Bromsberrow North Sandpit: Environmental Monitoring Plan

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Prepared for

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Contents

FIGURES

TABLES

APPENDICES

1 Introduction

1.1 Report Context

Stantec UK Ltd (Stantec) has been instructed by Allstone Sands Gravels Aggregates Trading Co. Ltd ('Allstone') to prepare an Environmental Permit (EP, or 'Permit') application for inert landfill at Bromsberrow North Sandpit, Bell Lane, Bromsberrow Heath, Ledbury, Gloucestershire, HR8 1NX (the 'Site'). The Operator of the EP will be Allstone. The operator of the sand pit is Bromsberrow Sand and Gravel Company Ltd , a wholly owned subsidiary of Allstone.

This report has been prepared for Allstone by Stantec as part of a new application for an EP in relation to the Site. The EP applied for, in accordance with the Review of Old Mineral Permits (ROMP) application (Bromsberrow Sand and Gravel Company Limited, 2022), would allow the progressive infilling of the former quarry void with approximately 670,000m^3 of imported inert materials.

This report sets out the proposed Site environmental monitoring plan and provides a framework for the management of potential environmental impacts associated with the site. As such, the plan is designed to offer suitable safeguards for the protection of various potential receptors (including human health, groundwater and local ecologies), as identified by a number of risk assessments performed in relation to the Site, as follows:

- Hydrogeological Risk Assessment (HRA) (Stantec, 2024b);
- Landfill Gas Risk Assessment (LFGRA) (Stantec, 2024c);
- Environmental Risk Assessment (Stantec, 2024d); and
- Ecological Appraisal (AA Environmental, 2022).

This report should be read together with the completed EP application form and the documents referenced therein.

1.2 Conceptual Site Model and Guidance

This environmental monitoring plan has been designed based on the conceptual site model, as set out in the ESSD report (Stantec, 2024a) and with reference to the requirements set out in the Environment Agency (EA) guidance on 'monitoring and report your performance' (EA, 2023).

1.3 Scope of this Report

The broad objectives of environmental monitoring (as set out in EA, 2023) are to:

- Demonstrate that the landfill is performing as designed and in accordance with the risk assessment predictions;
- Show that management and control systems are preventing pollution;
- Show compliance with the emission and compliance limits set in the EP;
- Identify where further investigation is needed and, where risks are unacceptable, the need for measures to prevent, reduce or remove pollution; and
- Identify when the Site no longer presents a risk of pollution.

The aim of the plan is to provide a summary of the methods, procedures and actions to be implemented at the site for the duration of the EP and up to the point of surrender, in order to meet the above objectives.

The plan will be reviewed and updated on a regular basis as the Site develops to ensure adequate controls are in place to meet the identified standards and objectives. Any changes will be agreed with the EA.

The plan provides details of the procedures for monitoring:

- Landfill gas (Section 2);
- Landfill leachate (Section 3);
- Groundwater (Section 4);
- Dust generation (Section 6); and
- Restoration fill materials (Section 7).

Drilling logs including installation records for the monitoring installations installed to date are included as Appendix A.

1.4 Management Structure and Technical Competence

The Site Manager will undertake overall management and supervision of the site.

Environmental monitoring (gas and groundwater) is undertaken by the monitoring contractor, Geotechnical Engineering Ltd (GEL). GEL's monitoring procedures, including details of the training and qualifications required for their technicians, are included as Appendix B.

Suitably qualified technicians who are experienced and trained in the use of monitoring and sampling equipment and interpretation of the data obtained will carry out all monitoring at the installation. Training records of monitoring personnel will be made available to the EA on request.

1.5 Review of Environmental Monitoring Plan

Monitoring data will be analysed, and this monitoring plan will be reviewed annually against:

- The monitoring objectives;
- The compliance limits; and
- The conclusions made in the risk assessments.

The monitoring plan will be revised based on this data review to make sure it remains appropriate. Any changes to the monitoring plan will be submitted to the local EA officer for their written agreement.

2 Landfill Gas Monitoring and Reporting

2.1 Landfill Gas Monitoring Installations

2.1.1 Locations within the Restored Area

Currently it is anticipated that eight in-waste monitoring installations will be provided within the restored area in the indicative locations shown on the monitoring point plan (MPP) (Figure 1.1). This is based on the EA Guidance (EA, 2023) requiring a minimum of two boreholes per hectare, to be installed as soon as each phase of the landfill is complete.

The pre-application advice sought for the inert landfill permit application indicates that in-waste gas monitoring will be required and could be combined with the leachate monitoring. The monitoring locations within the restored areas are, therefore, proposed as dual purpose landfill gas and leachate monitoring wells.

2.1.2 Design

The in-waste monitoring wells will be dual purpose landfill gas and leachate monitoring installations. These will be retrofitted by vertical drilling upon completion in each phase of the landfill.

The in-waste monitoring installations are expected to comprise a 150mm diameter HDPE monitoring standpipe installed within a minimum 250mm diameter borehole. The slotted (screened) section of the monitoring standpipe will extend throughout the waste mass.

The base of the standpipe will be sealed with a suitable plug or cap. The screened section of the standpipe will be perforated by holes not greater than 5mm diameter at intervals of approximately 75mm or equivalent area of slots. The perforated/slotted pipe will be surrounded by clean, non-calcareous gravel within the grading 10-20mm.

The upper section of the standpipe will comprise plain HDPE pipe surrounded by a bentonite seal. It is anticipated that this upper seal will be 3m thick.

The standpipe will be finished with a screwed plastic cap or similar fitted with a gas sampling valve and will be protected at the ground surface by a lockable steel cover set in concrete.

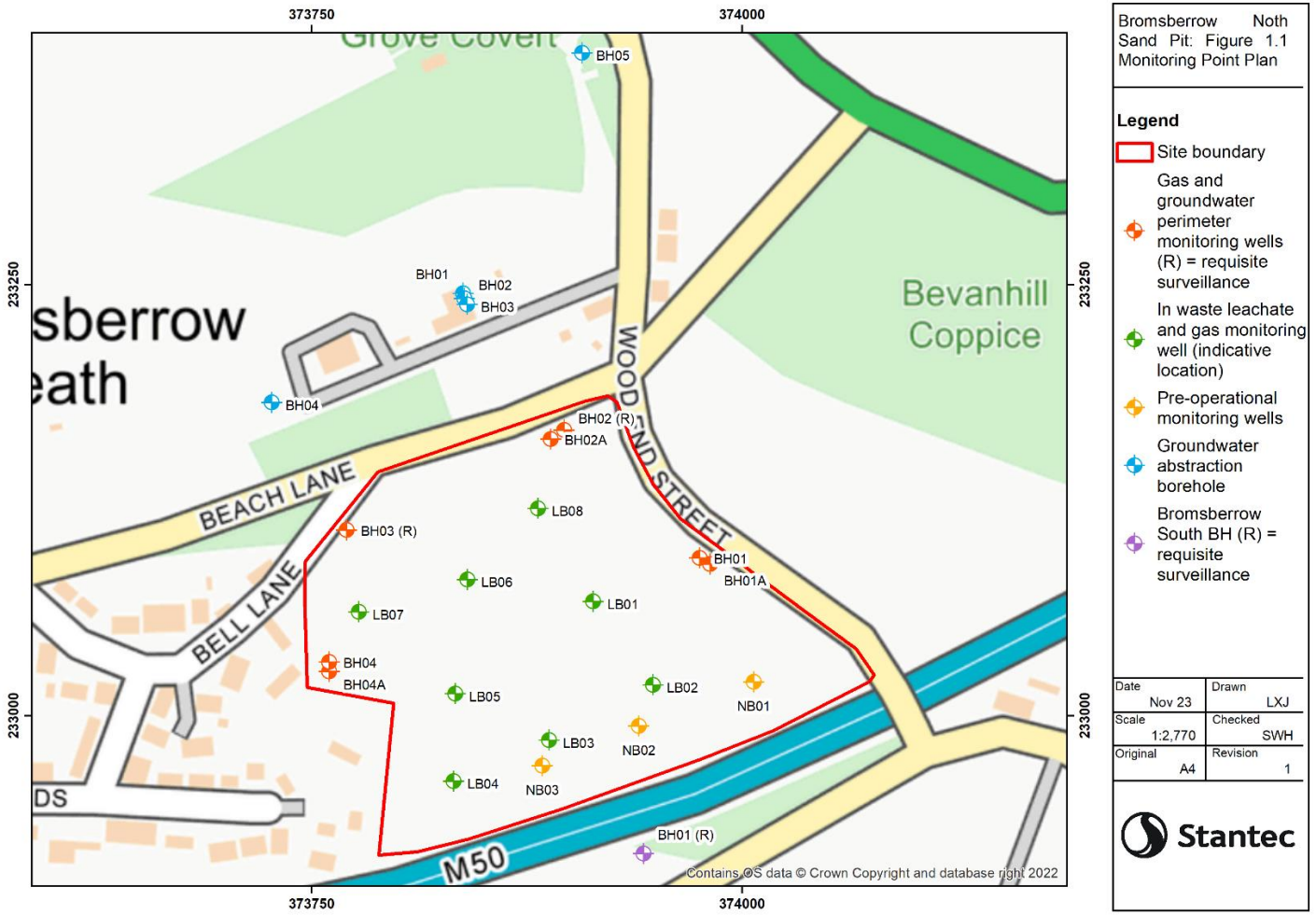
The final depth and installation details will be determined by suitably qualified and experienced personnel (e.g. experienced geologist or engineer) with previous experience of installing in-waste monitoring boreholes, having regard to the actual geology encountered.

2.1.3 Construction

The drilling of gas monitoring installations will be carried out using suitable drilling equipment operated by a suitably experienced driller. Boreholes will be drilled vertically.

Suitable measures will be taken to ensure that the basal and sidewall artificially enhanced geological barrier (AEGB) is not compromised during the drilling; this will include calculation of the required drill depths at each location based on the measured elevation at the surface and the known elevation of the top of the AEGB. The calculated drill depth will include an allowance for a stand-off of at least 0.5m above the top of the AEGB. Progress will be carefully monitored during drilling to ensure that the calculated drill depth is not exceeded.

Figure 1.1 Monitoring Point Plan



Were the AEGB to be penetrated, which would be detected by the presence of engineered clay within the arisings, drilling will be stopped immediately and the AEGB reinstated by placement of bentonite grout or hydrated bentonite pellets back to 1m above the known elevation of the top of the AEGB.

The standpipe, with centralising devices attached at intervals where required, will be lowered carefully down the borehole, with the annulus between the borehole and standpipe backfilled with gravel (see Section 2.1.2) to the level at the top of the standpipe screened section.

The upper section of the borehole will be sealed with bentonite grout. Alternatively, compressed bentonite pellets may be used, in which case the pellets will be partially hydrated before being added to the borehole.

2.1.4 Construction Quality Assurance

CQA Plan

Construction of monitoring installations will be carried out in accordance with a written Construction Quality Assurance (CQA) Plan, prepared by the CQA Engineer, approved by the EA and under the supervision of a CQA Inspector with previous experience of installing in-waste monitoring boreholes.

The CQA Plan will include the following:

- A detailed design description for the monitoring installations, including drawings;
- Specification of the proposed materials for monitoring installations, including the type and frequency of conformance testing (where appropriate);
- Pass or fail criteria for all the materials to be used;
- CQA procedures to be adopted;
- The procedure for agreeing changes to the design;
- Details of the measures to be taken take where any non-compliance with the specification is identified; and
- Details of the information to include in the Validation Report.

Monitoring Borehole Installation Records

Installation records will be prepared for each monitoring installation showing:

- Site name;
- Drilling contractors and Operators name;
- Borehole number;
- Date of drilling;
- Equipment and technique used;
- Diameter and depth of borehole and any casing used;

- Depth of each change of stratum;
- Description of each stratum;
- Depth of groundwater strikes and flow rates;
- Depth and length of pipework, filters and bentonite seals;
- All above information to be presented on a geological log; and
- Details of manufacturer and supplier of each component with respective reference numbers.

The CQA Inspector will verify that the details included on each monitoring installation record are accurate.

CQA Validation Report

Following construction of the monitoring boreholes, a CQA Validation Report will be submitted to the EA within 4 weeks of completing the construction, or other time period agreed in writing with the EA.

The CQA Validation Report provides the final 'as-built' construction and engineering details of the works, and will include:

- Details of how the CQA Plan has been complied with;
- Justifications for any changes or deviations from the agreed plan;
- As-built plans and drawings of the monitoring installations;
- Copies of the site inspector's daily records;
- Records of any problems or non-compliance and the solution;
- Any other relevant site-specific information to prove the integrity of the construction; and
- All test results.

The Validation Report will be signed by the CQA Engineer.

2.1.5 Locations Outside the Restored Area

A landfill gas monitoring system has been installed to enable monitoring of potential landfill gas migration outside the restored area. The locations of these gas monitoring installations are shown on the monitoring point plan (MPP) (Figure 1.1).

Drilling logs including installation records for the monitoring installations installed to date are included as Appendix A.

Some of the existing monitoring installations outside the restored areas (including BH03) have a dual purpose also satisfying requirements for groundwater monitoring. Details of the design, construction and quality assurance of these installations are provided in Section 4.2.

2.2 Maintenance

Inspections will be carried out during each routine monitoring visit to ensure that the installations are undamaged and functioning correctly. If any damage or defect is found the details will be recorded in the site diary and remedial measures implemented as soon as practicable.

Usually this will be within one month unless a replacement is required, in which case a new borehole will be installed as soon as ground conditions permit. A record of the remedial measures will also be made in the site diary. Once completed, the installations will be given permanent marker posts that will be located to Ordnance Survey National Grid and levelled to Ordnance Datum.

2.3 Landfill Gas Monitoring and Sampling Programme

2.3.1 Within Restored Area

Monitoring and sampling of landfill gas within the restored area will be carried out and recorded in accordance with Table 2.1 and GEL's procedures specified in Appendix B.

Table 2.1. Gas Monitoring Programme within the Restored Area

Phase	Sampling Frequency	Determinants	Units	Accuracy
Operational (following monitoring borehole installation in each completed phase)	Monthly	Methane (CH4)	% v/v	±0.3 - 3% v/v
		Carbon Dioxide (CO2)	% v/v	±1% v/v
		Oxygen (O2)	% v/v	±1% v/v
		Atmospheric Pressure	mb	±1 mb
		Flow Rate	l/s	±0.1 l/s
Site Post Closure	Monthly for 1 year, then quarterly until beginning of Site Completion phase	Methane (CH4)	% v/v	±0.3 - 3% v/v
		Carbon Dioxide (CO2)	% v/v	±1% v/v
		Oxygen (O2)	% v/v	±1% v/v
		Atmospheric Pressure	mb	±1 mb
		Flow Rate	l/s	±0.1 l/s

Note. Accuracy of methane and carbon dioxide monitoring equipment varies depending on the concentration of gas being measured. The greater accuracy is achieved at lower gas concentrations.

Monitoring of surface emissions will not be undertaken as the gas risk assessment has identified that the risk of landfill gas generation is very low, consequently the likelihood of measurable surface emissions is very low. However, if gas concentrations and flow rates in the monitoring installations in the restored area exceed the designated trigger levels, the need for surface emission monitoring will be reviewed.

2.3.2 External to Restored Area

Monitoring and sampling of landfill gas external to the restored area will be carried out and recorded in accordance with Table 2.2 and GEL's procedures set out in Appendix B.

Table 2.2. Gas Monitoring Programme - External to the Restored Area

Phase	Boreholes	Sampling Frequency	Determinants	Units	Accuracy
Site Pre Operation	BH01A, BH02A, BH03, BH04A	Monthly	Methane (CH4)	% v/v	±0.5% v/v
			Carbon Dioxide (CO2)	% v/v	±0.5% v/v
			Oxygen (O2)	% v/v	±1% v/v
			Atmospheric Pressure	mb	±1 mb
			Flow Rate*	l/s	±0.1 l/s
Site Operation	BH01A, BH02A, BH03, BH04A	Monthly	Methane (CH4)	% v/v	±0.5% v/v
			Carbon Dioxide (CO2)	% v/v	±0.5% v/v
			Oxygen (O2)	% v/v	±1% v/v
			Atmospheric Pressure	mb	±1 mb
			Flow Rate*	l/s	±0.1 l/s
Site Post Closure	BH01A, BH02A, BH03, BH04A	Monthly for 1 year, then quarterly until Site Completion phase begins	Methane (CH4)	% v/v	±0.5% v/v
			Carbon Dioxide (CO2)	% v/v	±0.5% v/v
			Oxygen (O2)	% v/v	±1% v/v
			Atmospheric Pressure	mb	±1 mb

Phase	Boreholes	Sampling Frequency	Determinants	Units	Accuracy
			Flow Rate*	l/s	±0.1 l/s
	*Only if methane concentration exceeds the Action Level. Note. Accuracy of methane and carbon dioxide monitoring equipment varies depending on the concentration of gas being measured. The greater accuracy is achieved at lower gas concentrations.				

2.3.3 Monitoring and Sampling Records

A record of the landfill gas monitoring and sampling results will be made in accordance with GEL's procedures, which are included as Appendix B.

A permanent record of all gas monitoring will be maintained by the Operator.

2.3.4 Quality Assurance of Monitoring and Sampling

The monitoring and sampling will be quality assured in accordance with GEL's procedures, which are included as Appendix B.

2.3.5 Submission of Records

A copy of the latest assured records of each monitoring or sampling result will be submitted to the EA, within one month of it being carried out. The format of the records will be agreed with the EA.

2.4 Baseline Gas Monitoring Results

Gas monitoring is ongoing in the boreholes external to the area to be restored in accordance with Table 2.2 and the procedures set out in Appendix B. This information will be used to assess baseline conditions and to calculate appropriate action level and compliance limits prior to the commencement of landfilling operations at the Site.

2.5 Landfill Gas Monitoring Action Plan

2.5.1 Action Levels and Compliance Limits

After the baseline monitoring results have been collected (see Section 2.4), appropriate action levels and compliance limits be calculated for methane and carbon dioxide concentrations for each of the landfill gas monitoring boreholes external to the area to be restored.

Action levels and compliance limits are defined as follows:

- **Action Levels:** These are set at a level at which the Operator should take action to remain compliant and form an early warning and/or may instigate additional monitoring or emergency procedures. The EA need not be informed of an exceedance. Action levels are not set in the Environmental Permit but should be in the operator's management procedures (i.e. this plan). Action levels should be concentrations between background and the Compliance limits.

- **Compliance Limits:** These are set in the Environmental Permit and are designed to show the landfill engineering is performing properly. Compliance limits are a regulatory requirement. If the results of monitoring are at or above the agreed compliance limits, the EA

must be informed immediately and remedial action implemented within an agreed, defined, timescale because the site is deemed not to be in compliance.

It is now recognised that carbon dioxide is a poor choice of gas to regulate emissions from landfills because there are alternative sources in the sub-surface environment. Therefore, it is proposed that no compliance limits will be calculated for carbon dioxide, but that carbon dioxide data will continue to be collected and assessed against a lower action level because this activity informs the conceptual model and initiates investigatory action by the Operator.

In the event that concentrations of landfill gas in any of the external monitoring installations exceed the action levels, the Operator will initiate the investigation procedure set out in 2.5.2 below.

Action levels and compliance limits are not set for oxygen as there is an inverse relationship between oxygen and carbon dioxide concentrations. Consequently, conditions of low oxygen concentration will be identified anyway due to elevated carbon dioxide concentrations.

2.5.2 Investigation Procedure

The procedures for the assessment of gas monitoring results in relation to the action levels are as follows:

1. For methane and carbon dioxide concentrations below the action level - allow as normal variability.
2. If methane or carbon dioxide concentrations exceed the action level, then check previous two readings from the gas database and:
    a. If the methane concentrations also exceeds the relevant compliance limit, then inform the EA **immediately**. Increase monitoring frequency to weekly (including borehole gas flow rates) in affected and adjacent installations until concentrations fall back below the action level. Assess the possible cause of the increase in concentrations by problem solving described in Section 2.5.3 and review previous monitoring results to see if there is any indication of a trend.
    b. Where only the action level has been exceeded, and if the previous readings do not exceed the action level, then no further action is required other than to note that an exceedance has occurred.
    c. If the previous two readings do exceed the action level, then increase monitoring frequency to fortnightly (including borehole gas flow rates) in affected and adjacent installations until concentrations fall back below the action level. Assess the possible cause of the increase in concentrations by problem solving described in Section 2.5.3 and review previous monitoring results to see if there is any indication of a trend.

The procedures for the assessment of gas flow monitoring results are as follows:

1. If significant flow rates (greater than ±3 l/hr) are absent, then continue monitoring weekly until gas concentrations reduce below action level.
2. If significant flow rates are absent but methane concentrations do not reduce below the compliance limits within three months and the source of the gas has been identified as the licensed restoration, then consider the initiation of appropriate gas control measures in association with the EA (see Section 2.5.4).
3. If significant flow rates are present and methane concentrations persist above the compliance limit for more than six weeks with no signs of decreasing levels then carry out a gas survey of the site (for methane and carbon dioxide). Dependent on the results

of the survey, consider carrying out a gas survey of potentially affected off-site properties after discussion with the EA.

Should they be deemed necessary, immediate arrangements will be made to install gas control measures after consultation with the EA.

2.5.3 Problem Solving

In the preceding section, the first course of action proposed following any exceedance of an action level or compliance limit is to "assess the possible cause of the increase in gas concentrations". The routine to be followed to perform this instruction is set out below:

1. Check whether the barometric pressure was rising, falling or steady on the day and in the day(s) preceding the date of monitoring.
2. Check the results against those of other site monitoring installations to determine if the result is part of a general deterioration in the gas levels in the area, or a localised occurrence.
3. Check oxygen and carbon dioxide concentrations to determine if these correlate to a deterioration in methane concentrations.
4. Ensure that monitoring equipment is functioning effectively and consider taking a confirmatory sample for gas-chromatographic analysis.
5. Attempt to identify the most likely source of methane, in relationship to the history of landfill at the site, and previous monitoring results.
6. Investigate the surrounding area for signs of gas or leachate escape.
7. If a problem is identified, it will be rectified as soon as possible. The Site Manager or his nominee will be informed immediately, and he will co-ordinate any action required.
8. Record all actions in the site diary.

2.5.4 Gas Control Measures

The selection of the appropriate control measures will be discussed with the EA prior to installation, and will take into account the nature and depth of the waste deposited. As the site will only contain inert materials, it is possible that a passive vent trench or passive venting boreholes would be the most effective remedy. This solution might also be supported by the installation of pumped wells in virgin ground around the periphery of the site adjacent to affected area(s). Such wells would be installed after construction of any passive system to avoid drawing gas from the waste towards the perimeter. The wells would be used to bring about an immediate reduction in gas concentrations in land outside but adjacent to the restored areas. Pumping from these wells would be discontinued once gas concentrations are reduced to acceptable levels but would be retained in case of future gas excursions.

Increased gas monitoring in the affected installations will continue throughout and after installation of the control measures and until values drop below the action level. Monthly monitoring will then resume unless the action level is exceeded again.

2.6 Landfill Gas Completion Criteria

To meet the completion criteria for landfill gas, the Operator will need to demonstrate that:

- Methane concentration within the waste mass is less than or equal to 1.5%v/v
- Carbon dioxide concentration within the waste mass is less than or equal to 5%v/v

To demonstrate this, the Operator will provide a minimum of 12 datasets from regular monitoring, e.g., monthly for a year or over a longer period.

It is understood that the above limits have to be met throughout the waste, and must not be exceeded at any time during the monitoring period.

If the above gas completion criteria cannot be satisfied, the Operator will provide a minimum of 24 datasets from regular monitoring, e.g. monthly for 2 years or over a longer period. Where continuous monitoring is used to replace or supplement the regular monitoring, this will be done for a minimum of 6 months.

The landfill gas completion criteria will be deemed as being met when the Operator can show that the concentration of methane and carbon dioxide within the waste is no greater than background concentrations (either natural sources or because of non-landfill activities) in the surrounding environment.

3 Leachate Monitoring and Reporting

3.1 Leachate Storage, Collection, or Treatment Systems

As the Site will accept only inert waste, no leachate extraction or treatment systems are proposed. Further details on the proposals for leachate management are presented in the ESSD report (Stantec, 2024a).

3.2 Leachate Monitoring Installations

Within the pre-application advice sought for the inert landfill permit application, the EA have recommended the installation of leachate quality and level monitoring within the site (not leachate drainage) to validate the modelling undertaken, confirm the conceptual model presented, ensure any risks of leachate breakout are detected early and provide data suitable to support the surrender of the permit.

The pre-application advice confirms that in-waste gas monitoring will be required and could be combined with the leachate monitoring. The monitoring locations proposed within the restored areas are, therefore, proposed as dual purpose landfill gas and leachate monitoring wells.

Details of the locations, design, construction, CQA and maintenance of these wells are provided in Sections 2.1 and 2.2 of this plan.

3.3 Leachate Monitoring and Sampling Programme

Monitoring and sampling of leachate within the restored area will be carried out and recorded in accordance with Table 3.1 and the procedures set out in Appendix B.

Table 3.1. Leachate Monitoring Programme

Phase	Sampling Frequency	Determinands
Operational Phase (following monitoring borehole installation in each completed phase)	Monthly	Leachate Level
	Quarterly	pH, electrical conductivity (EC), ammoniacal nitrogen, chloride, sulphate, alkalinity, total organic nitrogen (TON), total organic carbon (TOC), sodium, potassium, calcium, magnesium, iron, manganese, arsenic, cadmium, chromium, copper, nickel, lead and zinc.
Post Closure	Monthly*	Leachate Level
	Quarterly*	pH, EC, ammoniacal nitrogen, chloride, sulphate, alkalinity, TON, TOC, sodium, potassium, calcium, magnesium, iron, manganese, arsenic, cadmium, chromium, copper, nickel, lead and zinc.
* This frequency may be reduced based on a risk-based monitoring review during aftercare.		

3.3.1 Monitoring and Sampling Records

A record of the leachate monitoring and sampling results will be made in accordance with the procedures set out in Appendix B. Note that these procedures are those provided by GEL for gas and groundwater monitoring, but are expected to be the same for leachate monitoring.

Any specific leachate monitoring procedures developed would be included in an updated version of this EMP and/or the Site Operating Plan (SOP).

A permanent record of all leachate monitoring will be maintained by the Operator.

3.3.2 Quality Assurance of Monitoring and Sampling

The monitoring and sampling will be quality assured in accordance with the monitoring procedures set out in Appendix B.

3.3.3 Submission of Records

A copy of the latest assured records of each monitoring or sampling result will be submitted to the EA, within one month of it being carried out. The format of the records will be agreed with the EA.

4 Groundwater Monitoring and Reporting

4.1 Risk Assessment and Management

Details of the groundwater risk assessment are presented in the HRA (Stantec, 2024b).

4.2 Design, Construction and Construction Quality Assurance

4.2.1 Groundwater Monitoring Installations

The locations of the groundwater monitoring installations are shown on the MPP (Figure 1.1).

As described in Section 2.1.5, some of these groundwater monitoring installations including BH03 are dual purpose for groundwater as well as landfill gas monitoring outside the restored area.

4.3 Design and Construction

Drilling logs including installation records for the groundwater monitoring installations outside the restored area are included within Appendix A.

Construction of any additional groundwater monitoring installations required will be carried out in accordance with a written CQA Plan, prepared by the CQA Engineer, approved by the EA and under the supervision of a CQA Inspector with previous experience of installing groundwater monitoring boreholes.

Further details of the proposed CQA for monitoring installations is provided in Section 2.1.4 of this plan.

4.4 Maintenance

Inspections will be carried out during each routine monitoring visit to ensure that the installations are undamaged and functioning correctly. If any damage or defect is found the details will be recorded in the site diary and remedial measures implemented as soon as practicable.

Usually this will be within one month unless re-drilling is required, in which case a new borehole will be installed as soon as ground conditions permit. A record of the remedial measures will also be made in the site diary. Once completed the installations will be given permanent marker posts that will be located to Ordnance Survey National Grid and levelled to Ordnance Datum.

4.5 Groundwater Monitoring and Sampling Programme

Procedures for groundwater monitoring and sampling are set out in Appendix B. Sampling frequency and determinants will be as summarised in Table 4.1.

Table 4.1. Groundwater Monitoring Programme

Phase	Boreholes	Sampling Frequency	Determinands
Pre Site Operation	BH01 (Bromsberrow South, northern boundary) BH01, BH02, BH03, BH04 (Bromsberrow North - perimeter boreholes) NB01, NB02, NB03 (Bromsberrow North, base of quarry)	Monthly	Water level pH, EC, sulphate, chloride, ammoniacal nitrogen, TOC, nitrate, nitrite, alkalinity, speciated polycyclic aromatic hydrocarbons (PAHs), iron, calcium, magnesium, potassium, sodium, arsenic, cadmium, chromium, copper, lead, manganese, nickel, zinc, benzene, toluene, ethylbenzene and xylenes (BTEX), methyl tertiary butyl ether (MTBE), total petroleum hydrocarbons (TPH-CWG)
Site Operation ('Requisite Surveillance' groundwater monitoring)	BH01 (Bromsberrow South northern perimeter) – up gradient monitoring borehole BH02, BH03 (Bromsberrow North northern perimeter) – down hydraulic gradient boreholes	Monthly	Water level pH, EC, ammoniacal nitrogen, chloride, sulphate, alkalinity, TON, TOC, sodium, potassium, calcium and magnesium.
		Quarterly	As monthly, plus iron, manganese, arsenic, cadmium, chromium, copper, nickel, lead and zinc. BTEX, MTBE, TPH-CWG.
		Annually	Hazardous substances**
Site Operation	BH01, BH04 (Bromsberrow North - perimeter monitoring boreholes)	Monthly	Water level pH, EC, ammoniacal nitrogen, chloride, sulphate, alkalinity, TON, TOC, sodium, potassium, calcium and magnesium.
		Quarterly	As monthly, plus iron, manganese, arsenic, cadmium, chromium, copper, nickel, lead and zinc.
		Annually	Hazardous substances**
Site Operation (Turbidity Monitoring)	Two new sentinel wells SW01 and SW02 (refer to Figure 9.1 in SOP for proposed locations)	Continuous* by Aqua TROLL Turbidity Sensor (or similar)	Turbidity (Nephelometric Turbidity Units, NTU)

Phase	Boreholes	Sampling Frequency	Determinands
Site Post Closure	BH01 (Bromsberrow South, northern boundary) BH01, BH02, BH03, BH04 (Bromsberrow North - perimeter boreholes)	Quarterly	Water level pH, EC, ammoniacal nitrogen, chloride, sulphate, alkalinity, TON, TOC, sodium, potassium, calcium, magnesium, iron, manganese, arsenic, cadmium, chromium, copper, nickel, lead and zinc.
		Annually	Hazardous substances**
	* Turbidity monitoring during the operation phase is yet to be agreed with the EA and Severn Trent Water as operators of the adjacent public water supply boreholes. It is understood that the EA must agree with the Operator's proposal before continuous monitoring is started. The SOP summarises Allstone's proposals for turbidity monitoring at the Site during the operational phase at this stage. ** Hazardous substances as defined by the as defined by the Environmental Permitting (England and Wales) Regulations 2016, SI 2016 No.1154, schedule 22.		

The minimum reporting value (MRV) is the lowest concentration of a substance that a laboratory can achieve with current analytical equipment. The laboratory must report this in the results of an analysis. The Operator will report groundwater monitoring data for hazardous substances to an MRV. The MRVs are defined as the limit of quantification. The limits of quantification for hazardous substances are presented in Table 1 of the Technical Report on Groundwater Hazardous Substances on the UK Technical Advisory Group on the Water Framework Directive website (UK TAG, 2016).

4.6 Groundwater Monitoring and Sampling Records

4.6.1 Groundwater Levels

Groundwater level monitoring will be undertaken in accordance with the procedures included in Appendix B and the results will be entered into the environmental database maintained by the Operator.

4.6.2 Groundwater Sampling and Analysis

Groundwater sampling will be undertaken in accordance with the procedures included in Appendix B and the results will be entered into the environmental database maintained by the Operator.

The groundwater analysis will be carried out by a UKAS accredited laboratory.

4.6.3 Quality Assurance of Monitoring and Sampling

The records will be quality assured in accordance with the groundwater monitoring procedures set out in Appendix B.

4.6.4 Submission of Records

A copy of the latest quality assured records of each monitoring or sampling result will be submitted

to the EA in accordance with the sampling frequency indicated in Table 4.1 within one calendar month of the results becoming available. The format of the data to be submitted will be agreed with the EA.

4.7 Baseline Groundwater Quality Results

Prior to the operation of the site, groundwater monitoring will be performed for at least twelve months in accordance with Table 4.1 and the procedures set out in Appendix B. This information will be used to assess baseline conditions prior to operations at the site.

4.8 Groundwater Action Plan

4.8.1 Groundwater Control Levels and Trigger Levels

EA Guidance (EA, 2023) states that the Operator must set assessment levels and propose compliance and emission limits in your permit application.

- Assessment levels (**'Control Levels'**) are levels the Operator uses to decide whether the site and its pollution control systems are performing as you planned. The Operator will use these to identify negative trends in the monitoring data and then take appropriate action to prevent the breach of a compliance limit.
- Compliance limits (**'Trigger Levels'**) are concentrations that the EA will put in the permit. If these limits are exceeded then the Operator will be deemed as in breach of the permit. This will be recorded as a non-compliance.

Control and Trigger Levels have been determined in the HRA (Stantec, 2024b) in accordance with the guidance provided by the Environment Agency (EA, 2003). These are presented in the HRA.

4.8.2 Investigation Procedure and Follow-up Action

In the event that any Control Level is exceeded in one monitoring installation on one occasion, the following action will be taken:

1. The monitoring database will be queried to identify the past 12 months results from the affected location. If less than two of the last four results have breached the Control Level, no further action will be taken, other than to note that a breach has occurred. However if two or more of the last four sampling results have breached the Control Level at this location, then the borehole will be re-sampled as soon as possible after receipt of the results.

If the repeat sample also exceeds the Control Level the following course of action will be taken:

2. Data from the monitoring installation exceeding the Control Level and adjacent monitoring installations will be reviewed by use of statistics and graphical presentation to establish the presence of any trends or patterns.
3. Groundwater levels will be reviewed to establish flow direction in order to determine whether the landfill is the most likely cause of any change in groundwater quality.
4. A preliminary inspection will be carried out to determine whether there has been:
    a. Any unusual activity or occurrence on or around the site that could account for the increase in the parameter exceeding the Control Level.
    b. Any spillage of contaminants at the surface in the vicinity of the affected boreholes.
5. The results of all of the above information will be assessed and further action on future monitoring will be specified.

In the event that any Trigger Level is exceeded in one monitoring installation on one occasion, the following action will be taken:

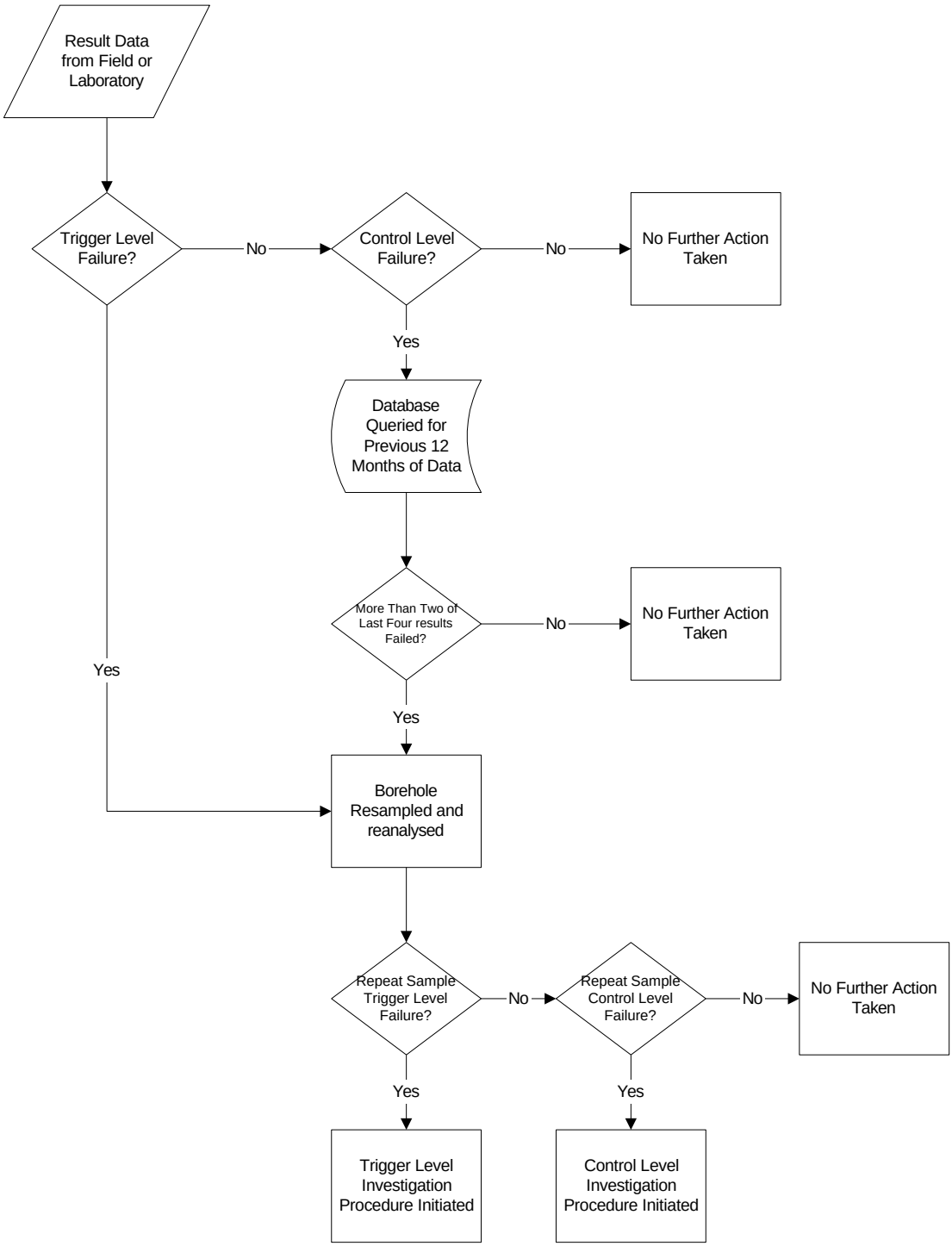
1. The monitoring installation will be re-sampled as soon as possible after receipt of the results; whether the elevated determinant was derived from field or laboratory analysis the re-analysis will be carried out in the laboratory. This initial procedure will be used to eliminate errors that might be introduced during sampling, field analysis or laboratory analysis, before continuing. If this second sample does not exceed the Trigger Level, then no further action will be taken unless it exceeds the Control Level in which case the procedures set out above will be followed.

If the additional repeat sample also exceeds the Trigger Level, then:

2. The actions described to investigate exceedances of a Control Level detailed in 2 to 4 above will be carried out; and
3. The monitoring frequency will be increased to fortnightly for an agreed set of monitoring determinands by laboratory analysis in the affected borehole and adjacent boreholes until the determinand concentration falls below the Trigger Level.
4. If the laboratory results from the monitoring show no indication of decline over a four month period (or other period assessed appropriate with respect to the rate of flow of groundwater at the site), and the evidence indicates that the restoration is the most likely cause of the increase in concentrations, then a review of the HRA will be carried out (see below).
5. The risk assessment will conclude with an explanation of the effect of the groundwater quality changes on the groundwater and surface water resource with recommendations for any remedial action if it is considered necessary. A course of action will be agreed with the EA.

The control and trigger level procedure is summarised on the flow chart overleaf.

Control and Trigger Level Procedure



4.8.3 Hydrogeological Risk Assessment Review

Where a hydrogeological risk assessment is required, it will have particular regard to those substances that have exceeded the Trigger Level. The assessment will determine the likely effects of the inert materials deposited within the licensed area on surrounding groundwater quality and will be presented in the form of a written report that will include:

1. A summary of all groundwater monitoring carried out to date, including graphical representations of time series data for water levels and the concentrations of determinants measured in the existing observation boreholes around the licensed area.
2. An assessment of the expected dilution and attenuation of contaminants migrating from the restoration area.
3. Consideration of the need for the construction of additional groundwater monitoring installations both up and down hydraulic gradient of the restored area together with a timetable for their installation.
4. Recommendations for water quality objectives at down hydraulic gradient groundwater monitoring boreholes.
5. An assessment of possible remedial options which could be taken in the event that adverse changes are detected in the quality of groundwater in the vicinity of the site.

4.9 Groundwater Completion Criteria

Completion is considered to occur once the Site no longer poses a threat to the environment. The risk assessment shows that the discharges from the Site will not pose a threat either to groundwater in the Bridgnorth Sandstone or to the Bromsberrow Heath PWS. We believe that a five-year period of monitoring following termination of the operational phase will suffice to demonstrate completion.

5 Surface Water Quality Monitoring and Reporting

The proposals for surface water management are included in the ESSD report (Stantec, 2024a) Monthly checks of the SuDS infiltration trenches and basin, once established after completion of the landfill, to ensure that there is no visible oil or other pollutant entering the feature.

As there will be no point source discharge of surface water from the landfill, no other surface water monitoring is proposed.

6 Dust Monitoring and Reporting

Refer to the Dust and Emissions Management Plan (DEMP) (Stantec, 2024e) for details of the Site dust monitoring and reporting proposed.

7 Monitoring of Restoration Fill Materials

7.1 Topographic Surveys

Topographic surveys of the Site will be carried out annually, including:

- During the development phase;
- Before waste is placed in the landfill;
- During the operational phase;
- On completion of the restoration; and
- Until surrender of the permit.

Written agreement will be sought from the EA before topographic surveys of the Site are stopped.

Permanent survey markers will be established on the site, co-ordinated to the Ordnance Survey National Grid and levelled to Ordnance Datum before the Site development commences.

With regard to the accuracy of the topographic survey, the:

- Grid alignment will be accurate to within 1 metre;
- Horizontal accuracy will be at least 1 metre in 20,000 metres; and
- Level values of the stations will be accurate to within 20mm.

Plan positions of ground features will be taken at a density to allow adequate representation of the true landform.

The survey drawings produced will:

- Be an appropriate scale (such as 1:1,250) to show the surveyed features of the landfill;
- Include 1 metre contours;
- Include the landform or an indication of the landform immediately adjacent to the landfill;
- Include the roads, engineering structures, boundaries, monitoring points, landform features and all other relevant Site features in the permitted area; and
- Include significant landform changes such as embankments or stockpiles.

7.2 Settlement and Slope Stability Completion Criteria

For EP surrender, the Operator will need to demonstrate that waste settlement has stopped and all slopes are stable.

The Operator will ensure that the cap remains effective and that topographic surveys are carried out in accordance with the EP. Following the completion of settlement, the integrity of the cap will be confirmed.

8 Reporting Environmental Performance

8.1 Waste Reporting

It is expected that the EP will require reporting to the EA of how much waste has been accepted for disposal (and/or removed from site) at the end of each quarter, using a waste return form made available for the purpose (RATS2E or similar). This will include details of the types of wastes.

Waste reporting requirements will be set out within the EP.

8.2 Annual Report

It is expected that the EP will require the preparation of an annual report, to include:

- A summary of the previous year's progress against improvement targets (where appropriate);
- Improvement targets plan for the coming year;
- An assessment of the monitoring data, including a description of any trends, assessment level or compliance limit breaches and problems with individual monitoring points;
- A summary of the results of any waste validation (level 3) testing carried out; and
- A topographic survey to show the structure and composition of the landfill body, using this survey and the previous survey to calculate the void space taken up, the remaining void space and the settlement behaviour of the waste.

Once the Site is in 'definite closure' it is expected that a report will be required once every 3 years.

The annual reports will be submitted to the EA by 31st January each year unless the EA has agreed to accept it on another date.

Annual reporting requirements will be set out within the EP.

8.3 HRA Review

The Operator will undertake a review of the HRA every six years. Reviews will be due on the sixth anniversary of the original issue date of the EP and every subsequent 6 years.

HRA review requirements will be set out within the EP.

References

AA Environmental Ltd, 2022. Bromsberrow Quarry Ledbury Ecological Report. Job No. 223326. AA Environmental Ltd, October 2022.

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EA, 2003. Hydrogeological Risk Assessments for Landfills and the Derivation of Groundwater Control and Trigger levels. March 2003.

EA, 2023. Landfill operators: environmental permits. Monitor and report your performance. Last updated 29 June 2023. Accessed at: https://www.gov.uk/guidance/landfill-operators-environmental-permits/monitor-and-report-your-performance

Stantec, 2024a. Bromsberrow North Sandpit: Environmental Setting & Site Design. Report Reference 331201261R2. Stantec UK Ltd, 2024.

Stantec, 2024b. Bromsberrow North Sandpit: Hydrogeological Risk Assessment. Report Reference 331201147R3 Rev2. Stantec UK Ltd, 2024.

Stantec, 2024c. Bromsberrow North Sandpit: Landfill Gas Risk Assessment. Report Reference 331201261R6. Stantec UK Ltd, 2024.

Stantec, 2024d. Bromsberrow North Sandpit: Environmental Risk Assessment. Report Reference 331201261R3. Stantec UK Ltd, 2024.

Stantec, 2024e. Bromsberrow North Sandpit: Dust and Emissions Management Plan. Report Reference 331201261R8. Stantec UK Ltd, 2024.

UKTAG, 2016. UK Technical Advisory Group on the Water Framework Directive. Technical report on Groundwater Hazardous Substances. Working Paper Version 11b(iii) v12, UKTAG review September 2016. Accessed here: https://www.wfduk.org/sites/default/files/Media/UKTAG_Technical%20report_GW_Haz-Subs_ForWebfinal.pdf

APPENDICES

Appendix A

Borehole Installation Records

2022 BOREHOLE LOGS - BASE OF QUARRY

M&J DRILLING SERVICES LTD.

DRILLER: Pete Gibbens

BOREHOLE No.
ORIENTATION

DAILY SITE RECORD
GROUND INVESTIGATION

DAY	Monday	DATE	12-12-22	SITE	Bromsborrow Rd
CLIENT / CONTRACT				JOB No.	

BH	DEPTH FROM	DEPTH TO	CASING	FORMATION	RUN No.	DEPTH FROM	DEPTH TO	T.C.R.	PENETRATION RATE
BH01	GL	10.00	-	Red brown Sandstone					
Install									
	GL	3.00		Plain pipe bentonite Seal					
	3.00	10.00		Slotted pipe gravel pack (With Sock)					
BH02	GL	10.00	-	Red brown Sandstone					
Install									
	GL	3.00		Plain pipe bentonite Seal					
	3.00	10.00		Slotted pipe gravel pack (With Sock)					
BH03	GL	10.00	-	Red brown Sandstone					
Install									
	GL	3.00		Plain pipe bentonite Seal					
	3.00	10.00		Slotted pipe gravel pack (With Sock)					
Fitted top hat covers									

WATER LEVELS	TIME
START OF SHIFT	
MID-SHIFT	
END OF SHIFT	

OTHER COMMENTS	
FIRST STRUCK	5.30
SEEPAGES	
DRYING OUT	No
CASING SIZE - DEPTH	None
CORE BARREL - LINER	

FLUSHING MEDIUM	
AIR ✓ / WATER / FOAM / OTHER	
LOSS OF FLUSH / EXTENT	None
OPEN HOLE DRILLING	
BIT TYPE	PCD
BIT SIZE	120MM
CORE DRILLING	
BIT TYPE	
BIT SIZE	
BACKFILL	
STANDPIPES/ PIEZOMETERS	
INSTRUMENTATION	

PLANT IN USE	Klemm Compressor
START TIME	
BREAK TIME	
FINISH TIME	
WEATHER	DRY - Cold
GAS MONITORING	
CH_4 : 0 % LEL	H_2S : 0 PPM
CO : 0 PPM	O_2 : 20.9 %
NOTES:	
REMARKS - VISITORS	
R.E.	

M&J DRILLING SERVICES LTD.

DRILLER: Pete Gibbons

BOREHOLE No.
ORIENTATION

DAILY SITE RECORD
GROUND INVESTIGATION

DAY	Tuesday	DATE	13-12-22	SITE	Bromsberrow Rd
CLIENT / CONTRACT				JOB No.	

BH	DEPTH FROM	DEPTH TO	CASING	FORMATION	RUN No.	DEPTH FROM	DEPTH TO	T.C.R.	PENETRATION RATE
BH01	GL	11.00	9.00	Fill					
	Instructed by Mark Gill to abandon borehole and Move position								
BH01A	GL	4.00	5.00	Fill					
	4.00	20.00		Red brown Sandstone					
	Instructed by Mark Gill to abandon and backfill as position is close to existing borehole								
	8.00am - 9.45am			Loading and unloading plant & Materials and Moving to second location					

WATER LEVELS	TIME
START OF SHIFT	
MID-SHIFT	
END OF SHIFT	

OTHER COMMENTS
FIRST STRUCK
SEEPAGES
DRYING OUT
CASING SIZE - DEPTH 152mm
CORE BARREL - LINER

FLUSHING MEDIUM								
AIR	✓	WATER		FOAM		OTHER		
LOSS OF FLUSH / EXTENT	None							

OPEN HOLE DRILLING
BIT TYPE PCD
BIT SIZE 120mm
CORE DRILLING
BIT TYPE
BIT SIZE
BACKFILL OPC - Arisings
STANDPIPES/ PIEZOMETERS
INSTRUMENTATION

PLANT IN USE	Klemm Compressor
START TIME	
BREAK TIME	
FINISH TIME	
WEATHER	DRY - Cold
GAS MONITORING	
CH_4 : 0 % LEL	H_2S : 0 PPM
CO : 0 PPM	O_2 : 20.9 %
NOTES:	
REMARKS - VISITORS	
R.E.	

Location
Ryton Road, Ledbury, HR8 1NX

Requirement
Topographical Survey

Client
Allstone Sand & Gravel

Notes
Position & level fixed to OSGB(15) Grid. No scale factor has been applied.
All dimensions should be checked on site prior to construction.
Where invert levels are shown, depths/pipe sizes have been obtained witout entry.
This drawing is subject to Copyright and should not be duplicated or altered without the consent of William Morris Surveys or the 'Client'.

Reference	Scale
1220–013/D	1:200@A0

Initial	Date
CM	09–12–20

Legend

BH	Bore Hole	F–PW	Post & Wire Fence	TAC	Tactile Paving
BT	BT Cover	F–P	Pallisade Fence	TP	Telegraph Pole
BO	Bollard	FH	Fire Hydrant	TS	Traffic Signal
BP	Block Paving	FL	Finish Level	UL	Up Light
CAB	Cabinet	GT	Gate	>150>	Flow Direction & Pipe Size
CB	Collapsible Bollard	GY	Gully		
CTV	Cable TV Cover	I–B	Illuminated Bollard		
DK	Drop Kerb	IC–C	Inspection Chamber (Combined)		
DP	Down Pipe	IC–F	Inspection Chamber (Foul)		
DPC	Damp Proof Course	IC–S	Inspection Chamber (Surface Water)		
EL	Eaves Level	KI	Kerb Inlet		
EP	Electricity Pole	LP	Lamp Post		
ER	Earth Rod	MH–C	Manhole (Combined)		
FB	Flower Bed	MH–F	Manhole (Foul)		
F–BW	Barbed Wire Fence	MH–S	Manbhole (Surface Water)		
F–CB	Close Boarded Fence	NP	Name Plate		
F–CL	Chain Link Fence	PM	Parking Meter		
F–KR	Knee Rail	PO	Post		
F–H	Herrace Fence	SCB	Signal Control Box		
F–MR	Metal Railings	SP	Sign Post		
F–PI	Picket Fence	SV	Stop Vavle		
F–PR	Post & Rail Fence	SVG	Stop Valve (Gas)		

Symbols & Hatches
Building
Concrete
Shrubs/Vegetation
Block Paving
Wall
Spot Level
Survey Station
Tadpole (Bank Detail)
Tree (to scale) & Height

Line Types
Block Paving
Change of Surface
Concrete
Sewer (Foul)
Sewer (Surface)
Sewer (Combined)
Fence (Close Boarded)
Fence (Chain Link)
Fence (Post & Rail)
Fence (Post & Wire)
Fence (Metal Railings)
Overhead Cable
Vegetation

Survey Control

Revision Notes
A – Quarry pit levels updated. Data 01.07.21
B – Quarry pit levels updated. Data 28.09.21 (Green Boundary)
C – Northern road added to survey. 13.12.21
D – Basin Levels updated. 23/12/22

Bore Hole Information

ID	Easting	Northing	Cover Level
1	373960.447	233100.013	57.580
2	373959.491	233100.476	57.590
3	373898.227	233157.874	54.607
4	373778.043	233118.021	50.714
5	373757.933	233036.526	48.832

William Morris Surveys Limited
17 Lees Lane
South Normanton
Alfreton
Derbyshire
DE55 2AD

Office. 0800 002 5517
www.williammorrissurveys.co.uk

2021 Perimeter Boreholes

BROMSBERROW SAND AND GRAVEL QUARRY

FACTUAL REPORT ON WELL INSTALLATION

Prepared for ALLSTONE SAND AND GRAVEL AGGREGATES TRADING COMPANY LTD

Report Ref: 36646

Geotechnical Engineering Ltd
Centurion House, Olympus Park
Quedgeley, Gloucester. GL2 4NF

01452 527743
www.geoeng.co.uk

BROMSBERROW SAND AND GRAVEL QUARRY

FACTUAL REPORT ON WELL INSTALLATION

Prepared for ALLSTONE SAND AND GRAVEL AGGREGATES TRADING COMPANY LTD

Report Ref: 36646

PROJECT: Proposed Quarry Infilling

CONSULTANT: P. E. Duncliffe Limited

VOLUME - VERSION	STATUS	ORIGINATOR	CHECKER	APPROVED	DATE
1 of 1 – A	FINAL	JH	CT	CT	23/09/2021

ORIGINATOR	APPROVER
	
JOHN HANSON Director	COLIN THOMAS Consultant

The report is not to be used for contractual or engineering purposes unless this sheet is signed and the report designated "Final".
The report has been prepared for the sole use and reliance by Allstone Sand and Gravel Aggregates Trading Company Limited. GEL accepts no liability as a result of the use or reliance of this report by any other parties.

CONTENTS

REPORT **PAGE**

FIGURES **Nos.**

APPENDICES

1. INTRODUCTION

It is proposed to backfill a quarry at Bromsberrow Heath, Ledbury. Geotechnical Engineering Limited (GEL) was instructed by P. E. Duncliffe Limited acting on behalf of Allstone Sand and Gravel Aggregates Trading Company Limited to install a number of monitoring wells to facilitate groundwater and gas monitoring.

The scope of works and terms and conditions of appointment were specified by the Consultant and GEL correspondence reference T32011-2 dated 4th August 2021. The investigation was carried out under supervision of the Client.

This report describes the investigation and presents the findings.

2. SITE LOCATION

The site is situated off Bell Lane, Bromsberrow Heath, near Ledbury HR8 1NX and may be located by its National Grid co-ordinates SO 7383 3304.

3. WELL INSTALLATION

3.1 Fieldwork

The monitoring wells were installed during the period 31st August to the ** September 2021 and comprised seven boreholes/installations. The borehole locations were selected by the Consultant and set out by this Company and are shown on Figure 1.

Statutory service plans were obtained and the location of the highlighted services identified in the field, prior to commencement of the boreholes. The statutory service plans are provide separately.

The boreholes, referenced BH01, BH01A, BH02, BH02A, BH03, BH04 and BH04A, were formed using a track-mounted Geotechnical P601 Rig. Initially, an inspection pit was hand excavated at each borehole location to a maximum depth of 1.20m to check for buried services.

Open hole drilling techniques were employed from the base of the inspection pit utilising a polycrystalline diamond full face bit with compressed air flush to form a 120mm diameter borehole. Temporary casing was installed to a maximum depth of 3.00m to ensure hole stability.

Boreholes were monitored for groundwater ingress as the borehole was formed. Water levels were also recorded on completion of the borehole and prior to the installation of the monitoring well. The water levels are tabulated below and presented on the installation records, Appendix A.

Borehole	Response Zone (m – bgl)*	Water level (m bgl)*
BH01	20.00-35.00	27.32
BH01A	1.00-20.00	Dry
BH02	20.00 – 35.00	25.84
BH02A	1.00 – 20.00	Dry
BH03	3.00 – 35.00	26.89
BH04	20.00 – 35.00	20.00 – recorded strike
BH04A	1.00 – 20.00	Dry

* m bgl – m below ground level

On completion, gas/water monitoring standpipes were installed in each borehole. The installation consisted of a 50mm ID HDPE slotted tube set in a filter response zone of non-calcareous pea gravel. The installation was sealed above with a bentonite plug and accessed

via a valve assembly. As instructed by the Client, the installations were protected at the surface by a lockable stopcock cover set in concrete. Installation details are in Appendix A.

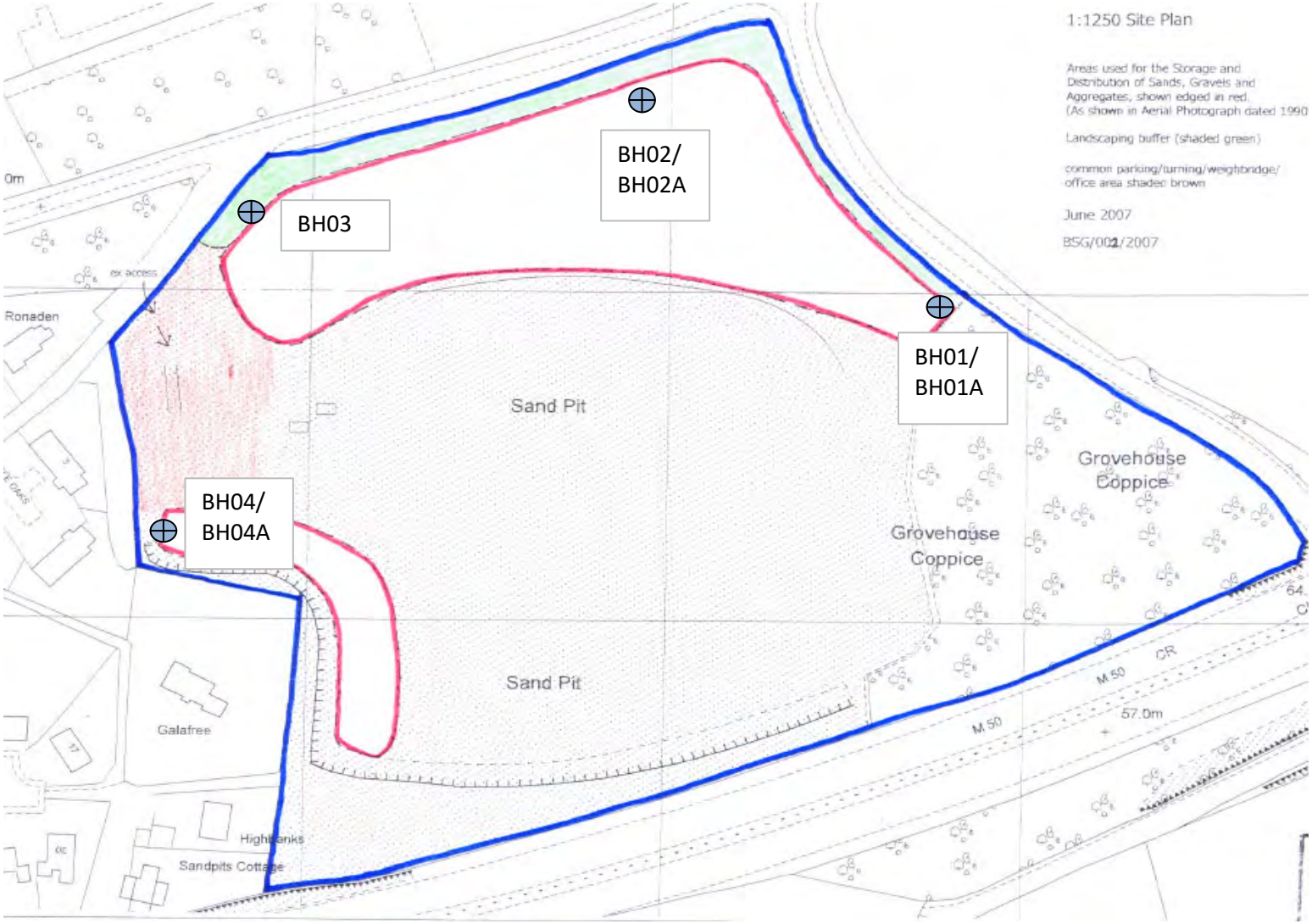
GEOTECHNICAL ENGINEERING LIMITED

Geotechnical Engineering Limited

EXPLORATORY HOLE LOCATION PLAN

CLIENT ALLSTONE SAND AND GRAVEL AGGREGATES TRADING COMPANY LTD

SITE BROMSBERROW SAND AND GRAVEL QUARRY



N

Plan provided by Consultant
Scale unknown

⊕ Approximate Exploratory hole location

CONTRACT	FIGURE
36646	1

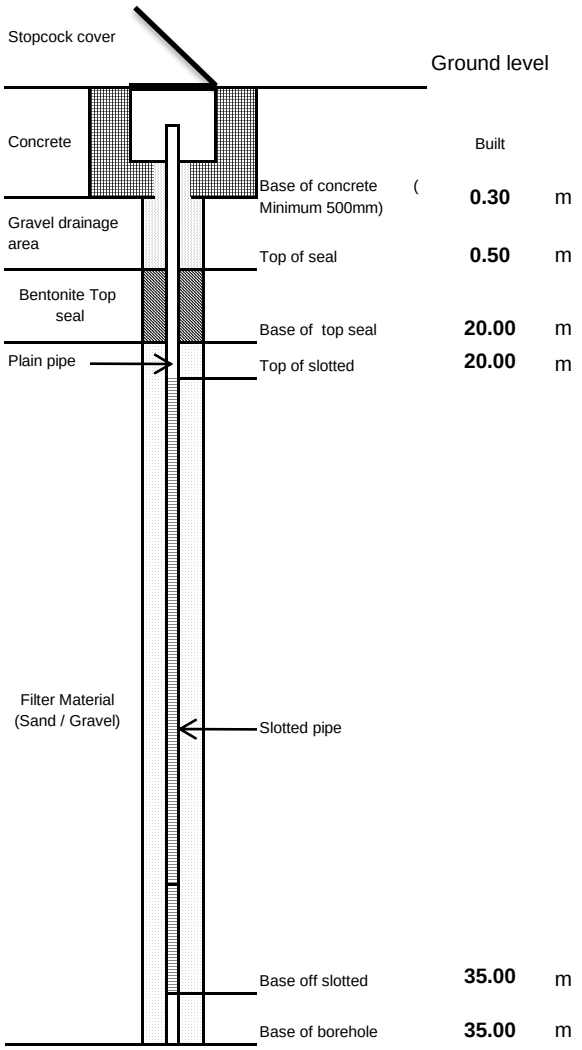
APPENDIX A

INSTALLATION DETAILS

GEOTECHNICAL ENGINEERING LTD

Summary of Standpipe Installation

Schematic Diagram
(not to scale)



Installation Details

Standpipe diameter (id)	50	mm
Borehole diameter	120	mm
Slot size	1	mm
Geosock	Yes	
Gas tap	Single	
Filter type	Gravel	
Type of cover	Flush (cast)	
Initial reading	27.32	m
Time of Initial reading	1000	hhmm

	Base (m)	Top (m)
Concrete	0.30	GL
Gravel drainage	0.50	0.30
Borehole seal top	20.00	0.50
Filter zone	35.00	20.00
Plain pipe	20.00	GL
Slotted zone	35.00	20.00
Base of borehole	35.00	

Remarks

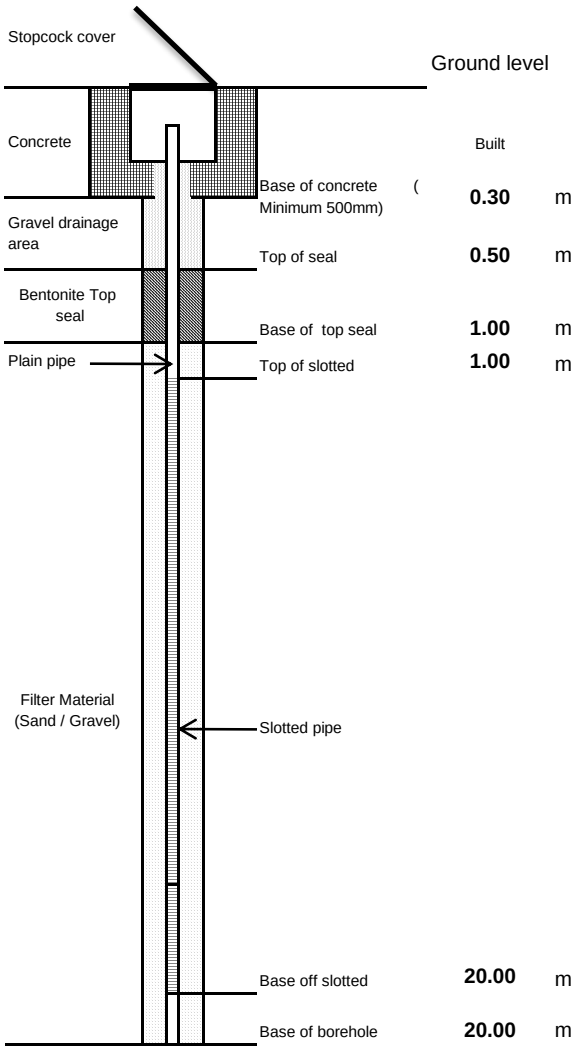
11 bags of gravel 13 bags of bentonite pellets 1 balast 1/4 cement

Rig type	Commachio·601	**Project Title**			
Drilling Crew Details		Bromesberrow Quarry			
Support Operative	Kieran·Bryant				
Lead Driller	Nick Lewis-Watkins	**Project No**		36646	
Site category	Green	**Day**	Wednesday	**Date**	September 1, 2021
Engineer	Allstone			**Borehole Number**	
				BH01	

GEOTECHNICAL ENGINEERING LTD

Summary of Standpipe Installation

Schematic Diagram
(not to scale)



Installation Details

Standpipe diameter (id)	50	mm
Borehole diameter	120	mm
Slot size	1	mm
Geosock	Yes	
Gas tap	Single	
Filter type	Gravel	
Type of cover	Flush (cast)	
Initial reading	Dry	m
Time of Initial reading	1230	hhmm

	Base (m)	Top (m)
Concrete	0.30	GL
Gravel drainage	0.50	0.30
Borehole seal top	1.00	0.50
Filter zone	20.00	1.00
Plain pipe	1.00	GL
Slotted zone	20.00	1.00
Base of borehole	20.00	

Remarks

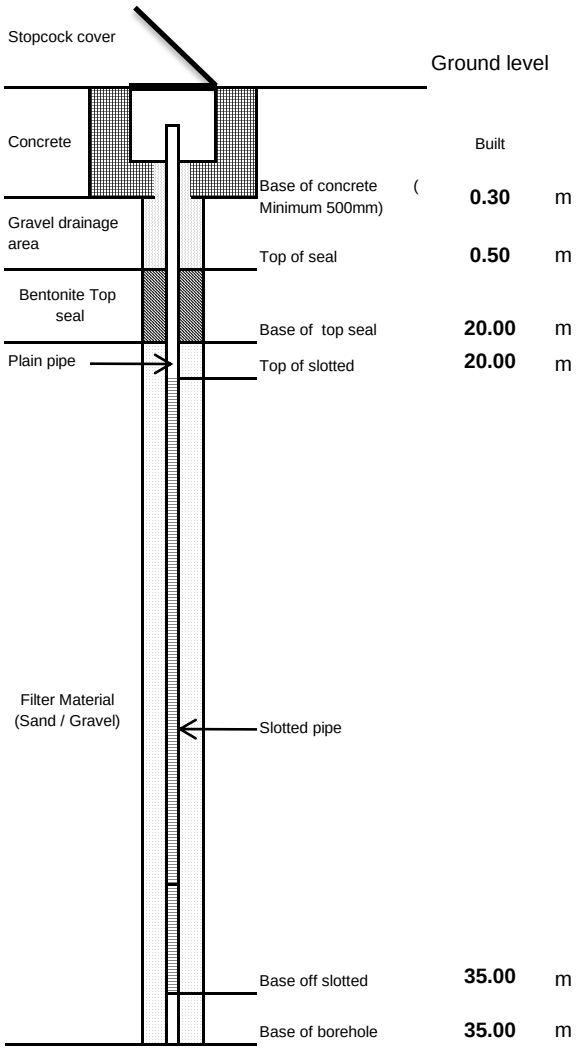
16 bags of gravel 1 bentonite 1 balast 1/4 cement

Rig type	Commachio 601	**Project Title**			
Drilling Crew Details		Bromesberrow Quarry			
Support Operative	Kieran Bryant				
Lead Driller	Nick Lewis-Watkins	**Project No**		36646	
Site category	Green	**Day**	Monday	**Date**	September 6, 2021
Engineer	Allstone			**Borehole Number**	
				BH01A	

GEOTECHNICAL ENGINEERING LTD

Summary of Standpipe Installation

Schematic Diagram
(not to scale)



Installation Details

Standpipe diameter (id)	50	mm
Borehole diameter	120	mm
Slot size	1	mm
Geosock	Yes	
Gas tap	Single	
Filter type	Gravel	
Type of cover	Flush (cast)	
Initial reading	25.84	m
Time of Initial reading	1700	hhmm

	Base (m)	Top (m)
Concrete	0.30	GL
Gravel drainage	0.50	0.30
Borehole seal top	20.00	0.50
Filter zone	35.00	20.00
Plain pipe	20.00	GL
Slotted zone	35.00	20.00
Base of borehole	35.00	

Remarks

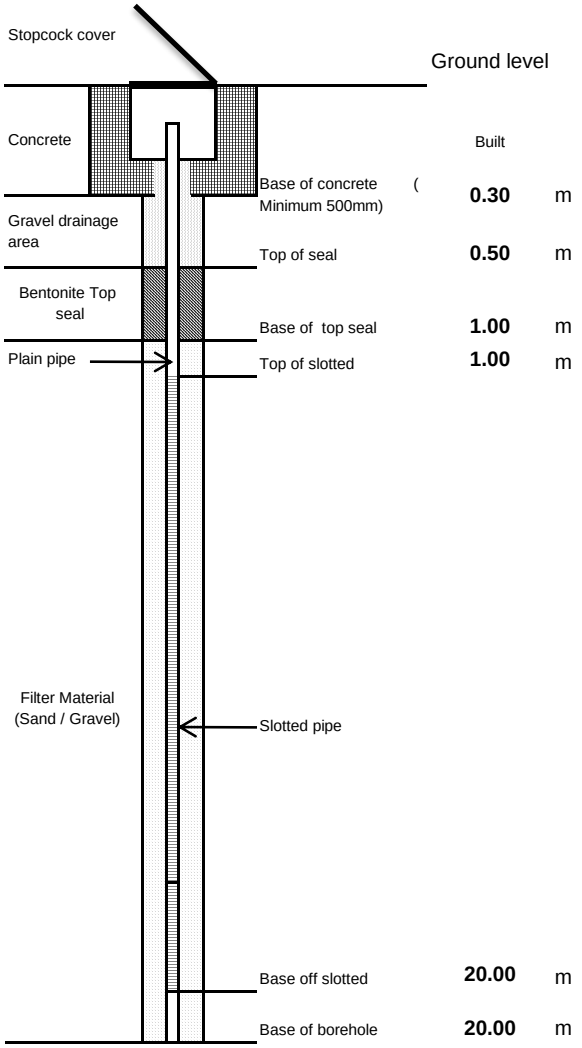
gravel 11 bags 14 bags bentonite 1 balast 1/4 cement

Rig type	Commachio·601	**Project Title**			
Drilling Crew Details		Bromesberrow Quarry			
Support Operative	Kieran·Bryant				
Lead Driller	Nick Lewis-Watkins	**Project No**		36646	
Site category	Green	**Day**	Wednesday	**Date**	September 1, 2021
Engineer	Allstone			**Borehole Number**	
				BH02	

GEOTECHNICAL ENGINEERING LTD

Summary of Standpipe Installation

Schematic Diagram
(not to scale)



Installation Details

Standpipe diameter (id)	50	mm
Borehole diameter	120	mm
Slot size	1	mm
Geosock	Yes	
Gas tap	Single	
Filter type	Gravel	
Type of cover	Flush (cast)	
Initial reading	Dry	m
Time of Initial reading	1015	hhmm

	Base (m)	Top (m)
Concrete	0.30	GL
Gravel drainage	0.50	0.30
Borehole seal top	1.00	0.50
Filter zone	20.00	1.00
Plain pipe	1.00	GL
Slotted zone	20.00	1.00
Base of borehole	20.00	

Remarks

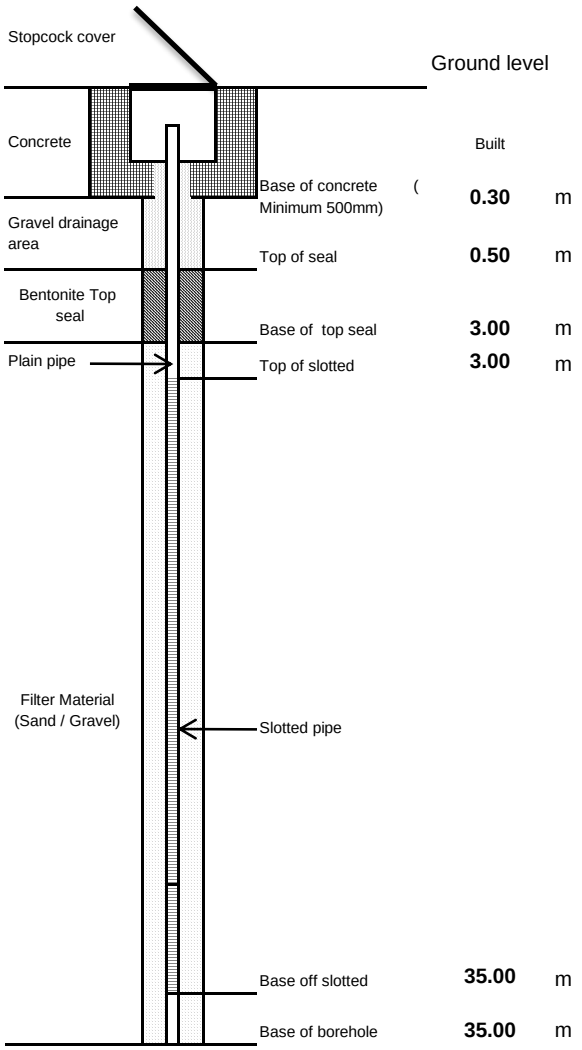
17 bags gravel 1 bentonite pellets 1 balast 1/4 cement

Rig type	Commachio·601	**Project Title**			
Drilling Crew Details		Bromesberrow Quarry			
Support Operative	Kieran·Bryant				
Lead Driller	Nick Lewis-Watkins	**Project No**		36646	
Site category	Green	**Day**	Monday	**Date**	September 6, 2021
Engineer	Allstone			**Borehole Number**	
				BH02A	

GEOTECHNICAL ENGINEERING LTD

Summary of Standpipe Installation

Schematic Diagram
(not to scale)



Installation Details

Standpipe diameter (id)	50	mm
Borehole diameter	120	mm
Slot size	1	mm
Geosock	Yes	
Gas tap	Single	
Filter type	Gravel	
Type of cover	Flush (cast)	
Initial reading	26.89	m
Time of Initial reading	1530	hhmm

	Base (m)	Top (m)
Concrete	0.30	GL
Gravel drainage	0.50	0.30
Borehole seal top	3.00	0.50
Filter zone	35.00	3.00
Plain pipe	3.00	GL
Slotted zone	35.00	3.00
Base of borehole	35.00	

Remarks

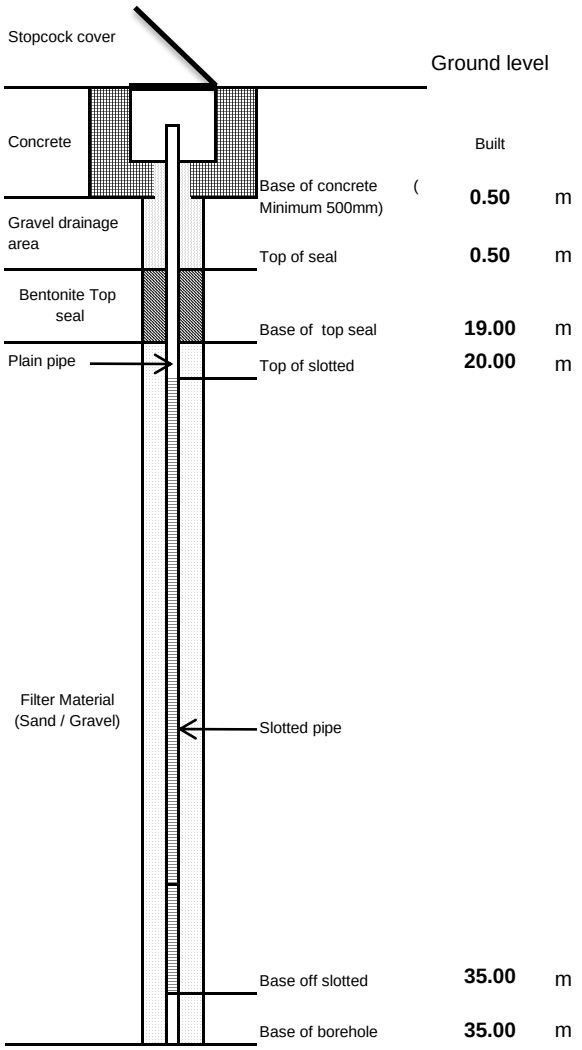
27 bags of gravel 3 bentonite pellets 1 balast 1/4 cement

Rig type	Commachio 601	**Project Title**			
Drilling Crew Details		Bromesberrow Quarry			
Support Operative	Kieran Bryant				
Lead Driller	Nick Lewis-Watkins	**Project No**		36646	
Site category	Green	**Day**	Friday	**Date**	September 3, 2021
Engineer	Allstone			**Borehole Number**	
				BH03	

GEOTECHNICAL ENGINEERING LTD

Summary of Standpipe Installation

Schematic Diagram
(not to scale)



Installation Details

Standpipe diameter (id)	50	mm
Borehole diameter	154	mm
Slot size	1	mm
Geosock	Yes	
Gas tap	Single	
Filter type	Gravel	
Type of cover	None	
Initial reading	-	m
Time of Initial reading	1450	hhmm

	Base (m)	Top (m)
Concrete	0.50	GL
Gravel drainage	0.50	0.50
Borehole seal top	19.00	0.50
Filter zone	35.00	19.00
Plain pipe	20.00	GL
Slotted zone	35.00	20.00
Base of borehole	35.00	

Remarks

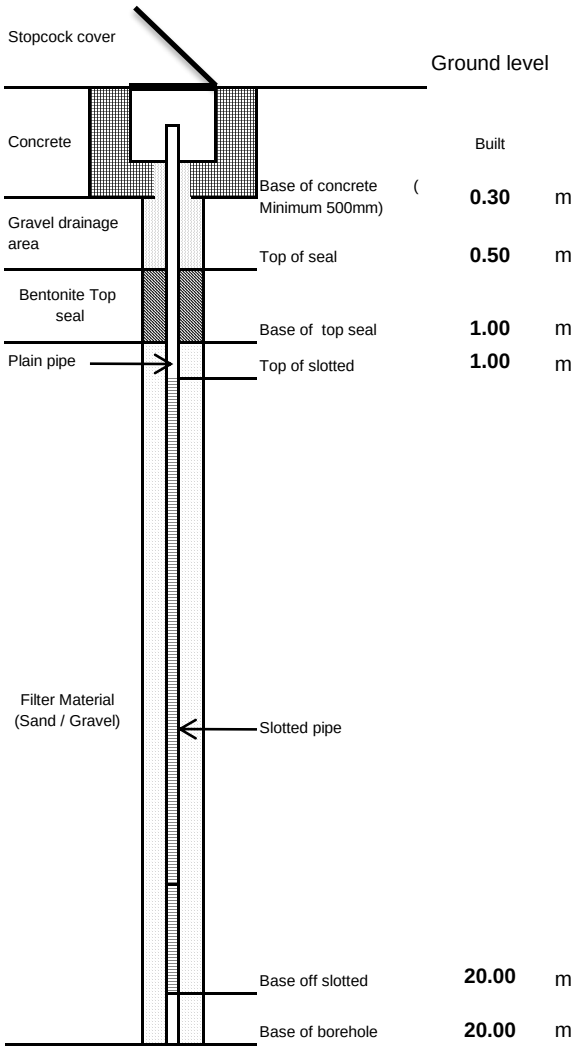
x18 gravel x16 bentonite

Rig type	Comacchio 601	**Project Title**			
Drilling Crew Details		Bromesberrow Quarry			
Support Operative	Tom Bowen				
Lead Driller	Chris Jones	**Project No**		36646	
Site category	Yellow	**Day**	Thursday	**Date**	September 2, 2021
Engineer	Allstone			**Borehole Number**	
				BH04	

GEOTECHNICAL ENGINEERING LTD

Summary of Standpipe Installation

Schematic Diagram
(not to scale)



Installation Details

Standpipe diameter (id)	50	mm
Borehole diameter	120	mm
Slot size	1	mm
Geosock	Yes	
Gas tap	Single	
Filter type	Gravel	
Type of cover	Flush (cast)	
Initial reading	Dry	m
Time of Initial reading	1650	hhmm

	Base (m)	Top (m)
Concrete	0.30	GL
Gravel drainage	0.50	0.30
Borehole seal top	1.00	0.50
Filter zone	20.00	1.00
Plain pipe	1.00	GL
Slotted zone	20.00	1.00
Base of borehole	20.00	

Remarks

16 bags of gravel 1 bag of bentonite 1 balast 1/4 cement

Rig type	Commachio 601	**Project Title**			
Drilling Crew Details		Bromesberrow Quarry			
Support Operative	Kieran Bryant				
Lead Driller	Nick Lewis-Watkins	**Project No**		36646	
Site category	Green	**Day**	Monday	**Date**	September 6, 2021
Engineer	Allstone			**Borehole Number**	
				BH04A	

GEOTECHNICAL ENGINEERING LTD on behalf of Allstone — Rotary Drilling Log

Depth of Stratum Top (m)	Driller's Stratum Description	Sample / Hole / Test Details: No	Type	Insitu test	From (m)	To (m)	Liner Dia (mm)	Drilling Details: Core run time (hhmm)	Total core Recovery (m)	Flush Return %	Flush Colour	Standard Penetration Test: Self Weight Pen (mm)	75 mm	150 mm	Seating Pen (mm)	75 mm	150 mm	225 mm	300 mm	Main Pen (mm)	N value	Casing Depth (m)	Water/ flush level (m)
			RO		1.20	35.00		0330		100	red											1.20	Dry
1.20	compact typ1 into sand																						
35.00	weakly cemented sand																						

Shift details

Start time (hhmm)	Hole (m)	Water (m)	Casing (m)
0600			
Finish time (hhmm)	Hole (m)	Water (m)	Casing (m)
1800	35.00	27.32	1.20

Drilling Equipment Details

Casing (C) Open Hole (RO) Coring (RC)	Dia. (mm)	From (m)	To (m)	Barrel	Liner Type	Core Dia (mm)	Bit Type	Casing Type	Bit serial No	Flush	Polymer
C	150.00	0.00	1.20					S			
RO	120.00	1.20	35.00				PCD			Air	No

Ground Water Record

Time of strike	Depth Struck (m)	Casing (m)	Inflow	5 min	10 min	15 min	20 min	Depth Sealed (m)

Backfill (m)

Type	From (m)	To (m)

Time from	Duration (hhmm)	Remarks or details of any additional testing information, Dayworks
0600		CAT Scanned: Yes
0600		Permit Completed: Yes
		General; 06:00 to 08:00 loading up in yard and sort van
		General; 08:00 to 08:33 travel to site
		General; 08:33 to 09:00 site walk over with sf and site induction
		General; 09:00 to 09:30 clear bh postion
		General; 09:30 to 11:30 dig pit and set up rig and kit

SPT I.D. Number		Calibration Date	
SPT Rod Type		SPT Energy Ratio	
Drilling Crew Details			CSCS No
Support Operative	.		
Lead Driller	Nick Lewis-Watkins		3123223
Site category	Green		
Project Engineer	Allstone		
Lead Driller's signature			

Project Title

Bromesberrow Quarry

Weather	Cloudy	Project No	36646
Date	31/08/2021	Day	Tuesday
Rig type		Borehole Number	
Inclination	Orientation		BH01
Sheet	1 of 3	Completed	N

GEOTECHNICAL ENGINEERING LTD on behalf of Allstone — Rotary Drilling Log

Depth of Stratum Top (m)	Driller's Stratum Description	Sample / Hole / Test Details: No	Type	Insitu test	From (m)	To (m)	Liner Dia (mm)	Drilling Details: Core run time (hhmm)	Total core Recovery (m)	Flush Return %	Flush Colour	Standard Penetration Test: Self Weight Pen (mm)	75 mm	150 mm	Seating Pen (mm)	75 mm	150 mm	225 mm	300 mm	Main Pen (mm)	N value	Casing Depth (m)	Water/ flush level (m)

Shift details

Start time (hhmm)	Hole (m)	Water (m)	Casing (m)
0600			
Finish time (hhmm)	Hole (m)	Water (m)	Casing (m)
1800	35.00	27.32	1.20

Drilling Equipment Details

Casing (C) Open Hole (RO) Coring (RC)	Dia. (mm)	From (m)	To (m)	Barrel	Liner Type	Core Dia (mm)	Bit Type	Casing Type	Bit serial No	Flush	Polymer

Ground Water Record

Time of strike	Depth Struck (m)	Casing (m)	Inflow	5 min	10 min	15 min	20 min	Depth Sealed (m)

Backfill (m)

Type	From (m)	To (m)

Time from	Duration (hhmm)	Remarks or details of any additional testing information, Dayworks
		General; 11:30 to 12:05 waitng on bit for compressor
		General; 12:05 to 15:30 drilling to 35.00m
		General; 15:30 to 16:30 pull rods tidy site wait for install kit
		General; 16:30 to 17:00 unlaod install kit

SPT I.D. Number		Calibration Date	
SPT Rod Type		SPT Energy Ratio	
Drilling Crew Details			CSCS No
Support Operative	.		
Lead Driller	Nick Lewis-Watkins		3123223
Site category	Green		
Project Engineer	Allstone		
Lead Driller's signature			

Project Title

Bromesberrow Quarry

Weather	Cloudy	Project No	36646
Date	31/08/2021	Day	Tuesday
Rig type		Borehole Number	
Inclination		Orientation	BH01
Sheet	2 of 3	Completed	N

AGS

Produced by KeyLogbook

GEOTECHNICAL ENGINEERING LTD on behalf of Allstone — Rotary Drilling Log

Depth of Stratum Top (m)	Driller's Stratum Description	Sample / Hole / Test Details: No	Type	Insitu test	From (m)	To (m)	Liner Dia (mm)	Drilling Details: Core run time (hhmm)	Total core Recovery (m)	Flush Return %	Flush Colour	Standard Penetration Test: Self Weight Pen (mm)	75 mm	150 mm	Seating Pen (mm)	75 mm	150 mm	225 mm	300 mm	Main Pen (mm)	N value	Casing Depth (m)	Water/ flush level (m)

Shift details

Start time (hhmm)	Hole (m)	Water (m)	Casing (m)
0630	35.00	27.88	1.20
Finish time (hhmm)	Hole (m)	Water (m)	Casing (m)
1100	0.00		

Drilling Equipment Details

Casing (C) Open Hole (RO) Coring (RC)	Dia. (mm)	From (m)	To (m)	Barrel	Liner Type	Core Dia (mm)	Bit Type	Casing Type	Bit serial No	Flush	Polymer

Ground Water Record

Time of strike	Depth Struck (m)	Casing (m)	Inflow	5 min	10 min	15 min	20 min	Depth Sealed (m)

Backfill (m)

Type	From (m)	To (m)

Time from	Duration (hhmm)	Remarks or details of any additional testing information, Dayworks
		General; 06:30 to 07:00 load up install kit
		General; 07:00 to 07:40 travel to site
		General; 07:40 to 08:00 sign in set up
		General; 08:00 to 10:00 flush bh for half hour with air and install bh
		General; 10:00 to 11:00 move rig and all kit to next bh had to get skips moved to access

SPT I.D. Number	P33	Calibration Date	
SPT Rod Type	NWY	SPT Energy Ratio	
Drilling Crew Details		CSCS No	
Support Operative	.		
Lead Driller	Nick Lewis-Watkins	3123223	
Site category	Green		
Project Engineer	Allstone		
Lead Driller's signature	*Nick Lewis-Watkins*		

Project Title

Bromesberrow Quarry

Weather	Fine	Project No	36646
Date	01/09/2021	Day	Wednesday
Rig type		Borehole Number	
Inclination	Orientation		BH01
Sheet	3 of 3	Completed	N

AGS

Produced by KeyLogbook

GEOTECHNICAL ENGINEERING LTD on behalf of Allstone — Rotary Drilling Log

Depth of Stratum Top (m)	Driller's Stratum Description	Sample / Hole / Test Details: No	Type	Insitu test	From (m)	To (m)	Liner Dia (mm)	Drilling Details: Core run time (hhmm)	Total core Recovery (m)	Flush Return %	Flush Colour	Standard Penetration Test: Self Weight Pen (mm)	75 mm	150 mm	Seating Pen (mm)	75 mm	150 mm	225 mm	300 mm	Main Pen (mm)	N value	Casing Depth (m)	Water/ flush level (m)
			RO		1.20	20.00		0100		100	red											1.20	Dry
20.00	red sand																						

Shift details

Start time (hhmm)	Hole (m)	Water (m)	Casing (m)
1015			
Finish time (hhmm)	Hole (m)	Water (m)	Casing (m)
1230	0.00		

Drilling Equipment Details

Casing (C) Open Hole (RO) Coring (RC)	Dia. (mm)	From (m)	To (m)	Barrel	Liner Type	Core Dia (mm)	Bit Type	Casing Type	Bit serial No	Flush	Polymer
C	150.00	0.00	1.20					S			
RO	120.00	1.20	20.00				PCD			Air	No

Ground Water Record

Time of strike	Depth Struck (m)	Casing (m)	Inflow	5 min	10 min	15 min	20 min	Depth Sealed (m)

Backfill (m)

Type	From (m)	To (m)

Time from	Duration (hhmm)	Remarks or details of any additional testing information, Dayworks
1015		CAT Scanned: Yes
1015		Permit Completed: Yes
		General; 10:17 to 10:50 pit and set up
		General; 10:50 to 11:50 drilling
		General; 11:50 to 12:30 installing bh and loading van

SPT I.D. Number		Calibration Date	
SPT Rod Type		SPT Energy Ratio	
Drilling Crew Details			CSCS No
Support Operative	.		
Lead Driller	Nick Lewis-Watkins		3123223
Site category	Green		
Project Engineer	Allstone		
Lead Driller's signature			

Project Title

Bromesberrow Quarry

Weather	Sunny	Project No	36646
Date	06/09/2021	Day	Monday
Rig type		Borehole Number	
Inclination	Orientation		BH01A
Sheet	1 of 1	Completed	N

AGS

Produced by KeyLogbook

GEOTECHNICAL ENGINEERING LTD on behalf of Allstone — Rotary Drilling Log

Depth of Stratum Top (m)	Driller's Stratum Description	Sample / Hole / Test Details: No	Type	Insitu test	From (m)	To (m)	Liner Dia (mm)	Drilling Details: Core run time (hhmm)	Total core Recovery (m)	Flush Return %	Flush Colour	Standard Penetration Test: Self Weight Pen (mm)	75 mm	150 mm	Seating Pen (mm)	75 mm	150 mm	225 mm	300 mm	Main Pen (mm)	N value	Casing Depth (m)	Water/ flush level (m)
			RO		1.20	35.00		0300		100	red											1.20	Dry
1.20	made ground into red sand																						
35.00	red sand																						

Shift details

Start time (hhmm)	Hole (m)	Water (m)	Casing (m)
1100			
Finish time (hhmm)	Hole (m)	Water (m)	Casing (m)
1815	0.00		

Drilling Equipment Details

Casing (C) Open Hole (RO) Coring (RC)	Dia. (mm)	From (m)	To (m)	Barrel	Liner Type	Core Dia (mm)	Bit Type	Casing Type	Bit serial No	Flush	Polymer
C	150.00	0.00	3.00					S			
RO	120.00	1.20	35.00				PCD			Air	No

Ground Water Record

Time of strike	Depth Struck (m)	Casing (m)	Inflow	5 min	10 min	15 min	20 min	Depth Sealed (m)

Backfill (m)

Type	From (m)	To (m)

Time from	Duration (hhmm)	Remarks or details of any additional testing information, Dayworks
1100		CAT Scanned: Yes
1100		Permit Completed: Yes
		General; 11:00 to 11:20 dig pit
		General; 11:20 to 11:55 set rig and kit
		General; water hit in bh 27.00m to 28.00m
		General; 12:00 to 14:30 drilling 14:30 to 15:15 flushing bh with air
		General; 14:30 to 17:00 installing bh tidy site pack away

SPT I.D. Number	P33	Calibration Date	
SPT Rod Type	NWY	SPT Energy Ratio	
Drilling Crew Details		CSCS No	
Support Operative	.		
Lead Driller	Nick Lewis-Watkins	3123223	
Site category	Green		
Project Engineer	Allstone		
Lead Driller's signature	*Nick Lewis-Watkins*		

Project Title

Bromesberrow Quarry

Weather	Fine	Project No	36646
Date	01/09/2021	Day	Wednesday
Rig type		Borehole Number	
Inclination		Orientation	BH02
Sheet	1 of 1	Completed	N

AGS

Produced by KeyLogbook

GEOTECHNICAL ENGINEERING LTD on behalf of Allstone — Rotary Drilling Log

Depth of Stratum Top (m)	Driller's Stratum Description	Sample / Hole / Test Details: No	Type	Insitu test	From (m)	To (m)	Liner Dia (mm)	Drilling Details: Core run time (hhmm)	Total core Recovery (m)	Flush Return %	Flush Colour	Standard Penetration Test: Self Weight Pen (mm)	75 mm	150 mm	Seating Pen (mm)	75 mm	150 mm	225 mm	300 mm	Main Pen (mm)	N value	Casing Depth (m)	Water/ flush level (m)
			RO		1.20	20.00		0100		100	orange											1.20	Dry
20.00	red sand																						

Shift details

Start time (hhmm)	Hole (m)	Water (m)	Casing (m)
0600			
Finish time (hhmm)	Hole (m)	Water (m)	Casing (m)
1015	0.00		

Drilling Equipment Details

Casing (C) Open Hole (RO) Coring (RC)	Dia. (mm)	From (m)	To (m)	Barrel	Liner Type	Core Dia (mm)	Bit Type	Casing Type	Bit serial No	Flush	Polymer
C	150.00	0.00	1.20					S			
RO	120.00	1.20	20.00				PCD			Air	No

Ground Water Record

Time of strike	Depth Struck (m)	Casing (m)	Inflow	5 min	10 min	15 min	20 min	Depth Sealed (m)

Backfill (m)

Type	From (m)	To (m)

Time from	Duration (hhmm)	Remarks or details of any additional testing information, Dayworks
0600		CAT Scanned: Yes
0600		Permit Completed: Yes
		General; 06:00 to 06:40 loading up in yard
		General; 06:40 to 07:03
		General; 07:03 to 08:00 dig pit and set up
		General; 08:00 to 08:14 setting up drilling kit
		General; 08:14 to 09:10 drilling

SPT I.D. Number		Calibration Date	
SPT Rod Type		SPT Energy Ratio	
Drilling Crew Details			CSCS No
Support Operative	.		
Lead Driller	Nick Lewis-Watkins		3123223
Site category	Green		
Project Engineer	Allstone		
Lead Driller's signature			

Project Title

Bromesberrow Quarry

Weather	Sunny	Project No	36646
Date	06/09/2021	Day	Monday
Rig type		Borehole Number	
Inclination		Orientation	BH02A
Sheet	1 of 2	Completed	N

AGS

Produced by KeyLogbook

GEOTECHNICAL ENGINEERING LTD on behalf of Allstone — Rotary Drilling Log

Depth of Stratum Top (m)	Driller's Stratum Description	Sample / Hole / Test Details: No	Type	Insitu test	From (m)	To (m)	Liner Dia (mm)	Drilling Details: Core run time (hhmm)	Total core Recovery (m)	Flush Return %	Flush Colour	Standard Penetration Test: Self Weight Pen (mm)	75 mm	150 mm	Seating Pen (mm)	75 mm	150 mm	225 mm	300 mm	Main Pen (mm)	N value	Casing Depth (m)	Water/ flush level (m)

Shift details

Start time (hhmm)	Hole (m)	Water (m)	Casing (m)
0600			
Finish time (hhmm)	Hole (m)	Water (m)	Casing (m)
1015	0.00		

Drilling Equipment Details

Casing (C) Open Hole (RO) Coring (RC)	Dia. (mm)	From (m)	To (m)	Barrel	Liner Type	Core Dia (mm)	Bit Type	Casing Type	Bit serial No	Flush	Polymer

Ground Water Record

Time of strike	Depth Struck (m)	Casing (m)	Inflow	5 min	10 min	15 min	20 min	Depth Sealed (m)

Backfill (m)

Type	From (m)	To (m)

Time from	Duration (hhmm)	Remarks or details of any additional testing information, Dayworks
		General; 09:10 to 10:00 installing bh
		General; 10:00 to 10:17 moving to next bh

SPT I.D. Number		Calibration Date	
SPT Rod Type		SPT Energy Ratio	
Drilling Crew Details			CSCS No
Support Operative	.		
Lead Driller	Nick Lewis-Watkins		3123223
Site category	Green		
Project Engineer	Allstone		
Lead Driller's signature			

Project Title

Bromesberrow Quarry

Weather	Sunny	Project No	36646
Date	06/09/2021	Day	Monday
Rig type		Borehole Number	
Inclination	Orientation		BH02A
Sheet	2 of 2	Completed	N

GEOTECHNICAL ENGINEERING LTD on behalf of Allstone — Rotary Drilling Log

Depth of Stratum Top (m)	Driller's Stratum Description	Sample / Hole / Test Details: No	Type	Insitu test	From (m)	To (m)	Liner Dia (mm)	Drilling Details: Core run time (hhmm)	Total core Recovery (m)	Flush Return %	Flush Colour	Standard Penetration Test: Self Weight Pen (mm)	75 mm	150 mm	Seating Pen (mm)	75 mm	150 mm	225 mm	300 mm	Main Pen (mm)	N value	Casing Depth (m)	Water/ flush level (m)
			RO		1.20	35.50		0130		100	red											1.20	Dry
35.00	red sand																						

Shift details

Start time (hhmm)	Hole (m)	Water (m)	Casing (m)
0645			
Finish time (hhmm)	Hole (m)	Water (m)	Casing (m)
1745	0.00		

Drilling Equipment Details

Casing (C) Open Hole (RO) Coring (RC)	Dia. (mm)	From (m)	To (m)	Barrel	Liner Type	Core Dia (mm)	Bit Type	Casing Type	Bit serial No	Flush	Polymer
C	150.00	0.00	1.20					S			
RO	120.00	1.20	35.00				PCD			Air	No

Ground Water Record

Time of strike	Depth Struck (m)	Casing (m)	Inflow	5 min	10 min	15 min	20 min	Depth Sealed (m)

Backfill (m)

Type	From (m)	To (m)

Time from	Duration (hhmm)	Remarks or details of any additional testing information, Dayworks
0645		CAT Scanned: Yes
0645		Permit Completed: Yes
		General; 06:45 to 07:15 loading up in yard
		General; 07:15 to 08:50 travel out to site
		General;07:50 to 08:00 get changed sign in
		General; 08:00 to 08:30 dig pit
		General; 08:30 to 10:30 move all kit and rig and set up on bh

SPT I.D. Number	P33	Calibration Date	
SPT Rod Type	NWY	SPT Energy Ratio	
Drilling Crew Details		CSCS No	
Support Operative	.		
Lead Driller	Nick Lewis-Watkins	3123223	
Site category	Green		
Project Engineer	Allstone		
Lead Driller's signature	Nick Watkins		

Project Title

Bromesberrow Quarry

Weather	Sunny	Project No	36646
Date	03/09/2021	Day	Friday
Rig type		Borehole Number	
Inclination	Orientation		BH03
Sheet	1 of 2	Completed	N

AGS

Produced by KeyLogbook

GEOTECHNICAL ENGINEERING LTD on behalf of Allstone — Rotary Drilling Log

Depth of Stratum Top (m)	Driller's Stratum Description	Sample / Hole / Test Details: No	Type	Insitu test	From (m)	To (m)	Liner Dia (mm)	Drilling Details: Core run time (hhmm)	Total core Recovery (m)	Flush Return %	Flush Colour	Standard Penetration Test: Self Weight Pen (mm)	75 mm	150 mm	Seating Pen (mm)	75 mm	150 mm	225 mm	300 mm	Main Pen (mm)	N value	Casing Depth (m)	Water/ flush level (m)

Shift details

Start time (hhmm)	Hole (m)	Water (m)	Casing (m)
0645			
Finish time (hhmm)	Hole (m)	Water (m)	Casing (m)
1745	0.00		

Drilling Equipment Details

Casing (C) Open Hole (RO) Coring (RC)	Dia. (mm)	From (m)	To (m)	Barrel	Liner Type	Core Dia (mm)	Bit Type	Casing Type	Bit serial No	Flush	Polymer

Ground Water Record

Time of strike	Depth Struck (m)	Casing (m)	Inflow	5 min	10 min	15 min	20 min	Depth Sealed (m)

Backfill (m)

Type	From (m)	To (m)

Time from	Duration (hhmm)	Remarks or details of any additional testing information, Dayworks
		General; 10:30 to 12:00 drilling to 35.00m
		General; 12:00 to 12:30 flush bh
		General; 12:30 to 13:00 waiting on decision on install
		General; 13:00 to 14:00 waiting for install pipe and gravel from yard
		General; 14:00 to 15:30 installing bh 32.00m slotted and 3.00m plain 50mm pipe
		General; 15:30 to 16:45 complete head works on bh move rig out and and kit up to next bh

SPT I.D. Number	P33	Calibration Date	
SPT Rod Type	NWY	SPT Energy Ratio	
Drilling Crew Details		CSCS No	
Support Operative	.		
Lead Driller	Nick Lewis-Watkins	3123223	
Site category	Green		
Project Engineer	Allstone		
Lead Driller's signature	*Nick Watkins*		

Project Title

Bromesberrow Quarry

Weather	Sunny	Project No	36646
Date	03/09/2021	Day	Friday
Rig type		Borehole Number	
Inclination	Orientation		BH03
Sheet	2 of 2	Completed	N

AGS

Produced by KeyLogbook

GEOTECHNICAL ENGINEERING LTD on behalf of Allstone — Rotary Drilling Log

Depth of Stratum Top (m)	Driller's Stratum Description	Sample / Hole / Test Details: No	Type	Insitu test	From (m)	To (m)	Liner Dia (mm)	Drilling Details: Core run time (hhmm)	Total core Recovery (m)	Flush Return %	Flush Colour	Standard Penetration Test: Self Weight Pen (mm)	75 mm	150 mm	Seating Pen (mm)	75 mm	150 mm	225 mm	300 mm	Main Pen (mm)	N value	Casing Depth (m)	Water/ flush level (m)
1.20	soft dark red sand																						

Shift details

Start time (hhmm)	Hole (m)	Water (m)	Casing (m)
0730			
Finish time (hhmm)	Hole (m)	Water (m)	Casing (m)
1700			

Drilling Equipment Details

Casing (C) Open Hole (RO) Coring (RC)	Dia. (mm)	From (m)	To (m)	Barrel	Liner Type	Core Dia (mm)	Bit Type	Casing Type	Bit serial No	Flush	Polymer
C	154.00	0.00	1.20					S			
RO	152.00	1.20	35.00				PCD			Air	No

Ground Water Record

Time of strike	Depth Struck (m)	Casing (m)	Inflow	5 min	10 min	15 min	20 min	Depth Sealed (m)

Backfill (m)

Type	From (m)	To (m)

Time from	Duration (hhmm)	Remarks or details of any additional testing information, Dayworks
0730		CAT Scanned: Yes
0730		Permit Completed: Yes
0730	0025	onsite. change into ppe and wait for induction
0755	0125	pack away kit from previous bh and track rig to bh04
0925	0040	Inspection pit: Hand dug 1.20m x 0.50m x 0.50m
1005	0020	setup rig and work area
1025	0235	drill ops -rotary open hole using air

SPT I.D. Number	ES3	Calibration Date	16/01/2018
SPT Rod Type	1 ½ Whitworth SPT	SPT Energy Ratio	.
Drilling Crew Details		CSCS No	
Support Operative	kearon bryant		5890255
Lead Driller	Chris Jones		2865277
Site category	Yellow		
Project Engineer	Allstone		
Lead Driller's signature			

Project Title

Bromesberrow Quarry

Weather	Sunny	Project No	36646
Date	02/09/2021	Day	Thursday
Rig type	Commachio 601	Borehole Number	
Inclination	Orientation		BH04
Sheet	1 of 2	Completed	Y

GEOTECHNICAL ENGINEERING LTD on behalf of Allstone — Rotary Drilling Log

Depth of Stratum Top (m)	Driller's Stratum Description	Sample / Hole / Test Details: No	Type	Insitu test	From (m)	To (m)	Liner Dia (mm)	Drilling Details: Core run time (hhmm)	Total core Recovery (m)	Flush Return %	Flush Colour	Standard Penetration Test: Self Weight Pen (mm)	75 mm	150 mm	Seating Pen (mm)	75 mm	150 mm	225 mm	300 mm	Main Pen (mm)	N value	Casing Depth (m)	Water/ flush level (m)

Shift details

Start time (hhmm)	Hole (m)	Water (m)	Casing (m)
0730			
Finish time (hhmm)	Hole (m)	Water (m)	Casing (m)
1700			

Drilling Equipment Details

Casing (C) Open Hole (RO) Coring (RC)	Dia. (mm)	From (m)	To (m)	Barrel	Liner Type	Core Dia (mm)	Bit Type	Casing Type	Bit serial No	Flush	Polymer

Ground Water Record

Time of strike	Depth Struck (m)	Casing (m)	Inflow	5 min	10 min	15 min	20 min	Depth Sealed (m)

Backfill (m)

Type	From (m)	To (m)

Time from	Duration (hhmm)	Remarks or details of any additional testing information, Dayworks
1300	0020	flush bh
1320	0140	install bh and pack away
		DREM (20.00m - 35.00m): water encountered at 20m

SPT I.D. Number	ES3	Calibration Date	16/01/2018
SPT Rod Type	1 ½ Whitworth SPT	SPT Energy Ratio	.
Drilling Crew Details			CSCS No
Support Operative	kearon bryant		5890255
Lead Driller	Chris Jones		2865277
Site category	Yellow		
Project Engineer	Allstone		
Lead Driller's signature			

Project Title

Bromesberrow Quarry

Weather	Sunny	Project No	36646
Date	02/09/2021	Day	Thursday
Rig type	Commachio 601	Borehole Number	
Inclination		Orientation	BH04
Sheet	2 of 2	Completed	Y

AGS

Produced by KeyLogbook

GEOTECHNICAL ENGINEERING LTD on behalf of Allstone — Rotary Drilling Log

Depth of Stratum Top (m)	Driller's Stratum Description	Sample / Hole / Test Details: No	Type	Insitu test	From (m)	To (m)	Liner Dia (mm)	Drilling Details: Core run time (hhmm)	Total core Recovery (m)	Flush Return %	Flush Colour	Standard Penetration Test: Self Weight Pen (mm)	75 mm	150 mm	Seating Pen (mm)	75 mm	150 mm	225 mm	300 mm	Main Pen (mm)	N value	Casing Depth (m)	Water/ flush level (m)
			RO		1.20	20.00		0100		100	red											1.20	Dry
20.00	red sand																						

Shift details

Start time (hhmm)	Hole (m)	Water (m)	Casing (m)
1230			
Finish time (hhmm)	Hole (m)	Water (m)	Casing (m)
1800	0.00		

Drilling Equipment Details

Casing (C) Open Hole (RO) Coring (RC)	Dia. (mm)	From (m)	To (m)	Barrel	Liner Type	Core Dia (mm)	Bit Type	Casing Type	Bit serial No	Flush	Polymer
C	150.00	0.00	1.20					S			
RO	120.00	1.20	20.00				PCD			Air	No

Ground Water Record

Time of strike	Depth Struck (m)	Casing (m)	Inflow	5 min	10 min	15 min	20 min	Depth Sealed (m)

Backfill (m)

Type	From (m)	To (m)

Time from	Duration (hhmm)	Remarks or details of any additional testing information, Dayworks
1230		CAT Scanned: Yes
1230		Permit Completed: Yes
		General; 12:30 to 13:00 move to last bh
		General; 13:00 to 15:00 diging 2 pits
		General; 15:00 to 15:15 setting up
		General; 15:15 to 16:15 drilling
		General; 16:15 to 16:50 installing bh

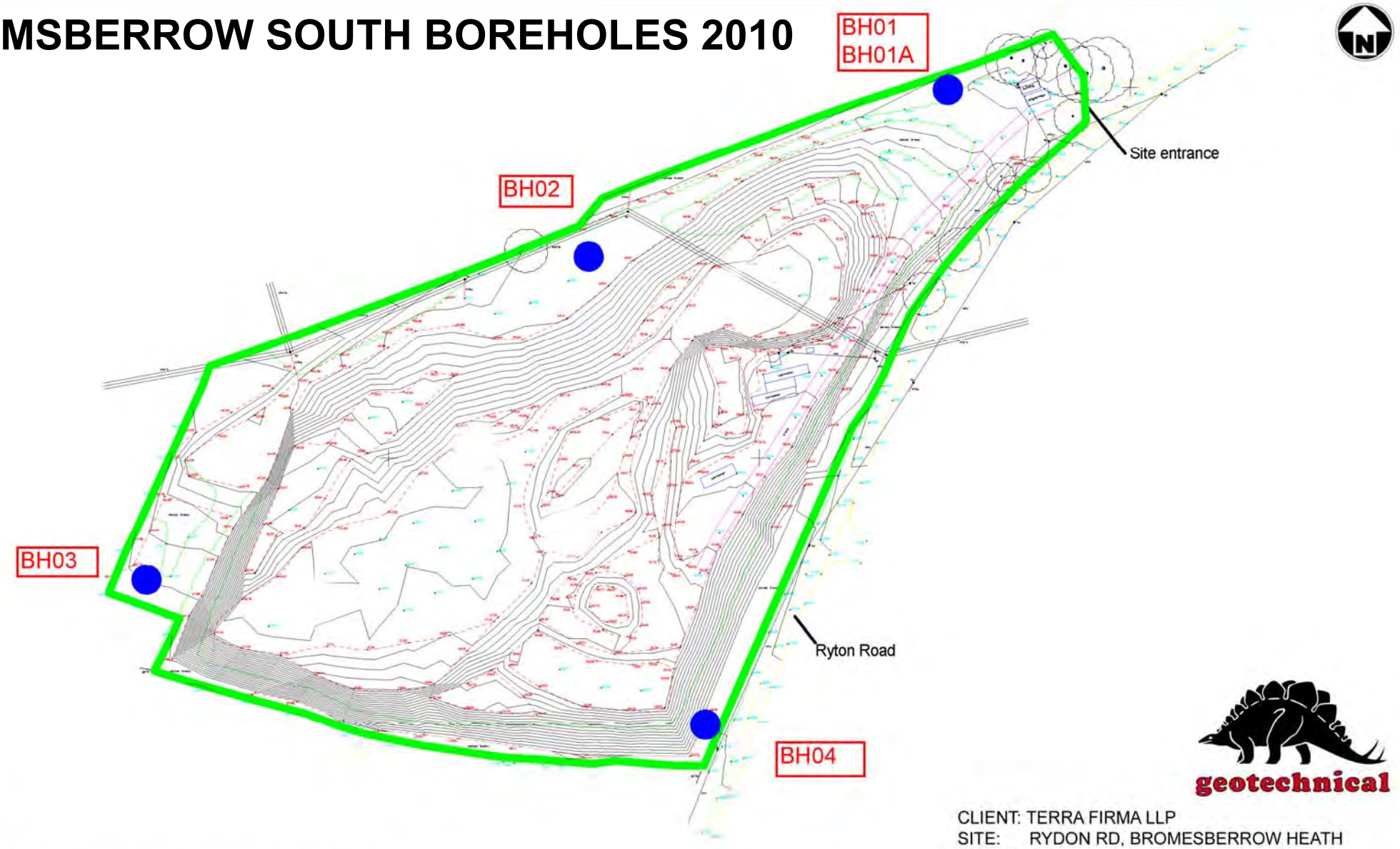
SPT I.D. Number		Calibration Date	
SPT Rod Type		SPT Energy Ratio	
Drilling Crew Details			CSCS No
Support Operative	.		
Lead Driller	Nick Lewis-Watkins		3123223
Site category	Green		
Project Engineer	Allstone		
Lead Driller's signature			

Project Title

Bromesberrow Quarry

Weather	Sunny	Project No	36646
Date	06/09/2021	Day	Monday
Rig type		Borehole Number	
Inclination	Orientation		BH04A
Sheet	1 of 1	Completed	N

BROMSBERROW SOUTH BOREHOLES 2010



geotechnical

CLIENT: TERRA FIRMA LLP
SITE: RYDON RD, BROMESBERROW HEATH
FIGURE 1
24672

100m

Approximate gas/groundwater monitoring borehole positions

Installation boundary

ESID11
Gas and groundwater monitoring locations

Adopted from plan provided by ESI

Date: JUNE 2010	Drawn: PCB
Scale: As shown	Checked: RAG
Original: A4	Revision: 1
File Reference: O:\60088\60088R2\ESID11.skf	

esi

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KEY TO EXPLORATORY HOLE LOGS

Sample type

D	Small disturbed sample	B	Bulk disturbed sample	D*	Contamination sample
LB	Large bulk disturbed sample	W	Water sample	P	Piston sample
X	Dynamic sample	C	Core sample	Cs	Core subsample (prepared)
U	Undisturbed sample open drive				
UT	Thin wall open drive tube sample				

Test type

S SPT - Split spoon sampler followed by SPT 'N' value
C SPT - Solid cone followed by SPT 'N' value
*250 - Where full test drive not completed, linearly extrapolated N value reported
** - No effective penetration

H Hand vane – direct reading in kPa – not corrected for BS1377 (1990). Re* denotes refusal.
M Mackintosh probe result – number of blows to achieve 100mm penetration.
PP Pocket penetrometer result – direct reading in kg/sq.cm.
Vo Headspace vapour readings, uncorrected peak values in ppm, using a PID (calibrated with Isobutylene, using a 10.6 eV bulb).

Sample/core range/I_f

Dynamic sample

Undisturbed sample - open drive including thin wall. Symbol length reflects recovery

X = Total Core Recovery (TCR) as percentage of core run.

Y = Solid Core Recovery (SCR) as percentage of core run. Note: assessment of solid core is based on full diameter.

Z = Rock Quality Designation (RQD). The amount of solid core greater than 100mm expressed as percentage of core run.

Where SPT has been carried out at beginning of core run, disturbed section of core excluded from SCR and RQD assessment.

I_f - fracture spacing – the average fracture spacing (in millimetres) over the indicated length of core. Where spacing varies significantly, the minimum, average and maximum values are given.
NI = non-intact core NA = not applicable

Instrumentation

Porous tip
Perforated standpipe
Gas monitoring standpipe
Granular response zone
Bentonite seal
Concrete
Cement/bentonite grout
Soil backfill

Stratum boundaries

Estimated boundary
Grading boundary

KEY TO EXPLORATORY HOLE LOGS

Logging

The logging of soils and rocks has been carried out in general accordance with BS 5930:1999 incorporating Amendment 1 (2006) & 2 (2010). Amendment 1 removes text superseded by BS EN ISO 14688-1:2002, BS EN ISO 14688-2:2004 and BS EN ISO 14689-1:2003, and makes reference to the relevant standard for each affected sub clause. Amendment 2 removes text superseded by BS EN 22475-1:2006 and makes reference to the relevant standard for each affected sub clause.

Chalk is logged in general accordance with Lord et al (2002) Ciria C574. Rock strength descriptors are based on Ciria C574 and do not comply with rock strength ranges quoted in BS 5930 (1999) Amendment No. 2. Where possible, dynamic samples in chalk have been logged in broad accordance with Ciria C574; descriptions and gradings should be treated with caution given the potential for sample disturbance.

For mixed soils the proportions of secondary constituents have been described using the following terms:

Description before SOIL NAME	SOIL NAME	
	SAND or GRAVEL	CLAY or SILT
slightly *	< 5%	< 35%
*	5 – 20%	35 – 65%
very *	> 20%	> 65%

* clayey, silty, sandy or gravelly as appropriate

For rocks the term fracture has been used to identify a mechanical break within the core. Where possible incipient and drilling induced fractures have been excluded from the assessment of the fracture state. Where doubt exists, a note has been made in the descriptions. All fractures are considered to be continuous unless otherwise reported.

General Comments

The process of drilling and sampling will inevitably lead to disturbance, mixing or loss of material in some soils and rocks.

Indicated water levels are those recorded during the progress of drilling in open or cased boreholes and may not represent standing water levels.

Legends are drawn in accordance with BS 5930:1999 incorporating Amendment No. 2

All depths are measured along the axis of the borehole and are related to ground level at the point of entry.

Made Ground is readily identifiable when, within the material make up, man made constituents are evident. Where the Made Ground appears to be reworked natural material the differentiation between in situ natural deposits and Made Ground is much more difficult to ascertain. The interpretation of Made Ground within the logs should therefore be treated with caution.

Geotechnical Engineering Limited

BOREHOLE LOG

BH01

CLIENT TERRA FIRMA LLP

SITE RYDON RD, BROMESBERROW HEATH

Start Date 12 October 2010

End Date 12 October 2010

Sheet 1 of 2

Scale 1 : 100

Depth 30.00 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range	instru -ment	description	depth (m)	reduced level (m)	legend
12/10/10 0800hrs							Open holed - Reworked reddish brown SAND grading to SANDSTONE			
								5.00		
							Open holed - Reddish brown SANDSTONE			
							Continued Next Page	{16.00}		

EQUIPMENT: Geotechnical Pioneer rig.

METHOD: Dynamic sampled (128mm) 0.00-4.90m. Open hole drilled with airflush (125mm) 4.90-30.00m.

CASING: 140mm diam to 4.90m.

BACKFILL: On completion, a slotted standpipe (50mm) was installed to 30.00m, granular response zone 15.00-30.00m, bentonite seal 0.30-15.00m, concrete and raised cover 0.00-0.30m.

EXPLORATORY HOLE LOGS SHOULD BE READ IN CONJUNCTION WITH KEY SHEETS

water strike (m) casing (m) rose to (m) time to rise (min) remarks

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BOREHOLE LOG

BH01

CLIENT TERRA FIRMA LLP

SITE RYDON RD, BROMESBERROW HEATH

Start Date 12 October 2010

End Date 12 October 2010

Sheet 2 of 2

Scale 1 : 100

Depth 30.00 m

progress date/time water depth	sample no & type	depth (m) from	depth (m) to	casing depth (m)	test type & value	samp. /core range		instru -ment	description	depth (m)	reduced level (m)	legend
12/10/10 1715hrs 25.96m									Borehole completed at 30.00m.	30.00 {36.00}		

water strike (m)	casing (m)	rose to (m)	time to rise (m)	remarks
25.90	4.90	25.83	15	

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BOREHOLE LOG

BH01A

CLIENT TERRA FIRMA LLP

SITE RYDON RD, BROMESBERROW HEATH

Start Date 14 October 2010

End Date 14 October 2010

Sheet 1 of 1

Scale 1 : 100

Depth 15.10 m

progress date/time water depth	sample no & type	depth (m) from	depth (m) to	casing depth (m)	test type & value	samp. /core range	instru -ment	description	depth (m)	reduced level (m)	legend
14/10/10 0800hrs								Open holed - Reworked reddish brown SAND grading to SANDSTONE			
									3.00		
								Open holed - Reddish brown SANDSTONE			
14/10/10 1130hrs dry									15.10		
								Borehole completed at 15.10m.	{16.00}		

EQUIPMENT: Geotechnical Pioneer rig.

METHOD: Dynamic sampled (128mm) 0.00-3.00m. Open hole drilled with airflush (125mm) 3.00-15.10m.

CASING: Not used.

BACKFILL: On completion, a slotted standpipe (50mm) was installed to 15.10m, granular response zone 0.80-15.10m, bentonite seal 0.30-0.80m, concrete and raised cover 0.00-0.30m.

EXPLORATORY HOLE LOGS SHOULD BE READ IN CONJUNCTION WITH KEY SHEETS

water strike (m)	casing (m)	rose to (m)	time to rise (min)	remarks
				Groundwater not encountered.

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BOREHOLE LOG

BH02

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SITE RYDON RD, BROMESBERROW HEATH — Sheet 1 of 2

Start Date 13 October 2010 — Scale 1 : 100

End Date 13 October 2010 — Depth 30.10 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range	instru -ment	description	depth (m)	reduced level (m)	legend
13/10/10 0800hrs							Open holed - Reworked reddish brown SAND grading to SANDSTONE			
								1.50		
							Open holed - Reddish brown SANDSTONE			
							Continued Next Page	{16.00}		

EQUIPMENT: Geotechnical Pioneer rig.

METHOD: Dynamic sampled (128mm) 0.00-1.50m. Open hole drilled with airflush (125mm) 1.50-30.10m.

CASING: 140mm diam to 9.30m.

BACKFILL: On completion, a slotted standpipe (50mm) was installed to 30.10m, granular response zone 0.80-30.10m, bentonite seal 0.30-0.80m, concrete and raised cover 0.00-0.30m.

EXPLORATORY HOLE LOGS SHOULD BE READ IN CONJUNCTION WITH KEY SHEETS

water strike (m) casing (m) rose to (m) time to rise (min) remarks

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BOREHOLE LOG

BH02

CLIENT TERRA FIRMA LLP

SITE RYDON RD, BROMESBERROW HEATH

Start Date 13 October 2010

End Date 13 October 2010

Sheet 2 of 2

Scale 1 : 100

Depth 30.10 m

progress date/time water depth	sample no & type	depth (m) from	depth (m) to	casing depth (m)	test type & value	samp. /core range		instru -ment	description	depth (m)	reduced level (m)	legend
13/10/10 1700hrs 25.32m									Borehole completed at 30.10m.	30.10		
										{36.00}		

water strike (m)	casing (m)	rose to (m)	time to rise (m)	remarks
25.40	0.00	25.37	20	

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BOREHOLE LOG

BH03

CLIENT TERRA FIRMA LLP

SITE RYDON RD, BROMESBERROW HEATH — Sheet 1 of 3

Start Date 14 October 2010 — Scale 1 : 100

End Date 15 October 2010 — Depth 43.10 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range	instru -ment	description	depth (m)	reduced level (m)	legend
14/10/10 1130hrs							Open holed - Reworked reddish brown SAND grading to SANDSTONE			
								1.50		
							Open holed - Reddish brown SANDSTONE			
							Continued Next Page	{16.00}		

EQUIPMENT: Geotechnical Pioneer rig.

METHOD: Dynamic sampled (128mm) 0.00-1.50m. Open hole drilled with airflush (125mm) 1.50-43.10m.

CASING: Not used.

BACKFILL: On completion, a slotted standpipe (50mm) was installed to 43.10m, granular response zone 0.80-43.10m, bentonite seal 0.30-0.80m, concrete and raised cover 0.00-0.30m.

EXPLORATORY HOLE LOGS SHOULD BE READ IN CONJUNCTION WITH KEY SHEETS

water strike (m) casing (m) rose to (m) time to rise (min) remarks

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Geotechnical Engineering Limited

BOREHOLE LOG

BH03

CLIENT TERRA FIRMA LLP

SITE RYDON RD, BROMESBERROW HEATH

Start Date 14 October 2010

End Date 15 October 2010

Sheet 2 of 3

Scale 1 : 100

Depth 43.10 m

progress date/time water depth	sample no & type	depth (m) from	depth (m) to	casing depth (m)	test type & value	samp. /core range		instru -ment	description	depth (m)	reduced level (m)	legend
14/10/10 1700hrs Dry												
15/10/10 0800hrs Dry												
									Continued Next Page	{36.00}		

water strike (m)	casing (m)	rose to (m)	time to rise (m)	remarks
34.20	0.00	34.28	20	

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BOREHOLE LOG

BH03

CLIENT TERRA FIRMA LLP

SITE RYDON RD, BROMESBERROW HEATH

Start Date 14 October 2010

End Date 15 October 2010

Sheet 3 of 3

Scale 1 : 100

Depth 43.10 m

progress date/time water depth	sample no & type	depth (m) from	depth (m) to	casing depth (m)	test type & value	samp. /core range		instru -ment	description	depth (m)	reduced level (m)	legend
15/10/10 1300hrs 32.10m												
									Borehole completed at 43.10m.	43.10		
										{56.00}		

water strike (m) casing (m) rose to (m) time to rise (m) remarks

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BOREHOLE LOG

BH04

CLIENT	TERRA FIRMA LLP		
SITE	RYDON RD, BROMESBERROW HEATH	Sheet	1 of 2
Start Date	15 October 2010	Scale	1 : 100
End Date	18 October 2010	Depth	35.70 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range	instru -ment	description	depth (m)	reduced level (m)	legend
15/10/10 1300hrs							Open holed - Reworked reddish brown SAND grading to SANDSTONE			
								3.00		
							Open holed - Reddish brown SANDSTONE			
15/10/10 1700hrs Dry										
18/10/10 0800hrs 12.00m							Continued Next Page	{16.00}		

EQUIPMENT: Geotechnical Pioneer rig.

METHOD: Dynamic sampled (128mm) 0.00-2.70m. Open hole drilled with airflush (125mm) 2.70-35.70m.

CASING: 140mm diam to 2.70m.

BACKFILL: On completion, a slotted standpipe (50mm) was installed to 35.20m, granular response zone 0.80-35.70m, bentonite seal 0.30-0.80m, concrete and raised cover 0.00-0.30m.

EXPLORATORY HOLE LOGS SHOULD BE READ IN CONJUNCTION WITH KEY SHEETS

water strike (m)	casing (m)	rose to (m)	time to rise (min)	remarks
12.00	2.70			Standing level 18/10/10 morning

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BOREHOLE LOG

BH04

CLIENT TERRA FIRMA LLP

SITE RYDON RD, BROMESBERROW HEATH

Start Date 15 October 2010

End Date 18 October 2010

Sheet 2 of 2

Scale 1 : 100

Depth 35.70 m

progress date/time water depth	sample no & type	depth (m) from	depth (m) to	casing depth (m)	test type & value	samp. /core range		instru -ment	description	depth (m)	reduced level (m)	legend
18/10/10 1700hrs 33.15m									Borehole completed at 35.70m.	35.70 {36.00}		

water strike (m)	casing (m)	rose to (m)	time to rise (m)	remarks
31.70	2.70	33.10	25	

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GAS AND GROUNDWATER LEVELS

CLIENT TERRA FIRMA LLP

SITE RYDON RD, BROMESBERROW HEATH

borehole /trial pit no.	date & time	barometric pressure (mb)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)
BH01	22/10/10 12:00	1014	1.8	0.0	19.4	0.0	0.0		16	
BH01	22/10/10 12:01		1.8	0.0	19.3	0.0	0.0			
BH01	22/10/10 12:01		1.8	0.0	19.3	0.0	0.0			
BH01	22/10/10 12:02		1.8	0.0	19.3	0.0	0.0			
BH01	22/10/10 12:02		1.8	0.0	19.3	0.0	0.0			
BH01	22/10/10 12:03		1.8	0.0	19.3	0.0	0.0			
BH01	22/10/10 12:03		1.8	0.0	19.3	0.0	0.0			
BH01	22/10/10 12:04		1.8	0.0	19.3	0.0	0.0			
BH01	22/10/10 12:04		1.8	0.0	19.3	0.0	0.0			
BH01	22/10/10 12:05		1.8	0.0	19.3	0.0	0.0			
BH01	22/10/10 12:05									26.12

general remarks:

# denotes result exceeding capacity of gas monitoring equipment

CONTRACT	CHECKED
24672	

Geotechnical Engineering Limited

GAS AND GROUNDWATER LEVELS

CLIENT TERRA FIRMA LLP

SITE RYDON RD, BROMESBERROW HEATH

borehole /trial pit no.	date & time	barometric pressure (mb)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)
BH01A	22/10/10 12:10	1014	1.0	0.0	20.2	0.0	0.0		16	
BH01A	22/10/10 12:10		1.0	0.0	20.1	0.0	0.0			
BH01A	22/10/10 12:11		1.0	0.0	20.1	0.0	0.0			
BH01A	22/10/10 12:11		1.0	0.0	20.1	0.0	0.0			
BH01A	22/10/10 12:12		1.0	0.0	20.0	0.0	0.0			
BH01A	22/10/10 12:12		1.0	0.0	20.0	0.0	0.0			
BH01A	22/10/10 12:13		1.0	0.0	20.0	0.0	0.0			
BH01A	22/10/10 12:13		1.0	0.0	20.0	0.0	0.0			
BH01A	22/10/10 12:14		1.1	0.0	20.0	0.0	0.0			
BH01A	22/10/10 12:14		1.1	0.0	19.9	0.0	0.0			
BH01A	22/10/10 12:15									Dry

general remarks:

# denotes result exceeding capacity of gas monitoring equipment

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Geotechnical Engineering Limited

GAS AND GROUNDWATER LEVELS

CLIENT TERRA FIRMA LLP

SITE RYDON RD, BROMESBERROW HEATH

borehole /trial pit no.	date & time	barometric pressure (mb)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)
BH02	22/10/10 12:40	1014	1.6	0.0	19.5	0.0	0.0		17	
BH02	22/10/10 12:40		1.6	0.0	19.5	0.0	0.0			
BH02	22/10/10 12:41		1.7	0.0	19.5	0.0	0.0			
BH02	22/10/10 12:41		1.7	0.0	19.5	0.0	0.0			
BH02	22/10/10 12:42		1.7	0.0	19.5	0.0	0.0			
BH02	22/10/10 12:42		1.7	0.0	19.5	0.0	0.0			
BH02	22/10/10 12:43		1.7	0.0	19.5	0.0	0.0			
BH02	22/10/10 12:43		1.7	0.0	19.5	0.0	0.0			
BH02	22/10/10 12:44		1.7	0.0	19.5	0.0	0.0			
BH02	22/10/10 12:44		1.7	0.0	19.5	0.0	0.0			
BH02	22/10/10 12:45									25.45

general remarks:

# denotes result exceeding capacity of gas monitoring equipment

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Geotechnical Engineering Limited

GAS AND GROUNDWATER LEVELS

CLIENT TERRA FIRMA LLP

SITE RYDON RD, BROMESBERROW HEATH

borehole /trial pit no.	date & time	barometric pressure (mb)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)
BH03	22/10/10 13:30	1010	0.2	0.0	21.1	0.0	0.0		13	
BH03	22/10/10 13:30		0.2	0.0	21.1	0.0	0.0			
BH03	22/10/10 13:31		0.2	0.0	21.1	0.0	0.0			
BH03	22/10/10 13:31		0.2	0.0	21.1	0.0	0.0			
BH03	22/10/10 13:32		0.2	0.0	21.1	0.0	0.0			
BH03	22/10/10 13:32		0.2	0.0	21.1	0.0	0.0			
BH03	22/10/10 13:33		0.2	0.0	21.1	0.0	0.0			
BH03	22/10/10 13:33		0.2	0.0	21.1	0.0	0.0			
BH03	22/10/10 13:34		0.2	0.0	21.1	0.0	0.0			
BH03	22/10/10 13:34		0.2	0.0	21.1	0.0	0.0			
BH03	22/10/10 13:35									32.60

general remarks:

# denotes result exceeding capacity of gas monitoring equipment

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Geotechnical Engineering Limited

GAS AND GROUNDWATER LEVELS

CLIENT TERRA FIRMA LLP

SITE RYDON RD, BROMESBERROW HEATH

borehole /trial pit no.	date & time	barometric pressure (mb)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)
BH04	22/10/10 13:00	1010	0.5	0.0	20.5	0.0	0.0		14	
BH04	22/10/10 13:00		0.5	0.0	20.5	0.0	0.0			
BH04	22/10/10 13:01		0.5	0.0	20.5	0.0	0.0			
BH04	22/10/10 13:01		0.5	0.0	20.6	0.0	0.0			
BH04	22/10/10 13:02		0.5	0.0	20.6	0.0	0.0			
BH04	22/10/10 13:02		0.5	0.0	20.6	0.0	0.0			
BH04	22/10/10 13:03		0.5	0.0	20.6	0.0	0.0			
BH04	22/10/10 13:03		0.5	0.0	20.6	0.0	0.0			
BH04	22/10/10 13:04		0.5	0.0	20.7	0.0	0.0			
BH04	22/10/10 13:04		0.5	0.0	20.7	0.0	0.0			
BH04	22/10/10 13:05									33.50

general remarks:

# denotes result exceeding capacity of gas monitoring equipment

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Appendix B
Monitoring Procedures

BACKGROUND

This method statement describes the procedures to be followed when monitoring or sub-sampling from installations. Monitoring is undertaken to record data and seasonal trends of water levels and / or gas concentrations. Samples will be obtained after wells are developed and / or purged and will be taken using various containers and bailers. Sub-samples will be removed from site for subsequent laboratory testing. The arrangements for the development, purging and sub-sampling will generally depend on the conditions encountered and the laboratory analysis likely to be undertaken.

Following completion of each respective borehole and associated installation, standpipes may be developed or commissioned before any water samples are taken. Prior to subsequent water sampling, each installation may be suitably purged (or micro-purged should contamination be noted). Development and purging will be carried out in accordance with the safe system of work detailed below.

The types of instrumentation to be monitored are:

- Open tube groundwater and / or gas standpipes.

Water samples are generally taken from open tube standpipes, but may also be obtained from:

- Standing water bodies, ponds, lagoons, streams, rivers, canals and lakes; or
- Manholes, drains, culverts, wells and other man-made catchments.

Confined spaces will not be accessed by site personnel. No sampling will be undertaken from open water bodies unless adequate, safe access, providing protection from falls from height (i.e., fixed handrails) are available.

Elements of this Method Statement shown in italics may only apply according to site specific and contractual arrangements. This Method Statement should be read in conjunction with the relevant Risk Assessment.

RESOURCES

POSITION	RESPONSIBILITIES	TRAINING AND QUALIFICATIONS
Site engineer or technician	Undertake instrument monitoring and sampling.	CSCS Asbestos Awareness Safe Driving Awareness Manual Handling. Emergency First Aid at Work Fire Awareness. Banksman Awareness

TASK SPECIFIC PLANT / VEHICLES / EQUIPMENT

The following vehicles and equipment will be utilised for instrument monitoring and sampling:

- Site plans and field notebook.
- Dipmeter.
- Hand tools and stopwatch.
- *Gas analyser and flow pod, Photo Ionisation Detector (PID), multi-parameter meter*
- *Oil / Water Interface meter.*
- *In hole bailers*
- *Petrol operated submersible pump (for development, purging and sampling).*
- *Battery operated submersible (WaSP) pump (for development, purging and sampling).*

- *Peristaltic pump for shallow groundwater micro-purging and sampling where contamination is present.*
- *Sampling containers, cool boxes, and ice packs.*
- *Clean water (in 20ltr drums).*
- *Garden mesh trolley cart or wheelbarrow.*

TASK SPECIFIC MATERIALS INCLUDING COSHH

The following task specific materials will be used during works:

- *Petrol.*

TASK SPECIFIC PERSONAL PROTECTIVE EQUIPMENT (PPE) / RESPIRATORY PROTECTIVE EQUIPMENT (RPE)

In addition to mandatory 5-point PPE (safety hard hat, light eye protection, high visibility clothing, safety boots and gloves), the following additional task specific PPE will be provided and worn by site staff as and when indicated.

Grade / type of PPE required		*Task*
Eye protection		
Gloves 	*Nitrile*	*Water sampling and for refuelling*
RPE		
Ear protection		
Overalls		

The adequacy of PPE will be continually monitored, and works shall cease if the levels of protection are deemed inadequate by any member of the site teams.

SAFE SYSTEM OF WORK

This safe system of work will be undertaken sequentially in the order shown unless otherwise instructed / necessary:

1. All equipment will be inspected prior to use and the inspection will be documented, where applicable. The GEL site engineer / technician will ensure that the equipment is calibrated (where necessary) and that all equipment is suitable, fit for purpose, has sufficient power (full batteries or fully charged) to prevent any unnecessary journeys.
2. Access routes will be inspected to identify any hazards (poor underfoot conditions, rough terrain, waterlogged ground, obstructions, adverse cambers, slip, trip and fall hazards etc.) and the information will be noted. A dynamic risk assessment will be completed if the site conditions are different to those anticipated at the planning stage.
3. The GEL site engineer / technician will ensure all the correct equipment is available prior commencing a visit.
4. The visit will be undertaken in a considerate manner without compromise to site safety. All exploratory hole locations will be approached on foot unless access tracks or suitable routes exist for a vehicle. Any access gates, fencing and security barriers will be open and closed for the minimum duration. They will be left closed, irrespective of how they are found.
5. Where vehicle access is not possible, all equipment will be carried by hand, in suitable fitted rucksack or on a suitable cage trolley or wheelbarrow. Only essential equipment will be taken to the work location. Walking through thick vegetation or in any area where the underfoot conditions cannot be predicted will be avoided.
6. Detailed site plans and Information about the installation construction will be available on site and will be checked against any markings in the headworks.

7. Staff will visually inspect the work site for sharps. Sharps will not be touched. Where contact is made inadvertently, site staff will irrigate wounds with fresh potable water and seek urgent medical attention.
8. Monitoring will be undertaken in line with the Company training policy, the technical Specification and in accordance with the manufacturer's instructions for any equipment used. This typically includes:

    a) Switch on gas box and select flow.
    b) Ensure gas tap is in off position, remove any dust/dirt/water from the top – connect gas box to gas tap.
    c) Zero gas box, press sample and open gas tap.
    d) Take flow readings each minute for 5mins. Also note atmospheric pressure, temperature and weather conditions.
    e) Close gas tap. Select gas sampling menu on gas box.
    f) Re-open gas tap and start gas sampling pump.
    g) Take readings of various gases each minute for 10mins.
    h) Close gas tap, remove gas box and purge for 30 seconds in fresh air.

    i) Remove gas tap and determine water level using dipmeter.
    j) Using a separate bailer for each borehole – purge 3x well volume of water.
    k) Prepare 2x 300ml samples bottles and 2x Vials.
    l) Collect sample of water in all four above receptacles ensuring no air bubbles present.
    m) Replace gas tap after ensuring there are no obstructions in the nozzle and that its closed.

9. While development or purging of sample locations is being undertaken, the GEL site engineer / technician will ensure that adequate precautions are taken to avoid the spread of contamination and the protection of other operatives.
10. All cables and tapes will be wound back on their reel on completion to prevent slips and trips between locations, or access and egress.
11. Where glass or jars are used, suitable and sufficient transportation materials (bubble wrap and a cool box) will be available. Latex gloves with good grip will be worn when handling glass containers.
12. On completion of sampling and monitoring, the area will be made safe by replacing and locking any covers and securing the work area.

ENVIRONMENTAL PROTECTION

The following environmental protection arrangements will be in place:

- *Refueling will be undertaken off-site wherever possible. If equipment needs topping up it will be undertaken from suitable containers, using funnels and over a spill mat.*
- Any surplus water which is generated during the sampling process should be disposed of by:
    - Discharge to ground adjacent to the instrument where no gross contamination exists.
    - *In certain circumstances, it may be acceptable to discharge development or purged water to a soakaway / drain or to a ditch at a distance from the borehole provided the appropriate permission is obtained from the operator / landowner. Activated carbon filters may be used for the purposes of removing moderate concentrations of hydrocarbon contaminants.*
    - *Collection and off-site disposal in full accordance with the appropriate legal requirements. Storage will be in 5-gallon containers. Purged or development water will be stored on site pending the results of the analyses which can then be utilised in the classification of the water as a waste for appropriate disposal*.

HEALTH, SAFETY AND ENVIRONMENTAL HOLD POINTS			
A "Hold Point" is an event experienced by the site team whereby they will stop the works, undertake a dynamic risk assessment and if necessary, seek clarification on how to proceed from a senior or specialist member of staff before continuing. Hold points may include:			
NUMBER	HOLD POINT DESCRIPTION	ACTIONS REQUIRED	BY WHOM
1	Where a deviation from a standard working practice occurs.	Cease work and complete an onsite dynamic risk assessment.	GEL site engineer / technician
2	Encountering grossly contaminated water within boreholes	Stop work and seek clarification from the GEL (or Client) site supervisor before proceeding.	GEL site engineer / technician

REFERENCE DOCUMENTS	
1	COSHH assessments
2	GEL Risk Register
3	GEL Dynamic Risk Assessment
4	GEL Lone working procedure