtain representative samples.

All works will be carried out in a safe manner, using only certified equipment, and the working area will be maintained to ensure the safe and efficient operation of the equipment.

Prior to commencing any sampling the personnel will be informed of any relevant environmental issues and mitigation measures, and will carry out the sampling in accordance with such measures.

Care should be taken not to leave excavations open and unattended. If excavations are to be left open, they should be enclosed using appropriate security fencing. Personnel should not be permitted to enter trial pit excavations greater than 1.2m depth.

## SOIL SAMPLING

### Introduction

Soil sampling will be carried out in general accordance with the guidance documents listed in section 1.2 of this document.

The method of sample collection should ensure that the samples are representative of the material under investigation. The sample should not be exposed to secondary contamination and should remain in a stable condition before being analysed. Sampling implements and containers should be constructed of materials appropriate to the analyses to be undertaken. This is particularly important for the determination of trace organic contaminants. Equipment should be thoroughly cleaned before re-use.

## Scope

This document provides guidance on soil sampling strategies, the number and depth of sampling positions, sample types, sampling techniques, avoiding cross contamination, obtaining appropriate soil samples for laboratory analysis, laboratory liaison procedures and the implications of the Environment Agencies MCERTS scheme in the selection of analytical methods.

This document does not give recommendations on certain constraints or problems that can affect a site, such as geotechnical aspects and drilling techniques (for guidance on these issues see BS5930: 1999, BS EN ISO14688-1:2002, BS EN ISO14688-2:2004 and BS EN ISO22476:2005), or the legal aspects, including the need for licenses, permits, etc. It also does not include any procedures for the formal assessment of the potential risks posed by contaminated land.

## Sampling Plans and Patterns

An appropriate sampling plan is a key aspect of any contaminated land investigation. The plan should, as far as possible, identify the types and concentrations of contaminants present.

It should also determine the lateral and vertical spread of the contamination, identify the source(s) of contamination and potential pathways and receptors, provide sufficient data points to plan remediation measures (if necessary) and identify the potential hazards and assess the risks.

A poorly designed sampling plan may fail to fully identify the contamination present, however, over-sampling and testing can be unnecessarily costly and may still be ineffective. A staged investigation is usually the most appropriate.

The two principal types of sampling pattern in use are:

**Judgmental or targeted**, suited to sites where the sources of contamination are known, or suspected areas have been well defined. Such patterns are useful where the purpose of the site investigation is to **delineate the extent of contamination** over particular parts of the site. The locations may also be positioned along probable migration routes of mobile contaminants. Actual sampling position may be a combination of targeted locations and localised grids.

**Regular or non-targeted**, such as rectilinear grids and herringbone patterns, are often used to provide coverage to areas when **specific sources of contamination could not be identified in the desk study**, or for **validation of remedial works**. These are suited to sites with similar probability of contamination being present across the site. In cases where one part of the site is more likely to be contaminated than the remainder, the grid spacing is often reduced in that area.

**The herringbone pattern is the most effective sampling pattern** and only very weakly influenced by the contaminant area shape and orientation. A rectilinear grid has a similar efficiency to a herringbone grid for non-elongated contaminant area shapes. Random sampling is not considered appropriate for contaminated land sites.

## Number of Sampling Positions

Statistical analysis by C. Ferguson of contaminated land sampling studies, concludes that 30 sampling positions have a 95% probability of locating an individual area of contamination (hot-spot), covering 5% of the site area. Furthermore, the probability of detecting a hot-spot can be improved by the use of multi stage sampling.

CIRIA SP103 Volume III, make recommendations on the minimum number of sampling locations required for sites of different sizes, assuming a regular grid pattern is employed. In practice, an increase in spacing up to about 25m occurs as the size of the site increases. Spacing greater than this on sites larger than 5 hectares are unlikely to provide a sufficiently detailed picture of contamination on which to base the final remediation strategy, although they may be sufficient for the first stage of a more comprehensive investigation or to demonstrate the presence of contamination to a site owner or potential purchaser.

Area of Site (hectares)	Minimum number of sampling points	Grid size (metres)
0.5	15	14-18
1.0	25	17-20
5.0	85	22-25

BS10175 recommends sampling grid densities of **50m to 100m for exploratory investigations** and **20m to 25m for main investigations**. A higher density sampling grid could be considered appropriate where heterogeneous contamination is indicated, for example, in localised areas on a former gasworks site. A high-density sampling grid can also be necessary where a high level of confidence is required for the outcome of a risk assessment, for example, for a housing development. In these **supplementary investigations, 10m grids may be necessary**.

Note that as a result of on-site observations, additional samples may need to be taken, further to the number specified in the overall strategy. Once the samples have been obtained, decisions can be made about which samples to analyse.

## Depth of Samples

When developing the sampling strategy, the sampling depths should be considered after establishing the sampling locations.

Several samples should be taken from each sampling position dependent on site conditions, likely sources of contamination, proposed final site levels and the prevailing ground conditions.

BS5930 states that the most common sampling approach adopted by some investigators involves sampling at specific depths, such as 0.15m, 0.5m, 1.0m, 2.0m and 3.0m. The approach has the disadvantage that underlying or thin layers of contamination may not be sampled, or that an unnecessary number of samples are taken where the low permeability natural deposits are at shallow depths.

Samples should be taken to reflect identifiable changes in appearance or the strata. Thus any strategy should have the flexibility to allow for on-site observations to include additional samples to be taken. Any material which has visual or olfactory signs of contamination must be sampled.

The surface layer may vary between the surface and a depth of 0.5m and may require sampling at more than one depth.

Material that could be disturbed by rainwater runoff and carried to adjacent water bodies, or present an immediate exposure hazard, can require sampling in the uppermost 0.1m. Where there are health hazard concerns e.g. **in domestic gardens, samples should be taken at 0.1m and 0.5m.**

Samples from within made ground or fill strata should ideally be taken at fixed depth intervals, typically at depth intervals of 0.5m.

Samples of natural ground beneath made ground or fill should be taken. The first of these should be close to the boundary with the made ground, approximately 0.25m to 0.5m into the natural ground. Further natural ground samples are typically collected at depth intervals of 1.0m. These natural ground samples, if uncontaminated, can indicate the local, natural background chemical conditions, which can be of assistance when determining the extent of contaminant migration and/or the degree of remediation that is appropriate.

Samples of ground in the capillary zones immediately above the water table should be considered, as slightly soluble compounds often concentrate in this region.

The depths of sampling should take into account the nature of the proposed development. For example, services and strip foundations are typically installed to a depth of 1.5m but main sewers can be installed at much greater depths.

## Choice of Sample Type

There are two types of sample, which are collected for the purposes of soil and ground conditions. These are **disturbed** samples, obtained from the ground without any attempt to preserve the soil structure, and **undisturbed** samples, and obtained using a method designed so that the particles and voids cannot change from the distribution which exists in the ground before sampling.

**Disturbed samples are suitable for most purposes**, except for some physical measurements, profiles and microbiological examinations.

Disturbed samples can be subdivided further into **spot, single or grab** samples, from a discrete location and depth, and **spatial or composite** samples, formed from a number of sub-samples combined in the field to represent a defined area.

**Composite sampling is not recommended for the investigation of contaminated land, where spot sampling is preferred.** Spot sampling should be taken from a single strata, within a narrow depth range, say 100mm to 150mm, or from within one excavator bucket. Composite sampling is often used where a sample is required to evaluate soil quality for agricultural purposes. Composite sampling is also recommended for landfill, waste acceptance criteria characterisation purposes.

## Site Sampling Techniques

This section only provides an outline of available techniques. It does not offer detailed guidance on which techniques are appropriate with varying site conditions (see BS5930: 1999).

When planning the site investigation and choosing the appropriate sampling technique, consideration to both geotechnical and environmental issues should be considered.

There are four main techniques outlined in BS5930: 1999 for obtaining soil samples (relevant section of BS5930 in brackets):

- taking disturbed samples from the drill tools or from excavating equipment in the course of boring or excavation (section 22.3);
- drive sampling, in which a tube or split tube sampler having a sharp cutting edge at its lower end is forced into the ground, either by a static thrust or by dynamic impact (sections 22.4 to 22.7);
- rotary sampling, in which a tube with a cutter at its lower end is rotated into the ground, thereby producing a core sample (section 22.8); and
- taking block samples specially cut by hand from a trial pit, shaft or heading (section 22.9).

The choice of sampling technique is site specific and influenced by the type and quality of sample to be retrieved, on-site access, the protection of water resources, geology, hydrogeology, and external factors such as cost and time. Techniques that minimise the exposure of the sample, cross-contamination and arisings at the surface are favoured.

Techniques in common use outlined in BS5930: 1999 are as follows (relevant sections of BS5930 in brackets):

Shallow trial pits (section 20.1). Trial pits can be very useful for obtaining solid samples and are cost effective. They are also useful for visual examination of soils and other buried materials.

On contaminated sites, however, there should be no physical entry into the pits at depths greater than 1.2m, and careful control is needed of backfilling and covering to ensure materials are replaced in the sequence that they were removed. If necessary, clean cover should be provided to prevent dispersal of contaminants. Trial pits may also be used to obtain groundwater samples (NB groundwater samples from trial pits should only be used where there is no other option available to collect groundwater in the area of the site) and are particularly useful in the identification and sampling of perched or shallow groundwater.

Continuous percussion sampling boreholes (section 22.9). This type of technique provides a complete stratigraphic section for sampling and visual inspection and minimises cross-contamination. Limited to a depth of about 5m to 8m, it is not suitable where obstructions may be present or the ground is not water bearing. Since the equipment is portable, percussion sampling is particularly suitable where there is restricted access.

Light cable percussion boreholes (section 20.5). This conventional method of geotechnical ground investigation may be used, although particular care should be taken in the casing-off of contaminated layers, the handling of spoil arisings, the use of water to advance the hole and in backfilling.

Mechanical augers (section 20.6). Rotary drilling with a hollow stem flight auger is an acceptable method of forming a borehole in contaminated ground. The potential for cross-contamination is minimised by the continuous auger casing. The auger can generate heat, which might affect the composition of some contaminants, particularly if there are volatile components. Driven soil samples are obtained at selected depths from the base of the hole and geotechnical testing such as SPT may also be performed. Water and gas samples are normally taken from standpipes installed on completion of drilling.

Rotary dry coring may be used to obtain soil consolidated samples at shallow depth, but this technique is not particularly suitable because high temperatures are generated, which can affect some contaminants. Rotary drilling with water flush is not suitable for contaminated ground. Air flush may not be suitable for organic contamination.

## Environmental Considerations

In selecting the appropriate sample collection technique, consideration should be given to preventing the creation of pathways for contaminant migration. The migration of contamination can be exacerbated by the formation of preferred pathways enabling greater penetration within the ground, but the possibility of migration at the surface due to wind (dust generation) or direct exposure of contaminants should also be considered:

- All deep-sampling locations on contaminated sites should be backfilled with clean low permeability material, for example, bentonite grout. Techniques that form uncased holes should be avoided and monitoring wells or systems should have response zones that are sealed into individual aquifers.
- Particular care should be taken where low permeability strata are passed through. The use of a double penetration technique (forming a larger borehole with a bentonite seal which is penetrated by a smaller borehole through the seal) to prevent boreholes forming a contamination migration pathway is likely to be necessary. In some cases it may be possible to use permanent casing, though this will be dictated by the degree of protection offered and sensitivity of the site.
- When forming trial pits, it is good practice to separate the initial surface layer from the other excavated material. Excavated material should be reinstated as closely as possible to the depth from which it was removed. The material should be replaced in layers and firmly tamped down with the machine bucket. The surface material should then be replaced to provide the cover.
- In order to prevent the site surface from becoming contaminated it may be necessary to place the excavated material on strong impermeable sheeting.
- It is not recommended that trial pits should proceed after water is encountered due to problems relating to the dispersal of contaminated water and the poor quality soil samples which will be obtained due to the presence of water.
- Examination of potentially contaminated sites may pose a risk to the general environment. The work should be planned to prevent the spread of contaminated material by site working clothes, samples, machinery and vehicle wheels.

## Cross-Contamination during Sampling

The equipment usually used for sampling soil is often a simple trowel, which should be stainless steel. In many cases, samples are taken with glove-covered hands and gloves are changed between samples. For re-usable trowels, the level of cleaning can range widely depending on the level of protocol adopted. The Environment Agency advises that in most cases a simple wash between each sample is adequate though, if a legally defensible sampling protocol is to be used, then more onerous other procedures will be needed which will need to be documented.

Where a very high degree of confidence in the cleanliness of equipment is required, this can be achieved by using three buckets, three scrubbing brushes, a number of trowels and a quantity of paper. A biodegradable detergent in solution is added to the first bucket, clean tap water to the second and de-ionised water is added to the last. Between samples the trowel is scrubbed in each bucket in turn before drying.

When taking samples below surface level it is important that the sample is not affected by material (soil or water) falling from more shallow depths. Thus the base of the excavation, trial pit or borehole, should be cleared of debris before obtaining a good sample from the base.

Lubrication of casing and lining has the potential to contaminate the equipment and sample and should be avoided. Where water has to be added to the borehole in order to assist the drilling process, only clean mains water should be used and the volume recorded.

## **Soil Containers and Storage for Transit to Laboratories**

The size and type of sample container used should be suitable for the type of sample to be collected and will, in part, depend on the type of suspected contamination. Generally, it will be necessary to use either glass or PET plastic containers. Polyethylene bags are generally not suitable for chemical testing of contaminated soils. Bulk bags (10 kg to 20kg), however, are usually recommended for most physical testing parameters.

The use of wide necked amber glass jars (250g to 500g) is recommended for organic contaminants and plastic tubs (0.5kg to 1kg) for inorganic contaminants. Smaller glass jars (60g) or glass vials (40g) are recommended for volatile organic contaminants (VOCs) as they can be refrigerated immediately on receipt at the laboratory, without the need for sub-sampling, thus reducing the loss of the volatile contaminants. These can usually be obtained free of charge from the chosen laboratory.

The amount of sample to be collected depends upon the full analytical suite required and the laboratory should be consulted prior to obtaining the samples. In general, however, one small glass volatile jar (VOCs), one larger amber glass jar (PAHs, TPHs, SVOCs, PCBs, Pesticides, TOC) and one plastic tub (pH, metals, sulphates, cyanides, sulphides) should provide the laboratory with sufficient sample for most soil chemical test suites. If waste acceptance criteria testing is also required, an additional plastic container should be supplied. One bulk bag is generally sufficient for most physical testing suites.

It is best practice to check with the laboratory in advance of sampling to verify how much sample is required, what type of container should be used and what preservation protocol should be followed.

Ensure that the sample collected and analysed is representative of the physical and chemical composition of the area of interest (e.g. the site). Chemical test laboratories, however, do not analyse gravel sized particles as part of their standard methods. These are usually discarded prior to analysis during the sample preparation stage. Gravel sized material should therefore be avoided when obtaining soil samples for laboratory chemical analysis, unless their analysis is also required, for example, ballast or aggregate sample testing. Samples for certain physical analyses, however, for example, particle size distribution should reflect the actual ground conditions including any gravel present.

Once the sample is obtained, it should be clearly and uniquely labelled on the side of the container (and the lid if possible, but not on septum capped vials). The site name and/or reference number, sample identification number and depth, date and time of sampling and the initials of the site engineer should all be recorded on the sample container. Any labels used should be resistant to rain, water, handling and abrasion.

Whenever possible a duplicate sample regime should be included in the soil sampling strategy. This may entail one duplicate sample for every twenty soil samples collected from site. Both the original and duplicate sample should be of the same soil horizon.

The duplicate sample should be given an independent identification and scheduled for the same analysis as the original sample to provide information regarding the precision of the sampling techniques and the analytical laboratory. For some sites it may also be necessary to include provision for trip and/or field blanks into the soil sampling strategy.

A sampling report should be completed along with a laboratory chain of custody form. One copy of the chain of custody sheet should accompany the samples to the laboratory, and the site engineer should retain another copy. Care should be taken to ensure that the unique sample reference recorded on the container is the same as that recorded on the sampling report and the chain of custody sheet.

The sampling report should include information on the exact sampling locations, personnel, on-site observations such as visual or olfactory evidence of contamination, weather conditions, barometric pressure and tendency, temperature, a description of the sampling method and sampling devices used. Sampled material, borehole and trial pit excavation logs should be described as outlined in BS5930: 1999. Relevant photographs of site conditions, trial pits, unusual features etc. should be taken wherever possible.

Sample containers should always be filled and sealed so that there is minimum free air space. The container should be securely sealed and placed in the cool-box in an upright position, with sufficient bubble wrap to protect the containers during transit to the laboratory. Chilled ice packs should also be placed in the cool-box with the samples. A cool-box label should be placed onto the outside of the cool-box. If more than one cool-box is required, mark on the cool-box label e.g. cool-box 1 of 2. This ensures that the laboratory is aware of exactly how many cool-boxes to expect.

It is usually preferable to maintain the samples in a cooled condition (ideally 3°C to 4°C) particularly during the transport to the laboratory, and ideally from the moment of sample collection. This is because when cooled, samples retain their field composition and properties far better. Samples should be transported to the laboratory as quickly as possible to minimise any potential for chemical and biological changes to take place before analysis, and in any case within 24 hours.

**It is not recommended that sampling take place on a Friday, unless delivery of samples to the laboratory on the same day or on a Saturday is possible.** Sampling on a Thursday should also be avoided if the samples will not be sent to the laboratory until the following day via an overnight courier and the laboratory is not open for receipt of samples on Saturday (the sample would not be received in the laboratory until Monday in this case - i.e. 4 days after sampling).

## Notes on Scheduling Testing

The Environment Agency has established its Monitoring Certification Scheme (MCERTS) as an attempt to improve on the reliability of environmental analysis. The performance standard is applicable to all laboratories and procurers of analytical services where results are generated for the chemical testing of soils are submitted to the Agency for regulatory purposes.

It is essential that procurers of analytical data work closely with laboratories to ensure that exact requirements are understood and recorded.

The Agency recommends that the engineer scheduling testing:

- Ensure that chemical results submitted to the Agency for regulatory purposes conform to MCERTS requirements. Check whether the laboratory carrying out the analysis has MCERTS accreditation for all the requested parameters (NB MCERTS accreditation may not yet be available at any laboratory for some parameters).
- If a suitable laboratory cannot be found then the Agency should be consulted.
- Ensure that the analytical methods are fit for purpose in terms of the parameter, critical level of interest and matrix. The critical level of interest is the value around which a decision is often required, for example, it may be the soil guidance value. The method limit of detection must, therefore, be lower than the required critical level of interest.
- Ensure that sampling procedures, preservation and transportation are appropriate for both minimising the loss of parameters and the analytical methods being employed by the laboratory. Details should be recorded.
- Ensure in collaboration with the laboratory that complete audit trails of samples are made by making all relevant information available, including:
  - Location of sample, including depth where necessary;
  - Unique sample code or reference, date and time sample taken;
  - Name of laboratory, including sub-contracting laboratory where necessary;
  - Date sample analysis completed;
  - Parameter analysed, including whether sample preserved or stabilised on site;
  - Whether analysis carried out on a dried or as received basis;
  - Result of analysis must be on a dry-weight basis;
  - Other relevant comments, for example, visual characteristics of sample.

The laboratory would normally be selected prior to the commencement of site works, most probably based on their MCERTS status. The laboratory should give assurance that they are able to cope with the number of samples and determinants promptly. Consultation with the laboratory is required on sample testing, volume, preservation and transportation requirements. Sampling containers should be delivered to site or local Wardell Armstrong offices by the laboratory. The laboratory should subsequently arrange for the samples to be picked up from site or local Wardell Armstrong offices.

While it is preferred to schedule chemical analysis at the time of sampling when physical properties of samples is freshest in mind, it is sometimes necessary to schedule the laboratory testing from the office rather than using the site Chain of Custody (COC) sheets accompanying the samples. The COC should, therefore, clearly state that test schedules are to follow from a named Wardell Armstrong individual. The relevant Wardell Armstrong test schedule forms and client order or purchase order forms should be used and authorised as appropriate. It is imperative that this is done as soon as possible so that samples are analysed in the laboratory immediately and not left in storage, where degradation can occur, waiting for our instruction.

If a third party is undertaking the sampling on behalf of Wardell Armstrong, **insist** that they label the samples appropriately and that they include some paperwork with the samples, stating that Wardell Armstrong will schedule the testing.

The test schedule should be as thorough and as unambiguous as possible. Some chemical parameters have more than one analytical methodology, so state full chemical test names and your required limit of detection (LOD) on all correspondences, for example:

- Total or Speciated PAHs can be performed using GC-FID or GC-MS instrumentation, both with different LODs.
- Petroleum Hydrocarbon results can be expressed as a Total, Speciated, Banded or split between their aliphatic and aromatic fractions.

The laboratory should already have provided full test names and LODs.

Following receipt of your samples and testing schedule, insist that the laboratory confirm receipt via e-mail or fax. **Do not assume that because you have sent the schedule, the laboratory has received the instructions.** They should attach a copy of their internal scheduling document, which details their interpretation of your schedule and estimated due date for completion of results. Check the laboratory test schedule to confirm they have interpreted your instructions correctly and inform them immediately of any discrepancies.

### **In-situ Testing using a Photo-Ionisation Detector**

Should volatile compounds be suspected, a photo-ionisation detector (PID) may be used as a screening tool to assess the presence of these compounds. The calibration of the instrument must be checked prior to use and the instrument should be set up following the manufacturers' instructions.

A methodology by which the PID could be used as a screening tool is:

- Approximately 1kg sample of soil shall be collected within a 2kg capacity plastic container;
- The soil sample should be disaggregated;
- Cover the container with aluminium foil and store away from direct sunlight for 5 to 10 minutes;
- Place the measuring head of the PID through the foil into the head space and monitor the peak and steady state reading.

Another method may be to use a suitably sized plastic bag knotted at the top, which can then be punctured after equilibration to take a reading. Whatever method is used, it is important that a similar procedure (time left, quantity of sample etc.) is used for all samples from the same site so that comparison between results can be undertaken.

It should be noted that the use of a PID should be for screening purposes only and should elevated readings be recorded, consideration regarding the need for laboratory chemical analysis should be made.

### **Other In-situ Testing Techniques**

It should be noted that there are other in-situ testing techniques that are becoming more frequently used on sites in the UK (e.g. X-Ray fluorescence, HNU soil testing etc). The use of other in-situ techniques should be done in conjunction with best practice, and where possible, testing methodologies and reporting proposals should be agreed with regulators prior to use on site.

<b>TECHNICAL PROCEDURE NOTE</b>	
<b>Subject:</b> Summary Protocol for On-site Surface Water and Groundwater Monitoring and Sampling	<b>No.:</b> T-GEE-06a
	<b>Authority:</b> G Campbell
<b>Category:</b> Ground & Environmental Engineering	<b>Status:</b> Advisory
<b>Relevance:</b> Ground Engineering/Environmental/Waste	<b>Reviewed:</b> 18 December 2018

Please also refer to:

[T-GEE-06b](#) **Water Sampling Pro Forma**

[T-GEE-06c](#) **EA Guidance on Monitoring of Landfill Leachate, Groundwater and Surface Water**

[T-GEE-12](#) **Summary Protocol for Making On-Site Surface Water and Groundwater Physico-chemical Measurements**

The purpose of this technical procedure note is to ensure a consistent approach and methodology when surface water and groundwater monitoring and / or sampling is undertaken by Wardell Armstrong and in the event that different members of staff are required to attend site to undertake monitoring on separate occasions that the measurements are sufficiently reliable.

If we are requested to provide a protocol to the Client / Local Authority, it can also be submitted to demonstrate how water monitoring / sampling is undertaken. The personnel undertaking the surface water and groundwater monitoring should do so following the order outlined within this document.

In the event that the monitoring is sub-contracted or forms part of a larger site investigation programme undertaken by a site investigation contractor or specialist laboratory monitoring company, this note should form part of the site investigation / monitoring specification.

### **General**

This technical procedure has been developed in accordance with the guidance given in the following documents:

- Environment Agency, 2003 – *Guidance on Monitoring of Landfill Leachate, Groundwater and Surface Water*;
- BS ISO 5667-11:2009 – *Guidance on sampling of groundwaters*;
- BS 10175:2011 – *Investigation of potentially contaminated sites – Code of practice*;
- CL:AIRE technical bulletin 3, 2008 – *Principles and practice for the collection of representative groundwater samples*;
- U.S. Environment Protection Agency, Science and Ecosystem Support Division – *Operating procedure, Groundwater sampling*;
- JK Trick, M Stuart, S Reeder, 2008 Contaminated groundwater sampling and Quality Control of water analyses. Environmental Geochemistry, Site Characterization, Data Analysis and Case Histories, Pages 29-57. Elsevier.

# Summary Protocol for On-site Surface Water and Groundwater Monitoring and Sampling



## Health and Safety

Only competent and experienced personnel will undertake the monitoring / sampling. They will be suitably trained, have undergone a H&S induction where necessary, and will be equipped with the appropriate personnel protective equipment (PPE).

The Wardell Armstrong 'Site-specific' risk assessment and any client 'site-specific' health and safety rules will be complied with.

Personnel carrying out the monitoring / sampling may be exposed to potentially contaminated soils, waters and hazardous ground gases on a regular basis and shall be provided with appropriate PPE, as outlined within the site-specific risk assessment.

Personnel shall receive appropriate training and instruction so that they:

- Can follow approved monitoring / sampling protocols;
- Are aware of the hazards of potentially contaminated soils, waters and ground gases / vapours;
- Take appropriate precautions when sampling to ensure that representative samples are obtained.

All works will be carried out safely, using only certified equipment, and the working area will be maintained to ensure the safe and efficient operation of the equipment. Prior to commencing any monitoring / sampling, the personnel will be informed of any relevant environmental issues and mitigation measures and will carry out the sampling in accordance with such measures.

## Prior to Site

To ensure that the monitoring visit occurs without any issue and that the correct information is obtained once on site, the monitoring / sampling should be planned prior to attending site. The following information should be considered and completed prior to attending site:

- *Agree the monitoring objectives with the Project Manager* – Ensure it is known which locations require sampling and the method that is to be undertaken to obtain the water samples and the level of precision applied to the analysis;
- *Site Investigation Plan* – Obtain a plan of the monitoring point locations with adequate information to ensure that the correct location is monitored and samples can be labelled correctly;
- *Prepare a Water Sampling Pro Forma* – Ensure all information that is required, as outlined within the monitoring objectives, is present on the pro forma. Any information that can be determined before attending site should be infilled on the pro forma;
- *Monitoring point information* – Obtain all information relating to the monitoring points undergoing sampling and complete the water sampling proforma. Information that is useful for groundwater sampling includes; the borehole depth, diameter, screened interval, information from any previous visits and headwork details (i.e. need for Allen keys, Phillips screwdriver, padlock key etc.);
- *Access* – Check access to the site with the client / land owner to ensure that there are no issues in attending site. If specific access routes to monitoring / sampling points are imposed by the Client, then these should be recorded on an access plan. Ensure personnel attending site know the location of access. Do **not** undertake water sampling on a Friday if the laboratory cannot accept samples the following day;

# Summary Protocol for On-site Surface Water and Groundwater Monitoring and Sampling



- *Equipment* – Determine what equipment is required to purge and sample the monitoring locations and that they can transfer the samples with the least physical and chemical changes in water quality (i.e. the sample should be taken from as close to the borehole headworks as possible; avoid long transfers by pipe or sampling post-storage). The sample analysed needs to be representative of the physical and chemical state of the aquifer. All equipment should be suitably charged and decontaminated prior to attending site and between sampling locations, if necessary;
- *Laboratory Equipment* – Ensure that the appropriate bottles / vials are available for each monitoring location. The specified laboratory can advise on which bottles to take based on the analysis that is planned. Different analysis methods require different volumes of water in appropriate bottles / vials. Samples for inorganic substances (e.g. metals) **must** be filtered on site, rather than once the analysis is undertaken, therefore filters will be required on site.
- Physical, chemical and biological processes may occur once the water is removed from the aquifer or surface water body (e.g. adsorption to the inside of the bottle, oxidation, outgassing, reaction in sunlight). These processes are prevented by the selection of the correct bottle and where necessary, the correct preservative for certain parameters. The laboratory should provide pre-preserved sample bottles for use on site;
- *Laboratory methodologies* – when a quote is obtained from the laboratory, the level of precision being applied to the analysis shall be checked against those in the monitoring objectives. In most projects, checking the concentrations of chemicals analysed against water quality standards (e.g. drinking water standards, environmental quality standards) is a requirement. The precision of analysis known as the *Level of Detection (LOD e.g. <math><0.1\mu\text{g}/\text{l}</math>)*, should be lower than the water quality standard that it is being screened against. It is important to choose the correct methodology that provides the correct LOD for your analysis; and
- *Health and Safety* – Ensure that a site-specific task risk assessment has been carried out and has been signed by the appropriate people. Ensure that appropriate PPE is available to take to site when monitoring is to be undertaken.

## On-Site

### **Depth Measurements – Groundwater**

Once personnel undertaking the monitoring reaches the required sampling location, adequate PPE should be worn (e.g. suitably waterproof gloves that should be changed between each sampling location).

If a borehole requires ground gas monitoring, this should be carried out prior to any groundwater monitoring; see Technical Procedure Note for Ground Gas On-site Monitoring ([T-GEE-03](#)).

Using data obtained from the installation of boreholes and previous groundwater monitoring, if free product is suspected, an interface probe should be utilised rather than a standard monotone dip meter. Measurements should be recorded from a fixed datum (e.g. ground level or top of casing) and recorded on the water sampling pro forma. Where possible, a consistent datum should be used for each borehole throughout monitoring visits. When using a dip meter to determine water level, **only** the depth to water (DTW) can be recorded by the audible tone. Boreholes should **always** be dipped to the base and the depth to base (DTB) recorded. This can be compared to previous visits as a quality assurance measure and to assess any 'silting up' that is occurring.

# Summary Protocol for On-site Surface Water and Groundwater Monitoring and Sampling



When using an interface probe, the depth to product (DTP) should be recorded. Product on the surface is referred to as light non-aqueous phase liquid (LNAPL). The probe should then be lowered into the underlying water and then pulled back up to the product. This reading is the depth to water (DTW). This step is necessary as the oil-water interface can be depressed during the insertion of an interface probe and it may be necessary to repeat it several times to confirm the location of this interface. Continuing the dip to the base of the borehole with the interface probe can confirm the presence or absence of any dense non-aqueous phase liquid (DNAPL) within the screened section of the aquifer. Make a note of any odour or visual contamination on the dip meter / interface probe upon completion. Where contamination is known, monitoring points should be monitored starting with the cleanest and finishing with the most contaminated.

Should any product be detected using the interface probe, a sample should be obtained using an appropriate sampling method (e.g. a bailer). This sample (within a vial) can then be sent to the analytical laboratory to determine the nature of the product. A small quantity of groundwater from the borehole should also be obtained to compare the nature of the liquids.

Prior to undertaking measurements at any further monitoring points, the equipment should be suitably decontaminated (e.g. using non-phosphate based soap and water followed by de-ionised water). The waste wash water should be disposed of in the correct manner (See disposal of purge water later in this document). It is considered that any contamination associated with clean equipment is minimal.

This step should be repeated on site following the completion of the last monitoring event and when the equipment is returned to the office.

## ***Depth Measurements – Surface Water***

The approximate surface water sampling location should be determined prior to attending site. The sample should be taken from an area that is considered to be of suitable flow, ensuring that stagnation is not occurring within the surface water source. The monitoring location should be recorded to ensure that future visits can lead to comparable results. The height of the location should be recorded within the site notes.

## ***Purging Groundwater***

Purging is the process of removing stagnant water from a monitoring borehole immediately prior to sampling to ensure that the groundwater sampled is representative of the chemistry of the aquifer.

The act of purging causes the replacement of stagnant water by groundwater adjacent to the borehole and representative of the actual aquifer conditions. The borehole is considered to be adequately purged once the physico-chemical parameters (temperature, pH, electrical conductivity and dissolved oxygen) of the groundwater in the borehole resembles that of the aquifer.

Purging should generally be carried out at a flow rate greater than that of sampling. There are two main purge strategies available; multiple well volume purge or micro-purge (low-flow sampling). If the site is considered to be contaminated, i.e. free phase product is present, a micro-purge method should be considered to keep disturbance of the groundwater to a minimum as well as limiting the quantity of contaminated water that is brought to the surface.

# Summary Protocol for On-site Surface Water and Groundwater Monitoring and Sampling



Various equipment to be used when purging of boreholes is required is outlined in the Environment Agency, 2003 – *Guidance on Monitoring of Landfill Leachate, Groundwater and Surface Water*; Appendix 10; Sampling equipment, included as T-GEE-06c. When using the multiple volume purge method, the preferred method for purging is the use of a submersible pump or inertial pump due to the higher flow rate.

For multiple volume purging, it is considered that the appropriate volume to be removed is between 3 and 5 borehole volumes. The borehole volume is determined based on the size of the standpipe within the borehole. The liquid volume of the borehole is calculated based on the equation  $\pi r^2 h$ , where r is the radius of the standpipe and h is the height of water column. A simple method for use on site is  $\pi d^2 h / 4$ , where d is the diameter of the standpipe.

Alternatively, the volumes in a borehole, based on the standpipe diameter, are outlined in Table 1.

<b>Table 1: Standing Water Volumes in the Standpipe of a Monitoring Point</b>			
Standpipe Diameter (mm)	Water Volume per metre Depth in litres (l)		
	One Borehole Volume	Three Borehole Volumes	Five Borehole Volumes
17	0.22	0.68	1.13
20	0.31	0.94	1.57
25	0.49	1.47	2.45
50	1.96	5.89	9.82
100	7.85	23.56	39.27
150	17.67	53.01	88.36
200	31.42	94.25	157.08
250	49.09	147.26	245.44
300	70.69	212.06	353.43

Micro-purging or low-flow monitoring is the most efficient way of monitoring a borehole when sands, gravels and similar lithology is recorded during the drilling process. This method has a reduction in purge volume, compared to the multiple well volume purge, leading to a shorter monitoring visit as a result. Low-flow utilises the continuous monitoring of field chemical parameters to ensure that purging has been effective and once parameters have stabilised the water in the borehole resembles that of the aquifer. As a minimum, pH, temperature, electrical conductivity (EC) and dissolved oxygen (DO) should be monitored. Bailers, grab samplers and inertial pumps are not suitable for micro-purging due to the mixing and disturbance of the water column that is generated. Low-flow monitoring can also identify stratification within aquifers.

During the low-flow monitoring, the pump should be located within the screened section of boreholes and where screens are short (< 3m), the pump should be located in the centre. The groundwater level should be continuously monitored to ensure that minimal drawdown occurs. Typically, the flow rate should not exceed 1 l/min with the drawdown not exceeding 9 cm.

Groundwater should be pumped through a flow cell with readings of physico-chemical parameters taken every 3 to 5 minutes, at regular intervals, using a multi-parameter probe. Please note, if using some multiparameter probes such as SmarTrolls and AquaTrolls, the measurement interval can be as little as 2 seconds and upon completion, monitoring reports can be generated. When you book out, hire and use either a SmarTROLL or AquaTROLL, please refer to the Wardell Armstrong SmarTroll user Guide, which can be found within the Summary Protocol for Making On-site Surface Water and Groundwater Physico-Chemical Measurements.

# Summary Protocol for On-site Surface Water and Groundwater Monitoring and Sampling



Purging is considered to be complete once the monitored physico-chemical parameters have stabilised. Stabilisation is reached once **three** consecutive readings are taken at least **3 to 5 minutes apart** within the allowable stabilisation limits. The allowable buffer associated with each monitoring parameter, based on the equation  $(\text{max} - \text{min of the last 3 readings} / \text{Last reading}) * 100$ , is outlined in Table 2.

The stabilisation order for the chemical parameters are; pH, T, EC, DO. The borehole is considered suitably purged once DO has stabilised.

Table 2: Percentage Buffer Allowed for Stabilisation	
Monitoring Parameter	Stabilisation Buffer
Turbidity	± 10 %
pH	± 0.1
Temperature (T)	± 3 %
Oxidation Reduction Potential (ORP)	± 10 mV
Electrical Conductivity (EC)	± 3 %
Dissolved Oxygen (DO)	± 10 %

Environment Agency (2003), BS 5667 and BS 10175 all identify the need for the disposal of purged water. Consideration should be given to the method of disposal and it should be designed to minimise the risks to current and future receptors (i.e. monitoring personnel, members of the public and future site occupiers, the water environment and agricultural receptors e.g. ripening crops). Should the groundwater be free from visual and olfactory contamination, the Environment Agency indicate that it can be pumped onto the ground surface.

The exception to this is when there are large volumes to be disposed of and the EA should be consulted on the matter, where a permit might be required. When the groundwater is contaminated there are several options that should be considered: remove directly to a waste water disposal system; dispose directly onto any areas of 'waste' material (sufficiently away from the monitoring point to avoid recirculation); or collect within an Intermediate Bulk Container (IBC)/bowser for suitable disposal. In a situation where contaminated water is encountered, low-flow monitoring should be adopted to limit the volume of groundwater brought to the surface. If free-product is detected at the surface of the groundwater, a grab sample (e.g. using a hydrasleeve) should be obtained below the product layer and tested at a laboratory prior to purging the borehole.

### Field physico-chemical measurements

Measurements of physico-chemical parameters should be obtained whenever sampling of water is being undertaken at site. The physico-chemical parameters should be recorded prior to sampling and should be obtained using a suitably calibrated multi-parameter probe (e.g. SmarTroll, AquaTroll and YSI multiparameter probe, easily available for hire). They should include as a minimum, pH, temperature, electrical conductivity (EC), Oxidation Reduction Potential (ORP) and dissolved oxygen (DO) as both percentage saturation and concentration (in mg/l). In some circumstances Redox may also be required. Prior to use, any multi-parameter probe should first be suitably calibrated, preferably on site.

# Summary Protocol for On-site Surface Water and Groundwater Monitoring and Sampling



If there is a large variation in altitude between the office and site (>150m), then the probe must be calibrated on site. A flow cell should be used to take the measurements in the absence of oxygen. Should a flow cell not be available a bucket can be used, as long as water is continuously being pumped in and the probe sensors are fully submerged within the water. If samples are being taken using a bailer, only temperature, pH and electrical conductivity should be recorded from beakers of standing water. Any issues that are identified during the physico-chemical measurements should be recorded on the sampling pro forma (e.g. pH outside normal 6-9 range).

When sampling surface water, the probe should be suitably placed directly into the surface water body, and within the fastest flowing part, where flow is visible. This region will be the sample location.

## Sampling of Groundwater

At each monitoring location, ensure that all sample bottles outlined by the required laboratory are prepared for the groundwater. Labels should be completed, including; the borehole ID, date, time and depth the water sample is taken from (height of pump for low-flow monitoring or screen height for full purge). If during the purging process the borehole does not recharge quickly and becomes fully dewatered, sufficient time should be allowed for water levels to recover to an adequate volume for samples to be taken.

Collect a sample using the appropriate method selected by the Project Manager (i.e. submersible pump or bailer). Disposable bailers can be utilised to avoid cross-contamination, however, should not be the default sampling method due to the reduced field chemistry that can be obtained. Do not cause any undue agitation to the water sample during collection, ensuring that a minimal change in environment is achieved between the aquifer and sample bottle. When a flow cell has been used for field chemistry, samples should not be taken through the flow cell and instead should be taken prior to water passing into the flow cell from a clean section of riser pipe.

Sample chemistry may be affected by biological and chemical processes within a few hours (or even minutes) of sampling. This has the potential to significantly modify some components of the sample chemistry. To overcome these changes, preservation of the samples can be undertaken by one or both of the following methods; chemical preservatives (Table 3), bottles that exclude ultraviolet light and maintaining low temperatures. Laboratories add preservatives to bottles prior to dispatching the bottles and therefore the personnel undertaking the monitoring should not alter the volume of preservative in the sample. Samples should not exceed the temperatures found in the aquifer and therefore water samples should be kept within a cool box with ice packs.

**Table 3: Sample bottle, Pre-treatment and Preservatives by Parameter**

Analysis	Sample Bottle Material	Pre-treatment	Preservative added
Bromide, Chloride, Fluoride, nitrate, nitrite, sulphate, total suspected solids, total dissolved solids, pH, electrical conductivity, phosphates, acidity, alkalinity	PET/HDPE	None	None
Cyanide	PET/HDPE	None	Sodium hydroxide, pH>12
Chemical oxygen demand (COD), ammonium, total phosphate.	PET/HDPE	None	1:1 Sulphuric acid, 1ml
Total Metals (ICP-MS)	HDPE	None	1:3 Nitric acid, 2 ml, pH<2
Dissolved Metals (ICP-MS)	HDPE	Filtration	1:3 Nitric acid, 2 ml, pH<2

# Summary Protocol for On-site Surface Water and Groundwater Monitoring and Sampling



Samples undergoing testing for inorganic substances (e.g. dissolved metals) **must** be filtered on site to ensure that a representative sample is achieved. Suspended particles can create anomalous results. The analytical laboratory will provide syringes and appropriate filters (a 0.63µm filter) for use on site.

The appropriate sample containers should be filled as full as possible, glass and plastic bottles should contain a small head space. For analysis of volatile organic compounds (VOCs) no air should be in the vial. Once the vial is filled, the vial should be inverted and the side gently tapped to check for air bubbles. If any air bubbles are present, more water needs to be added. When filling the vial with water, ensure it is slowly filled so that a dome is formed at the top. A small quantity of water can also be added into the cap prior to screwing. This ensures the best chance for no air to be present.

All samples should be wrapped in bubble wrap (or similar) to ensure the sample integrity during transport. Samples should be stored in a cool box during the sampling round with several ice packs to maintain their temperature.

Various no-purge sampling methods are available for use, e.g. hydrosleeves and equilibrators. These can be used, but the advantages and disadvantages should be considered prior to use. The use of these should be discussed with the Project Manager.

## **Sampling of Surface Water**

At each monitoring location ensure that all sample bottles outlined by the required laboratory are prepared for the surface water. Labels should be completed, including; the location ID, date and time. Surface water samples should be obtained directly from the source using either the sample bottles (unpreserved), a clean bucket rinsed with sample water or suitable equipment (e.g. bucket on a pole / rope) if out of reach.

Sample chemistry may be affected by biological and chemical processes and these have the potential to significantly modify some components of the sample chemistry. To overcome these changes, preservation of the samples can be undertaken by one or both of the following methods; chemical preservatives (Table 3), bottles that exclude ultraviolet light and maintaining low temperatures. Laboratories add preservatives to bottles prior to dispatching the bottles and therefore the personnel undertaking the monitoring should not alter the volume of preservative in the sample. Samples should not exceed the temperatures found in the aquifer and therefore water samples should be kept within a cool box with ice packs.

## **Post-Monitoring**

Immediately prior to leaving site, ensure that all rubbish has been removed from the borehole vicinities and disposed of appropriately. Ensure that all borehole headworks are secured and if a gas bung has been removed ensure that it is replaced with the gas valve securely closed.

Samples should be delivered to the laboratory within 24 hours of sampling and samples should not be collected on a Friday. If sufficiently cold ice packs are not available, additional means of keeping samples cool should be sought (e.g. frozen peas). The laboratory should record the temperature at which the sample is received. The laboratory requires the scheduling of samples as soon as possible due to the holding time of water samples. The laboratory can advise of holding times.

All monitoring equipment should be suitably cleaned and calibrated to ensure that it is appropriate for use at the next site.

# Summary Protocol for On-site Surface Water and Groundwater Monitoring and Sampling



## Sample Quality Control Procedures

An important part of surface water and groundwater monitoring and / or sampling is assuring the quality of the data produced to provide us and our clients with confidence in the results provided in our projects. It is recommended within numerous documents (e.g. Trick et al, 2008 and Environment Agency, 2003) that a Quality Control (QC) procedure is followed during monitoring.

Field physico-chemical measurements of pH and electrical conductivity provide a Quality Control of laboratory pH and electrical conductivity measurements, and vice versa. Field measurement of dissolved oxygen and ORP, together with laboratory measurements of redox sensitive parameters (e.g. ammonium, nitrate, iron, manganese, arsenic) provide a clear picture of redox conditions, and a further QC check should be to ensure that these parameters agree with one another.

Sampling duplicates, where two sets of samples are taken at one location; trip blanks of de-ionised water prepared in the laboratory sent into the field to test for cross contamination in the laboratory; or field blanks, de-ionised water samples prepared in the field to check for sample cross contamination in the field, are the most common forms of QC samples.

It is recommended within the EA guidance that QC samples make up 10% of the samples obtained during that monitoring visit i.e. one duplicate sample and one field blank for all parameters for every ten field samples, and one trip blank for each cool box used. The QC samples should be labelled such that they are not indicative of a QC sample i.e. to ensure that the laboratory are not aware that they are QA samples. The proportion of QC samples should be increased for more critical monitoring investigations (e.g. monitoring for legal purposes). Not all duplicates and blanks need to be analysed at the laboratory, however they should be available in case of spurious laboratory results. Information on other types of QC procedures is contained within Trick et al. (2008) and Appendix 11 of Environment Agency guidance 2008.

Erratic sample results, which may be indicative of either pollution or sample error, should be compared with other samples from the site / in the area. Checks should be made with the laboratory for transcription errors and repeat analyses to check results. If this does not resolve the erratic sample result, consideration should be given to resampling. If there is still doubt within the sample then duplicate samples can be obtained during the resampling, i.e. two from the same location and sent to the same laboratory or two samples sent to different laboratories for the same analysis.

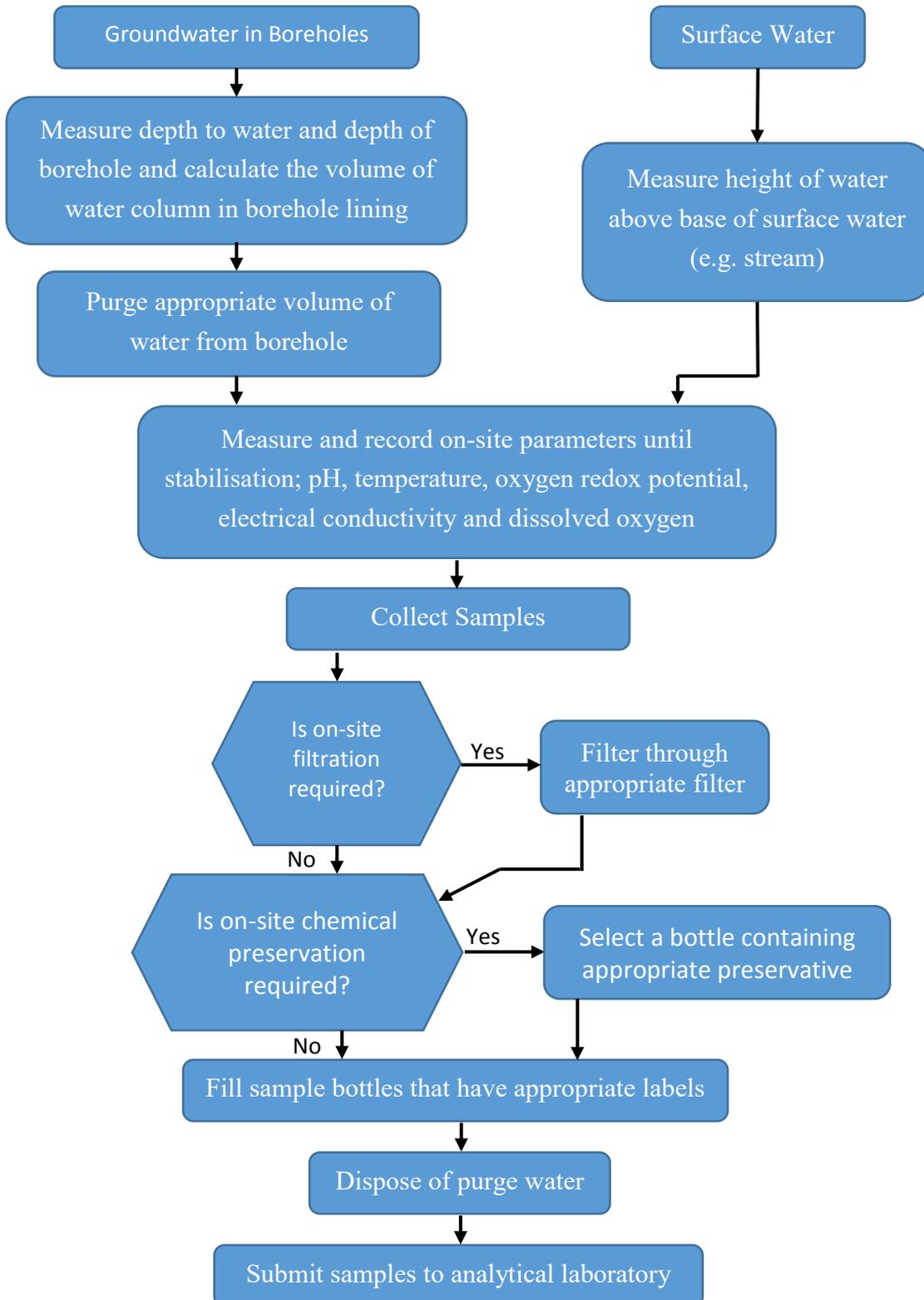
## Summary

A summary of the procedure is provided in Figure 1 on page 10 of this document, adapted from Figure 9.3 of Environment Agency, 2003.

# Summary Protocol for On-site Surface Water and Groundwater Monitoring and Sampling



**Figure 1** – Groundwater monitoring procedure summary for obtaining an appropriate water quality sample in locations that do not contain LNAPL or DNAPL. If these are present refer to earlier sections.



<b>TECHNICAL PROCEDURE NOTE</b>	
<b>Subject:</b> Summary Protocol for Making On-Site Surface Water and Groundwater Physico-chemical Measurements	<b>No.:</b> T-GEE-12
	<b>Authority:</b> L Prazsky
<b>Category:</b> Ground & Environmental Engineering	<b>Status:</b> Mandatory
<b>Relevance:</b> Ground Engineering/Environmental/Waste/Water	<b>Reviewed:</b> 18 December 2018

This document should be read and used in conjunction with the Wardell Armstrong 'Summary Protocol for On-site Surface Water and Groundwater Monitoring and Sampling' ([T-GEE-06a](#)).

The SmarTROLL Multiparameter Handheld system allows you to collect real-time data and share data instantly from your Android or iOS mobile device.

The following parameters are measured by the SmarTROLL:

- Conductivity ( $\mu\text{S}/\text{cm}$ );
- pH (pH);
- Oxygen redox potential (ORP) (mV);
- Rugged Dissolved oxygen (RDO) (mg/L and %Sat);
- Water level/pressure (psi);
- Salinity (PSU);
- Total dissolved solids (TDS) (ppt);
- Resistivity (W.cm)
- Density ( $\text{g}/\text{cm}^3$ );
- Temperature ( $^{\circ}\text{C}$ ); and
- Barometric pressure (mbar).

The purpose of this document is to provide steps on how to use the SmarTROLL. This "How To" guide contains the following sections:

- Instructions;
- Connecting phone to the SmarTROLL Bluetooth device;
- Water quality analysis;
- Low flow sampling;
- Maintenance; and
- Calibration.



**Figure 1: SmarTROLL Device**

The SmarTROLL should not be used on contaminated sites without prior discussions with the hydrogeology and hydrology team.

### Instructions

SmarTROLL Equipment:

- SmarTROLL Probe (*takes and records water quality measurements*);
- pH chamber (*to store the SmarTROLL Probe when not in use, there is pH solution within the chamber, take care not the spill this solution while on site*);
- SmarTROLL Bluetooth device (*to connect the SmarTROLL Probe to the Vu-Situ or iSitu App*);
- Connection cable (*to connect the SmarTROLL Bluetooth device to the SmarTROLL Probe*);
- Protective cover (*to protect the SmarTROLL Probe sensors when taking a surface water quality measurement*);
- Flow cell (*to take groundwater quality measurements*); and
- Mobile device with Bluetooth capability and Vu-Situ/iSitu Mobile App installed (*to communicate with SmarTROLL Probe and view data*).

In addition to the SmarTROLL equipment, depending on your required use you may need:

- WASP pump, battery and watterra tubing to obtain a groundwater sample; or
- Bailer and sample bucket/container to obtain a surface water sample.

Download Vu-Situ Mobile App from the Google play store or iSitu Mobile App from the App store – see [link](#).

Prior to going on site, the SmarTROLL Bluetooth device needs to be connected to the Vu-situ App installed on your phone.

# Summary Protocol for On-site Surface Water and Groundwater Monitoring and Sampling



## Connecting Phone to Bluetooth Device:

1. Connect the cable from the SmarTROLL Bluetooth device to the SmarTROLL Probe. Do this by removing the red caps from the end of the connector cable, the SmarTROLL Probe and the SmarTROLL Bluetooth device and then screw together;
2. Turn on the SmarTROLL Bluetooth device;
3. Turn on the phones Bluetooth and open Vu-Situ App;
4. Click 'Choose or Add a device';
5. This will open your phone's Bluetooth settings;
6. Search for devices;
7. Choose the correct In-Situ device (**425541 Power Pack**). Pairing should only take a couple of minutes;
8. After pairing, tap the phone's back arrow to return to the app;
9. If successful, the SmarTROLL Probe and Vu-Situ App will connect, and you can begin.

Ensure SmarTROLL Bluetooth device and phone are both fully charged when taking them into the field.

If you have connected to the SmarTROLL Bluetooth device before it will show up in your recently connected devices. Usually it will connect automatically after opening the Vu-Situ App. Your phones Bluetooth must be switched on to connect automatically.

If you are having issues connecting the phone with the SmarTROLL Bluetooth device:

1. Make sure the connectors are clean, use a small amount of the hand sanitiser provided (or other alcohol gel) and the cotton cleaning buds;
2. Make sure the cable connectors are fully connected (screw connections);
3. Try turning the SmarTROLL Bluetooth device on before turning the Vu-Situ App on (and vice-versa);
4. Check you have the most recent Vu-Situ App.

## Water Quality Analysis: Surface Water

1. Unscrew the SmarTROLL Probe from the pH buffer solution chamber;
2. Screw on the protective cover;
3. Insert the SmarTROLL into a water sample. Best way to do this is by taking a clean spare plastic bucket/container. Do NOT lower the SmarTROLL Probe down a borehole;
4. Click on the 'Live Readings' button on the app;
5. Once each value has a blue tick next to it, the probe has stabilised, and you can start recording. This can take a few moments;
6. Press the 'Start Recording' button on the bottom of the screen. This will start monitoring the water quality. A reading will be taken every 2 seconds once recording;



**Figure 2: Screenshot of Vu-Situ App. Live readings screen**



**Figure 3: SmarTROLL with protective cover connected to the SmarTROLL Bluetooth device**

7. Monitor until values have stabilised. See Wardell Armstrong's document: Summary Protocol for On-site Surface Water and Groundwater Monitoring and Sampling;
8. When you are finished, click 'Stop'. This will display all the monitoring data from that particular sample;
9. It is important you save the recordings in the correct location. Press 'Export' and choose desired location. It is recommended to save them to the Vu-Situ folder and to also email yourself a copy. The water monitoring pro forma ([T-GEE-06b](#)) can also be used to record the data;
10. Dry the SmarTROLL and remove any silt/sediment from the probe. Screw the probe into the pH solution chamber and pack away;
11. Return red caps on the end of connector wire, SmarTROLL and Bluetooth Device.

## Water Quality Analysis: Groundwater

### Obtaining a low flow sample:

1. Usually this would be carried out using a submersible WASP pump connected to a flow cell;
2. Screw the probe into the flow cell;
3. Connect the tubing from the pump to the lower of the two pipes on the flow cell. Water will flow into the flow cell through this valve;
4. Put the tube attached to the upper value into a bucket/container, the water will leave the flow cell through this tube;
5. Turn pump on and allow air to be completely expelled from the flow cell before beginning measurements.



Figure 5: Flow Cell



Figure 4: Flow Cell and Tubing

6. Once each value has a blue tick next to it, the probe has stabilised, and you can start recording. This can take a few moments;
7. Press the 'Start Recording' button on the bottom of the screen. This will start monitoring the physico-chemical water quality. A reading will be taken every 2 seconds once recording;
8. Monitor until values have stabilised. The order of stabilisation is pH > temp > EC > DO (sample should only be taken once DO has stabilised). See Wardell Armstrong's document: Summary Protocol for Summary Protocol for On-site Surface Water and Groundwater Monitoring and Sampling;
9. Once the measurements have stabilised, click 'Stop';
10. Disconnect the flow cell and collect water samples. See Wardell Armstrong's document: Summary Protocol for On-site Surface Water and Groundwater Monitoring and Sampling (ref: T-GEE-06a);
11. It is important you save the recordings in the correct location. Press 'Export' and choose desired location. It is recommended to save them to the Vu-Situ folder and to also email yourself a copy. The Water Monitoring Pro Forma can also be used to record the data;
12. Dry the SmarTROLL and remove any silt/sediment from the probe. Screw the probe into the pH solution chamber and pack away;
13. Return red caps on the end of connector wire, SmarTROLL and Bluetooth Device.

## Maintenance

After using the SmarTROLL it is important it is cleaned effectively. Use cold water to wash the monitoring probe. Ensure all sediment is removed from the flow cell, monitoring chamber and probe itself. Return clean probe to the pH chamber containing pH solution. Ensure all equipment is dry before putting it away.



Figure 6: Maintenance of Equipment

# Summary Protocol for On-site Surface Water and Groundwater Monitoring and Sampling



## Calibration:

The SmarTROLL will be calibrated on a monthly basis by the hydrogeology and hydrology team.

In the event of any issues or difficulties occurring on site, please contact \_\_\_\_\_ for assistance.

Please detail any difficulties in the issue log spreadsheet.

## File Name:

SmarTROLL Log

## File Location:

<N:\HO\HO90738 - Hydro Coordination\02 - Data\Research\15 - Equipment\SmarTroll>

**APPENDIX D**

**Selected Salespart :** S15871

**Salespart Description :** Wardell Brownfield Suite incl  
TPH 2024 (S)

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
ASB_SOIL_IDN_S	Asbestos ID in Solid Samples	TM048	400g Tub (ALE 214)

<b>Component Name</b>	<b>LOD</b>
-----------------------	------------

Amosite (Brown) Asbestos

Asbestos Tremolite

Asbestos Actinolite

Chrysotile (White) Asbestos

Analysed By

Comments

Asbestos Anthophyllite

Crocidolite (Blue) Asbestos

Date of Analysis

Non-Asbestos Fibre

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
B_WS	Boron Water Soluble	TM222	250g Amber Jar (ALE 210)

<b>Component Name</b>	<b>LOD</b>
-----------------------	------------

Boron, water soluble <1

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
CR_VI_S	Hexavalent Chromium (s)	TM151	250g Amber Jar (ALE 210)

<b>Component Name</b>	<b>LOD</b>
-----------------------	------------

Chromium, Hexavalent <0.6

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
CWG_EPH_S	EPH CWG GC (S)	TM414	250g Amber Jar (ALE 210)

<b>Component Name</b>	<b>LOD</b>
-----------------------	------------

Aliphatics >C12-C16 <1000

Aliphatics >C10-C12 <1000

Aliphatics >C16-C21 <1000

<b>Component Name</b>	<b>LOD</b>
Aliphatics >C35-C44	<1000
Aliphatics >C21-C35	<1000
Aromatics > EC12-EC16	<1000
Aromatics > EC40-EC44	<1000
Aromatics > EC10-EC12	<1000
Total Aromatics > EC10-EC44	<5000
Aromatics > EC16-EC21	<1000
Aromatics > EC21-EC35	<1000
Aromatics >EC35-EC44	<1000
Total Aliphatics & Aromatics >C10-C44	<10000
Total Aliphatics >C10-C44	<5000

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
CWG_TPH_S	TPH CWG GC (S)	TM414	250g Amber Jar (ALE 210)

<b>Component Name</b>	<b>LOD</b>
Total Aliphatics & Aromatics >C5-C44	<10000

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
CYANIDES_SFA_S	Cyanide Comp/Free/Total/Thiocyanate	TM153	250g Amber Jar (ALE 210)

<b>Component Name</b>	<b>LOD</b>
Cyanide, Total	<1

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
GRO_S	GRO by GC-FID (S)	TM089	60g Jar (ALE 215) *

<b>Component Name</b>	<b>LOD</b>
Aromatics >EC8-EC10	<10
Aliphatics >C6-C8	<10
Aliphatics >C5-C6	<10
Total Aromatics >EC5-EC10	<50
Aromatics >EC7-EC8	<10
Aliphatics >C8-C10	<10
GRO Surrogate % recovery**	
Aromatics >EC5-EC7	<10

<b>Component Name</b>	<b>LOD</b>
GRO >C5-C10	<20
Total Aliphatics >C5-C10	<50

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
KONE_S	Anions by Kone (soil)	TM243	250g Amber Jar (ALE 210)

<b>Component Name</b>	<b>LOD</b>
Water Soluble Sulphate as SO4 2:1 Extract	<0.004

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
METALS_OES_S	Metals in solid samples by OES	TM181	250g Amber Jar (ALE 210)

**Component Name LOD**

Copper	<1.4
Arsenic	<0.6
Lead	<0.7
Cadmium	<0.02
Nickel	<0.2
Chromium	<0.9
Selenium	<1
Mercury	<0.1
Zinc	<1.9

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
PAH_MICRO_GCMS_S	PAH by GCMS	TM218	250g Amber Jar (ALE 210)

**Component Name LOD**

Acenaphthene	<8
Acenaphthene-d10 % recovery**	
Indeno(1,2,3-cd)pyrene	<18
Acenaphthylene	<12
Anthracene	<16
Benz(a)anthracene	<14
Phenanthrene	<15
Benzo(k)fluoranthene	<14
Benzo(a)pyrene	<15

<b>Component Name</b>	<b>LOD</b>
Dibenzo(a,h)anthracene	<23
Benzo(b)fluoranthene	<15
Chrysene	<10
Benzo(g,h,i)perylene	<24
Fluorene	<10
Perylene-d12 % recovery**	
Chrysene-d12 % recovery**	
PAH, Total Detected USEPA 16	<118
Fluoranthene	<17
Pyrene	<15
Naphthalene	<9
Naphthalene-d8 % recovery**	
Phenanthrene-d10 % recovery**	

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
PH_S	pH	TM133	250g Amber Jar (ALE 210)

<b>Component Name</b>	<b>LOD</b>
pH	1

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
PHEN_HPLC_S	Phenols by HPLC (S)	TM062 (S)	250g Amber Jar (ALE 210)

<b>Component Name</b>	<b>LOD</b>
Phenol	<0.01
Cresols	<0.01
Phenols, Total Detected monohydric	<0.035
Xylenols	<0.015

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
S2-_EASYLIB_S	Easily Liberated Sulphide	TM180	250g Amber Jar (ALE 210)

<b>Component Name</b>	<b>LOD</b>
Sulphide, Easily liberated	<15

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
SULPHATE_TOTAL_S	Total Sulphate	TM221	250g Amber Jar (ALE 210)

**Component Name LOD**

Sulphate, Total &lt;48

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
TOC_S	Total Organic Carbon	TM132	250g Amber Jar (ALE 210)

<b>Component Name</b>	<b>LOD</b>
Soil Organic Matter (SOM)	<0.35

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
VOC_MS_S	VOC MS (S)	TM116	60g Jar (ALE 215) *

<b>Component Name</b>	<b>LOD</b>
p/m-Xylene	<2
4-Bromofluorobenzene**	
Sum of BTEX	<7
Benzene	<1
Sum of Detected Xylenes	<0.02
Ethylbenzene	<1
Methyl Tertiary Butyl Ether	<0.5
Dibromofluoromethane**	
o-Xylene	<2
Toluene	<1
Toluene-d8**	

**Selected Salespart :** S15874  
**Salespart Description :** Wardell Brownfield Suite excl  
TPH 2024 (S)

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
ASB_SOIL_IDN_S	Asbestos ID in Solid Samples	TM048	400g Tub (ALE 214)

**Component Name**      **LOD**

Amosite (Brown) Asbestos

Analysed By

Asbestos Actinolite

Date of Analysis

Asbestos Anthophyllite

Chrysotile (White) Asbestos

Asbestos Tremolite

Crocidolite (Blue) Asbestos

Comments

Non-Asbestos Fibre

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
B_WS	Boron Water Soluble	TM222	250g Amber Jar (ALE 210)

**Component Name**      **LOD**

Boron, water soluble <1

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
CR_VI_S	Hexavalent Chromium (s)	TM151	250g Amber Jar (ALE 210)

**Component Name**      **LOD**

Chromium, Hexavalent <0.6

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
CYANIDES_SFA_S	Cyanide Comp/Free/Total/Thiocyanate	TM153	250g Amber Jar (ALE 210)

**Component Name**      **LOD**

Cyanide, Total      <1

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
KONE_S	Anions by Kone (soil)	TM243	250g Amber Jar (ALE 210)

Component Name	LOD
Water Soluble Sulphate as SO4 2:1 Extract	<0.004

Analysis Code	Description	Method	Bottle Type
METALS_OES_S	Metals in solid samples by OES TM181		250g Amber Jar (ALE 210)

Component Name	LOD
----------------	-----

Arsenic	<0.6
Cadmium	<0.02
Copper	<1.4
Chromium	<0.9
Mercury	<0.1
Lead	<0.7
Nickel	<0.2
Selenium	<1
Zinc	<1.9

Analysis Code	Description	Method	Bottle Type
PAH_MICRO_GCMS_S	PAH by GCMS	TM218	250g Amber Jar (ALE 210)

Component Name	LOD
----------------	-----

Acenaphthene-d10 % recovery**	
Acenaphthene	<8
Acenaphthylene	<12
Benzo(g,h,i)perylene	<24
Anthracene	<16
Benzo(b)fluoranthene	<15
Benzo(k)fluoranthene	<14
Chrysene	<10
Benz(a)anthracene	<14
Perylene-d12 % recovery**	
Chrysene-d12 % recovery**	
Dibenzo(a,h)anthracene	<23
Benzo(a)pyrene	<15
Phenanthrene-d10 % recovery**	

<b>Component Name</b>	<b>LOD</b>
Fluorene	<10
Fluoranthene	<17
Naphthalene	<9
Pyrene	<15
Naphthalene-d8 % recovery**	
Indeno(1,2,3-cd)pyrene	<18
Phenanthrene	<15
PAH, Total Detected USEPA 16	<118

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
PH_S	pH	TM133	250g Amber Jar (ALE 210)

<b>Component Name</b>	<b>LOD</b>
pH	1

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
PHEN_HPLC_S	Phenols by HPLC (S)	TM062 (S)	250g Amber Jar (ALE 210)

<b>Component Name</b>	<b>LOD</b>
Cresols	<0.01
Xylenols	<0.015
Phenol	<0.01
Phenols, Total Detected monohydric	<0.035

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
S2-_EASYLIB_S	Easily Liberated Sulphide	TM180	250g Amber Jar (ALE 210)

<b>Component Name</b>	<b>LOD</b>
Sulphide, Easily liberated	<15

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
SULPHATE_TOTAL_S	Total Sulphate	TM221	250g Amber Jar (ALE 210)

<b>Component Name</b>	<b>LOD</b>
Sulphate, Total	<48

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
TOC_S	Total Organic Carbon	TM132	250g Amber Jar (ALE 210)

<b>Component Name</b>	<b>LOD</b>
Soil Organic Matter (SOM)	<0.35

**Selected Salespart :** S2225

**Salespart Description :** SVOC (S) by GC MS

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
SVOC_MS_S	Semi Volatile Organic Compounds TM157		250g Amber Jar (ALE 210)
<b>Component Name</b>	<b>LOD</b>		
1,4-Dichlorobenzene	<100		
1,2-Dichlorobenzene	<100		
2,4-Dimethylphenol	<100		
1,2,4-Trichlorobenzene	<100		
2,4,5-Trichlorophenol	<100		
2-Chloronaphthalene	<100		
2,6-Dinitrotoluene	<100		
1,3-Dichlorobenzene	<100		
2,4-Dinitrotoluene	<100		
2-Methylphenol	<100		
2-Nitrophenol	<100		
2,4,6-Trichlorophenol	<100		
4-Chloroaniline	<100		
2-Nitroaniline	<100		
3-Nitroaniline	<100		
2,4-Dichlorophenol	<100		
Benzo(a)anthracene	<100		
4-Chlorophenylphenylether	<100		
4-Chloro-3-methylphenol	<100		
2-Chlorophenol	<100		
Benzo(k)fluoranthene	<100		
4-Nitroaniline	<100		
Azobenzene	<100		
2-Methylnaphthalene	<100		
bis(2-Chloroethoxy)methane	<100		
4-Nitrophenol	<100		

<b>Component Name</b>	<b>LOD</b>
Chrysene	<100
4-Bromophenylphenylether	<100
Dibenzofuran	<100
Benzo(b)fluoranthene	<100
Indeno(1,2,3-cd)pyrene	<100
4-Methylphenol	<100
n-Dibutyl phthalate	<100
Benzo(g,h,i)perylene	<100
Nitrobenzene	<100
Acenaphthene	<100
Hexachlorobenzene	<100
bis(2-Ethylhexyl) phthalate	<100
Phenanthrene	<100
Acenaphthylene	<100
Naphthalene	<100
Butylbenzyl phthalate	<100
Pyrene	<100
Anthracene	<100
Phenol	<100
Carbazole	<100
Benzo(a)pyrene	<100
Dibenzo(a,h)anthracene	<100
bis(2-Chloroethyl)ether	<100
Diethyl phthalate	<100
Fluoranthene	<100
Dimethyl phthalate	<100
Hexachlorobutadiene	<100
n-Dioctyl phthalate	<100
Isophorone	<100
Fluorene	<100
Pentachlorophenol	<100

<b>Component Name</b>	<b>LOD</b>
Hexachlorocyclopentadiene	<100
Hexachloroethane	<100
n-Nitroso-n-dipropylamine	<100

**Selected Salespart :** S11255

**Salespart**  
**Description :** VOC (S) by GC MS

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
VOC_MS_S	VOC MS (S)	TM116	60g Jar (ALE 215) *
<b>Component Name</b>	<b>LOD</b>		
1,1,1-Trichloroethane	<0.5		
1,1,1,2-Tetrachloroethane	<1		
1,2,4-Trichlorobenzene	<7		
1,1,2,2-Tetrachloroethane	<2		
1,1-Dichloroethene	<0.5		
1,2-Dibromo-3-chloropropane	<2		
1,2,4-Trimethylbenzene	<3		
1,1,2-Trichloroethane	<1		
1,1-Dichloropropene	<0.5		
1,2-Dibromoethane	<1		
1,2-Dichloroethane	<1		
1,1-Dichloroethane	<0.5		
1,2,3-Trichloropropane	<2		
1,2-Dichlorobenzene	<5		
1,2-Dichloropropane	<0.5		
1,2,3-Trichlorobenzene	<10		
1,3-Dichloropropane	<1		
1,3,5-Trichlorobenzene	<7		
1,3,5-Trimethylbenzene	<2		
Chlorobenzene	<2		
1,4-Dichlorobenzene	<5		
2,2-Dichloropropane	<1		
1,3-Dichlorobenzene	<5		
cis-1,2-Dichloroethene	<0.5		
2-Chlorotoluene	<3		
Bromochloromethane	<2		

<b>Component Name</b>	<b>LOD</b>
4-Bromofluorobenzene**	
sec-Butylbenzene	<1
4-Chlorotoluene	<3
Chloroethane	<1
Benzene	<1
Styrene	<2
4-Isopropyltoluene	<2
Chloroform	<3
Carbon Disulphide	<1
Tert-amyl methyl ether	<1
Bromobenzene	<2
Dibromochloromethane	<2
Dibromofluoromethane**	
Methyl Tertiary Butyl Ether	<0.5
Bromodichloromethane	<2
Dibromomethane	<1
Dichlorodifluoromethane	<0.5
Trichloroethene	<1
Bromoform	<2
Ethylbenzene	<1
Toluene	<1
Naphthalene	<8
Bromomethane	<1
n-Butylbenzene	<3
Toluene-d8**	
o-Xylene	<2
Carbontetrachloride	<0.5
Propylbenzene	<2
trans-1,3-Dichloropropene	<1
tert-Butylbenzene	<2
Chloromethane	<2

<b>Component Name</b>	<b>LOD</b>
Vinyl Chloride	<0.5
Trichlorofluoromethane	<0.5
cis-1,3-Dichloropropene	<0.5
Dichloromethane	<5
Hexachlorobutadiene	<4
Isopropylbenzene	<2
p/m-Xylene	<2
Sum of BTEX	<7
Tetrachloroethene	<2
trans-1,2-Dichloroethene	<1

**Selected Salespart :** S15872  
**Salespart Description :** Wardell Leachate Suite incl TPH  
2024 (W)

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
CR_VI_KONE_LOW_W	Low Level Hexavalent Chromium (w)	TM331	1 Litre Plastic (ALE 221)

<b>Component Name</b>	<b>LOD</b>
Low Level Hexavalent Chromium	<0.003

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
CWG_EPH_FILT_W	EPH and CWG (Filtered) by FID	TM439	1 Litre Glass (ALE 220)

<b>Component Name</b>	<b>LOD</b>
Aliphatics >C21-C35 (diss.filt)	<10
Aromatics >EC16-EC21 (diss.filt)	<10
Total Aliphatics >C12-C35 (diss.filt)	<10
Aliphatics >C12-C16 (diss.filt)	<10
Aromatics >EC21-EC35 (diss.filt)	<10
Aliphatics >C16-C21 (diss.filt)	<10
Total Aromatics >EC12-EC35 (diss.filt)	<10
Aromatics >EC12-EC16 (diss.filt)	<10

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
CWG_TPH_FILT_W	TPH CWG Filtered (W)	TM439	1 Litre Glass (ALE 220)

<b>Component Name</b>	<b>LOD</b>
Total Aliphatics & Aromatics >C5-35 (diss. filt)	<10

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
CYANIDES_SFA_W	Cyanide Comp/Free/Total/Thiocyanate	TM227	125ml Plastic + NaOH (ALE 245)

<b>Component Name</b>	<b>LOD</b>
Cyanide, Free	<0.05
Thiocyanate	<0.05
Cyanide, Total	<0.05

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
DOC_DIC_IR_W	Dissolved Organic/Inorganic Carbon	TM090	1 Litre Glass (ALE 220)

**Component Name LOD**

Carbon, Organic (diss.filt) <3

**Analysis Code Description**

**Method**

**Bottle Type**

GRO\_W GRO by GC-FID (W) TM245

40ml Glass Vial (ALE297)

**Component Name LOD**

Aromatics >EC10-EC12 <10

Aliphatics >C6-C8 <10

GRO Surrogate % recovery\*\*

Aliphatics >C10-C12 <10

Aromatics >EC7-EC8 <10

Aliphatics >C8-C10 <10

Aromatics >EC5-EC7 <10

Aliphatics >C5-C6 <10

GRO >C5-C12 <50

Aromatics >EC8-EC10 <10

**Analysis Code**

**Description**

**Method**

**Bottle Type**

HG\_CVAF\_W Mercury Dissolved

TM183

60ml Plastic + HNO3 Filtered (ALE 204)

**Component Name LOD**

Mercury (diss.filt) <0.01

**Analysis Code**

**Description**

**Method**

**Bottle Type**

ICPMS\_W Dissolved Metals by ICP-MS

TM152

60ml Plastic + HNO3 Filtered (ALE 204)

**Component Name LOD**

Arsenic (diss.filt) <0.5

Boron (diss.filt) <10

Chromium (diss.filt) <1

Calcium (Dis.Filt) <0.2

Copper (diss.filt) <0.3

Cadmium (diss.filt) <0.08

Lead (diss.filt) <0.2

**Component Name LOD**

Nickel (diss.filt) <0.4  
 Selenium (diss.filt) <1.0  
 Zinc (diss.filt) <1.0

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
KONE_W	Anions by Kone (w)	TM184	1 Litre Plastic (ALE 221)

**Component Name LOD**

Sulphate <2

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
PAH_EPAMS_FILT_W	PAH in waters by GC-MS (diss.filt)	TM178	1 Litre Glass (ALE 220)

**Component Name LOD**

<b>Component Name</b>	<b>LOD</b>
Acenaphthylene (diss.filt)	<0.005
Benzo(k)fluoranthene (diss.filt)	<0.005
Acenaphthene (diss.filt)	<0.005
Anthracene (diss.filt)	<0.005
Benzo(g,h,i)perylene (diss.filt)	<0.005
Dibenzo(a,h)anthracene (diss.filt)	<0.005
Benzo(a)anthracene (diss.filt)	<0.005
Chrysene (diss.filt)	<0.005
Pyrene (diss.filt)	<0.005
Indeno(1,2,3-cd)pyrene (diss.filt)	<0.005
Benzo(a)pyrene (diss.filt)	<0.002
Fluorene (diss.filt)	<0.005
Benzo(b)fluoranthene (diss.filt)	<0.005
PAH Sum of EPA 16 detected (Diss filt)	<0.082
Fluoranthene (diss.filt)	<0.005
Phenanthrene (diss.filt)	<0.005
Naphthalene (diss.filt)	<0.01

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
PH_W	pH Value	TM256	1 Litre Plastic (ALE 221)

**Component Name      LOD**

Alkalinity, Total as CaCO3 <3

**Analysis Code      Description**

**Method**

**Bottle Type**

PH\_W\_F      pH Value of Filtered Water TM256

1 Litre Plastic (ALE 221)

**Component Name      LOD**

pH (diss.filt)      <1

**Analysis Code      Description**

**Method**

**Bottle Type**

PHEN\_HPLC\_W      Phenols by HPLC (W)

TM259

125ml Plastic + H2SO4 (ALE 244)

**Component Name      LOD**

Cresols      <0.006

Phenol      <0.002

Phenols, Total Detected monohydric <0.016

Xylenols      <0.008

**Analysis Code      Description**

**Method**

**Bottle Type**

S2\_W      Sulphide      TM101

ZnAc (ALE246)

**Component Name      LOD**

Sulphide      <0.01

**Analysis Code      Description**

**Method**

**Bottle Type**

VOC\_MS\_W      VOC MS (W)      TM208

40ml Glass Vial (ALE297)

**Component Name      LOD**

o-Xylene      <1

Ethylbenzene      <1

Benzene      <1

Methyl tertiary butyl ether (MTBE) <1

m,p-Xylene      <1

Sum of BTEX      <5

Toluene      <1

Sum of detected Xylenes      <2

**Selected Salespart :** S15875

**Salespart Description :** Wardell Leachate Suite excl TPH  
2024 (W)

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
CR_VI_KONE_LOW_W	Low Level Hexavalent Chromium (w) TM331		1 Litre Plastic (ALE 221)
<b>Component Name LOD</b>			
Low Level Hexavalent Chromium <0.003			
<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
CYANIDES_SFA_W	Cyanide Comp/Free/Total/Thiocyanate TM227		125ml Plastic + NaOH (ALE 245)
<b>Component Name LOD</b>			
Cyanide, Total <0.05			
Cyanide, Free <0.05			
Thiocyanate <0.05			
<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
DOC_DIC_IR_W	Dissolved Organic/Inorganic Carbon TM090		1 Litre Glass (ALE 220)
<b>Component Name LOD</b>			
Carbon, Organic (diss.filt) <3			
<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
HG_CVAF_W	Mercury Dissolved TM183		60ml Plastic + HNO3 Filtered (ALE 204)
<b>Component Name LOD</b>			
Mercury (diss.filt) <0.01			
<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
ICPMS_W	Dissolved Metals by ICP-MS TM152		60ml Plastic + HNO3 Filtered (ALE 204)
<b>Component Name LOD</b>			
Arsenic (diss.filt) <0.5			
Zinc (diss.filt) <1.0			
Boron (diss.filt) <10			
Chromium (diss.filt) <1			

**Component Name LOD**

Cadmium (diss.filt) <0.08  
 Lead (diss.filt) <0.2  
 Calcium (Dis.Filt) <0.2  
 Nickel (diss.filt) <0.4  
 Copper (diss.filt) <0.3  
 Selenium (diss.filt) <1.0

Analysis Code	Description	Method	Bottle Type
KONE_W	Anions by Kone (w)	TM184	1 Litre Plastic (ALE 221)

**Component Name LOD**

Sulphate <2

Analysis Code	Description	Method	Bottle Type
PAH_EPAMS_FILT_W	PAH in waters by GC-MS (diss.filt)	TM178	1 Litre Glass (ALE 220)

**Component Name LOD**

Component Name	LOD
Indeno(1,2,3-cd)pyrene (diss.filt)	<0.005
Anthracene (diss.filt)	<0.005
Acenaphthylene (diss.filt)	<0.005
Acenaphthene (diss.filt)	<0.005
Benzo(g,h,i)perylene (diss.filt)	<0.005
Benzo(a)pyrene (diss.filt)	<0.002
Benzo(k)fluoranthene (diss.filt)	<0.005
Benzo(a)anthracene (diss.filt)	<0.005
Dibenzo(a,h)anthracene (diss.filt)	<0.005
Chrysene (diss.filt)	<0.005
Pyrene (diss.filt)	<0.005
Benzo(b)fluoranthene (diss.filt)	<0.005
Fluorene (diss.filt)	<0.005
Fluoranthene (diss.filt)	<0.005
PAH Sum of EPA 16 detected (Diss filt)	<0.082
Naphthalene (diss.filt)	<0.01
Phenanthrene (diss.filt)	<0.005

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
PH_W	pH Value	TM256	1 Litre Plastic (ALE 221)

<b>Component Name</b>	<b>LOD</b>
Alkalinity, Total as CaCO3	<3

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
PH_W_F	pH Value of Filtered Water	TM256	1 Litre Plastic (ALE 221)

<b>Component Name</b>	<b>LOD</b>
pH (diss.filt)	<1

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
PHEN_HPLC_W	Phenols by HPLC (W)	TM259	125ml Plastic + H2SO4 (ALE 244)

<b>Component Name</b>	<b>LOD</b>
Cresols	<0.006
Phenol	<0.002
Phenols, Total Detected monohydric	<0.016
Xylenols	<0.008

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
S2_W	Sulphide	TM101	ZnAc (ALE246)

<b>Component Name</b>	<b>LOD</b>
Sulphide	<0.01

**Selected Salespart :** S15870

**Salespart Description :** Wardell Groundwater Suite incl  
TPH 2024 (W)

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
CR_VI_KONE_LOW_W	Low Level Hexavalent Chromium (w)	TM331	1 Litre Plastic (ALE 221)

<b>Component Name</b>	<b>LOD</b>
Low Level Hexavalent Chromium	<0.003

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
CWG_EPH_W	EPH and CWG by FID	TM439	1 Litre Glass (ALE 220)

<b>Component Name</b>	<b>LOD</b>
Aliphatics >C21-C35 (aq)	<10
Aliphatics >C12-C16 (aq)	<10
Aromatics >EC16-EC21 (aq)	<10
Aromatics >EC21-EC35 (aq)	<10
Aromatics >EC12-EC16 (aq)	<10
Aliphatics >C16-C21 (aq)	<10
Total Aromatics >EC12-EC35 (aq)	<10
Total Aliphatics >C12-C35 (aq)	<10

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
CWG_TPH_W	TPH CWG (W)	TM439	1 Litre Glass (ALE 220)

<b>Component Name</b>	<b>LOD</b>
Total Aliphatics & Aromatics >C5-35 (aq)	<10

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
CYANIDES_SFA_W	Cyanide Comp/Free/Total/Thiocyanate	TM227	125ml Plastic + NaOH (ALE 245)

<b>Component Name</b>	<b>LOD</b>
Thiocyanate	<0.05
Cyanide, Free	<0.05
Cyanide, Total	<0.05

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
DOC_DIC_IR_W	Dissolved Organic/Inorganic Carbon	TM090	1 Litre Glass (ALE 220)

**Component Name LOD**

Carbon, Organic (diss.filt) <3

**Analysis Code Description**

**Method**

**Bottle Type**

GRO\_W GRO by GC-FID (W) TM245

40ml Glass Vial (ALE297)

**Component Name LOD**

Aliphatics >C10-C12 <10

GRO Surrogate % recovery\*\*

Aliphatics >C6-C8 <10

Aliphatics >C8-C10 <10

Aliphatics >C5-C6 <10

Aromatics >EC7-EC8 <10

Aromatics >EC10-EC12 <10

Aromatics >EC5-EC7 <10

Aromatics >EC8-EC10 <10

GRO >C5-C12 <50

**Analysis Code**

**Description**

**Method**

**Bottle Type**

HG\_CVAF\_W Mercury Dissolved

TM183

60ml Plastic + HNO3 Filtered (ALE 204)

**Component Name LOD**

Mercury (diss.filt) <0.01

**Analysis Code**

**Description**

**Method**

**Bottle Type**

ICPMS\_W Dissolved Metals by ICP-MS

TM152

60ml Plastic + HNO3 Filtered (ALE 204)

**Component Name LOD**

Arsenic (diss.filt) <0.5

Chromium (diss.filt) <1

Boron (diss.filt) <10

Calcium (Dis.Filt) <0.2

Selenium (diss.filt) <1.0

Copper (diss.filt) <0.3

Cadmium (diss.filt) <0.08

**Component Name LOD**

Lead (diss.filt) <0.2  
 Nickel (diss.filt) <0.4  
 Zinc (diss.filt) <1.0

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
KONE_W	Anions by Kone (w)	TM184	1 Litre Plastic (ALE 221)

**Component Name LOD**

Sulphate <2

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
PAH_EPAMS_W	PAH Spec MS - Aqueous (W)	TM178	1 Litre Glass (ALE 220)

<b>Component Name</b>	<b>LOD</b>
-----------------------	------------

Acenaphthene (aq)	<0.005
Anthracene (aq)	<0.005
Acenaphthylene (aq)	<0.005
Benzo(b)fluoranthene (aq)	<0.005
Chrysene (aq)	<0.005
Benzo(g,h,i)perylene (aq)	<0.005
Benzo(a)anthracene (aq)	<0.005
Benzo(k)fluoranthene (aq)	<0.005
Dibenzo(a,h)anthracene (aq)	<0.005
Fluoranthene (aq)	<0.005
Benzo(a)pyrene (aq)	<0.002
Fluorene (aq)	<0.005
Indeno(1,2,3-cd)pyrene (aq)	<0.005
Phenanthrene (aq)	<0.005
PAH, Total Detected USEPA 16 (aq)	<0.082
Pyrene (aq)	<0.005
Naphthalene (aq)	<0.01

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
PH_W	pH Value	TM256	1 Litre Plastic (ALE 221)

<b>Component Name</b>	<b>LOD</b>
Alkalinity, Total as CaCO3	<3
pH	<1.00

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
PHEN_HPLC_W	Phenols by HPLC (W)	TM259	125ml Plastic + H2SO4 (ALE 244)

<b>Component Name</b>	<b>LOD</b>
Cresols	<0.006
Xylenols	<0.008
Phenol	<0.002
Phenols, Total Detected monohydric	<0.016

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
S2_W	Sulphide	TM101	ZnAc (ALE246)

<b>Component Name</b>	<b>LOD</b>
Sulphide	<0.01

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
VOC_MS_W	VOC MS (W)	TM208	40ml Glass Vial (ALE297)

<b>Component Name</b>	<b>LOD</b>
m,p-Xylene	<1
Benzene	<1
Ethylbenzene	<1
Methyl tertiary butyl ether (MTBE)	<1
Toluene	<1
Sum of BTEX	<5
o-Xylene	<1
Sum of detected Xylenes	<2

**Selected Salespart :** S15873

**Salespart Description :** Wardell Groundwater Suite excl  
TPH 2024 (W)

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
CR_VI_KONE_LOW_W	Low Level Hexavalent Chromium (w) TM331		1 Litre Plastic (ALE 221)

<b>Component Name</b>	<b>LOD</b>
Low Level Hexavalent Chromium	<0.003

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
CYANIDES_SFA_W	Cyanide Comp/Free/Total/Thiocyanate TM227		125ml Plastic + NaOH (ALE 245)

<b>Component Name</b>	<b>LOD</b>
Thiocyanate	<0.05
Cyanide, Free	<0.05
Cyanide, Total	<0.05

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
DOC_DIC_IR_W	Dissolved Organic/Inorganic Carbon TM090		1 Litre Glass (ALE 220)

<b>Component Name</b>	<b>LOD</b>
Carbon, Organic (diss.filt)	<3

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
HG_CVAF_W	Mercury Dissolved TM183		60ml Plastic + HNO3 Filtered (ALE 204)

<b>Component Name</b>	<b>LOD</b>
Mercury (diss.filt)	<0.01

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
ICPMS_W	Dissolved Metals by ICP-MS TM152		60ml Plastic + HNO3 Filtered (ALE 204)

<b>Component Name</b>	<b>LOD</b>
Arsenic (diss.filt)	<0.5
Boron (diss.filt)	<10
Chromium (diss.filt)	<1
Cadmium (diss.filt)	<0.08

**Component Name LOD**

Selenium (diss.filt) <1.0  
Calcium (Dis.Filt) <0.2  
Lead (diss.filt) <0.2  
Copper (diss.filt) <0.3  
Nickel (diss.filt) <0.4  
Zinc (diss.filt) <1.0

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
KONE_W	Anions by Kone (w)	TM184	1 Litre Plastic (ALE 221)

**Component Name LOD**

Sulphate <2

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
PAH_EPAMS_W	PAH Spec MS - Aqueous (W)	TM178	1 Litre Glass (ALE 220)

**Component Name LOD**

<b>Component Name</b>	<b>LOD</b>
Anthracene (aq)	<0.005
Acenaphthylene (aq)	<0.005
Acenaphthene (aq)	<0.005
Benzo(a)pyrene (aq)	<0.002
Benzo(g,h,i)perylene (aq)	<0.005
Benzo(k)fluoranthene (aq)	<0.005
Benzo(a)anthracene (aq)	<0.005
Indeno(1,2,3-cd)pyrene (aq)	<0.005
PAH, Total Detected USEPA 16 (aq)	<0.082
Dibenzo(a,h)anthracene (aq)	<0.005
Benzo(b)fluoranthene (aq)	<0.005
Phenanthrene (aq)	<0.005
Chrysene (aq)	<0.005
Pyrene (aq)	<0.005
Fluoranthene (aq)	<0.005
Fluorene (aq)	<0.005
Naphthalene (aq)	<0.01

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
PH_W	pH Value	TM256	1 Litre Plastic (ALE 221)

<b>Component Name</b>	<b>LOD</b>
pH	<1.00
Alkalinity, Total as CaCO3	<3

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
PHEN_HPLC_W	Phenols by HPLC (W)	TM259	125ml Plastic + H2SO4 (ALE 244)

<b>Component Name</b>	<b>LOD</b>
Cresols	<0.006
Phenol	<0.002
Phenols, Total Detected monohydric	<0.016
Xylenols	<0.008

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
S2_W	Sulphide	TM101	ZnAc (ALE246)

<b>Component Name</b>	<b>LOD</b>
Sulphide	<0.01

**Selected Salespart :** S2226

**Salespart Description** : SVOC (W) by GC MS

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
<b>Component Name</b>	<b>LOD</b>		
<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
SVOC_MS_W	SVOC MS (W) - Aqueous TM176		1 Litre Glass (ALE 220)

<b>Component Name</b>	<b>LOD</b>
2,4-Dimethylphenol (aq)	<1
1,4-Dichlorobenzene (aq)	<1
1,2,4-Trichlorobenzene (aq)	<1
1,2-Dichlorobenzene (aq)	<1
2-Chloronaphthalene (aq)	<1
2,4-Dichlorophenol (aq)	<1
1,3-Dichlorobenzene (aq)	<1
2,4,5-Trichlorophenol (aq)	<1
4-Bromophenylphenylether (aq)	<1
2-Nitroaniline (aq)	<1
2,4,6-Trichlorophenol (aq)	<1
2,6-Dinitrotoluene (aq)	<1
4-Nitrophenol (aq)	<1
4-Chlorophenylphenylether (aq)	<1
2,4-Dinitrotoluene (aq)	<1
2-Methylnaphthalene (aq)	<1
Acenaphthylene (aq)	<1
4-Methylphenol (aq)	<1
2-Chlorophenol (aq)	<1
2-Methylphenol (aq)	<1
Azobenzene (aq)	<1
bis(2-Chloroethoxy)methane (aq)	<1
4-Chloroaniline (aq)	<1

<b>Component Name</b>	<b>LOD</b>
2-Nitrophenol (aq)	<1
Benzo(b)fluoranthene (aq)	<1
bis(2-Chloroethyl)ether (aq)	<1
4-Nitroaniline (aq)	<1
3-Nitroaniline (aq)	<1
Benzo(k)fluoranthene (aq)	<1
Carbazole (aq)	<1
Acenaphthene (aq)	<1
4-Chloro-3-methylphenol (aq)	<1
Dibenzofuran (aq)	<1
Chrysene (aq)	<1
Anthracene (aq)	<1
Benzo(a)anthracene (aq)	<1
n-Dibutyl phthalate (aq)	<1
Dibenzo(a,h)anthracene (aq)	<1
Benzo(g,h,i)perylene (aq)	<1
Benzo(a)pyrene (aq)	<1
n-Dioctyl phthalate (aq)	<5
Dimethyl phthalate (aq)	<1
bis(2-Ethylhexyl) phthalate (aq)	<2
Phenol (aq)	<1
Indeno(1,2,3-cd)pyrene (aq)	<1
Fluoranthene (aq)	<1
Butylbenzyl phthalate (aq)	<1
Hexachlorobenzene (aq)	<1
Isophorone (aq)	<1
Hexachlorocyclopentadiene (aq)	<1
Diethyl phthalate (aq)	<1
Nitrobenzene (aq)	<1
Naphthalene (aq)	<1
Fluorene (aq)	<1

<b>Component Name</b>	<b>LOD</b>
Pentachlorophenol (aq)	<1
Hexachlorobutadiene (aq)	<1
Hexachloroethane (aq)	<1
n-Nitroso-n-dipropylamine (aq)	<1
Phenanthrene (aq)	<1
Pyrene (aq)	<1

**Selected Salespart :** S11256

**Salespart Description :** VOC (W) by GC MS

<b>Analysis Code</b>	<b>Description</b>	<b>Method</b>	<b>Bottle Type</b>
VOC_MS_W	VOC MS (W)	TM208	40ml Glass Vial (ALE297)
<b>Component Name</b>	<b>LOD</b>		
1,1,1,2-Tetrachloroethane	<1		
1,2,4-Trichlorobenzene	<1		
1,1-Dichloroethene	<1		
1,2-Dibromo-3-chloropropane	<1		
1,1,1-Trichloroethane	<1		
1,2-Dichlorobenzene	<1		
1,1-Dichloropropene	<1		
1,2-Dichloropropane	<1		
1,1,2,2-Tetrachloroethane	<1		
1,3-Dichlorobenzene	<1		
1,2,3-Trichlorobenzene	<1		
1,3,5-Trichlorobenzene	<1		
1,1,2-Trichloroethane	<1		
1,3-Dichloropropane	<1		
1,2,4-Trimethylbenzene	<1		
1,4-Dichlorobenzene	<1		
1,1-Dichloroethane	<1		
4-Bromofluorobenzene**			
2,2-Dichloropropane	<1		
2-Chlorotoluene	<1		
1,2,3-Trichloropropane	<1		
4-iso-Propyltoluene	<1		
4-Chlorotoluene	<1		
Bromochloromethane	<1		
1,2-Dibromoethane	<1		
Bromodichloromethane	<1		

<b>Component Name</b>	<b>LOD</b>
Benzene	<1
Bromoform	<1
1,2-Dichloroethane	<1
Bromomethane	<1
Chloroethane	<1
Chloroform	<1
1,3,5-Trimethylbenzene	<1
Carbon disulphide	<1
Chloromethane	<1
cis-1,3-Dichloropropene	<1
Bromobenzene	<1
Carbontetrachloride	<1
cis-1,2-Dichloroethene	<1
Dibromochloromethane	<1
Chlorobenzene	<1
Hexachlorobutadiene	<1
Dibromofluoromethane**	
tert-Amyl methyl ether (TAME)	<1
Dibromomethane	<1
Naphthalene	<1
Dichlorodifluoromethane	<1
Tetrachloroethene	<1
Isopropylbenzene	<1
n-Butylbenzene	<1
Dichloromethane	<3
Trichloroethene	<1
Propylbenzene	<1
o-Xylene	<1
Ethylbenzene	<1
m,p-Xylene	<1
Toluene	<1

<b>Component Name</b>	<b>LOD</b>
sec-Butylbenzene	<1
tert-Butylbenzene	<1
Styrene	<1
Vinyl chloride	<1
Methyl tertiary butyl ether (MTBE)	<1
trans-1,2-Dichloroethene	<1
Toluene-d8**	
Trichlorofluoromethane	<1
trans-1,3-Dichloropropene	<1