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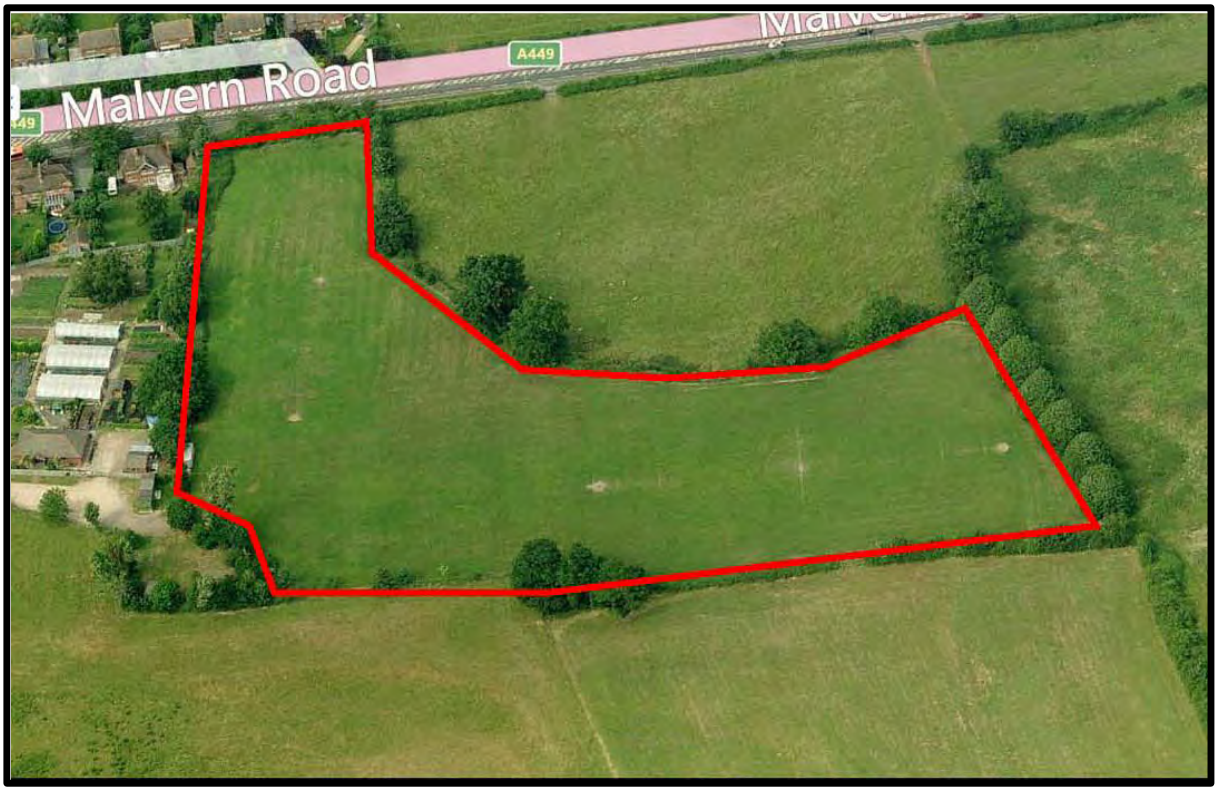
PHASE 2
CONTAMINATION ASSESSMENT REPORT
FOR
POWICK PAVILION, HAMILTON CLOSE, POWICK WR2 4NH



PREPARED FOR
POWICK PARISH COUNCIL

Report No. 4043/2

Report Production Record		
Report No	4043/2	
Site Name	Powick Pavilion, Hamilton Close, Powick WR2 4NH	
Client	Powick Parish Council	
Report on	Contamination Assessment	
Issue No. / Status	1	Final
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Date	7 March 2017	

Report Revision Record		
Issue No.	**Date**	**Revision Details**

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PHASE 2 CONTAMINATION ASSESSMENT REPORT FOR POWICK PAVILION, HAMILTON CLOSE, POWICK PREPARED FOR POWICK PARISH COUNCIL

1 INTRODUCTION

1.1 It is proposed to develop part of the recreational playing fields at Powick to comprise a sports pavilion complete with associated car parking. To address Part (ii) of Condition 6 of planning application 13/00401/FUL, a site investigation was requested the objectives of which were to confirm the ground profile and carry out a detailed quantitative contamination risk assessment with regard to potential impacts to human health and/or controlled waters. In line with the client's instructions there was no requirement to undertake a geotechnical assessment of the ground, or make foundation recommendations.

1.2 The research and investigations undertaken as part of this report supplement the existing Phase 1 desk study report (WA ref: 4043, dated 7 June 2016), to which reference should be made, although pertinent information from that document has been extracted and incorporated into this report where considered necessary.

1.3 This Geo-environmental assessment has been carried out in accordance with the Environment Agency (EA) and NHBC publication "Guidance for the Safe Development of Housing on Land Affected by Contamination" (2000), BS10175:2011 "Code of Practice for the Investigation of Potentially Contaminated Sites" and EA document CLR 11 "Model Procedures for the Management of Land Contamination".

2 BACKGROUND SETTING

2.1 This section summarises pertinent background site information previously presented in the Phase 1 report. For a full analysis of geo-environmental information, reference should be made to the previously submitted Phase 1 document.

- Centred on National Grid Reference 382277-250807 the site is located on the southern outskirts of the village Powick, some 5.0km southwest of Worcester city centre in Worcestershire, as shown on drawing 4043/2/1.
- The site comprises an 'L' shaped parcel of land occupied by grassed sports pitches. A storage container is present on the western boundary (presumably containing 'sports ground equipment'), with dilapidated spectator shelters noted towards the east of the site. To the southwest the land appears to be used as an ad hoc maintenance area, containing stockpiles of wood chippings, hard-core/tarmac scalpings, and the remains of a bonfire although it has been established that this area falls outside of the proposed development area.
- Ordnance Survey mapping and Google Earth satellite imagery record an elevation of approximately 47m AOD across the proposed development area, with no significant changes in gradient.
- Geological mapping indicates the site to be underlain by "bedrock" of the Sidmouth Mudstone Formation (SIM), part of the Mercia Mudstone Group. This is overlain by superficial deposits of River Terrace Deposits known locally as the Bushley Green Member (sands and gravels). There is no recorded made ground or geological faulting recorded within influencing distance.
- Both the SIM and the overlying superficial deposits are classified as "Secondary B" aquifers, described as lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering, but are not capable of supplying water at a 'strategic' scale. There are no consented groundwater abstractions recorded on the EA website, and the site is not located within a groundwater Source Protection Zone (SPZ).
- Historical research has shown the site to have been undeveloped agricultural land from earliest available mapping (1886). The site is currently used as sport pitches/playing fields, although it is not known when agricultural activity ceased. The site currently comprises a predominantly grassed 'L' shaped plot of land. A walkover inspection revealed several stock piles of material associated with site maintenance (wooden fence posts etc), as well as a dilapidated spectator shelter and off-site bonfire remains. A search of EA records revealed the field immediately south of the site to be a former landfill, and previous investigations undertaken by this Practice within that tipping area have proved it to be gassing (see below).
- The EA landfill register shows the 'Laser Engineering' landfill immediately south of the site, which was licenced to accept inert waste from November 1995 through to

May 1996. Previous extensive investigations undertaken by this Practice across the landfill (WA report ref. 3426 and 3426/2) reveals that the landfill infilled a valley feature with inert demolition rubble from the previously adjacent hospital, with negligible putrescible material encountered. Gas monitoring undertaken as part of those investigations found the landfill to be gassing, recorded maximum concentrations in the region of 6% carbon dioxide and 3% methane with <1l/hr flow rate.

- According to the Building Research Establishment (BRE) document "Guidance on Protective Measures for New Buildings" the site lies in an area where radon protection is not required within new development.
- Environment Agency records indicate that there have been no pollution incidents either on or within potential influencing distance of the site, nor are there any nearby industrial premises which could lead to pollution from the following categories: fuel and power, metal, mineral, chemical, waste, water or radioactive.

3 PROPOSED DEVELOPMENT

3.1 It is proposed to partially develop recreational playing fields off Hamilton Close, Powick to comprise a sports pavilion complete with associated car park. The proposed development layout has been reproduced as drawing 4043/2/2.

4 PRELIMINARY RISK ASSESSMENT AND CONCEPTUAL SITE MODEL

4.1 The site and its immediate surroundings have been assessed in terms of historical and current land use together with the environmental, geological and hydrogeological setting. In view of the foregoing the potential sources and the **principal contaminants of concern** are presented in Table 1 below.

TABLE 1: POTENTIAL SOURCES AND PRINCIPAL CONTAMINANTS OF CONCERN

	Potential Sources	Principal Contaminants of Concern
ON-SITE	General near surface made ground / topsoil / cultivated soils	Toxic and phytotoxic metals, and PAH compounds
OFF-SITE	Bonfire ash	Toxic and phytotoxic metals, and PAH compounds
	Adjacent landfill to the south	Methanogenic gases

4.2 Although strictly classifying as a commercial development, given that the sports pavilion will likely also be utilised by youth teams, the **critical receptor** is identified as a female child, age class 6 – 16, and therefore our assessment has been progressed adopting a conservative residential (without vegetable uptake) end-use.

4.3 The preliminary Conceptual Site Model presented in the Phase 1 desk study report is replicated in Figure 1 below for ease of reference. This illustrates how the presence of principal contaminants of concern, if proven, can be translated into **potential pollutant linkages** to future site users and local environmental receptors such as groundwater.

FIG 1: PRELIMINARY CONCEPTUAL SITE MODEL (NTS)

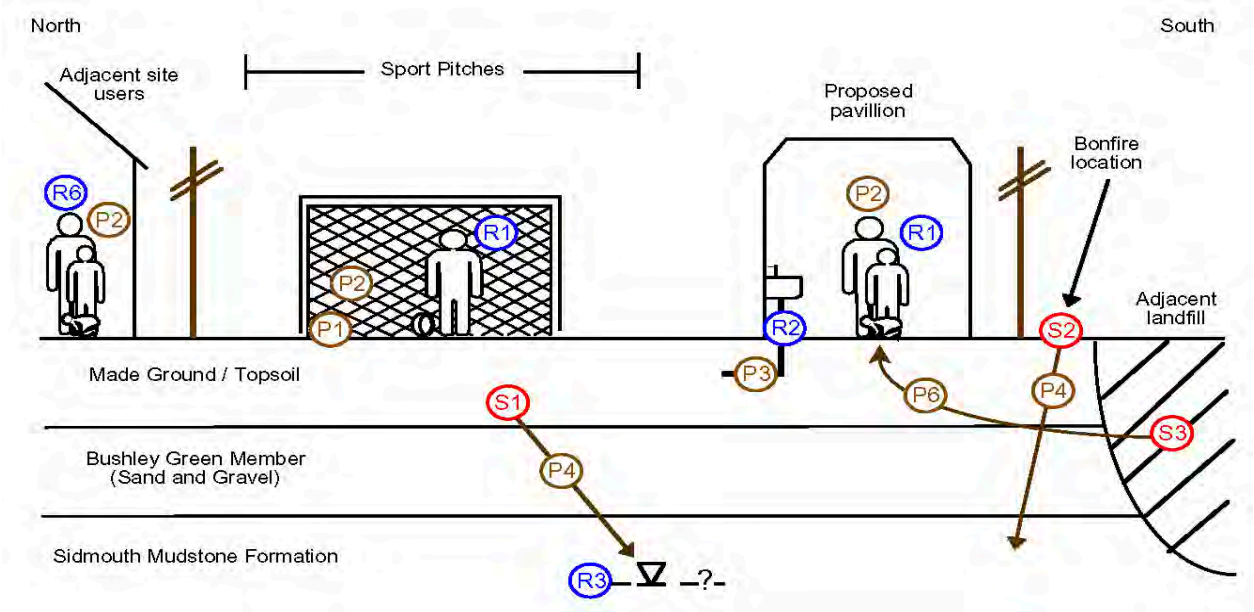


TABLE 2: SUMMARY OF PRELIMINARY POTENTIAL POLLUTANT LINKAGES

Potential Sources	Pathways	Receptors R1	R2	R3	R4	R5	R6	Comments	Preliminary Risk Assessment
ON-SITE									
S1	P1	X						Proposed commercial development with surrounding playing fields to be retained	Very low
	P2	X					X		
	P3		X						
	P4			X	X				
	P5								
	P6								
	P7								
OFF-SITE									
S2	P1	X						Proposed commercial development with surrounding playing fields to be retained Bonfire residue located off-site	Very low
	P2	X					X		
	P3		X						
	P4			X	X				
	P5								
	P6								
	P7								
S3	P1							Landfill known to be gassing, extent of lateral migration unknown	High
	P2								
	P3								
	P4								
	P5								
	P6	X					X		
	P7								

SOURCES	**S1**	General near surface topsoil/made ground/cultivated soils
	S2	Former bonfire location
	S3	Adjacent former landfill (to the immediate south)
PATHWAYS	**P1**	Direct dermal contact or ingestion via soil
	P2	Inhalation of dust and vapours
	P3	Permeation into new water supply pipework
	P4	Vertical leaching of leachable contaminants in unsaturated zone and lateral migration in saturated zone
	P5	Direct contact with high sulphate-bearing clay
	P6	Landfill gas migration through unsaturated zone and accumulation within confined spaces
	P7	Radon gas migration through unsaturated zone and accumulation within confined spaces
RECEPTORS	**R1**	Future site users
	R2	Potable water supply
	R3	Groundwater (bedrock and superficial soils classify as Secondary B aquifers)
	R4	Surface waters (closest is ‘issue’ 200m south)
	R5	Proposed building incl. concrete foundations
	R6	Adjacent site users

4.4 Given the above and preceding discussions, intrusive ground investigation has been undertaken, targeted to reflect both former/existing site usage though also to provide overall site coverage.

4.5 The scope of contamination testing carried out is discussed in Sections 5.5 and 5.6. All results have been incorporated into an appropriate risk assessment to determine risk levels to the obvious receptors in the form of future site users and groundwater quality, as well as those less obvious such as future buildings and infrastructure, such that any necessary remedial measures can be identified and recommended to ensure that the developed site will be "fit for purpose".

5 GROUND INVESTIGATION REPORT

Site Works

5.1 The Phase 2 intrusive investigation took place on 17th February 2017 by way of window-sample borehole drilling, supplemented by a small number of manually-excavated trial pits. The locations of all exploratory holes were selected by this Practice in order to obtain good coverage across the entire site and/or target any specific features identified in the Phase 1 researches. Positions were subsequently marked out on site (again by this Practice) using on and off-site reference points, and are indicated on drawing 4043/2/2. The client and architect reported that there were no known buried services beneath the site; notwithstanding, prior to commencement of intrusive works a CAT electrical service scanner was deployed with hand-dug pits excavated at all borehole positions prior to commencement of drilling; no buried services were encountered.

5.2 Four windowless-sample boreholes (WS1-WS4) were drilled to depths of up to 3.45m using a Terrier 2002 window-sampling rig. The boreholes were logged by an engineering geologist from this Practice in accordance with Eurocode 7 (BS EN ISO 14688-1:2002 and 14688-2:2004), with representative samples taken for geo-environmental testing as appropriate. Following completion of logging and sampling all boreholes were installed with gas/water monitoring wells with response zones between 1.0 and 3.0m depth as shown on the respective borehole logs. Initial gas/water monitoring visits were undertaken on 23rd and 28th February and 6th March 2017. Results are presented in Appendix 5 and discussed in Sections 6.5 – 6.10.

5.3 Boreholes were supplemented by four manually excavated trial pits (TP1 – TP4), used to establish near-surface ground conditions and obtain samples for contamination analysis, thereby providing good overall coverage of the proposed development area (soft-landscaping within/surrounding proposed car park areas).

Laboratory Testing - Contamination

5.4 The contamination sampling scheme was conducted in accordance with BS10175:2011, with sampling providing general spatial coverage across the site as well as targeting specific features identified during the Phase 1 report / reconnaissance. All test results have been incorporated into an appropriate risk assessment to determine risk levels to the receptors, such that any necessary remedial measures can be identified and recommended to ensure that the proposed development site is "fit for use".

5.5 Representative samples of topsoil, made ground and natural undisturbed soil generally taken from the upper 1.0m of extracted ground were sent to UKAS accredited Scientific Analysis Laboratories in Manchester where analysis selectively comprised the following:

- Toxic and phytotoxic metals
- pH
- Speciated polyaromatic hydrocarbons (PAH)
- Soil organic matter (SOM)

5.6 In the absence of made ground, the potential risk to groundwater resources was determined by leachate analysis on a single sample of topsoil, with the scope of analysis comprising leachable toxic and phytotoxic metals and leachable PAH.

5.7 The certified laboratory test results are presented in Appendix 3 and for convenience these have also been summarised to facilitate comparison against relevant assessment criteria. All results and their implications upon the preliminary CSM are further discussed in Sections 6 and 7.

Discussion on Ground Conditions

5.8 The boreholes and trial pits have shown natural ground conditions to be commensurate with geological mapping, with all investigation points proving superficial gravelly sandy clay / clayey sand of the Bushley Green Member, underlain by stiff reddish-brown silty clay representative of the upper weathered mantle of the Sidmouth Mudstone Formation. A summary of the observed strata from this investigation is presented in Table 3 below, although for specific descriptions of ground conditions, reference should be made to the exploratory hole logs presented in Appendix 2.

TABLE 3: SUMMARY OF OBSERVED STRATA

Stratum	Base Depth (m)	Notes
TOPSOIL: mid to light brown, silty, organic topsoil with roots / rootlets and occasional gravel	0.2 – 0.3m	Encountered in all exploratory holes
CLAY / SAND: variable brown and reddish-brown, silty/sandy, gravelly clay and clayey sand	>0.8 – 1.78	Encountered in all exploratory holes
CLAY: stiff to very stiff reddish-brown, silty clay; becoming friable with depth, containing relict mudstone fabric (Sidmouth Mudstone Formation)	>3.45	Encountered to termination depth in WS1 – WS4
Perched water	**N/A** **TP4:** soil moist at approx. 0.75m depth	
Groundwater	**N/A – during investigation** **Post investigation monitoring:** WS1: dry WS2: 2.53m - dry WS3: 1.15 - 2.75m WS4: 1.64 – 2.05m	

5.9 Made ground was notably absent within the site, with surface soils instead comprising organic, silty/clayey topsoil containing roots/rootlets and occasional quartzitic gravel; there was no obvious evidence of significant contamination within site arisings.

5.10 Beneath topsoil deposits, horizons of stiff to very stiff reddish-brown silty clay were recorded to termination depth in all exploratory holes, constituting the near surface weathered mantle of the mapped Sidmouth Mudstone Formation.

5.11 With reference to Table 3, there was no evidence of perched water / groundwater water within any of the exploratory holes during the time that they remained open, although post investigation monitoring has recorded standing groundwater levels of between

1.15m and 2.75m in WS2 - WS4; WS1 remained dry. Perched/groundwater levels are of course subject to seasonal fluctuation according to prevailing weather conditions, and the situation encountered and described above could potentially change in the future, especially in a period of seemingly ever-apparent but unpredictable climate change.

6 CONTAMINATION RISK ASSESSMENT

Human Health

6.1 The contamination risk assessment has been carried out in general accordance with the methodology described within Appendix 3. Table 4 below presents a comparison of laboratory test results with guideline values (LQM/CIEH S4UL). The 'deterministic' CLEA software model (Version 1.07) has been used to generate Tier 2 site-specific assessment criteria (SSACs) as necessary, based upon contamination test results from this investigation.

TABLE 4: COMPARISON OF SOIL CHEMICAL TEST RESULTS WITH GUIDELINE VALUES

Determinant	Maximum Measured Concentration (mg/kg)	LQM/CIEH S4UL Residential without veg uptake (mg/kg)	Tests Undertaken (No.)	Exceedances (No.)	Notes
Arsenic	27	40	11	0	
Cadmium	<1	85	11	0	
Chromium	41	910*	11	0	
Lead	54	310**	11	0	
Mercury	<1	56	11	0	
Selenium	<3	430	11	0	
Nickel	37	180	11	0	
Copper	25	7,100	11	0	
Zinc	74	40,000	11	0	
Naphthalene	<0.1	5.6	1	0	
Fluorene	<0.1	3,800	1	0	
Benzo(a)Pyrene	0.2	3.2	1	0	
Fluoranthene	0.4	1,600	1	0	
Pyrene	0.3	3,800	1	0	

Determinant	Maximum Measured Concentration (mg/kg)	LQM/CIEH S4UL Residential without veg uptake (mg/kg)	Tests Undertaken (No.)	Exceedances (No.)	Notes
Benzo(a)anthracene	0.2	14	1	0	
Chrysene	0.2	31	1	0	
Benzo(b)fluoranthene	0.2	4	1	0	
Benzo(k)fluoranthene	0.1	110	1	0	

Notes:

* assumed all chromium on site is in trivalent form

** provisional C4SL

based upon SOM of 2.5% (based upon laboratory testing)

6.2 It will be seen from the summary sheet in Appendix 3 that concentrations of all individual metals fall below Tier 1 C4SL/S4UL levels. On the basis of the foregoing, progression to a Tier 2 assessment is considered unnecessary, with no requirement for further assessment or consideration of remedial measures to address metals concentrations.

6.3 In the absence of made ground, PAH analysis carried out upon a single sample of topsoil records a Benzo(a)Pyrene concentration (main risk driver) below the Tier 1 S4UL value of 3.2mg/kg, indicating no apparent requirement for remedial measures to address potential human health risk. All other individual (speciated) determinands similarly fall below respective S4UL's; the low level of Naphthalene in the sample indicates no specific requirement for the adoption of hydrocarbon vapour-proof membranes in proposed construction. Consideration has been given to the bonfire residue located to the south of the site entrance, although given its limited extent and position outside the proposed development area, any associated contaminative risk can be sensibly discounted.

6.4 In view of the site history and given that there was no visual or olfactory evidence of hydrocarbon impaction recorded in any of the exploratory holes, TPH analysis was considered unnecessary.

6.5 In addition to the above, there was similarly considered to be no risk and therefore no requirement to screen samples for asbestos content.

Landfill Gas and Radon Gas

6.6 The landfill gas risk assessment has been undertaken in general accordance with BS8485:2015 "Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings", and with reference to Construction Industry Research and Information Association (CIRIA) C665: 'Assessing risks posed by hazardous ground gases to buildings' (2007). To date three rounds of monitoring have been undertaken including two at 'favourable' low/falling atmospheric pressure. Note that further monitoring may be necessary since given the context C665 would normally require six rounds over a two to three month period, although based upon the uniformity of the concentrations presented below, monitoring to date is considered to represent a robust assessment.

6.7 As shown in Appendix 5 the recent monitoring of WS1 – WS4 has recorded nil methane and low concentrations of carbon dioxide (0.5% and 3.0%), with a maximum steady-state flow rate of 0.3 L/hr. A single anomalous flow rate of -9.4l/hr was initially recorded in WS3 during the last visit, although this is expected to be attributable to a high groundwater level essentially 'sealing-off' the borehole response zone and creating a vacuum in the well into which air was drawn at the start of the monitoring process. Notwithstanding, gas concentrations in that borehole were very low (0.0% methane, 0.5% carbon dioxide), thus the anomalous flow rate is considered unrepresentative of the gas regime and can sensibly be discounted.

6.8 On this basis the implied maximum characteristic gas situation (CS) is derived by consideration of the maximum hazardous gas flow rate calculated from each single monitoring well during the recent monitoring rounds, as shown in Table 5 below.

TABLE 5: SUMMARY GAS MONITORING RESULTS AND MAXIMUM CHARACTERISTIC SITUATION

BH No.	Maximum Steady State Flow (l/hr)	Maximum Peak Gas Concentrations (%)		Peak Hazardous Gas Flow Rate (l/hr)		Implied CS (l/hr)		Worst-Case CS (l/hr)	
		Carbon Dioxide	Methane	$Q_{hg}CO_2$	$Q_{hg}CH_4$	CO_2	CH_4	CO_2	CH_4
1	0.3	2.6	0	0.0078	0	1	1	1	1
2	0.0	3.0	0	0	0	1	1	1	1
3	0.1	1.4	0	0.0014	0	1	1	1	1
4	0.2	2.8	0	0.0056	0	1	1	1	1

Notes:

CS = equivalent to GSV in C665

Worst-Case CS based on maximum observed flow rate and concentrations from any borehole during latest Wilson Associates monitoring

6.9 In line with BS8485 guidance, Table 5 above indicates a CS1 rating for the site based upon the calculations of peak hazardous gas flow rates for individual boreholes, for which a gas protection score of 0 is required (proposed building classifies as Type C – medium risk) meaning there is a negligible gas regime identified and no requirement for gas protection measures.

6.10 Whilst it is acknowledged that the above assessment has been undertaken based upon three monitoring visits, recorded levels of both carbon dioxide and methane as well as flow-rate have been relatively consistent particularly during periods of 'favourable' low atmospheric pressure. It is considered therefore that this represents a robust assessment, and further monitoring would be unlikely to result in a higher characteristic situation for the site. As noted however the LPA may still require further monitoring to verify the assessment.

Controlled Waters

6.11 In the absence of made ground or groundwater (during the actual investigation), risk to controlled waters has been assessed by leachate analysis upon a single sample of topsoil (WS3/0.2m). It will be seen from Appendix 3 that there are no recorded/significant elevations of toxic/phytotoxic metals or PAH compounds above relevant WFD thresholds, which combined with the secondary (non-aquifer) status of the underlying SIM, the lack of water abstractions within/close to the site, and that the site is not located in a groundwater source protection zone, indicates that pre-

construction remedial measures in respect of controlled waters are considered unnecessary.

Waste Classification for Off-site Disposal of Arisings

6.12 In accordance with current legislation all soil arisings generated for disposal as part of this development site are by definition a "commercial waste" and will be classified as both a directive and a controlled waste. In view of the proposed construction and hence likely derivation of excavated arisings for off-site disposal, then as per the European Waste Catalogue (EWC) such material will be coded 1705, that is "soil (including excavated soil from contaminated sites), stones and dredging spoil".

6.13 In accordance with Technical Guidance Waste Management 2 (TGWM2, EA Version 3, May 2013) the contamination test results obtained for that material have been compared with respective threshold data as set out in TGWM2 in order that this specific waste stream can be classified. As shown in Appendix 4, site arisings would classify as a "Non-hazardous Mirror Entry" under EWC Code 170504 (soil and stones that do not contain the tested dangerous substances above the respective threshold value), and can therefore be disposed of at a suitably licensed non-hazardous landfill site.

6.14 The landfill operator will require the contamination test data undertaken as part of this investigation, and should the client wish to consider disposal of non-hazardous material as inert waste at a lower tipping rate then Waste Acceptance Criteria (WAC) testing will also be necessary.

Water Supply Pipework

6.15 In addition to the foregoing consideration has been given to the potential effects of recorded concentrations on new water utility pipework, by comparison to generic guidance as set out in the UK Water Industry Research (UK WIR) report ‘Guidance for the Selection of Water Supply Pipes to be Used in Brownfield Sites’ (2010). At face recorded concentrations are highly unlikely to necessitate "toxic preventative measures" (i.e. upgrading of water supply pipework to a barrier pipe such as ‘Protectaline’ or similar), although it is recommended that advice be sought from the local regulatory authority / water provider prior to ordering pipework.

7 REFINED CONCEPTUAL SITE MODEL AND PRELIMINARY REMEDIAL RECOMMENDATIONS

7.1 In view of the above discussions the Preliminary Conceptual Site Model has been refined as shown in Figure 2 below.

FIG 2: REFINED CONCEPTUAL SITE MODEL (NTS)

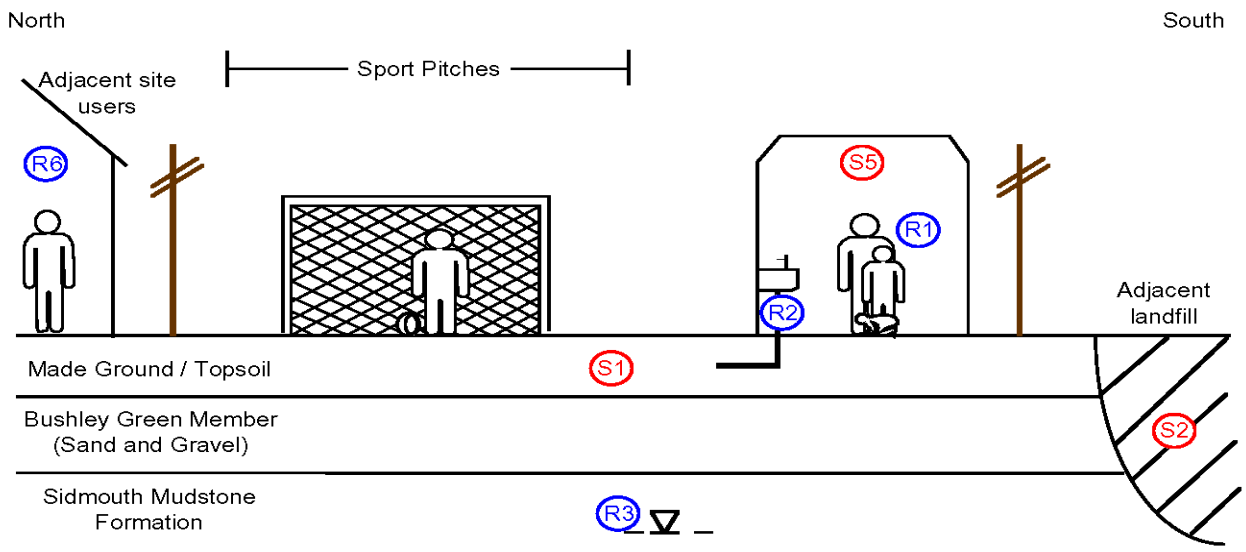


TABLE 6: SUMMARY OF IDENTIFIED/POTENTIAL POLLUTANT LINKAGES

Potential Sources	Pathways	Receptors R1	R2	R3	R4	R5	R6	Comments	Refined Risk Rating	Remedial / Mitigation Requirements
ON-SITE										
S1	P1							Laboratory analysis indicates no apparent/significant risk to human health or controlled waters; all results fall below Tier 1 threshold values	Very Low	N/A
	P2									
	P3									
	P4									
	P5									
	P6									
	P7									
OFF-SITE										
S2	P1							Gas monitoring assessment indicates a negligible gas regime, which indicates no requirement for gas protection measures in new construction	Very Low	N/A
	P2									
	P3									
	P4									
	P5									
	P6									
	P7									

SOURCES	S1	General near-surface topsoil / made ground / cultivated soils containing low-level toxic metals and PAH compounds
	S2	Adjacent historic landfill
PATHWAYS	P1	Direct dermal contact or ingestion via soil attached to vegetables
	P2	Inhalation of dust and vapours
	P3	Permeation into new water supply pipework
	P4	Vertical leaching of leachable contaminants in unsaturated zone and lateral migration in saturated zone
	P5	Direct contact with high sulphate-bearing clay
	P6	Landfill gas migration through unsaturated zone and accumulation within confined spaces
	P7	Radon gas migration through unsaturated zone and accumulation within confined spaces
RECEPTORS	R1	Future site occupants
	R2	Potable water supply
	R3	Groundwater (bedrock and superficial soils classify as Secondary B aquifers)
	R4	Surface Waters (closest is ;issue' 200m south)
	R5	Proposed building incl. concrete foundations
	R6	Adjacent site users / occupants

7.2 In summary the findings of the foregoing quantitative contamination risk assessment indicate that the site is effectively uncontaminated. There is considered to be no requirement for further assessment or remedial measures to address either ground contamination or landfill gas risk.

7.3 In line with best industry practice the scope of contamination testing has been based upon the site history, proposed land usage and actual findings, with reference where necessary to DoE Industry Profiles and DEFRA/EA guidance. To the best of our knowledge information concerning the land quality assessment is accurate at the date of issue, however subsurface conditions including ground contamination may vary spatially and with time. There may be conditions pertaining to the site not disclosed by the above sources of information which might have a bearing upon the recommendations made, were such conditions known. We have however used our professional judgement in order to limit this during the investigation.

7.4 The conclusions and recommendations made in respect of land quality do not address any potential risks to site operatives or ground workers during the construction stage. These issues should be addressed by the Principal Contractor in accordance with the relevant statutory procedures and regulations (CDM Regulations 2015).

7.5 It is important that these limitations be clearly recognised when the findings and recommendations of this report are being interpreted. Additional assessment may be necessary should a significant delay occur between report date and implementation of the proposed scheme to which it relates.

8 CONCLUSIONS AND RECOMMENDATIONS

8.1 The foregoing discussions and recommendations are based upon the results of a detailed desk study (reported under WA ref: 4043 to which reference should be made) supplemented by a combined borehole and trial pitting investigation, which has recorded consistent natural ground conditions across the site overlain by a veneer of topsoil. Ground conditions may vary between investigation points however; hence a careful watch should be maintained for any abnormalities encountered during site strip etc, which might require referral back to this Practice.

8.2 Historical research has shown the site to have been undeveloped agricultural land from earliest available mapping (1886). The site is currently used as sport pitches/playing fields, although it is not known when agricultural activity ceased. The site currently comprises a predominantly grassed 'L' shaped plot of land. A walkover inspection revealed several stock piles of material associated with site maintenance (wooden fence posts etc), as well as a dilapidated spectator shelter and off-site bonfire remains. A search of EA records revealed the field immediately south of the site to be a former landfill, and previous investigations undertaken by this Practice within the tipping area have proved it to be gassing (see below).

8.3 Beneath a veneer of surface topsoil, the intrusive investigation has recorded superficial gravelly sandy clay / clayey sand of the Bushley Green Member, underlain by stiff reddish-brown silty clay representative of the upper weathered mantle of the Sidmouth Mudstone Formation.

8.4 A detailed contamination risk assessment including toxic and phytotoxic metals, PAH and SOM analysis has recorded concentrations of all determinands to be below conservative residential S4ULs/C4SLs values, indicating no apparent/significant risk to controlled waters and no requirement for further analysis or remediation.

8.5 A preliminary, yet robust, gas risk assessment in general accordance with BS8485 guidance indicates a negligible gas regime, on which basis gas protection measures are considered unnecessary. This assessment is presented and fully discussed in Sections 6.6 – 6.10 of this report. Radon protection measures are not considered necessary within the proposed development although it would be good practice to confirm this or otherwise with local building control.

8.6 Should offsite disposal of arisings be required, initial waste classification using contamination test results suggests that site arisings, would be classified as a "Non-hazardous Mirror Entry" (EWC Code 170504).

8.7 Should planning consent be subject to certain conditions, this report and attachments should be lodged with the local planning authority, such that they can update their records.

8.8 The above recommendations must not be used in respect of any development differing in any way from the proposals described in this report, without reference back to this Practice or to another geo-environmental specialist.

9 REFERENCES

Geotechnical

British Geological Survey mapping Sheet SO 85 SW (1974)

Environmental

British Standards Institute, BS 10175: *'Code of Practice for the Investigation of Potentially Contaminated Sites'* (2011)

Environment Agency CLR 11: '*Model Procedures for the Management of Land Contamination*'

Environment Agency/National House Building Council (NHBC) R&D 66 'Guidance for the Safe Development of Housing on Land Affected by Contamination' (2000)

BS8485:2015: *'Code of Practice for the Design of Protective Measures for Methane and Carbon Dioxide Ground Gases for New Buildings'*

CIRIA C735:2014 '*Good Practice on the Testing and Verification of Protection Systems for Buildings Against Hazardous Ground Gases*'

Chartered Institute of Environmental Health (CIEH)/Land Quality Management Limited (LQM). 'S4ULs for Human Health Risk Assessment' (2015); Land Quality Press

DEFRA: SP1010: *Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination - Policy Companion Document (2014)*

Department of the Environment, Transport & the Regions: *'The Environmental Protection Act 1990: Part IIA'* (2000)

Construction Industry Research & Information Association (CIRIA) 665: '*Assessing Risks Posed by Hazardous Ground Gases to Buildings*' (2007)

Building Research Establishment (BRE): Radon – '*Guidance on Protective Measures for New Buildings*' (2015)

Landmark Envirocheck Report incl. Historical Ordnance Survey mapping (Ref: 77183583_1_1, dated 18 December 2015)

Water Framework Directive – Standards & Classification (England & Wales) 2015

The Water Supply (Water Quality) Regulations 2000 (Amendment) Regulations (2007)

Environment Agency (www.environment-agency.gov.uk)

Health Protection Agency (www.hpa.org.uk)

Zetica (www.zetica.com)

UK WIR Report 'Guidance for the selection of water supply pipes to be used in Brownfield Sites' (2010)

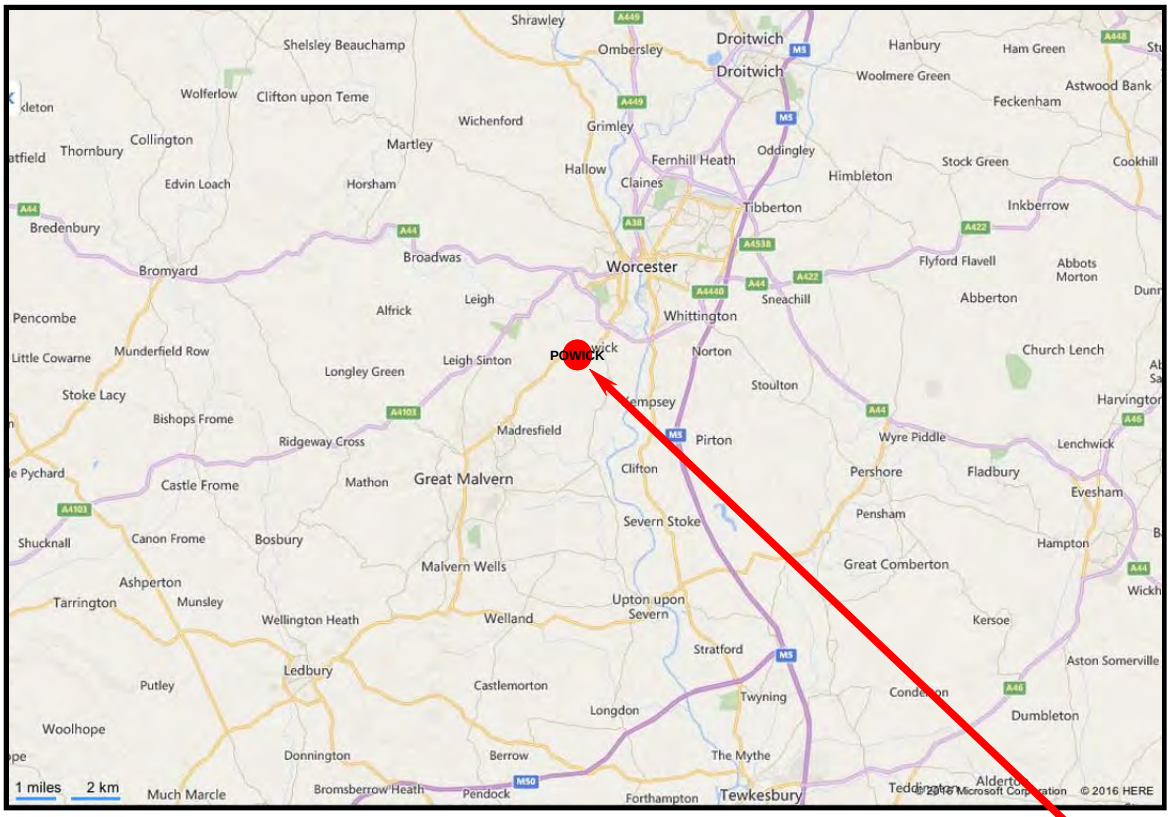
Wilson Associates Phase 1 Geo-Environmental Investigation report ref:4043, dated 7 June 2016

POWICK PAVILLION, HAMILTON CLOSE, POWICK,
WORCESTER, WR2 4NH

Wilson Associates
Consulting Engineering Geologists & Geo-Environmental Engineers

SITE LOCATION (based on Microsoft Bing Mapping)

Job No.	Drawing No.	Scale:	Date:
4043/2	4043/2/1	NTS	28-05-16



VIEW FROM EAST TOWARDS POWICK PAVILION

EXISTING GRASS VERGE REMOVED. NEW COMBINED CYCLE AND PEDESTRIAN FOOTPATH TO PROVIDE ACCESS TO LINK NURSERIES AND PROPOSED PAVILION

HAMILTON CLOSE

HAMILTON CLOSE

LINK NURSERIES

ECO GARDEN

NEW SPEED HUMP/A CROSSING

P1

P2

P3

P4

P5

P6

P7

P8

P9

WS1

WS2

WS3

WS4

TP1

TP2

TP3

TP4

root protection area to mature Oak tree

PROPOSED PAVILION

CAR PARKING FOR 40 CARS including 4 disabled

NEW SPEED HUMP/TRAFFIC CALMING

NEW YOUTH PITCH LINED OUT 72.8m x 45.5m

2m RUN-OFF ZONE

ROUNDERS FIELD

OUTLINE OF OLD FULL SIZE PITCH

PARKING FOR TWO MINIBUSES AND TURNING HEAD

PUBLIC FOOTPATH

BUS STOP

BUS STOP

WORCESTER ROAD A449

P1 Number and direction of photograph (Appendix 1)

POWICK PAVILLION, HAMILTON CLOSE, POWICK, WORCESTER, WR2 4NH

Wilson Associates
Consulting Engineering Geologists & Geo-Environmental Engineers

PROPOSED SITE LAYOUT (based upon Glazzard Architects drg. 1491 1100, dated September.2009) SHOWING INVESTIGATION LOCATIONS

Job No.	Drawing No.	Scale:	Date:
4043/2	4043/2/3	1:1000 @ A3	21-02-17

APPENDIX 1

SITE PHOTOGRAPHS

Photograph **P1**

Photograph **P2**

Photograph **P3**

Photograph **P4**

Photograph **P5**

Photograph **P6**

Photograph **P7**

Photograph **P8**

Photograph **P9**

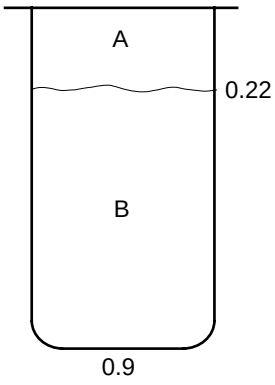
APPENDIX 2

BOREHOLE AND TRIAL PIT LOGS
(INCUDING PHOTOGRAPHS)

Wilson Associates
Consulting Engineering Geologists & Geo-Environmental Engineers

36 Brunswick Road, Gloucester GL1 1JJ
Tel: 01452 422843
Email: info@wilsonac.co.uk

Site: POWICK PAVILLION, HAMILTON CLOSE, POWICK, WORCESTER, WR2 4NH			TRIAL PIT No.
Job No. 4043/2	**Date** 17-02-17	**Ground Level (c.m, AOD)** c 47m	**Co-Ordinates (c.)** E 382,317 N 250,934	**TP1**



DETAILS OF SUBSOIL

A TOPSOIL: grass over mid brown, silty/sandy TOPSOIL with fine rootlets and occasional quartzite gravel

B SAND: probable firm/medium dense, reddish brown mottled greenish grey, sandy clay/clayey SAND with occasional quartzite gravel *(BUSHLEY GREEN MEMBER)*

NOTES

1 Pit logged from surface

2 Pit dry and stable

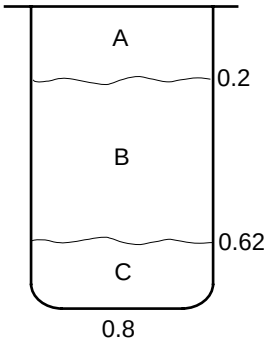
3 Soil sample taken at 0.5m depth

Scale: 1:20	**Client**	Powick Pavillion Council	**Logged By:** SW

Wilson Associates
Consulting Engineering Geologists & Geo-Environmental Engineers

36 Brunswick Road, Gloucester GL1 1JJ
Tel: 01452 422843
Email: info@wilsonac.co.uk

Site: POWICK PAVILLION, HAMILTON CLOSE, POWICK, WORCESTER, WR2 4NH				TRIAL PIT No.
Job No. 4043/2	**Date** 17-02-17	**Ground Level (c.m, AOD)** c 47m	**Co-Ordinates (c.)** E 382,319 N 250,963	**TP2**



DETAILS OF SUBSOIL

A TOPSOIL: grass over light brown, silty/clayey TOPSOIL with roots/rootlets

B SAND: probable loose, light greyish brown, clayey, slightly gravelly SAND. Gravel is sub to well rounded, medium quartzite
(BUSHLEY GREEN MEMBER)

C SAND: probable loose to medium dense, reddish brown, mottled grey, clayey, gravelly SAND
(BUSHLEY GREEN MEMBER)

NOTES

1 Pit logged from surface

2 Pit dry and stable

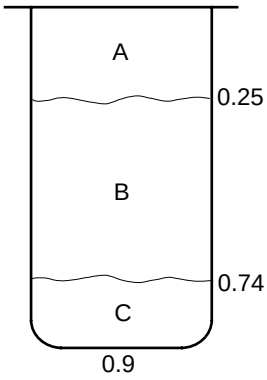
3 Soil sample taken at 0.65m depth

Scale: 1:20	**Client**	Powick Pavillion Council	**Logged By:** SW

Wilson Associates
Consulting Engineering Geologists & Geo-Environmental Engineers

36 Brunswick Road, Gloucester GL1 1JJ
Tel: 01452 422843
Email: info@wilsonac.co.uk

Site: POWICK PAVILLION, HAMILTON CLOSE, POWICK, WORCESTER, WR2 4NH				TRIAL PIT No.
Job No. 4043/2	**Date** 17-02-17	**Ground Level (c.m, AOD)** c 47m	**Co-Ordinates (c.)** E 382,334 N 250,963	**TP3**



DETAILS OF SUBSOIL

A TOPSOIL: grass over light brown, silty, sandy clay TOPSOIL with fine rootlets and occasional quartzite gravel

B CLAY: probable soft to firm, pinkish brown, slightly gravelly, very sandy CLAY. Gravel is subangular to rounded, fine to coarse quartzite; locally recovered as clayey sand
(BUSHLEY GREEN MEMBER)

C CLAY: probable firm, reddish/orangish brown, silty/sandy, slightly gravelly CLAY. Gravel is sub to well rounded, fine to medium quartzite with occaionsal siltstone
(BUSHLEY GREEN MEMBER)

NOTES

1 Pit logged from surface

2 Pit dry and stable

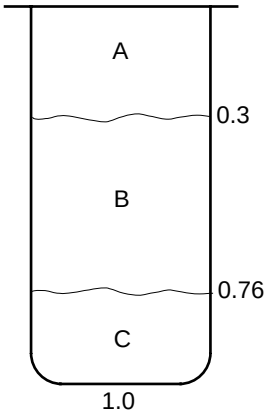
3 Soil sample taken at 0.1m depth

Scale: 1:20	Client	Powick Pavillion Council	Logged By: SW

Wilson Associates
Consulting Engineering Geologists & Geo-Environmental Engineers

36 Brunswick Road, Gloucester GL1 1JJ
Tel: 01452 422843
Email: info@wilsonac.co.uk

Site: POWICK PAVILLION, HAMILTON CLOSE, POWICK, WORCESTER, WR2 4NH				TRIAL PIT No.
Job No. 4043/2	**Date** 17-02-17	**Ground Level (c.m, AOD)** c 47m	**Co-Ordinates (c.)** E 382,339 N 251,008	**TP4**



DETAILS OF SUBSOIL

A TOPSOIL: grass over light brown, slightly silty, sandy TOPSOIL with fine grass rootles and occasional quarzite gravel

B CLAY: probable soft to firm, very sandy and sllightly gravelly to gravelly CLAY. Gravel is sub to well rounded, medium to coarse quarzite; moist at base of horizon
(BUSHLEY GREEN MEMBER)

C CLAY: firm, reddish brown, slightly gravelly, very sandy CLAY. Gravel is subrounded, medium to coarse quarzite
(BUSHLEY GREEN MEMBER)

NOTES

1 Pit logged from surface

2 Pit dry and stable

3 Soil sample taken at 0.4m depth

Scale: 1:20	**Client**	Powick Pavillion Council	**Logged By:** SW

Wilson Associates
Consulting Engineering Geologists & Geo-Environmental Engineers

KEY TO BOREHOLE LOG SYMBOLS

Symbol	Explanation
D or J	Small Disturbed Sample (tub or jar sample)
B	Large Disturbed Sample
U	Undisturbed Sample
W	Water Sample
U70	Undisturbed Sample

Undrained Shear Strength Test (HSV)

90	Hand vane - direct reading in kN/m^2

Standard Penetration Test (SPT)

15	SPT 'N' Value (BS EN ISO 22476-3:2005)
125/50	Where full test drive not completed, penetration (125mm) and blow count (50) recorded
NR	No effective penetration

Water

	Water struck
	Water standing

Test/Core Range

TCR	Total Core Recovery - as percentage of core run. Where value significantly exceeds 100%, a note is given on remarks on log
SCR	Solid Core Recovery - as percentage of core run. Note: assessment of solid core is based on full diameter
RQD	Rock Quality Designation - 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

Instrumentation

	Bentonite Seal
	Solid / Perforated Standpipe
	Granular Response Zone

Wilson Associates
Consulting Engineering Geologists & Geo-Environmental Engineers

BOREHOLE LOG

Project				BOREHOLE No
Powick Pavillion, Hamilton Close, Powick, Worcester, WR2 4NH				**WS1**
Job No	Date	Ground Level (c.m, AOD)	Co-Ordinates (c.)	
4043/2	17-02-17	47.00	E 382,353 N 250,902	
Contractor				Sheet
CC Ground Investigations Limited				1 of 1

SAMPLES & TESTS			STRATA						
Depth	Type No	Test Result	Water	Undrained Shear Strength	Legend	Depth (Thick-ness)	DESCRIPTION	Geology	Instrument/ Backfill
0.10	D					0.28	TOPSOIL: grass over, mid to light brown, silty TOPSOIL with roots and fine rootlets (1-25mm) and occasional sub to well rounded, medium to coarse quartzite gravel		
0.75	D					(1.36)	CLAY: probable stiff, mid brown and reddish brown locally mottled yellowish orange, slightly silty, gravelly to very gravelly CLAY with occasional roots/rootlets and occasional organic mottling/bands/fragments. Gravel is subangular to rounded, fine to coarse, quartzite gravel	BGM	
1.00	D								
1.00		N22							
						1.64			
2.00	D						CLAY: stiff to very stiff (118-125 kN/m²) reddish brown, slightly mottled greenish grey, slightly silty, friable CLAY with black organic mottling up to c 2.0m depth		
2.00		N27					2.20 - becoming fissured		
						(1.81)	2.48 - relict mudstone fabric	SIM	
							2.66 - very silty and fissured/friable		
3.00		N27							
						3.45			
							Core Recovery: 0.0 - 1.0m hand-dug starter pit 1.0 - 3.0m 100% Borehole terminated at 3.45m depth; backfilled with arisings upon completion of testing and sampling Gas/water monitoring well installed to 3.0m. Fitted with lockable cover and gas valve at surface		

Boring Progress and Water Observations						Chiselling			Water Added	
Date	Hole Dia. mm	Depth	Casing Depth	Casing Dia. mm	Water Dpt	From	To	Hours	From	To
17-02-17					dry					

GENERAL REMARKS

Borehole position scanned using Cable Avoidance Tool (CAT); no services detected

BGM = Bushley Green Member

SIM = Sidmouth Mudstone Formation

All dimensions in metres Scale 1:50	Client Powick Parish Council	Method/ Plant Used Window Sampling / Terrier 2002 (Rig T03)	Logged By SW

BOREHOLE PHOTOGRAPHS

Project	Borehole No.
Powick Pavilion, Hamilton Close, Powick, Worcester WR2 4NH	WS1
Job No. 4043/2 **Date:** 17-02-17	

Borehole position

Starter Pit Arisings

Borehole Arisings

Client	Method/Plant Used	Logged By
Powick Parish Council	Window Sampling / Terrier 2002 (Rig T03)	SW

Wilson Associates
Consulting Engineering Geologists & Geo-Environmental Engineers

BOREHOLE LOG

Project				BOREHOLE No
Powick Pavillion, Hamilton Close, Powick, Worcester, WR2 4NH				**WS2**
Job No	Date	Ground Level (c.m, AOD)	Co-Ordinates (c.)	
4043/2	17-02-17	47.00	E 382,336 N 250,904	
Contractor				Sheet
CC Ground Investigations Limited				1 of 1

SAMPLES & TESTS			STRATA							
Depth	Type No	Test Result	Water	Undrained Shear Strength	Legend	Depth (Thick-ness)	DESCRIPTION	Geology	Instrument/ Backfill
						0.30	TOPSOIL: grass over, mid brown, silty clay TOPSOIL with roots		
0.50	D						CLAY: probable soft to firm, light brown and reddish brown mottled greenish yellow, silty/sandy, gravelly CLAY. Gravel is subangular to subround, medium to coarse quartzite and siltstone, with occasional black organic mottling/fragments		
1.00	D					(1.48)	1.00 - matrix predominantly clayey and stiff	BGM	
1.00		N18							
						1.78			
2.00		N23					CLAY: stiff (105-112 kN/m²) reddish brown, slightly silty CLAY with relict mudstone fabric and fine, extremely weak mudstone lithorelicts		
						(1.67)	2.38 - slightly mottled greenish grey 2.52 - silty and friable	SIM	
3.00		N26							
						3.45			
							Core Recovery: 0.0 - 1.0m hand-dug starter pit 1.0 - 3.0m 100% Borehole terminated at 3.45m depth; backfilled with arisings upon completion of testing and sampling Gas/water monitoring well installed to 3.0m. Fitted with lockable cover and gas valve at surface		

Boring Progress and Water Observations						Chiselling			Water Added	
Date	Hole Dia. mm	Depth	Casing Depth	Casing Dia. mm	Water Dpt	From	To	Hours	From	To
17-02-17					dry					

GENERAL REMARKS

Borehole position scanned using Cable Avoidance Tool (CAT); no services detected

BGM = Bushley Green Member

SIM = Sidmouth Mudstone Formation

All dimensions in metres Scale 1:50	Client Powick Parish Council	Method/ Plant Used Window Sampling / Terrier 2002 (Rig T03)	Logged By SW

BOREHOLE PHOTOGRAPHS

Project	Borehole No.
Powick Pavilion, Hamilton Close, Powick, Worcester WR2 4NH	WS2
Job No. 4043/2 **Date:** 17-02-17	

Borehole position

Starter Pit Arisings

Borehole Arisings

Client	Method/Plant Used	Logged By
Powick Parish Council	Window Sampling / Terrier 2002 (Rig T03)	SW

Wilson Associates
Consulting Engineering Geologists & Geo-Environmental Engineers

BOREHOLE LOG

Project				BOREHOLE No
Powick Pavillion, Hamilton Close, Powick, Worcester, WR2 4NH				**WS3**
Job No	Date	Ground Level (c.m, AOD)	Co-Ordinates (c.)	
4043/2	17-02-17	47.00	E 382,328 N 250,921	
Contractor				Sheet
CC Ground Investigations Limited				1 of 1

SAMPLES & TESTS			STRATA						
Depth	Type No	Test Result	Water	Undrained Shear Strength	Legend	Depth (Thick-ness)	DESCRIPTION	Geology	Instrument/ Backfill
0.20	D					0.30	TOPSOIL: grass over mid brown, silty organic TOPSOIL with roots/rootlets (up to 6mm diameter) and occasional subrounded, medium quartzite gravel		
						(0.44) 0.74	CLAY: probable soft to firm, pinkish brown mottled greyish brown, silty/sandy, gravelly CLAY with occasional sand partings. Gravel is sub to well rounded, fine to coarse quartzite	BGM	
0.75	D								
1.00		N19				(0.60) 1.34	CLAY: probable firm, reddish brown mottled greenish grey, silty, slightly gravelly to gravelly CLAY. Gravel is subangular to subrounded, medium to coarse quartzite with occasional siltstone	BGM	
							CLAY: stiff (108 kN/m²) reddish brown, slightly silty CLAY 1.66 - occasional greenish grey, reduction spots and silty 1.75 - becoming very stiff (>125 kN/m²) 1.90 - friable with relict mudstone fabric and extremely weak, fine mudstone lithorelicts		
2.00		N23							
						(2.11)		SIM	
3.00		N43							
						3.45			
							Core Recovery: 0.0 - 1.0m hand-dug starter pit 1.0 - 3.0m 100% Borehole terminated at 3.45m depth; backfilled with arisings upon completion of testing and sampling Gas/water monitoring well installed to 3.0m. Fitted with lockable cover and gas valve at surface		

Boring Progress and Water Observations						Chiselling			Water Added	
Date	Hole Dia. mm	Depth	Casing Depth	Casing Dia. mm	Water Dpt	From	To	Hours	From	To
17-02-17					dry					

GENERAL REMARKS

Borehole position scanned using Cable Avoidance Tool (CAT); no services detected

BGM = Bushley Green Member

SIM = Sidmouth Mudstone Formation

All dimensions in metres Scale 1:50	Client Powick Parish Council	Method/ Plant Used Window Sampling / Terrier 2002 (Rig T03)	Logged By SW

BOREHOLE PHOTOGRAPHS

Project	Borehole No.
Powick Pavilion, Hamilton Close, Powick, Worcester WR2 4NH	WS3
Job No. 4043/2 **Date:** 17-02-17	

Borehole position

Starter Pit Arisings

Borehole Arisings

Client	Method/Plant Used	Logged By
Powick Parish Council	Window Sampling / Terrier 2002 (Rig T03)	SW

Wilson Associates
Consulting Engineering Geologists & Geo-Environmental Engineers

BOREHOLE LOG

Project				BOREHOLE No
Powick Pavillion, Hamilton Close, Powick, Worcester, WR2 4NH				**WS4**
Job No	Date	Ground Level (c.m, AOD)	Co-Ordinates (c.)	
4043/2	17-02-17	47.00	E 382,337 N 250,924	
Contractor				Sheet
CC Ground Investigations Limited				1 of 1

SAMPLES & TESTS			STRATA							
Depth	Type No	Test Result	Water	Undrained Shear Strength	Legend	Depth (Thick-ness)	DESCRIPTION	Geology	Instrument/ Backfill
						0.24	TOPSOIL: grass over, mid to light brown, silty clay TOPSOIL with fine grass rootlets		
0.50	D					(0.63)	CLAY: probable soft to firm, light brown sandy, slightly gravelly CLAY. Gravel is sub to well rounded quarzite	BGM	
						0.87			
1.00		N18				(0.50)	CLAY: probable firm, reddish brown, slightly silty, sandy, gravelly to veyr gravelly CLAY. Gravel is subangular to rounded, medium to coarse quarzite and siltstone with occasional black organic mottling/flecks	BGM	
						1.37			
2.00		N16				(2.08)	CLAY: stiff (80-105 kN/m²) reddish brown, slightly silty CLAY with occasional organic flecks 1.90 - with slight mudstone fabric and extremely weak, fine mudstone lithorelicts	SIM	
3.00		N28				3.45			
							Core Recovery: 0.0 - 1.0m hand-dug starter pit 1.0 - 3.0m 100% Borehole terminated at 3.45m depth; backfilled with arisings upon completion of testing and sampling Gas/water monitoring well installed to 3.0m. Fitted with lockable cover and gas valve at surface		

Boring Progress and Water Observations						Chiselling			Water Added	
Date	Hole Dia. mm	Depth	Casing Depth	Casing Dia. mm	Water Dpt	From	To	Hours	From	To
17-02-17					dry					

GENERAL REMARKS

Borehole position scanned using Cable Avoidance Tool (CAT); no services detected

BGM = Bushley Green Member

SIM = Sidmouth Mudstone Formation

All dimensions in metres Scale 1:50	Client Powick Parish Council	Method/ Plant Used Window Sampling / Terrier 2002 (Rig T03)	Logged By SW

BOREHOLE PHOTOGRAPHS

Project	Borehole No.
Powick Pavilion, Hamilton Close, Powick, Worcester WR2 4NH	WS4
Job No. 4043/2 **Date:** 17-02-17	

Borehole position

Starter Pit Arisings

Borehole Arisings

Client	Method/Plant Used	Logged By
Powick Parish Council	Window Sampling / Terrier 2002 (Rig T03)	SW

SPT Calibration Report

EQUIPE GROUP
www.equipegroup.com

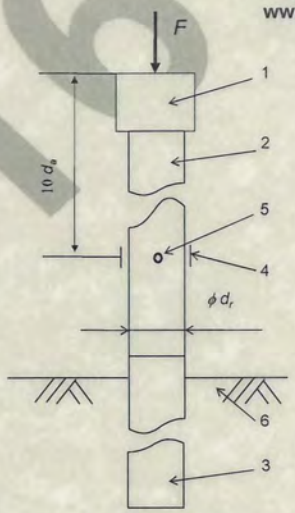
Hammer Energy Measurement Report

Type of Hammer	TERRIER
Client	CC GROUND INVESTIGATIONS
Test No	EQU1500_4
Test Depth (m)	9.40
Date of Test	19 February 2016
Valid until	18 February 2017
Hammer ID	TO3

Mass of the hammer	m =	63.5kg
Falling height	h =	0.76m
E_{theor} =	$m \times g \times h$ =	473J

Characteristics of the instrumented rod

Diameter	d_r =	0.052 m
Length of the instrumented rod		0.558 m
Area	A =	11.61 cm^2
Modulus	E_a =	206843 MPa

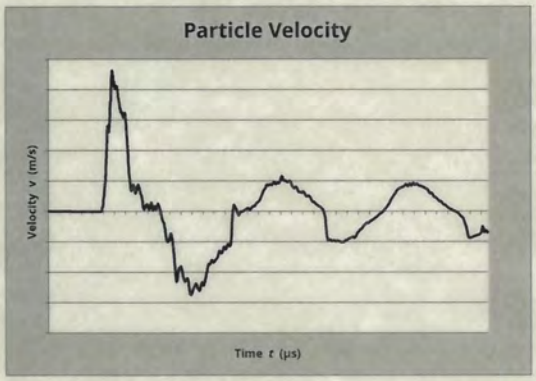


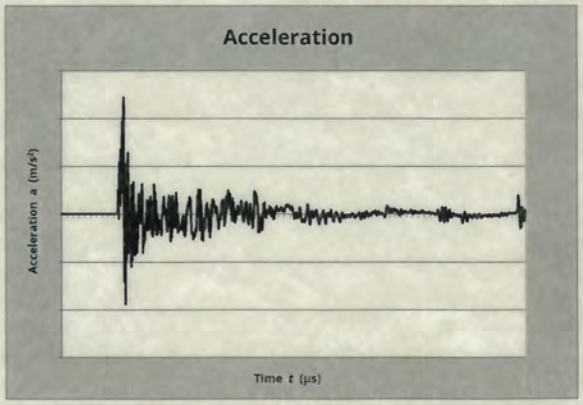
Key

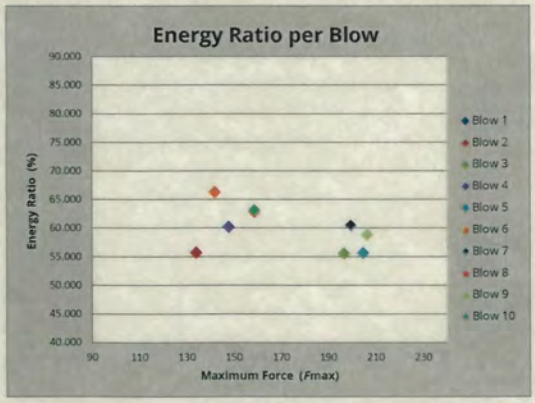
1 Anvil
2 Part of instrumented rod
3 Drive Rod
4 Strain Gauge
5 Accelerometer
6 Ground

F Force
d_r Diameter of rod

Fig. B.1 and B.2 BS EN ISO 22476-3 : 2005 + A1 : 2011







Observations:
1.

E_{meas} =	**0.290**	kN-m
E_{theor} =	**0.473**	kN-m

Energy Ratio (E_r) = $\frac{E_{meas}}{E_{theor}}$: **61.35%**

Equipe SPT Analyzer Operators: AF

Prepared by: **Checked by:** **Date** 08/03/2016

 Equipe Group, The Paddocks, Home Farm Offices, The Upton Estate, Banbury, Oxfordshire, OX15 6HU
Tel: +44 (0)1295 670990 Fax: +44 (0)1295 678232 Email: info@equipegroup.com

APPENDIX 3

CONTAMINATION
STATUTORY FRAMEWORK / METHODOLOGY
AND
CERTIFIED CONTAMINATION TEST RESULTS

A3 CONTAMINATION RISK ASSESSMENT

Statutory Framework

A3.1 Part 2A of the Environmental Protection Act 1990 (inserted by Section 57 of the Environment Act 1995) provides a regime for the control of specific threats to health or the environment from existing land contamination. In accordance with the Act and the statutory guidance document on the Contaminated Land (England) Regulations 2000, the definition of contaminated land is intended to embody the concept of risk assessment. Within the meaning of the Act, land is only 'contaminated land' where it appears to the regulatory authority, by reason of substances within or under the land, that:

- Significant harm is being caused or there is significant possibility of such harm being caused; or
- Pollution of controlled waters is being, or is likely to be, caused.

A3.2 In 2012 revised Statutory Guidance for Part 2A of the Environmental Protection Act (1990) came into force for England and Wales. This introduced a new four category approach for classifying land affected by contamination to assist decisions by regulators in cases of Significant Possibility of Significant Harm (SPOSH) to specified receptors, including humans, and significant pollution of controlled waters.

Category 1 describes land which is clearly problematic e.g. because similar sites are known to have caused a significant problem in the past. The legal definition is where "there is an unacceptably high probability, supported by robust science-based evidence, that significant harm would occur if no action is taken to stop it".

Categories 2 and 3 cover land where detailed consideration is needed before deciding whether it may be contaminated land. Category 2 is defined as land where "there is a strong case for considering that the risks from the land are of sufficient concern that the land poses a significant possibility of significant harm". Category 3 is defined as land where there is not the strong case described in the test for Category 2, and may include "land where the risks are not low, but nonetheless the authority considers that regulatory intervention under Part 2A is not warranted". The decision basis is initially related to human health risks, and if this is not conclusive due to uncertainty over risks, wider socio-economic factors (e.g. cost, local perception etc).

Category 4 describes land that is clearly not contaminated land, where there is no risk or the level or risk posed is low.

This same 4 category system has also been introduced to assist in identifying whether there is a significant possibility of significant pollution of controlled waters. Part 2A states that normal levels of contaminants in soil should not be considered to cause land to qualify as contaminated land, unless there is a particular reason to consider otherwise.

Following publication of the revised Statutory Guidance, DEFRA commissioned a research project to develop new Category 4 Screening Levels (C4SLs) to provide a simplified test for regulators to aid decision-making on when land was suitable for use and definitely not contaminated land under the statutory regime. The output from this research project was published by CL:AIRE in December 2013, with Policy Companion Documents published in England by DEFRA in March 2014 and the Welsh Government in May 2014. The culmination of this work was the development of a framework and methodology for deriving C4SLs and the publication of final C4SLs for use as new screening values for six common contaminants.

Further research by LQM on behalf of CIEH lead to the publication in 2015 of the Suitable for Use Levels known as S4ULs, and these are now widely adopted as a robust and authoritative source of guidance (see A3.14 below).

Once land has been determined as contaminated land, the enforcing authority must consider how it should be remediated and, where appropriate, it must issue a remediation notice to require such remediation. The enforcing authority for the purposes of remediation may be the local authority which determined the land, or the Environment Agency which takes on responsibility once land has been determined if the land is deemed to be a “special site”. The rules on what land is to be regarded as special sites, and various rules on the issuing of remediation notices, are set out in the Contaminated Land (England) Regulations 2006

A3.3 The UK guidance on the assessment of land contamination has developed as a direct result of the introduction of the above two Acts. The technical guidance supporting the new legislation has been summarised in a number of key documents collectively known as the Contaminated Land Reports (CLRs), a proposed series of twelve documents. Seven were originally published in March 1994, four more were published in April 2002, while the last remaining guidance document (CLR 11 was

published in 2004. In 2008 CLR reports 7 to 10 were withdrawn by the Department of Environment Food & Rural Affairs and the Environment Agency and updated versions of CLR 9 and 10 were produced in the form of Science Reports SR2 and SR3.

A3.4 The guidance defines 'risk' as the combination of:

- The probability, or frequency, of occurrence of a defined hazard (e.g. exposure of a property to a substance with the potential to cause harm); and
- The magnitude (including the seriousness) of the consequences.

A3.5 For a risk of pollution or environmental harm to occur as a result of ground contamination, all of the following elements must be present:

- A source, i.e. a substance that is capable of causing pollution or harm;
- A pathway, i.e. a route by which the contaminant can reach the receptor; and
- A receptor (or target), i.e. something which could be adversely affected by the contaminant.

A3.6 If any one of these elements is missing there can be no significant risk. If all are present then the magnitude of the risk is a function of the magnitude and mobility of the source, the sensitivity of the receptor and the nature of the migration pathway.

A3.7 The presence of contamination is also a material issue in the determination of planning applications, and where a change of use is proposed, especially on brownfield (former industrial) land, investigation, assessment and remediation of contamination is often a requirement of the Planning Authority. The presence of contamination may consequently require remedial action prior to redevelopment, in circumstances which would otherwise be unlikely to result in the determination of the land as contaminated land as defined in the above legislation.

Contamination Assessment Methodology

A3.8 The guidance proposes a four-stage assessment process for identifying potential pollutant linkages on a site. These stages are set out in the table below:

No.	Process	Description
1	Hazard Identification	Establishing contaminant sources, pathways and receptors (the preliminary conceptual site model).
2	Hazard Assessment	Analysing the potential for unacceptable risks (what linkages could be present, what could be the effects).
3	Risk Estimation	Trying to establish the magnitude and probability of the possible consequences (what degree of harm might result and to what receptors, and how likely is it).
4	Risk Evaluation	Deciding whether the risk is unacceptable.

A3.9 Stages 1 and 2 develop a *'preliminary conceptual model'* based upon information collated from desk studies and usually a site walkover inspection. The formation of a conceptual site model is an iterative process, and it should be updated and refined throughout each stage of the project to reflect any additional information obtained.

A3.10 The information gleaned from the desk studies and associated enquiries is presented in a desk study report with recommendations, if necessary, for further work based upon the preliminary conceptual site model. CLR 8, together with specific DoE 'Industry Profiles' provides guidance on the nature of contaminants relating to specific industrial processes. Whilst it is acknowledged that CLR 8 has been withdrawn no replacement guidance has yet been published that lists the contaminants likely to be present on contaminated sites, thus CLR 8 guidance is still considered relevant.

A3.11 If the preliminary conceptual model identifies potential pollutant linkages, a Phase 2 site investigation is normally recommended, unless appropriate mitigation measures can be incorporated into the proposed development sufficient to negate the identified risks, subject to local planning authority approval. The number of exploratory holes and samples collected for analysis should be consistent with the size of the site and the level of risk envisaged. This will enable a contamination risk assessment to be conducted, at which point the preliminary conceptual model can be updated and relevant pollutant linkages identified.

Preliminary Risk Assessment

A3.12 By considering the various potential sources, pathways and receptors, a preliminary assessment of potential risk is made based upon the likelihood of the occurrence and the severity of the potential consequence, the latter being a function of the

sensitivity of the receptor. At Phase 1 desk study stage the qualitative risk assessment is based on the categories tabulated below.

Category	Definition
Severe	Acute risks to human health, catastrophic damage to buildings/property, major pollution to controlled waters
Moderate	Chronic risk to human health, pollution of sensitive controlled waters, significant effects on sensitive ecosystems or species, significant damage to buildings or structures
Mild	Pollution of non-sensitive waters, minor damage to buildings or structures
Minor	Requirement for protective equipment during site works to mitigate health effects, damage to non-sensitive ecosystems or species

A3.13 The likelihood of an event (probability) takes into account both the presence of the hazard and receptor and viability of the pathway, and is based on the categories tabulated below.

Category	Definition
Highly likely	Pollutant linkage may be present, and risk is almost certain to occur in long term, or there is evidence of harm to the receptor
Likely	Pollutant linkage may be present, and it is probable that the risk will occur over the long term
Possible	Pollution linkage may be present, and there is a possibility of the risk occurring, although there is no certainty that it will do so
Unlikely	Pollutant linkage may be present, but the circumstances under which harm would occur are improbable

A3.14 On this basis potential hazards are assigned a risk rating as shown below.

		Consequence			
		Severe	*Moderate*	*Mild*	*Minor*
Probability (Likelihood)	**Highly likely**	very high	high	moderate	low
	Likely	high	moderate	low/moderate	low
	Possible	moderate	low/moderate	low	very low
	Unlikely	low/moderate	low	very low	very low

A3.15 At Phase 2 stage, quantitative assessment of human health risk posed by ground contamination is achieved by comparison of soil concentrations with Tier 1 Category Four Screening Levels (C4SL) published by DEFRA (2014), and/or Suitable for Use Levels (S4UL) as published by LQM/CIEH (2015). The official Soil Guideline Values utilise a soil organic matter content of 6% which is considered to be higher than typical UK soils, however three sets of S4UL's have been developed for organic matter contents of 1%, 2.5% and 6%, thus the most appropriate set is selected based upon proven site conditions.

A3.16 Contaminant concentrations below the threshold screening values are considered not to warrant further risk assessment. Concentrations of contaminants above these screening values require further consideration of potential pollutant linkages and may indicate potentially unacceptable risks to site users. Such exceedances may trigger a Tier 2 detailed quantitative risk assessment (DQRA) where site-specific parameters are used to derive site specific assessment criteria (SSAC), usually by using the CLEA Model (V1.06 at time of writing). It should be noted that exceedance of a screening value does not necessarily indicate that the site requires remediation.

A3.17 In order to assess any risk to controlled waters posed by contaminants within the underlying soils and groundwater, laboratory results have been screened against Level 1 Environmental Quality Standard (EQS) values derived from the Water Framework Directive (Standards & Classification) Directions (England & Wales) 2015 and the current UK Drinking Water Supply (Water Quality) Regulations (DWS), dependent upon the most vulnerable receptor. The EQS is usually an upper concentration set for the receiving watercourse and not the discharge itself. The DWS is established for compliance at the point of use or abstraction and not the source area.

Wilson Associates

SUMMARY OF CONTAMINATION TESTING RESULTS

Sample Ref	Sample Depth	Sample of	pH	SOILS											LEACHATE								
				TOXIC METALS (mg/kg)							PHYTOTOXIC METALS (mg/kg)		Soil Organic Matter (%)	Moisture Content @ 105 C (%)	TOXIC METALS (µg/l)							PHYTOTOXIC METALS (µg/l)	
				Arsenic	Cadmium	Chromium	Lead	Mercury	Selenium	Nickel	Copper	Zinc			Arsenic	Cadmium	Chromium	Lead	Mercury	Selenium	Nickel	Copper	Zinc
WS1	0.1	topsoil	7.4	8	<1	27	38	<1	<3	20	15	72	2.6	17.0									
WS1	0.8	gravelly clay	7.2	12	<1	35	19	<1	<3	31	23	54		12									
WS2	0.5	silty/sandy gravelly clay	7.1	7	<1	26	18	<1	<3	23	16	51		13									
WS2	1.0	silty/sandy gravelly clay	7.2	9	<1	29	12	<1	<3	26	19	44		13									
WS3	0.2	topsoil	7.2	9	<1	23	54	<1	<3	20	15	74		21	3.3	0.06	4.0	3.9	<0.05	<0.5	4.0	7.0	17
WS3	0.75	silty gravelly clay	7.1	19	<1	41	16	<1	<3	35	24	58		11									
WS4	0.5	sandy gravelly clay	7.2	27	<1	41	19	<1	<3	37	25	62		13									
TP1	0.5	sandy clay / clayey sand	7.3	5	<1	25	12	<1	<3	25	18	43		12									
TP2	0.7	clayey gravelly sand	7.4	6	<1	32	13	<1	<3	28	21	46		16									
TP3	0.1	topsoil	7.0	5	<1	22	13	<1	<3	21	9	43		15									
TP4	0.4	sandy, gravelly clay	7.1	11	<1	28	10	<1	<3	25	16	40		15									
TIER 1: GENERIC ASSESSMENT CRITERIA																							
S4UL (Residential with plant uptake)				37	11	910	200 ♠	40	250	180	2,400	3,700											
S4UL (Residential without plant uptake)				40	85	910	310 ♠	56	430	180	7,100	40,000											
S4UL (Allotments)				43	1.9	18,000	80 ♠	19	88	230	520	620											
S4UL (Commercial)				640	190	8,600	2330 ♠	1,100	12,000	980	68,000	730,000											
S4UL (Public Open Space - Residential)				79	120	1,500	630 ♠	120	1,100	230	12,000	81,000											
S4UL (Public Open Space - Park)				170	532	33,000	1300 ♠	240	1,800	3,400	44,000	170,000											
TIER 2: SITE SPECIFIC																							
Upper Confidence Limit [on true mean concentration, u] (CIEH Statistical Calculator)																							
Site-Specific Assessment Criteria (SSAC's) residential with homegrown produce																							
WFD "Water Framework Directive Standards & Classification (England & Wales)" 2015 *(Groundwater)*															7.5	3.75	37.5	7.5	0.75	75	15	1500	
WFD "Water Framework Directive Standards & Classification (England & Wales)" 2015 *(Fresh Surface Water)*															50	0.08	3.4	1.2	0.07		<1	1	12.3
EA EQS "River Basin Districts Typology, Standards & Groundwater Threshold Values (Water Framework Directive) (England & Wales) Directions 2010"															50	0.08-0.25	4.7	7.2	0.07		20	1-28	8-125
UK Drinking Water Standards "The Water Supply (Water Quality) Regulations 2000"															10	5	50	25	1	10	50	2000	5000

CIEH/LQM s= GAC/S4UL presented exceeds the solubility saturation limit, which is presented in brackets

CIEH/LQM v = GAC/S4UL presented exceeds the vapour saturation limit, which is presented in brackets

CIEH/LQM S4UL d = S4UL based on a threshold protective of direct skin contact with phenol (guideline in brackets based on health effects following long term expsoure provided for illustration only)

S4UL LQM/CIEH published Suitable for use levels (2015)

Based on Soil Organic Matter of 2.5%

DEFRA ♠ = C4SL (2014)

(13) = Results have been blank corrected

SUMMARY OF POLYAROMATIC HYDROCARBON (PAH) TESTING RESULTS

Sample Ref	Sample Depth (m)	Sample of	SOIL (mg/kg)																LEACHATE (µg/l)															
			TOTAL PAH	Naphthalene	Acenaphthylene	Acenaphthene	Fluorene	Phenanthrene	Anthracene	Fluoranthene	Pyrene	Benzo(a)Anthracene	Chrysene	Benzo(b)Fluoranthene	Benzo(k)Fluoranthene	Benzo(a)Pyrene	Indeno(1,2,3-cd)Pyrene	Dibenz(ah)Anthracene	Benzo(ghi)Perylene	TOTAL PAH	Naphthalene	Acenaphthylene	Acenaphthene	Fluorene	Phenanthrene	Anthracene	Fluoranthene	Pyrene	Benzo(a)Anthracene	Chrysene	Benzo(b)Fluoranthene	Benzo(k)Fluoranthene	Benzo(a)Pyrene	Dibenz(ah)Anthracene	Indeno(1,2,3)perylene	Benzo(ghi)Perylene
WS3	0.2	topsoil	1.8	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	0.4	0.3	0.2	0.2	0.2	0.1	0.2	<0.1	<0.1	<0.1	0.73	(13) 0.02	(13) 0.03	(13) 0.01	(13) 0.02	(13) 0.04	(13) 0.02	(13) 0.08	(13) 0.08	(13) 0.06	(13) 0.07	(13) 0.08	(13) 0.07	(13) 0.07	(13) 0.01	(13) 0.05	(13) 0.06
TIER 1: GENERIC ASSESSMENT CRITERIA																																		
S4UL (Residential with plant uptake)				5.6	420	510	400	220	5,400	560	1,200	11	22	3.3	93	3 (5♠)	36	0.28	340															
S4UL (Residential without plant uptake)				5.6	4,600 (212)s	4,700 (141)s	3,800 (76.5)s	1,500	35,000	1600	3,800	14	31	4	110	3.2 (5.3♠)	46	0.32	360															
S4UL (Allotments)				0	69	85	67	38	950	130	270	6.5	9.4	2.1	75	3.5 (5.7♠)	21	0.27	470															
S4UL (Commercial)				460 (183)s	97,000	97,000	68,000	22,000	540,000	23,000	54,000	170.00	350	44	1,200	36 (76♠)	510	3.60	4,000															
S4UL (Public Open Space - Residential)				4,900	15,000	15,000	9,900	3,100	74,000	3,100	7,400	29	57	7.2	190	5.7 (10♠)	82	0.57	640															
S4UL (Public Open Space - Park)				1,900 (183)s	30,000	30,000	20,000	6,200	150,000	6,300	15,000	56	110	15	410	13 (21♠)	170	1.3	1,500															
TIER 2: SITE SPECIFIC																																		
Upper Confidence Limit [on true mean concentration, u] (CIEH Statistical Calculator)																																		
Site-Specific Assessment Criteria (SSAC's) residential with homegrown produce																																		
WFD "Water Framework Directive Standards & Classification (England & Wales)" 2015 (Groundwater)																				0.075						0.075								
WFD "Water Framework Directive Standards & Classification (England & Wales)" 2015 (Fresh Surface Water)																				1.03 - 4.24					0.052 - 0.193	0.0033 - 0.0122				0.016 - 0.058		0.000009 - 0.000038			
EA EQS "River Basin Districts Typology, Standards & Groundwater Threshold Values (Water Framework Directive) (England & Wales) Directions 2010"																				2.4										0.03	0.03	0.05	Sum of = 0.002		
UK Drinking Water Standards "The Water Supply (Water Quality) Regulations 2000"																				0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.01	0.1	0.1	0.1

SCIENTIFIC ANALYSIS LABORATORIES
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Certificate of Analysis

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Report Number: 635259-1

Date of Report: 28-Feb-2017

Customer: Wilson Associates (Consulting) Limited
36 Brunswick Road
Gloucester
GL1 1JJ

Customer Contact: Mr Simon Wilkinson

Customer Job Reference: 4043/2
Customer Purchase Order: 4043/2/sw
Customer Site Reference: Powick
Date Job Received at SAL: 22-Feb-2017
Date Analysis Started: 23-Feb-2017
Date Analysis Completed: 28-Feb-2017

The results reported relate to samples received in the laboratory and may not be representative of a whole batch.

Opinions and interpretations expressed herein are outside the scope of UKAS accreditation

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Tests covered by this certificate were conducted in accordance with SAL SOPs

All results have been reviewed in accordance with Section 25 of the SAL Quality Manual

UKAS TESTING
1549

mCERTS
THE ENVIRONMENT AGENCY'S MONITORING CERTIFICATION SCHEME

Report checked and authorised by :
Muhammad Waqas
Project Manager

Issued by :
Muhammad Waqas
Project Manager

[redacted]

SAL Reference: 635259
Project Site: Powick
Customer Reference: 4043/2

Soil Analysed as Soil
MCERTS Preparation

				SAL Reference	**635259 001**	**635259 002**	**635259 003**	**635259 004**	**635259 005**
				Customer Sample Reference	**WS1**	**WS1**	**WS2**	**WS2**	**WS3**
				Bottom Depth	**0.1**	**0.75**	**0.5**	**1.0**	**0.2**
				Date Sampled	**17-FEB-2017**	**17-FEB-2017**	**17-FEB-2017**	**17-FEB-2017**	**17-FEB-2017**
				Type	**Sandy Soil**	**Sandy Soil**	**Sandy Soil**	**Sandy Soil**	**Sandy Soil**
Determinand	**Method**	**Test Sample**	**LOD**	**Units**					
Moisture @105C	T162	AR	0.1	%	**17**	**12**	**13**	**13**	**21**
Retained on 10mm sieve	T2	M40	0.1	%	<0.1	<0.1	<0.1	<0.1	<0.1

SAL Reference: 635259
Project Site: Powick
Customer Reference: 4043/2

Soil Analysed as Soil
MCERTS Preparation

				SAL Reference	**635259 006**	**635259 007**	**635259 008**	**635259 009**	**635259 010**
				Customer Sample Reference	**WS3**	**WS4**	**TP1**	**TP2**	**TP3**
				Bottom Depth	**0.75**	**0.5**	**0.5**	**0.65**	**0.1**
				Date Sampled	**17-FEB-2017**	**17-FEB-2017**	**17-FEB-2017**	**17-FEB-2017**	**17-FEB-2017**
				Type	**Sandy Soil**	**Sandy Soil**	**Sandy Soil**	**Sandy Soil**	**Sandy Soil**
Determinand	**Method**	**Test Sample**	**LOD**	**Units**					
Moisture @105C	T162	AR	0.1	%	**11**	**13**	**12**	**16**	**15**
Retained on 10mm sieve	T2	M40	0.1	%	<0.1	<0.1	<0.1	<0.1	<0.1

SAL Reference: 635259
Project Site: Powick
Customer Reference: 4043/2

Soil Analysed as Soil
MCERTS Preparation

				SAL Reference	**635259 011**
				Customer Sample Reference	**TP4**
				Bottom Depth	**0.4**
				Date Sampled	**17-FEB-2017**
				Type	**Sandy Soil**
Determinand	**Method**	**Test Sample**	**LOD**	**Units**	
Moisture @105C	T162	AR	0.1	%	**15**
Retained on 10mm sieve	T2	M40	0.1	%	<0.1

SAL Reference: 635259
Project Site: Powick
Customer Reference: 4043/2

Soil Analysed as Soil
Heavy Metals(9)

				SAL Reference	**635259 001**	**635259 002**	**635259 003**	**635259 004**	**635259 005**
				Customer Sample Reference	**WS1**	**WS1**	**WS2**	**WS2**	**WS3**
				Bottom Depth	**0.1**	**0.75**	**0.5**	**1.0**	**0.2**
				Date Sampled	**17-FEB-2017**	**17-FEB-2017**	**17-FEB-2017**	**17-FEB-2017**	**17-FEB-2017**
				Type	**Sandy Soil**	**Sandy Soil**	**Sandy Soil**	**Sandy Soil**	**Sandy Soil**
Determinand	**Method**	**Test Sample**	**LOD**	**Units**					
Arsenic	T6	M40	2	mg/kg	**8**	**12**	**7**	**9**	**9**
Cadmium	T6	M40	1	mg/kg	<1	<1	<1	<1	<1
Chromium	T6	M40	1	mg/kg	**27**	**35**	**26**	**29**	**23**
Copper	T6	M40	1	mg/kg	**15**	**23**	**16**	**19**	**15**
Lead	T6	M40	1	mg/kg	**38**	**19**	**18**	**12**	**54**
Mercury	T6	M40	1	mg/kg	<1	<1	<1	<1	<1
Nickel	T6	M40	1	mg/kg	**20**	**31**	**23**	**26**	**20**
Selenium	T6	M40	3	mg/kg	<3	<3	<3	<3	<3
Zinc	T6	M40	1	mg/kg	**72**	**54**	**51**	**44**	**74**

SAL Reference: 635259
Project Site: Powick
Customer Reference: 4043/2

Soil Analysed as Soil
Heavy Metals(9)

				SAL Reference	**635259 006**	**635259 007**	**635259 008**	**635259 009**	**635259 010**
				Customer Sample Reference	**WS3**	**WS4**	**TP1**	**TP2**	**TP3**
				Bottom Depth	**0.75**	**0.5**	**0.5**	**0.65**	**0.1**
				Date Sampled	**17-FEB-2017**	**17-FEB-2017**	**17-FEB-2017**	**17-FEB-2017**	**17-FEB-2017**
				Type	**Sandy Soil**	**Sandy Soil**	**Sandy Soil**	**Sandy Soil**	**Sandy Soil**
Determinand	**Method**	**Test Sample**	**LOD**	**Units**					
Arsenic	T6	M40	2	mg/kg	**19**	**27**	**5**	**6**	**5**
Cadmium	T6	M40	1	mg/kg	<1	<1	<1	<1	<1
Chromium	T6	M40	1	mg/kg	**41**	**41**	**25**	**32**	**22**
Copper	T6	M40	1	mg/kg	**24**	**25**	**18**	**21**	**9**
Lead	T6	M40	1	mg/kg	**16**	**19**	**12**	**13**	**13**
Mercury	T6	M40	1	mg/kg	<1	<1	<1	<1	<1
Nickel	T6	M40	1	mg/kg	**35**	**37**	**25**	**28**	**21**
Selenium	T6	M40	3	mg/kg	<3	<3	<3	<3	<3
Zinc	T6	M40	1	mg/kg	**58**	**62**	**43**	**46**	**43**

SAL Reference: 635259
Project Site: Powick
Customer Reference: 4043/2

Soil Analysed as Soil
Heavy Metals(9)

				SAL Reference	**635259 011**	
				Customer Sample Reference	**TP4**	
				Bottom Depth	**0.4**	
				Date Sampled	**17-FEB-2017**	
				Type	**Sandy Soil**	
Determinand	**Method**	**Test Sample**	**LOD**	**Units**		
Arsenic	T6	M40	2	mg/kg	**11**	
Cadmium	T6	M40	1	mg/kg	<1	
Chromium	T6	M40	1	mg/kg	**28**	
Copper	T6	M40	1	mg/kg	**16**	
Lead	T6	M40	1	mg/kg	**10**	
Mercury	T6	M40	1	mg/kg	<1	
Nickel	T6	M40	1	mg/kg	**25**	
Selenium	T6	M40	3	mg/kg	<3	
Zinc	T6	M40	1	mg/kg	**40**	

SAL Reference: 635259
Project Site: Powick
Customer Reference: 4043/2

Soil Analysed as Soil
Miscellaneous

				SAL Reference	**635259 001**	**635259 002**	**635259 003**	**635259 004**	**635259 005**
				Customer Sample Reference	**WS1**	**WS1**	**WS2**	**WS2**	**WS3**
				Bottom Depth	**0.1**	**0.75**	**0.5**	**1.0**	**0.2**
				Date Sampled	**17-FEB-2017**	**17-FEB-2017**	**17-FEB-2017**	**17-FEB-2017**	**17-FEB-2017**
				Type	**Sandy Soil**	**Sandy Soil**	**Sandy Soil**	**Sandy Soil**	**Sandy Soil**
Determinand	**Method**	**Test Sample**	**LOD**	**Units**					
pH	T7	AR			**7.4**	**7.2**	**7.1**	**7.2**	**7.2**
Soil Organic Matter	T287	AR	0.1	%	**2.6**	-	-	-	-

SAL Reference: 635259
Project Site: Powick
Customer Reference: 4043/2

Soil Analysed as Soil
Miscellaneous

				SAL Reference	**635259 006**	**635259 007**	**635259 008**	**635259 009**	**635259 010**
				Customer Sample Reference	**WS3**	**WS4**	**TP1**	**TP2**	**TP3**
				Bottom Depth	**0.75**	**0.5**	**0.5**	**0.65**	**0.1**
				Date Sampled	**17-FEB-2017**	**17-FEB-2017**	**17-FEB-2017**	**17-FEB-2017**	**17-FEB-2017**
				Type	**Sandy Soil**	**Sandy Soil**	**Sandy Soil**	**Sandy Soil**	**Sandy Soil**
Determinand	**Method**	**Test Sample**	**LOD**	**Units**					
pH	T7	AR			**7.1**	**7.2**	**7.3**	**7.4**	**7.0**

SAL Reference: 635259
Project Site: Powick
Customer Reference: 4043/2

Soil Analysed as Soil
Miscellaneous

				SAL Reference	**635259 011**
				Customer Sample Reference	**TP4**
				Bottom Depth	**0.4**
				Date Sampled	**17-FEB-2017**
				Type	**Sandy Soil**
Determinand	**Method**	**Test Sample**	**LOD**	**Units**	
pH	T7	AR			**7.1**

SAL Reference: 635259
Project Site: Powick
Customer Reference: 4043/2

Leachate Analysed as Water
Heavy Metals(9)

SAL Reference	**635259 005**
Customer Sample Reference	**WS3**
Bottom Depth	**0.2**
Date Sampled	**17-FEB-2017**
Type	**Sandy Soil**

Determinand	Method	Test Sample	LOD	Units	
As (Dissolved)	T281	10:1	0.2	µg/l	**3.3**
Cd (Dissolved)	T281	10:1	0.02	µg/l	**0.06**
Cr (Dissolved)	T281	10:1	1	µg/l	**4**
Cu (Dissolved)	T281	10:1	0.5	µg/l	**7.0**
Pb (Dissolved)	T281	10:1	0.3	µg/l	**3.9**
Hg (Dissolved)	T281	10:1	0.05	µg/l	<0.05
Ni (Dissolved)	T281	10:1	1	µg/l	**4**
Se (Dissolved)	T281	10:1	0.5	µg/l	<0.5
Zn (Dissolved)	T281	10:1	2	µg/l	**17**

SAL Reference: 635259
Project Site: Powick
Customer Reference: 4043/2

Soil Analysed as Soil
PAH US EPA 16 (B and K split)

SAL Reference	**635259 005**
Customer Sample Reference	**WS3**
Bottom Depth	**0.2**
Date Sampled	**17-FEB-2017**
Type	**Sandy Soil**

Determinand	Method	Test Sample	LOD	Units	
Naphthalene	T207	M105	0.1	mg/kg	<0.1
Acenaphthylene	T207	M105	0.1	mg/kg	<0.1
Acenaphthene	T207	M105	0.1	mg/kg	<0.1
Fluorene	T207	M105	0.1	mg/kg	<0.1
Phenanthrene	T207	M105	0.1	mg/kg	**0.1**
Anthracene	T207	M105	0.1	mg/kg	<0.1
Fluoranthene	T207	M105	0.1	mg/kg	**0.4**
Pyrene	T207	M105	0.1	mg/kg	**0.3**
Benzo(a)Anthracene	T207	M105	0.1	mg/kg	**0.2**
Chrysene	T207	M105	0.1	mg/kg	**0.2**
Benzo(b)fluoranthene	T207	M105	0.1	mg/kg	**0.2**
Benzo(k)fluoranthene	T207	M105	0.1	mg/kg	**0.1**
Benzo(a)Pyrene	T207	M105	0.1	mg/kg	**0.2**
Indeno(123-cd)Pyrene	T207	M105	0.1	mg/kg	<0.1
Dibenzo(ah)Anthracene	T207	M105	0.1	mg/kg	<0.1
Benzo(ghi)Perylene	T207	M105	0.1	mg/kg	<0.1
PAH(total)	T207	M105	0.1	mg/kg	**1.8**

SAL Reference: 635259
Project Site: Powick
Customer Reference: 4043/2

Leachate Analysed as Water
PAH US EPA 16 (B and K split)

SAL Reference	**635259 005**
Customer Sample Reference	**WS3**
Bottom Depth	**0.2**
Date Sampled	**17-FEB-2017**
Type	**Sandy Soil**

Determinand	Method	Test Sample	LOD	Units	
Naphthalene	T149	10:1	0.01	µg/l	(13) **0.02**
Acenaphthylene	T149	10:1	0.01	µg/l	(13) **0.03**
Acenaphthene	T149	10:1	0.01	µg/l	(13) **0.01**
Fluorene	T149	10:1	0.01	µg/l	(13) **0.02**
Phenanthrene	T149	10:1	0.01	µg/l	(13) **0.04**
Anthracene	T149	10:1	0.01	µg/l	(13) **0.02**
Fluoranthene	T149	10:1	0.01	µg/l	(13) **0.08**
Pyrene	T149	10:1	0.01	µg/l	(13) **0.08**
Benzo(a)Anthracene	T149	10:1	0.01	µg/l	(13) **0.06**
Chrysene	T149	10:1	0.01	µg/l	(13) **0.07**
Benzo(b)fluoranthene	T149	10:1	0.01	µg/l	(13) **0.08**
Benzo(k)fluoranthene	T149	10:1	0.01	µg/l	(13) **0.07**
Benzo(a)Pyrene	T149	10:1	0.01	µg/l	(13) **0.07**
Indeno(123-cd)Pyrene	T149	10:1	0.01	µg/l	(13) **0.05**
Dibenzo(ah)Anthracene	T149	10:1	0.01	µg/l	(13) **0.01**
Benzo(ghi)Perylene	T149	10:1	0.01	µg/l	(13) **0.06**
PAH(total)	T149	10:1	0.01	µg/l	**0.73**

Index to symbols used in 635259-1

Value	Description
10:1	Leachate
M40	Analysis conducted on sample assisted dried at no more than 40C. Results are reported on a dry weight basis.
AR	As Received
M105	Analysis conducted on an "as received" aliquot. Results are reported on a dry weight basis where moisture content was determined by assisted drying of sample at 105C
13	Results have been blank corrected.
M	Analysis is MCERTS accredited
U	Analysis is UKAS accredited
N	Analysis is not UKAS accredited

Method Index

Value	Description
T6	ICP/OES
T7	Probe
T2	Grav
T207	GC/MS (MCERTS)
T287	Calc TOC/0.58
T149	GC/MS (SIR)
T281	ICP/MS (Filtered)
T162	Grav (1 Dec) (105 C)

Accreditation Summary

Determinand	Method	Test Sample	LOD	Units	Symbol	SAL References
Arsenic	T6	M40	2	mg/kg	M	001-011
Cadmium	T6	M40	1	mg/kg	M	001-011
Chromium	T6	M40	1	mg/kg	M	001-011
Copper	T6	M40	1	mg/kg	M	001-011
Lead	T6	M40	1	mg/kg	M	001-011

Determinand	Method	Test Sample	LOD	Units	Symbol	SAL References
Mercury	T6	M40	1	mg/kg	M	001-011
Nickel	T6	M40	1	mg/kg	M	001-011
Selenium	T6	M40	3	mg/kg	M	001-011
Zinc	T6	M40	1	mg/kg	M	001-011
As (Dissolved)	T281	10:1	0.2	µg/l	U	005
Cd (Dissolved)	T281	10:1	0.02	µg/l	U	005
Cr (Dissolved)	T281	10:1	1	µg/l	U	005
Cu (Dissolved)	T281	10:1	0.5	µg/l	U	005
Pb (Dissolved)	T281	10:1	0.3	µg/l	U	005
Hg (Dissolved)	T281	10:1	0.05	µg/l	U	005
Ni (Dissolved)	T281	10:1	1	µg/l	U	005
Se (Dissolved)	T281	10:1	0.5	µg/l	U	005
Zn (Dissolved)	T281	10:1	2	µg/l	U	005
Moisture @105C	T162	AR	0.1	%	N	001-011
Retained on 10mm sieve	T2	M40	0.1	%	N	001-011
Naphthalene	T207	M105	0.1	mg/kg	M	005
Acenaphthylene	T207	M105	0.1	mg/kg	U	005
Acenaphthene	T207	M105	0.1	mg/kg	M	005
Fluorene	T207	M105	0.1	mg/kg	M	005
Phenanthrene	T207	M105	0.1	mg/kg	M	005
Anthracene	T207	M105	0.1	mg/kg	U	005
Fluoranthene	T207	M105	0.1	mg/kg	M	005
Pyrene	T207	M105	0.1	mg/kg	M	005
Benzo(a)Anthracene	T207	M105	0.1	mg/kg	M	005
Chrysene	T207	M105	0.1	mg/kg	M	005
Benzo(b)fluoranthene	T207	M105	0.1	mg/kg	M	005
Benzo(k)fluoranthene	T207	M105	0.1	mg/kg	M	005
Benzo(a)Pyrene	T207	M105	0.1	mg/kg	M	005
Indeno(123-cd)Pyrene	T207	M105	0.1	mg/kg	M	005
Dibenzo(ah)Anthracene	T207	M105	0.1	mg/kg	M	005
Benzo(ghi)Perylene	T207	M105	0.1	mg/kg	M	005
PAH(total)	T207	M105	0.1	mg/kg	U	005
Naphthalene	T149	10:1	0.01	µg/l	U	005
Acenaphthylene	T149	10:1	0.01	µg/l	U	005
Acenaphthene	T149	10:1	0.01	µg/l	U	005
Fluorene	T149	10:1	0.01	µg/l	U	005
Phenanthrene	T149	10:1	0.01	µg/l	U	005
Anthracene	T149	10:1	0.01	µg/l	U	005
Fluoranthene	T149	10:1	0.01	µg/l	U	005
Pyrene	T149	10:1	0.01	µg/l	U	005
Benzo(a)Anthracene	T149	10:1	0.01	µg/l	U	005
Chrysene	T149	10:1	0.01	µg/l	U	005
Benzo(b)fluoranthene	T149	10:1	0.01	µg/l	U	005
Benzo(k)fluoranthene	T149	10:1	0.01	µg/l	U	005
Benzo(a)Pyrene	T149	10:1	0.01	µg/l	U	005
Indeno(123-cd)Pyrene	T149	10:1	0.01	µg/l	U	005
Dibenzo(ah)Anthracene	T149	10:1	0.01	µg/l	U	005
Benzo(ghi)Perylene	T149	10:1	0.01	µg/l	U	005
PAH(total)	T149	10:1	0.01	µg/l	U	005
pH	T7	AR			M	001-011
Soil Organic Matter	T287	AR	0.1	%	N	001

APPENDIX 4

WASTE CLASSIFICATION CALCULATIONS

Job No: 4043/2

Site Name: Powick Pavilion

Soil/Stratum: COMPOSITE (all soil types)

RECORDED CONCENTRATIONS OF ELEMENT GROUPS TESTED AND RESPECTIVE RISK PHRASES (as % of selected compound)									HAZARD CLASS FOR RESPECTIVE RISK PHRASE																																
Substance	Atomic weight	*Total Concentration mg/kg	*Total Concentration %	Selected compound	Molecular mass	Concentration %	Category of danger	Risk Phase	H1	H2	H3a (iii)	H4		H5	H6		H7		H8		H9	H10		H11		H12		H13	H14										H15	
									explosive	oxidising	flammable	irritant	irritant	harmful	toxic	very toxic	carcinogenic category 1 and 2	carcinogenic category 3	corrosive burns	corrosive severe burns	infectious	toxic reproduction category 1 and 2	toxic reproduction category 3	mutagenic category 1 and 2	mutagenic category 3	contact with water air or acid releases toxic gases	contact with water air or acid releases very toxic gases	sensitizing	dangerous to ozone	very toxic AND may cause long term effects	toxic AND may cause long term effects	harmful and may cause long term effects	ecotoxic - non-aquatic environment	capable of yielding another substance post disposal	
ARSENIC	74.92	27.00	0.0027	Arsenic trioxide	197.84	0.007129845	Carcinogenic Cat 1 T+ C N	R45 R28 R34 R50/53				0.00713				0.00713	0.00713		0.00713												0.00713							
CADMIUM	112.41	1.00	0.0001	Cadmium chloride	183.32	0.000163082	Carcinogenic Cat 2 Mutagenic Cat 2 Reproduction Cat 2 T+ T N	R45 R46 R60, 61 R26 R25, 48/23/25 R50/53							0.00016	0.00016	0.00016					0.00016		0.00016								0.00016							
CHROMIUM	52	41.00	0.0041	Chromium (III) chromate	452	0.035638462	O Carcinogenic Cat 2 C N	R8 R45 R35/43 R50/53		0.03564							0.03564			0.03564											0.03564							
CHROMIUM	52		0	Chromium (VI) trioxide	100	0	Carcinogenic Cat 1 O Mutagenic Cat 2 Reproduction Cat 3 T+ T N C	R45 R9 R46 R62 R26 R24/25, 48, 23 R50-53 R35 R42/43		0.00000					0.00000	0.00000	0.00000			0.00000			0.00000		0.00000					0.00000							
LEAD	207.2	54.00	0.0054	Lead (II) sulphate	303.26	0.007903494	Reproduction Cat 1 Reproduction Cat 3 Xn N	R61 R62 R20/22/33 R50/53						0.00790								0.00790	0.00790								0.00790							
MERCURY	200.59	1.00	0.0001	Mercury	200.59	0.0001	T N	R23, 33 R50/53							0.00010														0.00010							
SELENIUM	78.96	3.00	0.0003	Selenium	78.96	0.0003	T N	R23/25 R33 R53							0.00030																0.00030					
BORON	10.81		0	Boron trifluoride	67.82	0	Reacts with water T+ C	R14 R26/28 R35								0.00000			0.00000																		
COPPER	63.55	25.00	0.0025	Copper sulphate	159.62	0.006279308	Xn Xi N	R22 R36/38 R50/53					0.00628	0.00628																0.00628							
NICKEL	58.69	37.00	0.0037	Nickel (II) sulphide	122.7	0.007735389	Carcinogenic Cat 3 Xn N	R49 R43 R50/53						0.00774			0.00774											0.00774		0.00774							
ZINC	65.38	74.00	0.0074	Zinc oxide	81.41	0.009214347	N	R50/53																					0.00921							
BTEX	78.11		0	Benzene	78.11	0	Carcinogenic Cat 1 Mutagenic Cat 2 T N F Xi Xn	R45 R46 R48/23/24/25 R51-53 R11 R36/38 R65				0.00000		0.00000	0.00000	0.00000	0.00000		0.00000						0.00000								0.00000							
BTEX	92.14		0	Toluene	92.14	0	F Reproduction Cat 3 Xn Xi	R11 R63 R48/20, 65 R38 R67				0.00000		0.00000								0.00000																
BTEX	106.17		0	Ethlybenzene	106.17	0	F Xn N	R11 R20 R51-53				0.00713		0.00000																	0.00000						
BTEX	106.16		0	Xylenes	106.16	0	F N Xn Xi	R10 R51-53 R20/21 R38				0.00000		0.00000	0.00000																0.00000						
GRO	103.37		0	C5-C10	103.37	0	F+ Carcinogenic Cat 2 N Xn	R12 R45 R51-53 R65				0.00000		0.00000			0.00000														0.00000						
DRO	183.33		0	C10-C25	183.33	0	Carcinogenic Cat 3 N Xn	R40 R51-53 R65						0.00000				0.00000													0.00000						
MINERAL OIL	365		0	C25-C44	365	0	Carcinogenic Cat 2 Mutagenic Cat 2 N Reproduction Cat 3 Xn	R45 R46 R51-53 R63 R65						0.00000			0.00000					0.00000		0.00000							0.00000						
PAH	252	0.20	0.00002	benzo-a-pyrene	252	0.00002	Carcinogenic Cat 2 Mutagenic Cat 2 Xi Reproduction Cat 2 N	R45 R46 R43 R60,R61 R50/53									0.00002					0.00002		0.00002					0.00002							
PAH	128	0.10	0.00001	naphthalene	128	0.00001	Carcinogenic Cat 3 Xn N	R40 R22 R50/53						0.00001				0.00001												0.00001						
PCB	337.91		0	PCB	337.91	0	N	R33-50/53																					0.00000						
							Total (%)			0.04	0.01	0.01	0.01	0.02	0.00	0.01	0.04	0.00	0.01	0.04	0.00	0.01	0.01	0.00	0.00	N/A	N/A	0.01	0.00	0.04	0.00	0.00	N/A	N/A	
							Threshold (%)		Appendix C1	Appendix C2	Appendix C3	≥5%	≥20%	≥25%	≥3%	≥0.1%	≥0.1%	≥1%	≥5%	≥1%	Appendix C9	≥0.5%	≥5%	≥0.1%	≥1%	Appendix C12	Appendix C12	≥1%*	≥0.1%	≥0.25%	≥2.5%	≥25%	N/A	N/A	

N.B. The total element concentration used in this analysis equates to the highest recorded concentration obtained from laboratory testing. The respective compound has been selected with reference to Table 3.2 of Part 3 of Annex VI of the CLP Regulation, 2009 (Directive 67/548/EEC).

* = use 1% unless specific conc limits available

LEGEND			
T+	very toxic	Xn	harmful
T	toxic	O	combustible
N	ecotoxic	C	causes burns
F	flammable	Xi	causes sensitisation

APPENDIX 5

GAS MONITORING RESULTS

MONITORING UNDERTAKEN 23 FEBRUARY 2017

Atmospheric Pressure (mb) and Trend	Temperature (°C) and Weather	BH No	Time (secs/ mins)	Concentrations (%)			Flow rates time (secs/mins)	Flow rates (l/hr)	Standing water level (m, bgl)	Depth and horizon of response zone (m,bgl)
				CH_4	CO_2	O_2				
21.2.17	10° C	WS1	15s	0.0	1.6	19.6	15s	0.2	dry	1.0 - 3.0
1015	cloudy, very		30s	0.0	1.6	18.8	30s	0.2		
22.2.17	windy,		45s	0.0	1.6	18.7	45s	0.3		
1007	occasional		1m	0.0	1.7	18.6	1m	0.2		
23.2.17	rain showers		2m	0.0	1.7	18.6	2m	0.2		
989			3m	0.0	1.8	18.5	3m	0.2		
(falling)			4m	0.0	1.8	18.5	4m	0.2		
			5m	0.0	1.7	18.7	5m	0.2		
			6m	0.0	1.6	18.8				
			7m	0.0	1.6	18.9				
			8m	0.0	1.6	18.9				
			9m	0.0	1.6	19.0				
			10m	0.0	1.6	19.0				
			Max Peak	0.0	1.8		Max Peak	0.3		
			Steady Values	0.0	1.6		Steady Values	0.2		
21.2.17	10° C	WS2	15s	0.0	0.6	18.8	15s	0.0	dry	1.0 - 3.0
1015	cloudy, very		30s	0.0	1.7	18.2	30s	0.0		
22.2.17	windy,		45s	0.0	1.7	18.1	45s	0.0		
1007	occasional		1m	0.0	1.7	18.1	1m	0.0		
23.2.17	rain showers		2m	0.0	1.7	18.1	2m	0.0		
989			3m	0.0	1.7	18.0	3m	0.0		
(falling)			4m	0.0	1.7	18.0	4m	0.0		
			5m	0.0	1.6	17.9	5m	0.0		
			6m	0.0	1.6	17.9				
			7m	0.0	1.6	17.9				
			8m	0.0	1.5	17.9				
			9m	0.0	1.5	17.9				
			10m	0.0	1.5	17.9				
			Max Peak	0.0	1.7		Max Peak	0.0		
			Steady Values	0.0	1.5		Steady Values	0.0		
21.2.17	10° C	WS3	15s	0.0	1.2	19.2	15s	0.0	2.75	1.0 - 3.0
1015	cloudy, very		30s	0.0	1.2	18.0	30s	0.0		
22.2.17	windy,		45s	0.0	1.2	18.0	45s	0.0		
1007	occasional		1m	0.0	1.2	18.0	1m	0.1		
23.2.17	rain showers		2m	0.0	1.3	17.9	2m	0.0		
989			3m	0.0	1.3	17.9	3m	0.0		
(falling)			4m	0.0	1.2	17.8	4m	0.0		
			5m	0.0	1.0	17.7	5m	0.0		
			6m	0.0	0.8	17.5				
			7m	0.0	0.7	17.5				
			8m	0.0	0.7	17.5				
			9m	0.0	0.7	17.6				
			10m	0.0	0.7	17.6				
			Max Peak	0.0	1.3		Max Peak	0.1		
			Steady Values	0.0	0.7		Steady Values	0.0		

MONITORING UNDERTAKEN 23 FEBRUARY 2017 *(continued)*

Atmospheric Pressure (mb) and Trend	Temperature (°C) and Weather	BH No	Time (secs/ mins)	Concentrations (%)			Flow rates time (secs/mins)	Flow rates (l/hr)	Standing water level (m, bgl)	Depth and horizon of response zone (m,bgl)
				CH_4	CO_2	O_2				
21.2.17	10° C	WS4	15s	0.0	1.5	17.5	15s	0.1	1.85	1.0 - 3.0
1015	cloudy, very		30s	0.0	1.5	16.8	30s	0.1		
22.2.17	windy,		45s	0.0	1.5	15.3	45s	0.1		
1007	occasional		1m	0.0	1.5	15.3	1m	0.1		
23.2.17	rain showers		2m	0.0	1.5	15.3	2m	0.0		
989			3m	0.0	1.6	15.2	3m	0.0		
(falling)			4m	0.0	1.6	15.2	4m	0.1		
			5m	0.0	1.6	15.3	5m	0.1		
			6m	0.0	1.7	15.3				
			7m	0.0	1.8	15.3				
			8m	0.0	1.8	15.4				
			9m	0.0	1.8	15.4				
			10m	0.0	1.8	15.4				
			Max Peak	0.0	1.8		Max Peak	0.1		
			Steady Values	0.0	1.8		Steady Values	0.1		

MONITORING UNDERTAKEN 28 FEBRUARY 2017

Atmospheric Pressure (mb) and Trend	Temperature (°C) and Weather	BH No	Time (secs/ mins)	Concentrations (%)			Flow rates time (secs/mins)	Flow rates (l/hr)	Standing water level (m, bgl)	Depth and horizon of response zone (m,bgl)
				CH_4	CO_2	O_2				
26.2.17	7° C	WS1	15s	0.0	2.4	19.0	15s	0.0	dry	1.0 - 3.0
1022	overcast,		30s	0.0	2.4	19.0	30s	0.0		
27.2.17	cool, slight		45s	0.0	2.4	19.0	45s	0.0		
984	breeze, light		1m	0.0	2.4	19.0	1m	0.0		
28.2.17	rain		2m	0.0	2.4	19.0	2m	0.0		
982			3m	0.0	2.4	19.0	3m	0.0		
(falling)			4m	0.0	2.3	19.1	4m	0.0		
			5m	0.0	2.2	19.3	5m	0.0		
			6m	0.0	2.2	19.4				
			Max Peak	0.0	2.4		Max Peak	0.0		
			Steady Values	0.0	2.2		Steady Values	0.0		
26.2.17	7° C	WS2	15s	0.0	2.3	19.0	15s	0.0	dry	1.0 - 3.0
1022	overcast,		30s	0.0	2.3	17.8	30s	0.0		
27.2.17	cool, slight		45s	0.0	2.3	17.8	45s	0.0		
984	breeze, light		1m	0.0	2.3	17.8	1m	0.0		
28.2.17	rain		2m	0.0	2.3	17.8	2m	0.0		
982			3m	0.0	2.3	17.8	3m	0.0		
(falling)			4m	0.0	2.3	17.9	4m	0.0		
			5m	0.0	2.3	18.0	5m	0.0		
			Max Peak	0.0	2.3		Max Peak	0.0		
			Steady Values	0.0	2.3		Steady Values	0.0		
26.2.17	7° C	WS3	15s	0.0	1.4	15.5	15s	0.0	2.75	1.0 - 3.0
1022	overcast,		30s	0.0	1.4	15.5	30s	0.0		
27.2.17	cool, slight		45s	0.0	1.3	15.5	45s	0.0		
984	breeze, light		1m	0.0	1.3	15.5	1m	0.0		
28.2.17	rain		2m	0.0	1.3	15.6	2m	0.0		
982			3m	0.0	1.3	15.5	3m	0.0		
(falling)			4m	0.0	1.2	15.5	4m	0.0		
			5m	0.0	1.2	15.5	5m	0.0		
			6m	0.0	1.2	15.5				
			Max Peak	0.0	1.4		Max Peak	0.1		
			Steady Values	0.0	1.2		Steady Values	0.0		
26.2.17	7° C	WS4	15s	0.0	2.4	16.4	15s	0.1	2.05	1.0 - 3.0
1022	overcast,		30s	0.0	2.4	14.4	30s	0.2		
27.2.17	cool, slight		45s	0.0	2.4	14.2	45s	0.2		
984	breeze, light		1m	0.0	2.4	14.1	1m	0.2		
28.2.17	rain		2m	0.0	2.5	14.1	2m	0.2		
982			3m	0.0	2.5	14.0	3m	0.2		
(falling)			4m	0.0	2.5	14.0	4m	0.2		
			5m	0.0	2.5	14.0	5m	0.2		
			Max Peak	0.0	2.5		Max Peak	0.2		
			Steady Values	0.0	2.5		Steady Values	0.2		

MONITORING UNDERTAKEN 6 MARCH 2017

Atmospheric Pressure (mb) and Trend	Temperature (°C) and Weather	BH No	Time (secs/ mins)	Concentrations (%)			Flow rates time (secs/mins)	Flow rates (l/hr)	Standing water level (m, bgl)	Depth and horizon of response zone (m,bgl)
				CH_4	CO_2	O_2				
4.3.17	7.5° C	WS1	15s	0.0	2.6	18.2	15s	0.2	dry	1.0 - 3.0
9862	cloudy, cool,		30s	0.0	2.6	17.4	30s	0.2		
5.3.17	light breeze		45s	0.0	2.6	17.4	45s	0.2		
987			1m	0.0	2.6	17.4	1m	0.2		
6.3.17			2m	0.0	2.6	17.4	2m	0.2		
1002			3m	0.0	2.6	17.4	3m	0.2		
(steady)			4m	0.0	2.6	17.4	4m	0.2		
			5m	0.0	2.6	17.4	5m	0.2		
			Max Peak	0.0	2.6		Max Peak	0.2		
			Steady Values	0.0	2.6		Steady Values	0.2		
4.3.17	7.5° C	WS2	15s	0.0	3.0	17.4	15s	0.0	2.53	1.0 - 3.0
9862	cloudy, cool,		30s	0.0	3.0	1.9	30s	0.0		
5.3.17	light breeze		45s	0.0	3.0	16.8	45s	0.0		
987			1m	0.0	3.0	16.8	1m	0.0		
6.3.17			2m	0.0	3.0	16.8	2m	0.0		
1001			3m	0.0	3.0	16.8	3m	0.0		
(steady)			4m	0.0	2.9	16.8	4m	0.0		
			5m	0.0	2.8	16.8	5m	0.0		
			6m	0.0	2.8	16.8				
			Max Peak	0.0	3.0		Max Peak	0.0		
			Steady Values	0.0	2.8		Steady Values	0.0		
4.3.17	7.5° C	WS3	15s	0.0	0.4	21.2	15s	-9.4	1.15	1.0 - 3.0
9862	cloudy, cool,		30s	0.0	0.5	21.2	30s	-0.4		
5.3.17	light breeze		45s	0.0	0.5	21.2	45s	0.0		
987			1m	0.0	0.4	21.2	1m	0.1		
6.3.17			2m	0.0	0.4	21.2	2m	0.1		
1001				pump			3m	0.0		
(steady)				failed			4m	0.0		
							5m	0.0		
			Max Peak				Max Peak	-9.4		
			Steady Values				Steady Values	0.0		
4.3.17	7.5° C	WS4	15s	0.0	2.7	15.5	15s	-0.0	1.64	1.0 - 3.0
9862	cloudy, cool,		30s	0.0	2.8	13.6	30s	-0.0		
5.3.17	light breeze		45s	0.0	2.8	13.5	45s	-0.0		
987			1m	0.0	2.8	13.5	1m	-0.0		
6.3.17			2m	0.0	2.8	13.5	2m	-0.0		
1000			3m	0.0	2.8	13.4	3m	-0.0		
(steady)			4m	0.0	2.7	13.4	4m	-0.0		
			5m	0.0	2.7	13.4	5m	-0.0		
			6m	0.0	2.7	13.4				
			7m	0.0	2.7	13.4				
			Max Peak	0.0	2.8		Max Peak	-0.0		
			Steady Values	0.0	2.7		Steady Values	-0.0		

CERTIFICATION OF CALIBRATION

Date Of Calibration: 25-Nov-2016 **Certificate Number:** G501432_1/17487

4533

ISSUED BY: GEOTECHNICAL INSTRUMENTS (UK) LTD

Customer: **Wilson Associates (Consulting) Ltd**

36 Brunswick Road GLOUCESTER Gloucestershire
GL1 1JJ UNITED KINGDOM

Description: Gas Analyser

Model: GA5000

Serial Number: G501432

UKAS Accredited results:

Results after adjustment :

Methane (CH_4)		
Certified Gas (%)	**Instrument Reading (%)**	**Uncertainty (%)**
5.1	5.0	0.41
15.0	15.0	0.64
50.0	49.6	0.94

Carbon Dioxide (CO_2)		
Certified Gas (%)	**Instrument Reading (%)**	**Uncertainty (%)**
5.1	4.9	0.43
15.1	14.9	0.70
50.0	50.1	1.1

Oxygen (O_2)		
Certified Gas (%)	**Instrument Reading (%)**	**Uncertainty (%)**
21.3	21.4	0.31

The inwards assessment was carried out 22-Nov-2016.
The maximum adjustment is larger than the inwards assessment uncertainty.
Inwards assessment data is available if requested.

All concentrations are molar.

CH_4, CO_2 readings recorded at : 32.9 °C ± 1.5 °C

O2 reading recorded at : 24.4 °C ± 1.5 °C

Barometric Pressure : 1016 mbar ± 3 mbar

Method of Test : The analyser is calibrated in a temperature controlled chamber using a series of reference gases, in compliance with procedure LP004.

Geotechnical Instruments (UK) Ltd
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CERTIFICATION OF CALIBRATION

Date Of Calibration: 25-Nov-2016 **Certificate Number:** G501432_1/17487

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The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor of k=2, providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements.

Calibrations marked 'Non-UKAS Accredited results' on this certificate have been included for completeness.

Non-UKAS Accredited results:

Barometer (mbar)	
Reference	Instrument Reading
1016	1018

Internal Flow	
Applied (l/hr)	Instrument Reading (l/hr)
5.00	5.00
10.00	10.00

Approved by Signatory

[redacted]

Jeremy Dunn

Laboratory Inspection

Geotechnical Instruments (UK) Ltd
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