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SITE ASSESSMENT REPORT

Former Windmill Filling Station
Dunchurch Highway, Allesley, West midlands

Report No: 04833 CL 001

October 2005

Client: BP Oil UK Ltd

Report Prepared By:

Debbie Brown

Report Reviewed By:

James Skinner

Summary

The purpose of this assessment is to identify and quantify any potential environmental liabilities associated with the condition of the soil and groundwater underlying the former Windmill Filling Station, specifically relating to the site's historical use as a retail filling station. This assessment has not been compiled to satisfy any specific planning conditions or other regulatory requirement. However, the information contained in this report may assist in satisfying any such requirements.

The site is located on Dunchurch Highway in a predominantly residential area of Allesley. The nearest residential property is located less than 25m from the site and the nearest off-site commercial property at a distance of 25m.

Desk study information indicates that the site overlies Allesley Member over Corley Sandstone. The Environment Agency Groundwater Vulnerability Map shows the site location as overlying a minor aquifer. We interpret this as referring to the Meriden Formation (Allesley Member and Corley Sandstone) that comprises red-brown mudstones and sandstones. Based upon review of the surrounding topography and river drainage system we would consider it likely that groundwater within this unit will flow towards the southeast.

We have identified a single potentially at risk groundwater abstraction currently licensed by the Environment Agency and within 2km of the site. This abstraction is licensed to Severn Trent Water Ltd, is used as a public drinking water supply and is located approximately 1,500m to the south of the site. The site is also located within Zone III or the 'Total Catchment' of the Source Protection Zone associated with this abstraction.

As the abstraction is located within the SPZ, and is also located hydraulically down gradient of the site with respect to predicted regional groundwater flow, we would consider it to be potentially at risk of impact from any petrol and/or diesel present in groundwater underlying the site.

The nearest surface water to the site is Pickford Brook, which is located approximately 375m to the southwest of the site and flows in a southeasterly direction. Dependent upon the nature of shallow geology underlying the site the brook could be at risk of impact via the migration of impacted 'perched' and/or shallow groundwater originating under the site. However, as the predicted direction of groundwater flow is to the southeast we consider the level of risk to be minimal.

We have not identified any potentially at risk surface water abstractions that are licensed by the Environment Agency and within 2km of the site.

We have constructed five boreholes to a depth of up to 5.4m at the site. We installed permanent groundwater monitoring wells in three of these boreholes. Our investigation confirmed that the shallow geology underlying the site comprises Made Ground overlying the Allesley Member (clays over sand with sandstone at depth).

We did not encounter groundwater in any of the boreholes constructed and no groundwater accumulated within any of the three wells installed on the day of our investigation.

We recorded olfactory and/or visual evidence of hydrocarbons in Boreholes One and Three within the Allesley Member unit at depths of 1.0 to 2.4m and 3.0 to 3.8m respectively.

The chemical analysis results carried out on soil samples recovered from Borehole One indicate the presence of compounds indicative of diesel at a depth of 2.0m with the upper surface of the weathered Allesley Member. Samples recovered from below this depth however showed decreasing concentrations of these compounds indicating that the nature of the unit may, to some extent, be acting to impede extensive vertical migration.

We have used the data from our desk study and site investigation to assess the site in accordance with the Environmental Protection Act 1990, Part IIa. Under these regulations, if a positive source-pathway-target linkage is established, a site will be considered potentially 'contaminated land' unless it can be demonstrated that there is no significant risk to human or environmental receptors. In order to demonstrate this requires that a qualitative/quantitative risk assessment be carried out.

Our generic risk assessment indicates that:

- The concentrations of inorganic contaminants encountered in soil underlying the site do not exceed the relevant CLEA Soil Guideline Values (SGVs) for commercial end use.
- The concentrations of organic contaminants identified in the soil only (groundwater not encountered) at the site do not exceed Risk Based Screening Levels.
- We have been unable to complete a valid assessment of the potential risk posed to environmental receptors associated with the site as we have been unable to confirm that soils surrounding the underground tank farm and also groundwater within the sandstone aquifer have not been impacted.

As specified above we have been unable to complete our Generic Risk Assessment (for both human and environmental receptors) due to the absence of either comprehensive soils data from surrounding and underling the site's former tank farm, or groundwater data.

The site overlies a minor aquifer and is located within the boundary of a Source Protection Zone. This places the site in a relatively environmentally sensitive area.

We therefore recommend that we return to the site and construct a series of deeper boreholes (using a specialised rock coring drilling system) to depths consistent with groundwater. This will allow us to install permanent groundwater monitoring wells and recover groundwater samples. This will allow us to complete the risk assessment process and hence determine whether the site is suitable for continued commercial use.

Your attention is drawn to the Notice to Interested Parties included as Attachment One.

Contents

List of Attachments

1 Introduction

1.1 The Purpose of This Assessment

The purpose of this assessment is to identify and quantify any potential environmental liabilities associated with the condition of the soil and groundwater underlying the site, specifically relating to the site's historical use as a retail filling station. Our intrusive investigation has therefore predominantly focused on the analysis of soil and groundwater samples for compounds likely to derive from petrol and diesel fuels.

Following the requirements of the Environmental Protection Act 1990, Part IIa, our investigation has been designed to obtain sufficient data to complete a qualitative and, if required, quantitative risk assessment for the site. Based on the results of our risk assessment we have determined whether the site is suitable for continued commercial use.

This assessment has not been compiled to satisfy any specific planning conditions or other regulatory requirement. However, the information contained in this report may assist in satisfying any such requirements. The Client specified the scope of work.

All the activities comprising this assessment were carried out in accordance with the procedures set out in our Quality Manual. Your attention is drawn to the Notice to Interested Parties included as Attachment One.

1.2 The Scope of This Assessment

Our assessment of the site was carried out in the following parts:

- Desk study. We have obtained an Envirocheck report from Landmark Information Group Ltd for the site, comprising information that is readily available in the public domain;
- A site walkover to inspect the operations currently being carried out at the site;
- Underground utilities survey of the site, using radio detection techniques;
- Development of a conceptual site model and completion of a Preliminary Risk Assessment as recommended by Environment Agency (2004) "Model Procedures for the Management of Contaminated Land" CLR11;
- An intrusive soil investigation comprising five boreholes;
- Chemical analysis of representative soil samples;
- Completion of a Generic (Quantitative) Risk Assessment.

2 Environmental Setting

The site is located at National Grid Reference 429130 280870 at approximately 110m above Ordnance Datum. The site is located on Dunchurch Highway in a predominantly residential area of Allesley, west of Coventry and currently comprises a car dealership. The land surrounding the site slopes gently downwards to the south. Surrounding land use is summarised in the following Table. The site's location is shown on the following page:

Orientation	Land Use	Details
North	Commercial	Hotel located across Dunchurch Highway (~25m), beyond which lies a large residential area
West / South	Residential	Residential properties just past site boundary (<5m)
East	Commercial	Commercial buildings (including an active petrol filling station) across Dunchurch Highway (~25m), beyond which lies a large residential area

Table One: Site Setting – Surrounding Land Use

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Site Location

2.1 Historical Map Review

We have not carried out a detailed historical desk study. Such a study may identify additional potentially contaminative land uses that have taken place at the site prior to its use as a retail filling station.

2.2 Proposed Future Use of the Site

We understand that the site is to remain in use as a car sales and repair workshop (commercial operation) and not been made aware of any future redevelopment works.

2.3 Geology

We have assessed the geology of the site's locality from available BGS maps and memoirs. These show the geology to comprise (in succession, from the surface downward):

Unit I: Allesley Member – Part of the Meriden Formation comprising red-brown mudstone and sandstone thin limestone bands, with sandstone increasing (generally) upwards. The estimated thickness of this unit under the site is 80m. The Environment Agency classifies this unit as a minor aquifer.

Unit II: Corley Sandstone – Also part of the Meriden Formation and comprising red-brown mudstone and sandstone with occasional limestone. The estimated thickness of this unit under the site is 80m. The Environment Agency classifies this unit as a minor aquifer.

The geology of the site area is shown on the following page.

2.4 Hydrogeology

The Environment Agency Groundwater Vulnerability Map shows the site location as overlying a minor aquifer. This is defined as a unit that, although rarely supplying sufficient quantities of groundwater for public abstraction, is important for both local supplies and for supplying base flows to rivers.

We interpret this as referring to the Meriden Formation (Allesley Member and Corley Sandstone) sandstone units. Based upon review of the surrounding topography and river drainage system we would consider it likely that groundwater within this unit will flow towards the southeast.

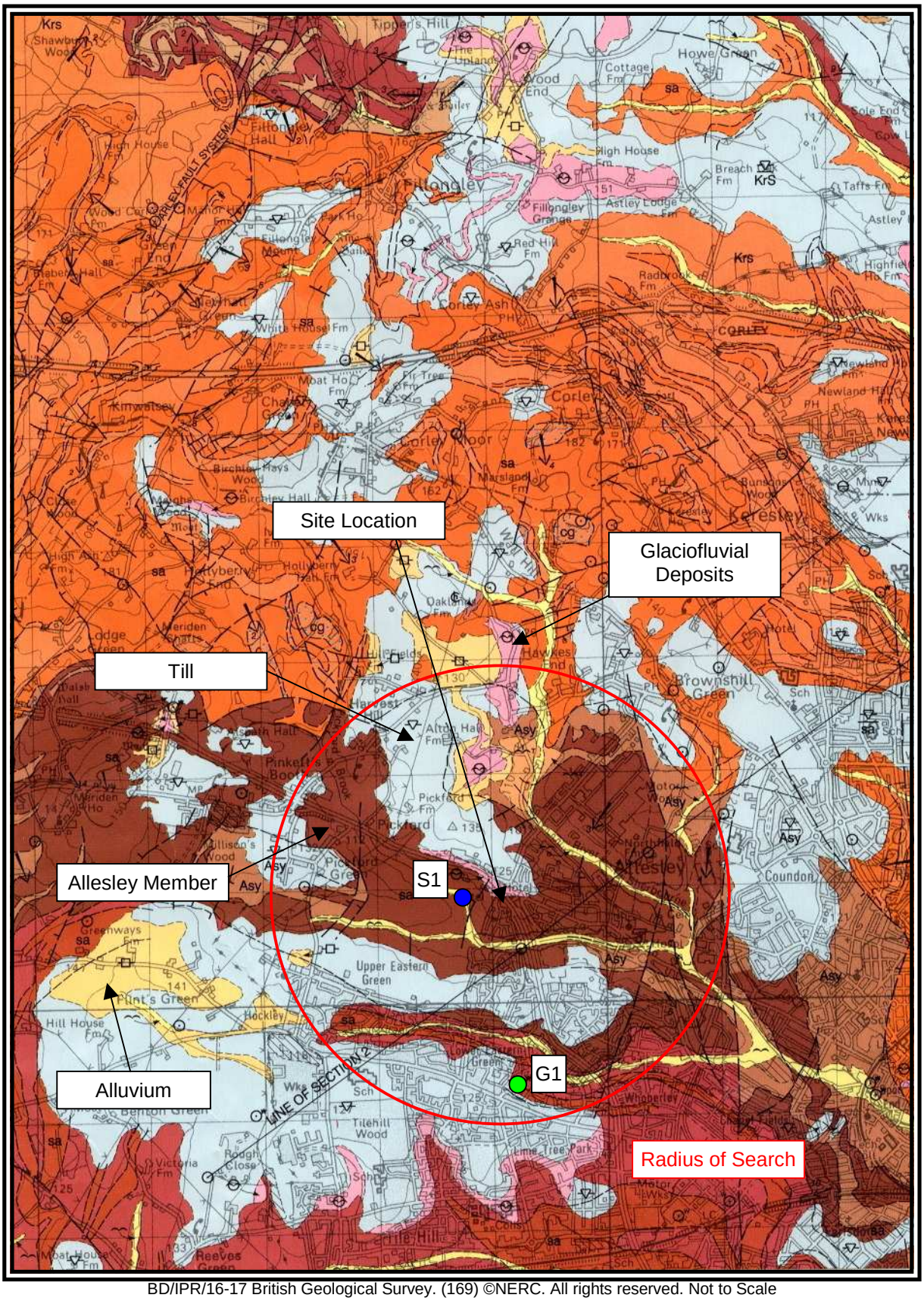
The following groundwater abstractions are currently licensed by the Environment Agency and within 2km of the site:

Ref	Location	Distance and Direction from Site	Licensee	Aquifer	End Use	Annual Volume (m^3)
G1	429220 279260	1,557m - S	Severn Trent Water Ltd	Not specified	Potable water supply	Not Supplied

Table Two: Licensed Groundwater Abstractions

The Environment Agency defines Source Protection Zones around groundwater abstractions used for public water supply. The Zones are defined by the estimated travel time of potential contaminants to the abstractions. This travel time can be influenced by factors such as the underlying geology or the volume of groundwater being abstracted. Source Protection Zones are therefore areas that may be considered to be particularly sensitive to groundwater impact.

The site is located within Zone III or the 'Total Catchment' of a Source Protection Zone. This is defined as the total area of aquifer that is considered required to actually support the protected groundwater abstraction.



Geology of the Site Area

The public groundwater abstraction associated with this SPZ is likely to be the abstraction we have identified (G1). As the abstraction is located within the SPZ, and is also located hydraulically down gradient of the site with respect to predicted regional groundwater flow, we would consider it to be potentially at risk of impact from any petrol and/or diesel present in groundwater underlying the site.

2.5 Hydrology

The nearest surface water to the site is the Pickford Brook, which is located approximately 375m to the southwest of the site and flows in a southeasterly direction. Dependent upon the nature of shallow geology underlying the site the brook could be at risk of impact via the migration of impacted 'perched' and/or shallow groundwater originating under the forecourt. However, as the predicted direction of groundwater flow is to the southeast we consider the level of risk to be minimal.

We have also identified the River Sherboure, which is located approximately 1km to the northeast of the site. Due to the large distance between site and the river, in addition to the anticipated direction of groundwater flow being to the south, we do not consider the river to be at risk of impact from any mobile contaminants originating at the site.

The following surface water abstractions are licensed by the Environment Agency and within 2km of the site:

Ref	Location	Distance and Direction from Site	Licensee	Source	End Use	Annual Volume (m^3)
S1	428690 280960	388m - NW	Convexed Ltd.	Surface	Spray Irrigation	Not given

Table Three: Licensed Surface Water Abstractions

The identified abstraction draws from Pickford Brook at point upstream from the subject site. As such we do not consider this abstraction to be at risk of impact.

2.6 Regulatory Comment

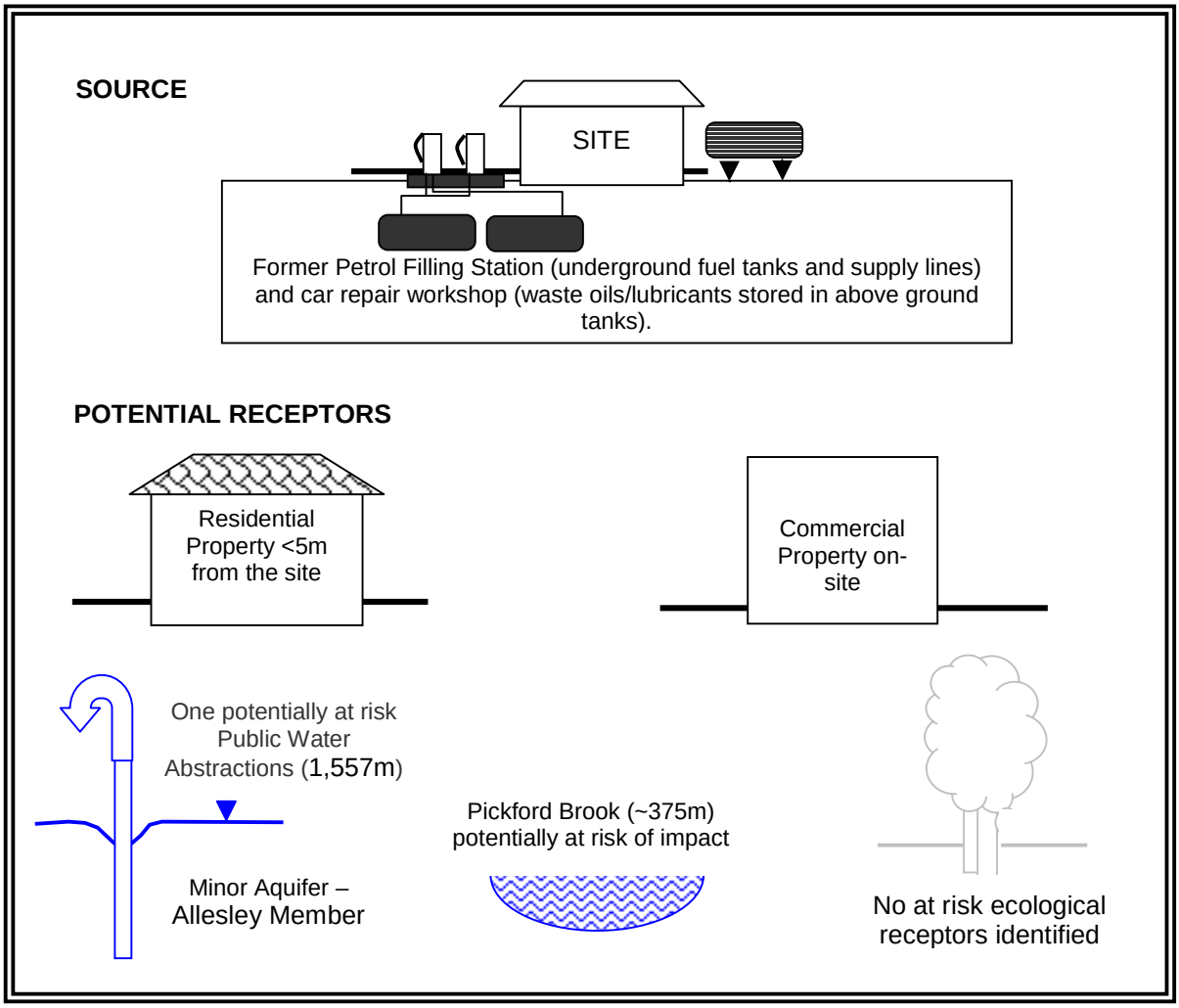
We have obtained an Envirocheck report from Landmark Information Group Ltd for the site, comprising information that is readily available in the public domain. Relevant information is summarised below:

- The site is located in an area where the National Radiological Protection Board have determined that less than 1% of houses are affected by radon. This places the site in a low risk area for radon. No special precautions are required to prevent radon infiltration into residential or commercial buildings at the site.
- The site is located in an area that is likely to be affected by past or present coal mining activities. We recommend that a more detailed evaluation report be obtained from the Coal Authority.
- The Environment Agency records show that there are no current or past landfill sites within 250m of the site. We do not consider the site to be at any particular risk of impact from landfill gas.
- The site is located in an area that the Environment Agency considers to be potentially at risk of flooding. The Environmental Agency classifies the site as being located within a flood plain. The Environment Agency maps indicate the potential risk to the site of flooding to be one in one hundred (or a one per cent) chance each year.

3 Conceptual Site Model and Preliminary Risk Assessment

3.1 Conceptual Site Model

Based on the results of our desk study we have compiled the following conceptual site model:



Conceptual Site Model

3.2 Preliminary Risk Assessment

We have completed a qualitative Preliminary Risk Assessment in accordance with current industry best practice. This is based on the concept of source-pathway-receptor linkages, known as pollutant linkages. In this context, each element can be defined as follows:

Source	A substance either on, or under the land, and which has the potential to cause harm or pollution to human or environmental receptors.
Pathway	A route or means by which a receptor can be exposed to or affected by a source.
Receptor	A living organism or an ecological system.

Our conceptual site model defines the pollutant linkages that we have assessed. We consider the following linkages to be viable:

Source	Contaminant Media	Pathway	Receptor	Viable Pollutant Linkage
Underground fuel storage tanks Drainage system and interceptor Above ground oil (waste/ lubricants) storage tanks associated with operational car repair workshop	Surficial soils	Volatilisation to indoor and outdoor air.	Commercial workers	Yes
		Ingestion and dermal contact	Residents	Yes
	Unsaturated soil	Volatilisation to indoor and outdoor air.	Commercial workers	Yes
			Residents	Yes
		Soil leaching to groundwater. Groundwater migration to surface water.	Pickford Brook	Yes
		Soil leaching to groundwater.	Minor Aquifer - Allesley Member	Yes
		Soil leaching to groundwater. Groundwater migration to abstraction. Groundwater ingestion.	Groundwater abstraction 1,557m from site	Yes
	Saturated soil/ Groundwater	Volatilisation to indoor and outdoor air.	Commercial workers	Yes
			Residents	Yes
		Soil leaching to groundwater.	Minor Aquifer - Allesley Member	Yes
		Groundwater migration to receptor.	Groundwater abstraction 1,557m from site	Yes
		Soil leaching to groundwater.	None identified	No

Table Four: Results of Preliminary Risk Assessment

We therefore conclude that one or more pollutant linkages potentially exist at the site. We have therefore carried out an intrusive soil and/or groundwater investigation to determine whether these linkages are likely to cause significant harm.

4 Results of our Investigation

4.1 Buried Utilities Survey

We have carried out a survey using radio detection methods of utilities buried underneath the site. Our survey was suitable for identifying power cables, metallic fuel pipework, surface water and foul water drainage. The technique that we used is unable to detect any plastic pipework or fibre optic cabling that might be present.

The results of our survey of the detectable underground services at the site are included in Attachment Two.

4.2 Walkover Survey and Review of Petroleum Register

The results of our walkover survey are summarised below:

The site occupies approximately 4206m^2 and is currently an Autobann Porsche Garage that comprises a car sales showroom and offices. In addition the northern end of the building has been converted into a car repair workshop.

We understand, however, that the site has previously been in use as a petrol filling station. We have not been able to obtain precise dates as to when the site was first used as a petrol filling station, although the site's former Petroleum Officer has indicated it has been so from the 1970s onwards.

We completed an inspection of the site during our intrusive investigation in order to identify any potential areas of concern with regard to the environmental condition of underlying soil or groundwater. The following observations were made:

- The site's car repair workshop (operational) is located to the eastern end of the main building. Lubricants and waste oils used/produced as part of the workshops daily operations are stored in three, bunded, above ground storage tanks located along the workshops outer wall. We did not identify any signs of leaks or spillages in this are on the day of our investigation;
- The former filling station's fuel pumps have been removed (date unknown). However, we identified scars in the forecourt to the front of the existing main site building indicating the former location of the pump islands when the forecourt was operational;
- We were unable to definitively identify the location of the site's former underground fuel storage tanks. Our site inspection identified two concrete filled inspection chambers located to the front of the current sale showroom, which due to their close proximity with the former pump islands could potentially be either two underground tanks (or a single split compartment tank);
- We also identified a series of nine concrete 'plinths' situated directly to the southwest of the main site building. Site-staff were unable to provide information regarding the former use of these plinths. It is possible that they were formerly used for supporting aboveground fuel storage tanks. We were unable to obtain confirmation for this;
- We identified a three-chambered, GRP lined, brick interceptor along the western end of the existing building. According to site staff this is the original filling station forecourt interceptor and is still operational. On the day of our site investigation all three chambers were noted as being in good condition and clean. Our on-site inspection indicated that the approximate capacity of the interceptor is 3,000 litres;

We have obtained information regarding the petroleum installation and environmental site history from the Petroleum Officer. The Petroleum Officer informed us that as the site was decommissioning some time ago his records for the site were limited. The site had not retained any records of the petroleum installation and/or the on-site petroleum register. We were able to obtain the following information:

- According to the sites former Petroleum Officer the petroleum installation consisted of a total of six underground storage tanks. He has no knowledge regarding the size/location or current status of these tanks;
- The site's Petroleum Officer also informed us that a single 9,092litres underground storage (petrol) tank, installed during the early 1970s, was rendered safe by slurry filling with a sand/cement mix in 1998.

4.3 Borehole Investigation

The site work was carried out on 31st March 2004.

We investigated the soil and groundwater quality at the site by constructing five boreholes using a GeoProbe direct push drilling system. The boreholes were constructed to a target depth of 6.0m. Representative soil samples were recovered from each borehole in sealed liners and logged onsite by a suitably qualified technician. Sub-samples were preserved in glass jars and stored in cool boxes during transportation to the laboratory for subsequent analysis.

Three of the boreholes were completed as permanent groundwater monitoring wells. We obtained no groundwater samples from any of the wells installed, as these were dry on day of our investigation.

A summary of our borehole locations is provided in the following Table. A site plan showing borehole locations is included in Attachment Two.

Borehole	Target / Rationale
One	Located near main site building and close to the former pump island area
Two	Located in the vicinity of the suspected tank farm area and the former pump islands
Three	Located adjacent to the car repair workshop
Four	Located adjacent to the main forecourt interceptor
Five	Located adjacent to the main forecourt interceptor and the former pump island area

Table Five: Borehole Locations

4.3.1 Soil Stratigraphy

The following strata were identified by the investigation.

Layer I Made Ground – LOOSE becoming MEDIUM DENSE red brown clayey SAND with concrete fragments in places;

Layer IIa Allesley Member (weathered) – SOFT becoming FIRM red brown sandy CLAY;

Layer IIb Allesley Member (weathered) – MEDIUM DENSE brown slightly clayey (in places) SAND;

Layer IIc Allesley Member – MODERATELY STRONG brown medium grained massive SANDSTONE:

The distribution of these strata between boreholes is summarised on the following Table. Borehole locations are shown on Figure Two.

Borehole	One		Two		Three		Four		Five	
Soil Layer	from	to	from	from	from	to	from	to	from	to
Layer I	0.15	1.0	0.15	2.5	0.15	3.0	0.2	0.3	0.15	2.1
Layer IIa	1.0	1.8	2.5	3.5	-	-	0.3	0.7	2.1	3.1
Layer IIb	1.8	2.8	3.5	5.15	3.0	>5.0	0.7	2.1	3.1	>3.5
Layer IIc	2.8	>3.6	5.15	>5.4	-	-	2.1	>3.8	-	-

All dimensions in meters below ground level

Table Six: Intrusive Investigation - Soil Stratigraphy

We encountered a layer of Made Ground of various thicknesses in each of the boreholes constructed. This was underlain across the majority of the site by a layer of sandy clay (approx 1,0m in thickness), which we interpret as constituting the upper (weathered) surface of the Allesley Member. Below this we encountered a layer of sand that we consider to be part of the weathered Allesley Member. Towards the base of the boreholes we encountered sandstone, which became increasingly hard with depth. Detailed logs for each borehole are included in Attachment Three.

4.3.2 Observed Contamination

We recorded olfactory and/or visual evidence of hydrocarbons in Boreholes One and Three within the Allesley Member unit at depths of 1.0 to 2.4m and 3.0 to 3.8m respectively.

4.3.3 Groundwater

We did not encounter groundwater in any of the boreholes constructed and no groundwater accumulated within any of the three wells installed on the day of our investigation.

4.3.4 Surface Water Sampling

We did not identify any surface water bodies in close proximity to the site.

4.4 Chemical Analysis Results – Soil Samples

We have completed the following analysis on representative soil samples from the site:

- Total Petroleum Hydrocarbons (TPH) – reported by carbon range – representative of compounds present in petrol, diesel and lube oils;
- Benzene, Toluene, Ethylbenzene and Xylenes (BTEX) representative of compounds present in petrol;
- Polycyclic aromatic hydrocarbons (PAHs) including naphthalene and benzo(a)pyrene, representative of compounds present in diesel and lube oil;
- Inorganic Compounds Suite (including total cyanides, arsenic, water soluble sulphate, boron, cadmium, chromium, copper, lead, mercury, nickel, selenium and zinc), typical of compounds found in imported fill material;
- Total Organic Carbon, to be used as part of any future risk assessment work to assess natural degradation rates.

The results of the analyses are summarised below:

Borehole	Depth (m)	Primary Soil Type	Concentration (mg/kg)				
			$>C_8$-C_{10}	$>C_{10}$-C_{12}	$>C_{12}$-C_{16}	$>C_{16}$-C_{21}	$>C_{21}$-C_{35}
One	1.2	Clay	<1	<1	2	1	1
One	2.0	Sand	2	55	158	80	11
One	3.6	Sand	<1	<1	<1	<1	1
Two	2.6	Clay	<1	<1	<1	<1	8
Two	5.0	Sand	<1	<1	1	<1	1
Three	3.5	Sand	<1	2	3	<1	3
Three	4.3	Sand	<1	<1	<1	<1	1
Four	2.0	Sand	<1	<1	<1	<1	1
Four	3.0	Sandstone	<1	<1	<1	<1	14
Five	1.3	Sand	<1	<1	<1	<1	1
Five	3.5	Sand	<1	<1	<1	<1	1

Table Eight: UKAS Accredited TPH Analysis Results – Soil (continued)

Borehole	Depth (m)	Primary Soil Type	Concentration (mg/kg)				
			Benzene	Toluene	Ethyl-benzene	Total Xylenes	MTBE
One	1.2	Clay	<0.005	<0.005	<0.005	<0.005	<0.005
One	2.0	Sand	<0.005	<0.005	<0.005	<0.005	<0.005
One	3.6	Sand	<0.005	<0.005	<0.005	<0.005	<0.005
Two	2.6	Clay	<0.005	<0.005	<0.005	<0.005	<0.005
Two	5.0	Sand	<0.005	<0.005	<0.005	<0.005	<0.005
Three	3.5	Sand	<0.005	<0.005	<0.005	<0.005	<0.005
Three	4.3	Sand	<0.005	<0.005	<0.005	<0.005	<0.005
Four	2.0	Sand	<0.005	<0.005	<0.005	<0.005	<0.005
Four	3.0	Sandstone	<0.005	<0.005	<0.005	<0.005	<0.005
Five	1.3	Sand	<0.005	<0.005	<0.005	<0.005	<0.005
Five	3.5	Sand	<0.005	<0.005	<0.005	<0.005	<0.005

Table Nine: UKAS Accredited BTEX and MTBE Analysis Results – Soil

Borehole	Depth (m)	Primary Soil Type	Concentration (mg/kg)		
			Naphthalene	Benzo(a)pyrene	Total PAHs
One	1.2	Clay	<1	<1	<15
One	2.0	Sand	<1	<1	<15
Two	2.6	Clay	<1	<1	<15
Three	3.5	Sand	<1	<1	<15
Three	4.3	Sand	<1	<1	<15
Four	3.0	Sandstone	<1	<1	<15
Five	1.3	Sand	<1	<1	<15

Table Ten: UKAS Accredited PAH Analysis Results – Soil

Borehole	Depth (m)	Primary Soil Type	Concentration (mg/kg)						
			Arsenic	Cadmium	Chromium	Lead	Mercury	Nickel	Selenium
One	0.2-0.6	Gravel	8	<1	16	31	<1	13	<2
Three	0.3-0.6	Gravel	5	<1	10	10	<1	10	<2
Four	0.2-0.3	Gravel	11	<1	26	11	<1	18	<2

Table Eleven: UKAS Accredited Inorganic Compounds Analysis Results - – Soil Samples

Borehole	Depth (m)	Primary Soil Type	Geological Unit	Total Organic Carbon (%)
One	2.6	Sand	Allesley Member	0.2
Two	1.6	Sand	Made Ground	0.7
Three	0.7	Sand	Allesley Member	0.7
Five	2.1	Sand	Made Ground	0.3

Table Twelve: UKAS Accredited Total Organic Carbon Analysis Results - Soil Samples

Results of all the chemical analyses carried out as part of our assessment are included in Attachment Five.

4.5 Discussion of Analytical Results

The chemical analysis results carried out on soil samples recovered from Borehole One indicate the presence of compounds indicative of diesel at a depth of 2.0m with the upper surface of the weathered Allesley Member. Samples recovered from below this depth however showed decreasing concentrations of these compounds indicating that the nature of the unit may, to some extent, be acting to impede extensive vertical migration.

5 Revised Conceptual Site Model

The results of the chemical analysis we have carried out also indicate that, although shallow soils have become impacted with low levels of diesel (predominantly 2.0m in BH1) these compounds have not migrated vertically through the dense sand to the non-weathered sandstone layer. Given the depth at which it was encountered the source of this contamination is likely to have been from underground fuel lines and/or pumps.

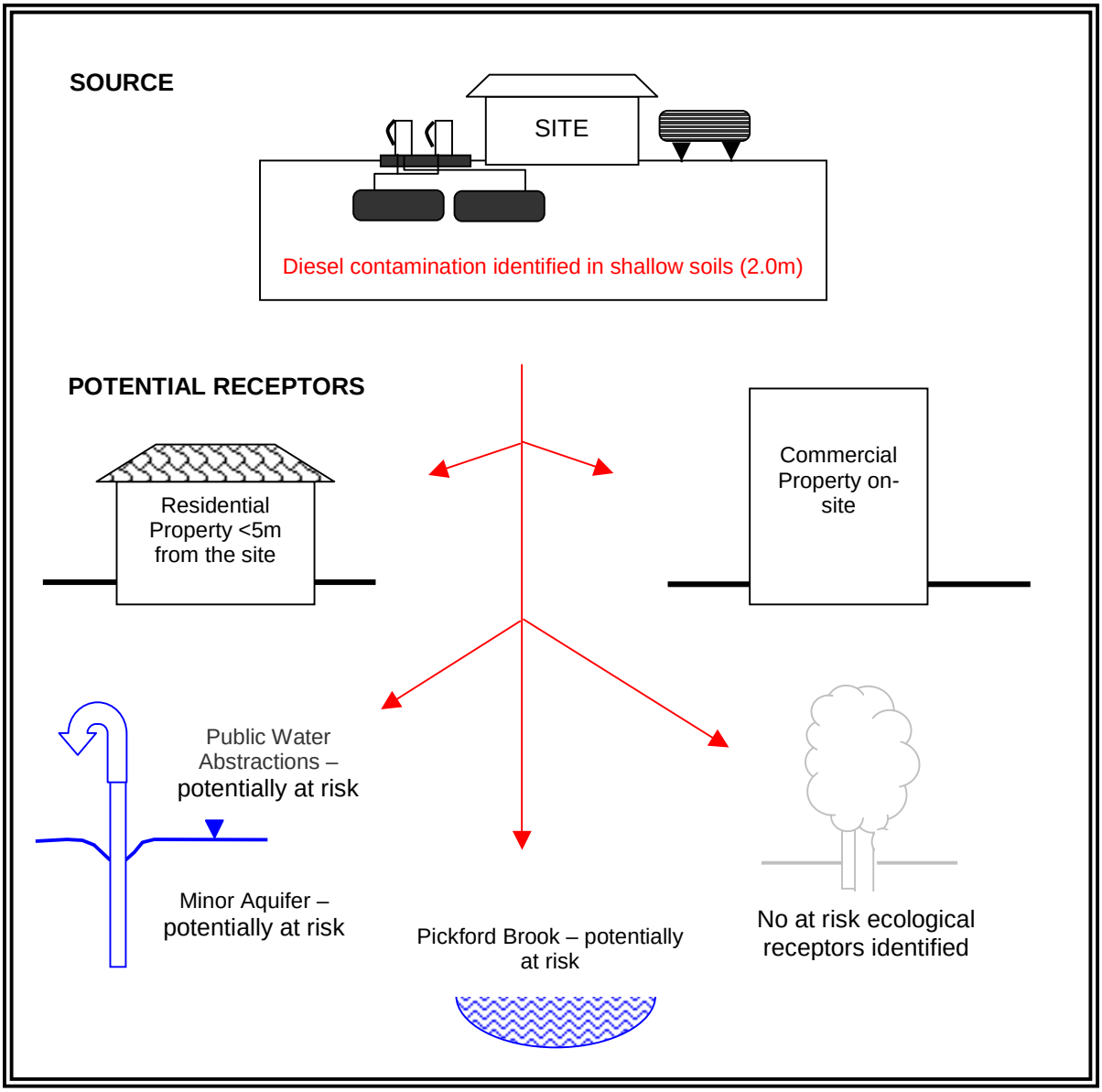
However, sandstone can often be fractured in nature and these fractures can form fast and effective vertical migration pathways for mobile contaminants. As such we cannot disregard entirely the possibility that the contaminants present is shallow soils have migrated to the sandstone and then on to impact the underlying minor aquifer.

Furthermore, due to the dense nature of the underlying geology, we were unable to construct all of our boreholes to depths consistent with the base of the site's former underground tanks farm installation. Our investigation was therefore unable to confirm that soils surrounding the base of the tank farm have not been impacted and, as such, we cannot verify that there have been no (historical) losses of fuel from the underground tanks.

In the absence of any further data we therefore consider necessary to consider the underlying aquifer (and therefore the Source Protection Zone and associated Public Water Abstraction) potentially at risk of impact as illustrated in our revised conceptual model below.

The absence of shallow groundwater reduces the probability that Pickford Brook is at risk of impact. Although, again, we are unable to categorically confirm that the stream is not at risk without groundwater quality data.

We have revised our preliminary conceptual site model to reflect the findings of our intrusive site investigation as follows:



Revised Conceptual Site Model

6 Generic Quantitative Risk Assessment

6.1 Methodology and Assumptions

Quantitative risk assessments are generally carried out in stages, or tiers. A generic assessment determines the risk for a site with "worst case" assumptions made for source, pathway and receptor. Hence a generic or tier one assessment will always give a conservative assessment of risk: the risk posed by a given concentration of contaminants will be over-predicted. Subsequent assessment tiers replace some or all of these assumptions with site-specific data. Thus the calculated risk becomes closer to the actual risk for each subsequent tier of assessment.

Our generic quantitative assessment of the risk posed by the identified contaminants has been carried out using three complimentary methodologies:

- We have evaluated the risk posed by inorganic contaminants to human receptors using the Department for Environment, Food and Rural Affairs/Environment Agency Contaminated Land Exposure Assessment Model (usually referred to as CLEA). The CLEA model has been developed to meet the requirements of the Environmental Protection Act 1990 Part IIa, with respect to assessing human health effects arising from the intake of a contaminant or other bodily contact with a contaminant. However, although use of the model is recommended by DEFRA, the model, and results derived using it, do not constitute a statutory standard.
- We have examined the toxicological risk posed by organic compounds to human receptors (e.g. site workers, nearby residents etc.) using RISC software. This software is based upon the American Society for Testing and Materials (ASTM) Risk Based Corrective Action (RBCA) methodology, but includes additional pathways, fate and transport information and contaminant information that are specific to UK legislation and guidance. The software is compatible with the CLEA approach, and CLEA specific parameters have been input wherever available (e.g., vegetable ingestion parameters, receptor characteristics, soil types, etc.). We have amended the software to include an index dose assessment for non-threshold carcinogens. Therefore, our assessment is consistent with the CLEA methodology, but allows for a broader assessment of compounds and pathways.
- We have examined the risk posed by organic compounds to environmental receptors (e.g. aquifers, streams and ponds) using the Environment Agency's Methodology for Derivation of Remedial Targets for Soil and Groundwater to Protect Water Resources[1] (R&D Technical Report P20).

In carrying out these risk assessments we have assumed the following:

- The site is to be used for on-going commercial purposes;
- Inorganic contaminants of concern are limited to arsenic, cadmium, chromium, lead, mercury, nickel and selenium;
- Organic contaminants of concern are limited to benzene, toluene, ethylbenzene, xylenes, benzo(a)pyrene and naphthalene and total petroleum hydrocarbons by carbon group;
- The results of the chemical analyses carried out on soil samples have been used to determine concentrations of these contaminants at the site;
- The acceptable risk for each non-threshold contaminant is the index dose, assuming additivity of pathways;
- The acceptable risk for each threshold contaminant is a hazard quotient of 1.0, assuming additivity of pathways.

6.2 Risk to Human Receptors from Inorganic Contaminants

For our generic risk assessment of identified inorganic contaminants we have compared the concentrations identified in soil underlying the site with the published CLEA Soil Guideline Values (SGV).

In accordance with the CLEA methodology we have calculated the 95% confidence limits of the measured mean of contaminant concentrations and compared the upper 95th percentile with the SGV. Concentrations of contaminants will vary across a site and so the use of the 95th percentile addresses the uncertainty of comparing the measured mean concentration directly with the SGV.

The results of these analyses are summarised in the following Table:

	Concentration (mg/kg)						
	Arsenic	Cadmium	Chromium	Lead	Mercury	Nickel	Selenium
Upper 95th percentile of mean sample concentration	13*	1*	31*	35*	1*	20*	2*
Soil Guidance Value – Commercial End Use	500	1,400	5,000	750	480	5,000	8,000

Note: * - Statistical analysis indicates insufficient analysis.

Table Thirteen: Inorganic Risk Assessment Results

None of the soil samples analysed contained concentrations of inorganic contaminants in excess of their relevant SGVs for commercial end use.

6.3 Risk to Human Receptors from Organic Contaminants

The generic Risk Based Screening Levels (RBSLs) for organic contaminants of concern derived using RISC, using input parameters and procedures recommended by CLEA, are summarised in the following Table. A summary of the input parameters used is included as Attachment Six.

Contaminant of Concern	Soil (mg/kg)		Groundwater (µg/litre)	
	RBSL for Residential End Use	RBSL for Commercial End Use	RBSL for Residential End Use	RBSL for Commercial End Use
Benzene	det	0.24	5.4	29
Benzo(a)pyrene	2.9	38	0.37	sol
Ethylbenzene	83	450	1,800	9,900
MTBE	430	8,400	2,900,000	sol
Naphthalene	58	480	370	2,000
Toluene	35	460	3,700	20,000

Note: det = Acceptable risk exceeded if benzene is present in detectable concentrations.
sol = Acceptable risk not exceeded at maximum theoretical solubility limit in groundwater

Table Nineteen: RISC - Generic Risk Based Screening Levels (continued overleaf)

Contaminant of Concern	Soil (mg/kg)		Groundwater (µg/litre)	
	RBSL for Residential End Use	RBSL for Commercial End Use	RBSL for Residential End Use	RBSL for Commercial End Use
TPH – C_8-C_{10}	43	760	740	4,000
TPH – C_{10}-C_{12}	230	75,000	740	4,000
TPH – C_{12}-C_{16}	5,900	75,000	740	4,000
TPH – C_{16}-C_{21}	4,400	57,000	sol	sol
TPH – C_{21}-C_{35}	4,400	57,000	sol	sol
Total Xylenes	14	260	3,700	20,000

Note: det = Acceptable risk exceeded if benzene is present in detectable concentrations.
sol = Acceptable risk not exceeded at maximum theoretical solubility limit in groundwater

Table Nineteen: RISC - Generic Risk Based Screening Levels

None of the soil samples that we analysed contained concentrations of contaminants in excess of the relevant RBSLs for commercial end use of the site. However, no groundwater was encountered on the day of our investigation and as such no assessment of risk posed by underlying potentially impacted groundwater has been undertaken. Additional risk assessment works may therefore be required when a suitable assessment of groundwater quality is undertaken.

6.4 Risk Posed to Environmental Receptors by Organic Contaminants

We have been unable to confirm that groundwater underlying the site has not been impacted by any historical losses of petrol and/or diesel from the site's former tank farm installation.

We have therefore not been able to complete a valid assessment of the risk environmental receptors associated with the site.

6.5 Conclusions from Generic Risk Assessment

Our generic risk assessment indicates that the concentrations of inorganic contaminants encountered in soil underlying the site exceed the relevant CLEA Soil Guideline Values (SGVs) for commercial end use.

Our generic risk assessment indicates that the concentrations of organic contaminants identified in the soil at the site exceed Risk Based Screening Levels.

We have been unable to complete a valid assessment of the risk environmental receptors associated with the site as we have been unable to confirm that soils surrounding the underground tank farm and also groundwater within the sandstone aquifer have not been impacted.

The site overlies a minor aquifer and is located within the boundary of a Source Protection Zone. This places the site in a relatively environmentally sensitive area. As such we would consider that additional intrusive works are required to obtain the necessary site data prior to the completion of our assessment of environmental receptors.

The provision of groundwater data would also be used to complete our assessment of risk posed to human receptors.

These results are summarised in the following Table.

	Human Health	Environmental Receptor
Contaminants in Soil	Pass	-
Contaminants in Groundwater	Unable to complete assessment due to absence of necessary soil/groundwater data	

Notes: Pass denotes allowable risk or quality standard not exceeded. No further action required.
Fail denotes allowable risk or quality standard exceeded. Further action required.

Table Fifteen: Summary of Generic Quantitative Risk Assessment Results

7 Recommendations

We make the following recommendations with respect to the site:

- We have been unable to complete our Generic Risk Assessment (for both human and environmental receptors) due to the absence of either comprehensive soils data from surrounding and underling the site's former tank farm, or groundwater data.

  We therefore recommend that we return to the site and construct a series of deeper boreholes (using a specialised rock coring drilling system) to depths consistent with groundwater. This will allow us to install permanent groundwater monitoring wells and recover groundwater samples. This will allow us to complete the risk assessment process and hence determine whether the site is suitable for continued commercial use.

- The statistical calculations carried out as part of our assessment of inorganic compounds indicated that there has been insufficient analysis to complete a truly representative assessment. As such we would recommend that, during the additional drilling works that we have determined are necessary, further shallow soils samples be recovered and analysed for inorganic compounds. The additional chemical analysis results can then be used to complete our assessment.

8 References

HSE (1991) "Protection of Workers and the General Public During the Development of Contaminated Land" HMSO, London

Construction (Design and Management) Regulations 1994. SI 1994/3140. The Stationery Office.

DEFRA and Environment Agency (2002a) "Priority Contaminants for the Assessment of Contaminated Land" Report CLR8, R&D Dissemination Centre, WRc plc, Swindon.

DEFRA and Environment Agency (2002b) "Assessment of Risks to Human Health from Land Contamination: An Overview of the Development of Soil Guideline Values and Related Research.", Report CLR 7 R&D Dissemination Centre, WRc plc, Swindon.

DEFRA and Environment Agency (2004) "Model Procedures for the Management of Land Contamination" Report CLR 11 Environment Agency, Bristol.

ATTACHMENT ONE: NOTICE TO INTERESTED PARTIES

NOTICE TO INTERESTED PARTIES

The purpose of our site assessment is to provide general information on the environmental and/or geotechnical conditions existing at the site and related to soil or groundwater. Where the Client or others specified the scope of the investigation, the validity of our conclusions may be limited by the scope of work completed. We are not responsible for any such limitations imposed by the scope of work.

Where stated in this report, we have used information supplied by third parties. While we have evaluated as far as possible the validity of this information, we cannot guarantee its accuracy in any way whatsoever.

No investigation technique is capable of completely identifying all of the contaminants that might be present in the soil or groundwater under a site. Where specified in our report, we have examined the ground by constructing a number of boreholes and/or trial pits. We recovered samples of soil and/or groundwater from available exposures.

The depth and spacing of our sampling locations were selected to ensure with a reasonable probability that they would be representative of the actual conditions across the whole site. However, safety considerations relating to existing site infrastructure may have restricted our ability to investigate all potential contaminant sources. Specifically, we were unable to investigate the soil and groundwater condition immediately adjacent to the underground petroleum installation and other buried services. These limitations must be borne in mind when considering the conclusions reached in this report.

Soil is intrinsically variable and the spread of contaminants within the soil is therefore subject to a degree of non-uniformity. For these reasons no sampling technique can completely eliminate the possibility of obtaining samples that are not representative of the actual conditions. Our sampling techniques are intended to reduce the possibility to an acceptable level.

Groundwater levels and soil vapour levels that we report were accurate at the time of the investigation. Groundwater and soil vapour levels are variable. Long term monitoring may be required to ensure that the levels recorded during our investigation are representative of long term and possible ‘worst case’ conditions.

This investigation was carried out to assess the significance of contamination resulting from use of the site as identified in this report. Unless we have indicated otherwise, no assessment of the potential impact of any other previous uses has been made. No investigation was carried out to determine whether or not any deleterious or hazardous materials have been used in the construction of the buildings present on the site.

We do not accept any responsibility for the cost of remedial works or other costs incurred in whatever way whatsoever as a result of any omissions, errors or other shortcomings in this report unless we have been given reasonable opportunity to verify ourselves that such faults exist and we have been given a reasonable opportunity to carry out works to remedy such faults ourselves using the most practicable means available to us. We do not accept liability for any consequential losses incurred by you while we carry out any remedial works we deem necessary.

This report has been prepared for BP Oil UK Ltd. Use of, and reliance on, this report by other third parties will be at such third parties own risk, and we are unable to accept any liability or responsibility to third parties.

Neither the whole nor any part of this report, or any reference to it, may be included in any published document circular or statement or published in any way without our prior written approval.

This report and its contents, together with any supporting correspondence or other documentation, remain the property of Subadra Consulting Limited until paid for in full.

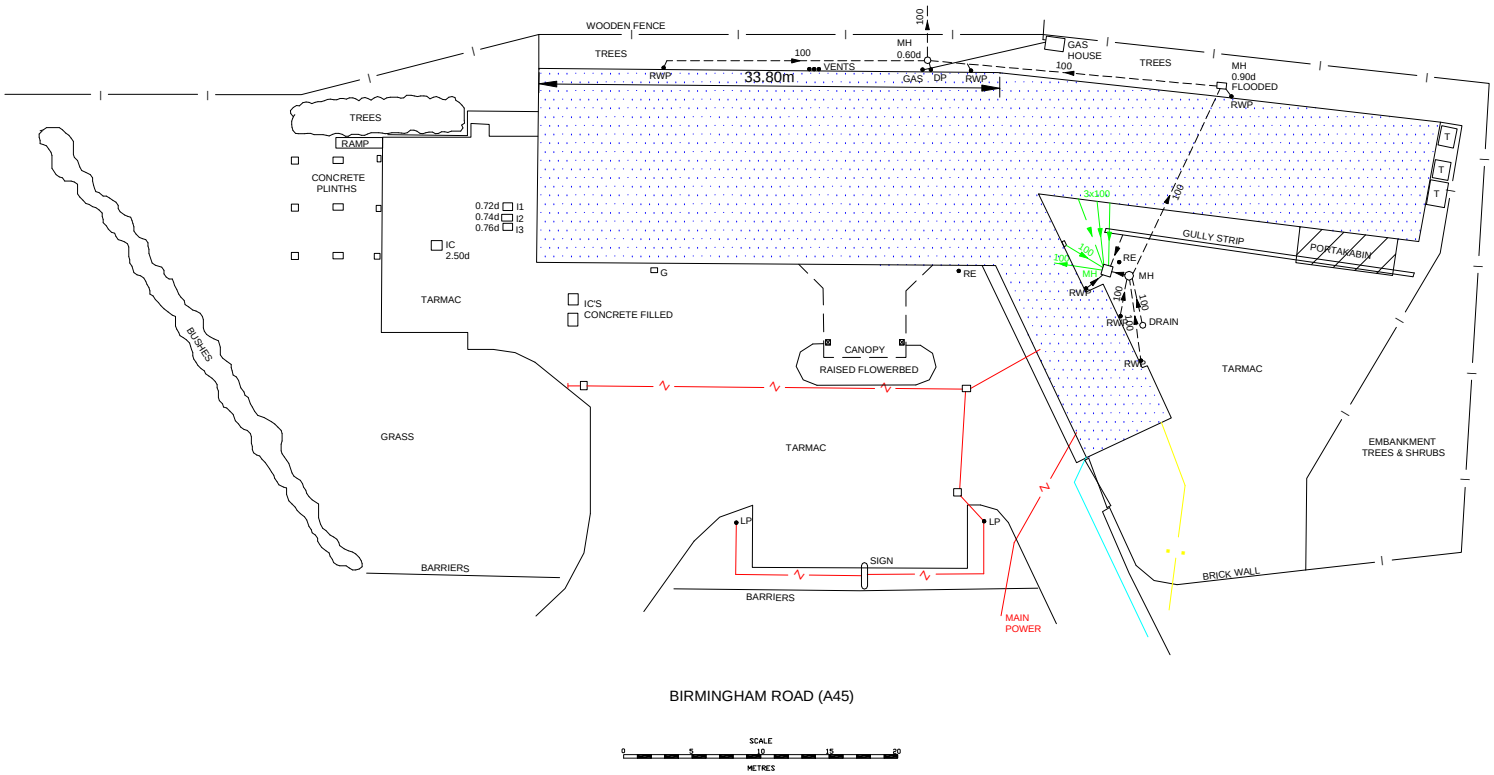
ATTACHMENT TWO: SITE DRAWINGS

INTERCEPTOR DETAILS

TYPE	CONDITION	MATERIAL	DEPTH
SUPER	GOOD	PLASTIC	1.79d

NOTES:

1. PLASTIC GAS - ASSUMED ROUTE
2. ASSUME THAT FWS EXITS BUILDING AT REAR, NEAR GAS RISER
3. UNABLE TO ASCERTAIN RUN OF DRAIN FROM INTERCEPTOR
4. 2 IC'S AT FRONT OF BUILDING ARE CONCRETE FILLED



SUBADRA

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Stoke Mandeville, Bucks HP22 5BL
Tel. 01296 739400 Fax. 01296 739401

FORMER WINDMILL STATION
BIRMINGHAM ROAD (A45)
ALLESLEY
COVENTRY

DATE : MARCH 2004

SUBADRA ARCHIVE NO : 04833 DR 002

DRAWING BY : SVS CHECKED BY : P.COX

KEY

- MANHOLE
- PILLAR
- BUILDING
- CANOPY OUTLINE
- WATER
- BRITISH GAS
- ELECTRICITY CABLE
- TELECOM CABLE
- END OF TRACE
- FOUL WATER DRAIN
- SURFACE WATER DRAIN
- UNIDENTIFIED

ABBREVIATIONS

BT	BRITISH TELECOM
CP	CABLE OR CMS PIT
CL	COVER LEVEL
EP	ELECTRICITY POLE OR PYLON
EOC	EDGE OF CANOPY
G	GULLY
IC	INSPECTION CHAMBER
I1	INTERCEPTOR CHAMBER
LP	LAMP POST
MH	MANHOLE
RE	RODDING EYE
RWP	RAINWATER PIPE
SC	SECURITY CAMERA
SW	SURFACE WATER
T	TANK
UTS	UNABLE TO SURVEY
UTL	UNABLE TO LOCATE
WM	WATER METER

LOCATION OF UNDERGROUND SERVICES

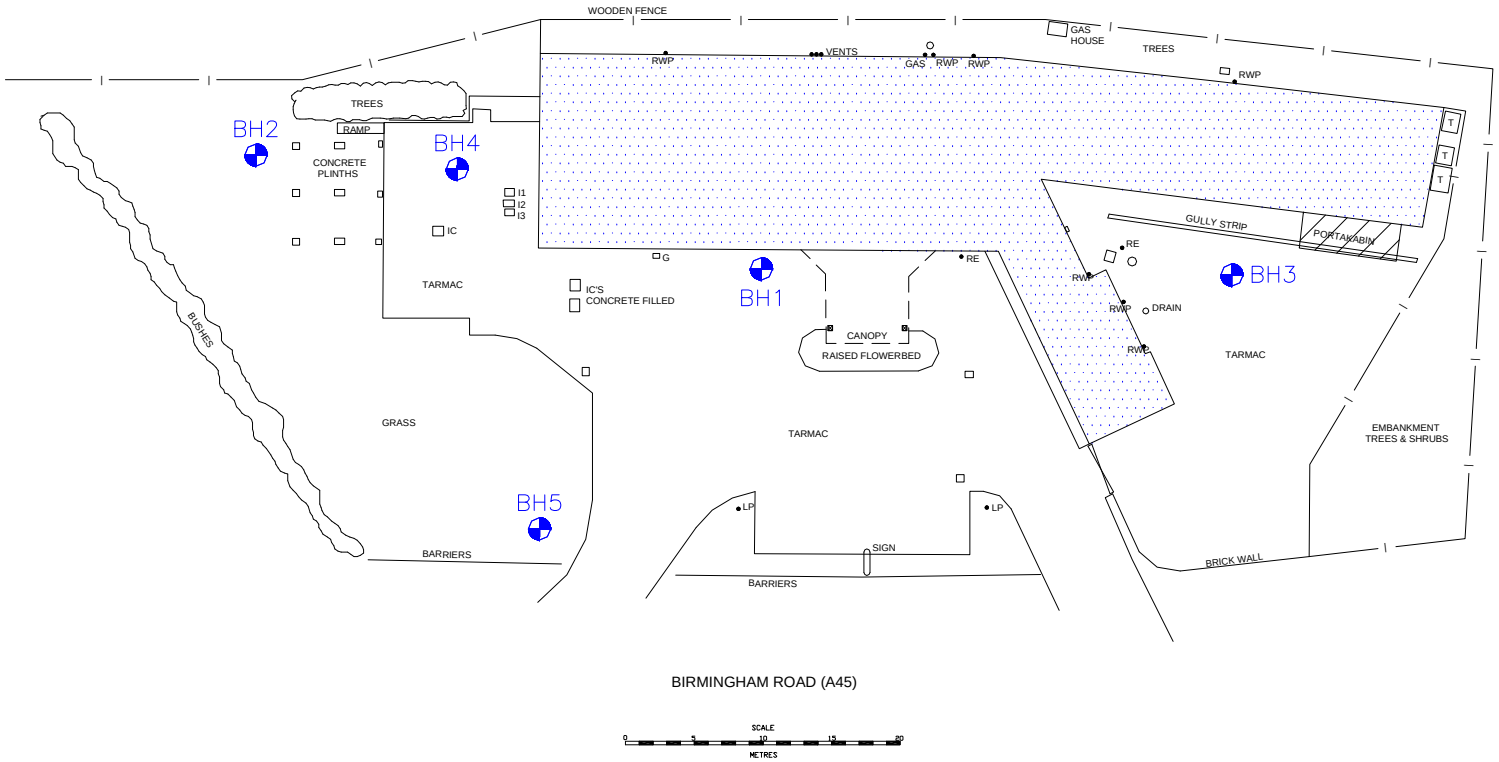
FIGURE ONE

INTERCEPTOR DETAILS

TYPE	CONDITION	MATERIAL	DEPTH
SUPER	GOOD	PLASTIC	1.79d

NOTES:

1. PLASTIC GAS - ASSUMED ROUTE
2. ASSUME THAT FWS EXITS BUILDING AT REAR, NEAR GAS RISER
3. UNABLE TO ASCERTAIN RUN OF DRAIN FROM INTERCEPTOR
4. 2 IC'S AT FRONT OF BUILDING ARE CONCRETE FILLED



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DATE : MARCH 2004

SUBADRA ARCHIVE NO : 04833 DR 002

DRAWING BY :SVS CHECKED BY :P.COX

KEY

□	MANHOLE
▫	PILLAR
▨	BUILDING
⬚	CANOPY OUTLINE
BH1	BOREHOLE LOCATION

ABBREVIATIONS

BT	BRITISH TELECOM
CP	CABLE OR CMS PIT
CL	COVER LEVEL
EP	ELECTRICITY POLE OR PYLON
EOC	EDGE OF CANOPY
G	GULLY
IC	INSPECTION CHAMBER
I1	INTERCEPTOR CHAMBER
LP	LAMP POST
MH	MANHOLE
RE	RODDING EYE
RWP	RAINWATER PIPE
SC	SECURITY CAMERA
SW	SURFACE WATER
T	TANK
UTS	UNABLE TO SURVEY
UTL	UNABLE TO LOCATE
WM	WATER METER

BOREHOLE LOCATIONS

FIGURE TWO

ATTACHMENT THREE: BOREHOLE LOGS

Borehole No.1

SUBADRA
Consultants in the Earth Sciences
Unit 13 Triangle Business Park, Stoke Mandeville
Tel. 01296 739400 Fax. 01296 739401

Equipment	Direct Push – Sealed Liner	Ground Level	NA	Dwn : CD
Date	331st March 2004	Co-ordinates	429130 280870	Ckd : DB

	Monitor Well	Water Level	Sample	Log	Su (kPa)	C_6-C_{15} (mg/kg)	Description
		Dry	Metals at				0.0 to 0.15m TARMAC/CONCRETE
0.5m			0.2 to 0.6m				0.5 to 1.0m LOOSE becoming medium, DENSE red brown, black sandy GRAVEL, containing some brick sand and clinker *{Made Ground}*
1.0m							
			S1 at 1.2m				1.0 to 1.8m SOFT becoming FIRM brown red sandy CLAY *{Allesley Member}*
1.5m							
2.0m							1.8 to 2.3m MEDIUM DENSE brown slightly clayey SAND. Contains very occasional pea-size rounded white quartz gravel *{AM}*
			S2 at 2.0m				
2.5m							
			S3 at 2.6m				2.3 to 2.8m Medium DENSE brown SAND *{AM}*
3.0m							2.8 to 3.6m MEDIUM DENSE brown SAND
3.5m							
			S4 at 3.6m				*{Allesley Member}*
4.0m							
4.5m							
5.0m							
5.5m							- Borehole terminated at 3.6m - Monitoring well installed to 3.6m - No groundwater encountered - Hydrocarbon odour noted 1.0 to 2.4m
6.0m							

Key

- Concrete
- Bentonite
- Clay
- Silt
- Sand
- Gravel
- Peat
- Chalk
- Sandstone
- Limestone
- Mudstone/Siltstone
- Rock (other)
- Well Casing
- Well Screen

Notes

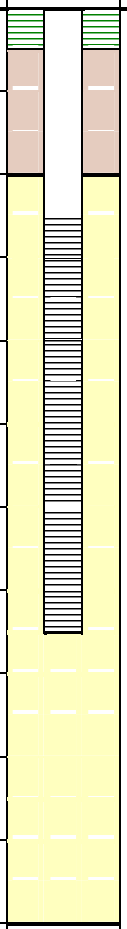
40mm i.d. monitor well with 0.5mm screen, 100 micron sleeve and 1-2mm filter pack installed where noted.
Water level denotes water level measured after well development and 24hr recovery period unless otherwise noted.
Sample column denotes soil samples taken for off-site chemical analysis.
Su denotes undrained shear strength of cohesive deposits measured using pocket penetrometer or torvane.
C_6-C_{15} denotes carbon range for Total Petroleum Hydrocarbons measured using HS40/GC-FID.
Ground level relative to a site datum of 100m.

Borehole Log

Borehole No.2

SUBADRA
Consultants in the Earth Sciences
Unit 13 Triangle Business Park, Stoke Mandeville
Tel. 01296 739400 Fax. 01296 739401

Equipment	Direct Push – Sealed Liner	Ground Level	NA	Dwn : CD
Date	331st March 2004	Co-ordinates	429130 280870	Ckd : DB



	Monitor Well	Water Level	Sample	Log	Su (kPa)	C_6-C_{15} (mg/kg)	Description
		Dry					0.0 to 0.15m Sandy CLAY
0.5m			S1 at 0.5m				0.5 to 2.5m LOOSE MEDIUM becoming DENSE brown clayey SAND. Contains occasional rounded pea-size gravels
1.0m							
1.5m							
			S2 at 1.6m				
2.0m							
2.5m							*{Made Ground}*
			S3 at 2.6m				2.5 to 3.5m Very SOFT to SOFT brown sandy CLAY, containing occasional rounded pea-size gravels
3.0m							
3.5m							*{Allesley Member}*
							3.5 to 4.8m LOOSE becoming MEDIUM DENSE brown SAND *{Allesley Member}*
4.0m			S4 at 4.0m				
4.5m							4.8 to 5.4m MEDIUM DENSE brown very clayey SAND. Contains occasional rounded pea size gravels. Band of DENSE brown SAND 5.15 to 5.20m *{Allesley Member}*
5.0m			S5 at 5.0				
5.5m							- Borehole terminated at 5.4m - Monitoring well installed to 5.4m
6.0m							- No groundwater - No Hydrocarbon odour noted

Key

- Concrete
- Bentonite
- Clay
- Silt
- Sand
- Gravel
- Peat
- Chalk
- Sandstone
- Limestone
- Mudstone/Siltstone
- Rock (other)
- Well Casing
- Well Screen

Notes

40mm i.d. monitor well with 0.5mm screen, 100 micron sleeve and 1-2mm filter pack installed where noted.
Water level denotes water level measured after well development and 24hr recovery period unless otherwise noted.
Sample column denotes soil samples taken for off-site chemical analysis.
Su denotes undrained shear strength of cohesive deposits measured using pocket penetrometer or torvane.
C_6-C_{15} denotes carbon range for Total Petroleum Hydrocarbons measured using HS40/GC-FID.
Ground level relative to a site datum of 100m.

Borehole Log

Borehole No.3

SUBADRA
Consultants in the Earth Sciences
Unit 13 Triangle Business Park, Stoke Mandeville
Tel. 01296 739400 Fax. 01296 739401

Equipment	Direct Push – Sealed Liner	Ground Level	NA	Dwn : CD
Date	331st March 2004	Co-ordinates	429130 280870	Ckd : DB

	Monitor Well	Water Level	Sample	Log	Su (kPa)	C_6-C_{15} (mg/kg)	Description
		Dry	Metals at 0.3 to 0.6m				0.0 to 0.15m TARMAC/CONCRETE
0.5m							0.15 to 0.6m LOOSE grey to brown sandy GRAVEL. Contains concrete, sand and pea-size gravel *{Made Ground}*
1.0m							
1.5m			S1 at 0.7m				0.6 to 3.0m LOOSE becoming MEDIUM DENSE brown to red very clayey SAND. Contains rounded pea-size occasional gravel (quartz) *{Made Ground}*
2.0m							
2.5m			S2 at 1.8m				
3.0m			S3 at 2.8m				
3.5m							3.0 to 3.8m LOOSE becoming medium DENSE brown SAND *{Allesley Member}*
4.0m			S4 at 3.5m				3.8 to 5.0m MEDIUM becoming DENSE brown very clayey SAND *{Allesley Member}*
4.5m			S5 at 4.3m				
5.0m							
5.5m							- Borehole terminated at 5.0m - No monitoring well installed - No groundwater encountered - Hydrocarbon odour noted at 3.0 to 3.8m
6.0m							

Key

- Concrete
- Bentonite
- Clay
- Silt
- Sand
- Gravel
- Peat
- Chalk
- Sandstone
- Limestone
- Mudstone/Siltstone
- Rock (other)
- Well Casing
- Well Screen

Notes

40mm i.d. monitor well with 0.5mm screen, 100 micron sleeve and 1-2mm filter pack installed where noted.
Water level denotes water level measured after well development and 24hr recovery period unless otherwise noted.
Sample column denotes soil samples taken for off-site chemical analysis.
Su denotes undrained shear strength of cohesive deposits measured using pocket penetrometer or torvane.
C_6-C_{15} denotes carbon range for Total Petroleum Hydrocarbons measured using HS40/GC-FID.
Ground level relative to a site datum of 100m.

Borehole Log

Borehole No.4

SUBADRA
Consultants in the Earth Sciences
Unit 13 Triangle Business Park, Stoke Mandeville
Tel. 01296 739400 Fax. 01296 739401

Equipment	Direct Push – Sealed Liner	Ground Level	NA	Dwn : CD
Date	331st March 2004	Co-ordinates	429130 280870	Ckd : DB

	Monitor Well	Water Level	Sample	Log	Su (kPa)	C_6-C_{15} (mg/kg)	Description
		Dry	Metals at 0.2 to 0.3m				0.0 to 0.2m CONCRETE/TARMAC
0.5m							0.2 to 0.3m LOOSE grey sandy GRAVEL with concrete fragements *{Made Ground}*
1.0m			S1 at 1.0m				0.3 to 2.1m MEDIUM DENSE brown SAND. Band of clayey SAND 0.6 to 0.7m
1.5m							
2.0m			S2 at 2.0m				*{Allesley Member}*
2.5m			S3 at 2.4m				2.1 to 3.6m HARD brown SANDSTONE band of Very hard brown sandstone at 3.6 to 3.8m
3.0m			S4 at 3.0m				
3.5m			S5 at 3.6m				*{Allesley Member}*
4.0m							
4.5m							
5.0m							
5.5m							- Borehole terminated at 3.6m - No monitoring well installed - No groundwater encountered
6.0m							- No hydrocarbon odour noted

Key

- Concrete
- Bentonite
- Clay
- Silt
- Sand
- Gravel
- Peat
- Chalk
- Sandstone
- Limestone
- Mudstone/Siltstone
- Rock (other)
- Well Casing
- Well Screen

Notes

40mm i.d. monitor well with 0.5mm screen, 100 micron sleeve and 1-2mm filter pack installed where noted.
Water level denotes water level measured after well development and 24hr recovery period unless otherwise noted.
Sample column denotes soil samples taken for off-site chemical analysis.
Su denotes undrained shear strength of cohesive deposits measured using pocket penetrometer or torvane.
C_6-C_{15} denotes carbon range for Total Petroleum Hydrocarbons measured using HS40/GC-FID.
Ground level relative to a site datum of 100m.

Borehole Log

Borehole No.5

SUBADRA
Consultants in the Earth Sciences
Unit 13 Triangle Business Park, Stoke Mandeville
Tel. 01296 739400 Fax. 01296 739401

Equipment	Direct Push – Sealed Liner	Ground Level	NA	Dwn : CD
Date	331st March 2004	Co-ordinates	429130 280870	Ckd : DB

	Monitor Well	Water Level	Sample	Log	Su (kPa)	C_6-C_{15} (mg/kg)	Description
		Dry	S1 at 0.2m				0.0 to 0.15m Sandy CLAY
0.5m							0.15 to 2.1m LOOSE becoming MEDIUM DENSE brown clayey SAND. Contains occasional pea-size rounded gravels
1.0m							
			S2 at 1.3m				
1.5m							
2.0m							*{Made Ground}*
			S3 at 2.1m				2.1 to 3.1m SOFT brown sandy CLAY Band of brown SAND at 2.7m
2.5m							
3.0m							*{Allesley Member}*
							3.1 to 3.5m MEDIUM DENSE becoming DENSE slightly clayey SAND. Band of sand 3.5m
3.5m			S4 at 3.5m				*{Allesley Member}*
4.0m							
4.5m							
5.0m							
5.5m							- Borehole terminated at 3.5m - Well installed to 3.5m - No groundwater encountered - No Hydrocarbon odour noted
6.0m							

Key

- Concrete
- Bentonite
- Clay
- Silt
- Sand
- Gravel
- Peat
- Chalk
- Sandstone
- Limestone
- Mudstone/Siltstone
- Rock (other)
- Well Casing
- Well Screen

Notes

40mm i.d. monitor well with 0.5mm screen, 100 micron sleeve and 1-2mm filter pack installed where noted.
Water level denotes water level measured after well development and 24hr recovery period unless otherwise noted.
Sample column denotes soil samples taken for off-site chemical analysis.
Su denotes undrained shear strength of cohesive deposits measured using pocket penetrometer or torvane.
C_6-C_{15} denotes carbon range for Total Petroleum Hydrocarbons measured using HS40/GC-FID.
Ground level relative to a site datum of 100m.

Borehole Log

ATTACHMENT FOUR: CHEMICAL ANALYSIS CERTIFICATES

Scientific Analysis Laboratories

Report Number:	44692 compiled
Date of Report:	30-Apr-04
Client :	Subadra Limited Unit 13 Triangle Business Park Wendover Road Stoke Mandeville Bucks HP22 5BL
Client Contact:	Chris Downes
Client Job Reference:	Windmill/04833 PO-1245
Date Job Received at SAL:	16-Apr-04
Date Analysis Started:	16-Apr-04

The results reported relate to samples received at the laboratory
Opinions and interpretations expressed herein are outside the scope of UKAS accreditation
This report should not be reproduced except in full without the written approval of the laboratory
Tests covered by this certificate were conducted in accordance with SAL SOPs

Key to symbols used in this report:
W: Analysis was performed within the SAL group of laboratories
S: Analysis was subcontracted to a laboratory that holds UKAS accreditation
C: Analysis was subcontracted
N: Analysis is not UKAS accredited
U: Analysis is UKAS accredited

Report written by: I Haslock
Project Manager

Report checked and authorised by: A Bailey
Project Manager

UKAS TESTING
1549

Produced by: Scientific Analysis Laboratories Ltd. Medlock House, New Elm Road, Manchester, M3 4JH

Report Number: 44692 compiled
Client Job Reference: Windmill/04833
PO:1245

				SAL Ref:	44692 012	44692 013	44692 014	44692 015	44692 016	44692 017	44692 018
				Client Ref:	BH1/S3/2.6	BH2/S2/1.6	BH3/S1/0.7	BH5/S3/2.1	BH1/0.2-0.6	BH3/0.3-0.6	BH4/0.2-0.3
				Type:	Soil	Soil	Soil	Soil	Soil	Soil	Soil
Determinand	**Method**	**Units**	**LOD**	**Symbol**							
Cyanide (Total)	Colorimetry	mg/kg	1	U		-	-	-	<1	<1	<1
Phenols (Total-Mono)	Colorimetry	mg/kg	1	U	-	-	-	-	<1	<1	<1
Sulphide	Colorimetry	mg/kg	10	N	-	-	-	-	<10	<10	<10
Sulphur (Free)	Grav	mg/kg	500	N	-	-	-	-	<500	<500	<500
Arsenic	ICP/OES	mg/kg	1	U	-	-	-	-	8	5	11
Boron	ICP/OES	mg/kg	1	N	-	-	-	-	<1	<1	<1
Cadmium	ICP/OES	mg/kg	1	U	-	-	-	-	<1	<1	<1
Chromium	ICP/OES	mg/kg	1	U	-	-	-	-	16	10	26
Copper	ICP/OES	mg/kg	1	U	-	-	-	-	30	10	36
Lead	ICP/OES	mg/kg	1	U	-	-	-	-	31	10	11
Mercury	ICP/OES	mg/kg	1	U	-	-	-	-	<1	<1	<1
Nickel	ICP/OES	mg/kg	1	U	-	-	-	-	13	10	18
Selenium	ICP/OES	mg/kg	2	U	-	-	-	-	<2	<2	<2
Sulphate(2:1)	ICP/OES	g/l	0.1	N	-	-	-	-	<0.1	<0.1	<0.1
Zinc	ICP/OES	mg/kg	1	U	-	-	-	-	117	37	82
Total Organic Carbon	OX/IR	%	0.1	S	0.2	0.7	0.7	0.3	-	-	-
pH	Probe			U	-	-	-	-	10.8	11.3	7.9

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SAL Ref.	44692 001	44692 002	44692 003	44692 004	44692 005	44692 006	44692 007	44692 008	44692 009	44692 010	44692 011
Client Ref.	BH1/S1/1.2	BH1/S2/2.0	BH1/S4/3.6	BH2/S3/2.6	BH2/S5/5.0	BH3/S4/3.5	BH3/S5/4.3	BH4/S2/2.0	BH4/S4/3.0	BH5/S2/1.3	BH5/S4/3.5
Type	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil

Determinand	Method	Units	LOD	Symbol											
Benzene	GC/MS	ug/kg	5	U	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Toluene	GC/MS	ug/kg	5	U	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Ethylbenzene	GC/MS	ug/kg	5	U	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
m&p-Xylene	GC/MS	ug/kg	5	U	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
o-Xylene	GC/MS	ug/kg	5	U	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Methyl-tert-Butyl Ether	GC/MS	ug/kg	5	U	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5

Analysis was carried out on the samples 'as received'.

Samples were analysed by GCMS Headspace

TPH Banded															
C8-C10	GC/FID	mg/kg	1	U	<1	2	<1	<1	<1	<1	<1	<1	<1	<1	<1
C10-C12	GC/FID	mg/kg	1	U	<1	55	<1	<1	<1	2	<1	<1	<1	<1	<1
C12-C16	GC/FID	mg/kg	1	U	2	158	<1	<1	1	3	<1	<1	<1	<1	<1
C16-C21	GC/FID	mg/kg	1	U	1	80	<1	<1	<1	<1	<1	<1	<1	<1	<1
C21-C35	GC/FID	mg/kg	1	U	1	11	1	8	1	3	1	1	14	1	1

Analysis was carried out on the samples 'as received'.

SAL Ref.	44692-001	44692-002	44692-004	44692-006	44692-007	44692-009	44692-010
Client Ref.	BH1/S1/1.2	BH1/S2/2.0	BH2/S3/2.6	BH3/S4/3.5	BH3/S5/4.3	BH4/S4/3.0	BH5/S2/1.3
Type	Soil	Soil	Soil	Soil	Soil	Soil	Soil

Determinand	Method	Units	LOD	Symbol							
Naphthalene	GC/MS	mg/kg	1	N	<1	<1	<1	<1	<1	<1	<1
Acenaphthylene	GC/MS	mg/kg	1	N	<1	<1	<1	<1	<1	<1	<1
Acenaphthene	GC/MS	mg/kg	1	N	<1	<1	<1	<1	<1	<1	<1
Fluorene	GC/MS	mg/kg	1	N	<1	<1	<1	<1	<1	<1	<1
Phenanthrene	GC/MS	mg/kg	1	N	<1	<1	<1	<1	<1	<1	<1
Anthracene	GC/MS	mg/kg	1	N	<1	<1	<1	<1	<1	<1	<1
Fluoranthene	GC/MS	mg/kg	1	N	<1	<1	<1	<1	<1	<1	<1
Pyrene	GC/MS	mg/kg	1	N	<1	<1	<1	<1	<1	<1	<1
Benzo (a) anthracene	GC/MS	mg/kg	1	N	<1	<1	<1	<1	<1	<1	<1
Chrysene	GC/MS	mg/kg	1	N	<1	<1	<1	<1	<1	<1	<1
Benzo (b/k) fluoranthene	GC/MS	mg/kg	1	N	<1	<1	<1	<1	<1	<1	<1
Benzo (a) pyrene	GC/MS	mg/kg	1	N	<1	<1	<1	<1	<1	<1	<1
Indeno (123-cd) pyrene	GC/MS	mg/kg	1	N	<1	<1	<1	<1	<1	<1	<1
Benzo (ghi) perylene	GC/MS	mg/kg	1	N	<1	<1	<1	<1	<1	<1	<1
Dibenzo (ah) anthracene	GC/MS	mg/kg	1	N	<1	<1	<1	<1	<1	<1	<1

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ATTACHMENT FIVE: TIER ONE SCREENING LEVELS – RISC INPUT PARAMETERS

Parameter	Child Resident	Worker
Body weight (kg)	20.3 (CLR10 Table 5.6)	68.5 (CLR10 Table 5.6)
Lifetime (years)	6 (CLR10 Table 3.2)	43 (CLR10 Table 3.2)
Shallow Soil Pathways		
Exposure frequency (events/year)	365 (CLR10 Table 3.38)	230 (CLR10 Table 4.13)
Total skin surface area (cm^2)	8,000 (CLR10 Table 5.8)	17,600 (CLR10 Table 5.8)
Total skin exposed as a fraction	0.24 (CLR10 Table 5.8)	0.05 (CLR10 Table 5.8)
Exposure frequency for soil ingestion (days/year)	180 (CLR 10 Table 6.1)	230 (CLR 10 Table 6.1)
Amount of soil ingested (mg/day)	100 (CLR 10 Table 6.1)	40 (CLR10 Table 6.1)
Groundwater Pathways		
Volume of water ingested (litres)	1.1 No CLEA data available. This value has been recommended by local authorities as suitable	
Total skin surface area (cm^2)	8,000 (CLR10 Table 5.8)	17,600 (CLR10 Table 5.8)
Indoor Air Inhalation		
Exposure frequency for inhalation of indoor air (events/year)	365 (CLR10 Table 3.38)	230 (CLR10 Table 4.13)
Exposure duration for indoor air (years)	6 (CLR10 Table 3.2)	43 (CLR10 Table 3.2)
Inhalation rate for indoor air (m^3/hour)	0.609 (CLR10 Table 5.9)	0.668 (CLR10 Table 5.9 and Table 4.13 – average of active and passive respiration calculated))
Time indoors (hours/day)	18.0 (CLR10 Table 4.4)	7.5 (CLR10 Table 4.13)
Lung retention factor for indoor air	1.0 (conservative value)	1.0 (conservative value)
Active respiration rate (for outdoor air inhalation) (m^3/hour)	0.609 (CLR10 Table 5.9)	1.234 (CLR10 Table 5.9)

CLEA-Defined Exposure Data for Human Receptors (continued overleaf)

Outdoor Air Inhalation		
Box height (m)	0.47 (CLR10, Table 5.7). The average of heights for a child of 0 to 6 years is 0.93m. CLEA recommends that half the height is used to allow for time spent sitting or crawling etc	0.81 (CLR Table, 5.7) The height of an adult is give as 1.62. CLEA recommends that half this height is used to allow for time spend sitting etc.
Wind speed (m/second)	8 (CLR 10, Section 6.93). CLR10 states that the annual mean wind speed in the UK is between 8 and 18m/second. To calculate SGVs the have assumed a wind speed of 8m/sceond	
Time outdoors (hours/day)	2 (CLR10, Table 4.4) Average of the values give for a child of 0 to 6 years.	1.5 (CLR10, Table 4.4)
Active respiration rate (for outdoor air inhalation) (m^3/hour)	0.609 (CLR10 Table 5.9)	1.234 (CLR10 Table 5.9)

CLEA-Defined Exposure Data for Human Receptors (continued)

Parameter	Value	Data Source
Lithology	Sand	Conservative Assumption for Generic risk assessment
Lower Depth of Surface Soils	50 cm	CLEA Defined
Total Porosity	0.30	CLEA recommended value for sand
Effective porosity (cm^3/cm^3)	0.25	RISC recommended value for sand
Water-filled porosity (cm^3/cm^3)	0.10	CLEA recommended value for sand
Soil bulk density (g/cm^3)	1.60	CLEA recommended value for sand
Fraction of organic carbon (g oc/g soil)	0.01	RISC recommended value

CLEA-Defined Data for Average Soils

Parameter	Value	Data Source
Distance down-gradient (m)	200	Hypothetical compliance borehole
Distance cross-gradient (m)	0	Most conservative case
Depth below groundwater level to top of well screen (m)	0	Most conservative case
Depth below groundwater level to bottom of well screen (m)	1	Most conservative case

Locations of Off Site Receptors – Compliance Borehole