

Comprehensive Environmental Site Assessment

Shell Hitchin

NPS: 10019011



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Shell UK Oil Products Ltd.

Prepared by:
URS Infrastructure and
Environment Limited

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EXECUTIVE SUMMARY

URS Infrastructure and Environment Limited (URS) has undertaken an Environmental Site Assessment (ESA) of the Shell Hitchin located at Bedford Road, Hitchin, Hertfordshire, SG5 2TY to ascertain environmental conditions of the site. Specifically the purpose of this ESA is to assess the hydrogeological characteristics of the site; assess the extent, magnitude, and nature of impact, if present; and update the Conceptual Site Model (CSM) for the site.

The scope of work included the installation of five groundwater monitoring wells (BH101 to BH103, BH105 and BH106) and three vapour monitoring wells (VP101 to VP103). Boreholes on the eastern site boundary were advanced to a maximum depth of 9.0m bgl at the site into the superficial deposits of the Lowestoft Formation classified by the Environment Agency as unproductive strata. These boreholes encountered groundwater between 7.3m bgl and 7.6m bgl. Chalk was encountered at the western side of the site in BH105 and BH106 at depths of 5.3m bgl. Monitoring wells were installed into the overlying superficial deposits, and did not contain groundwater. Due to the location of the boreholes which contained water, it was not possible to calculate an inferred groundwater flow at the site. However, regional topography suggests that underlying groundwater flow is to the north east.

The principal Controlled Waters receptor for the site is the underlying Zig Zag Chalk (Principal Aquifer) and Superficial Deposits (Secondary-A Aquifer). Other potential receptors include surface water features in the vicinity of the site, Bearton Pond approximately 200m north of the site, and the River Oughton, River Purwell, and River Hiz located greater than 1km north/north-east of the site.

Phase separate hydrocarbons (PSH) or visual evidence of soil staining was not identified at the site, however mild hydrocarbon odours and a slight sheen was noted on groundwater samples collected from BH102.

Suggested potential source areas identified by the current CSM consist of seven known operational USTs at the site located south of the pump islands which date back to 1970, a three stage interceptor located near the north-eastern corner of the site. Underground drainage and fuel pipelines and accidental releases at below ground off-set fill points and fuel pumps.

Generic screening of soil, groundwater and vapour results identified potential risks to controlled waters at Stage 2 assessment. No significant risks to human health were identified.

URS conducted a Controlled Waters Detailed Quantitative Risk Assessment (DQRA) to assess the significance of identified potential pollutant linkages. The potential pollutant linkages modelled as part of the DQRA are presented below.

Modelled Pollutant Linkages			
Assessment	Source	Pathway(s)	Receptor
CW Pollutant Linkage No. 1	Impacted Soils (above URS Stage 2 CW GAC)	- Partitioning between soil and pore water - Infiltration of impacted pore water down to the saturated zone (water table) - Dilution of impacted pore water within the saturated zone	Groundwater within the Gault Formation (Secondary-A Aquifer) and the Zig Zag Chalk Formation bedrock (Principal Aquifer).

Modelled Pollutant Linkages			
Assessment	Source	Pathway(s)	Receptor
		Horizontal migration of impacted groundwater	
CW Pollutant Linkage No. 2	Impacted groundwater (above URS Stage 2 CW GAC)	- Horizontal migration of impacted groundwater. - Vertical migration of impacted groundwater.	

The principal conclusions of the ESA and Controlled Waters DQRA are summarised below:

- No significant risks to human health (on site workers or off-site residents) were identified.
- Shallow soil concentrations of naphthalene exceeded the human health high density residential GAC at BH105 and BH106 located in close proximity to the fuel dispensers, and groundwater concentrations of benzene and TPH exceeded the exceeded the human health high density residential GAC at BH102 located approximately 5m east of the tank farm. Potential risks to human health for naphthalene, benzene and TPH is likely to be driven by inhalation of volatile vapours. Given the distance to the nearest residential receptor, depth to groundwater and site specific TOC concentrations these exceedances of the GAC are not considered significant
- Vapour analytical data collected from three areas of the site in October 2011 were compared with URS GAC protective of human health for a high density residential scenario. No chemicals of potential concern (COPC) were reported above the relevant human health GAC suggesting the theoretical risk from soil and groundwater is not significant.
- Potentially unacceptable risks to groundwater in the underlying superficial deposits were identified from reported concentrations of benzene, TPH Aromatics <C5-C7 and naphthalene in groundwater at a 50m compliance point. The 50m compliance point was selected based on the hazardous classification of these substances the presence of the Principal Aquifer beneath the superficial deposits and the uncertainty in groundwater flow direction and gradient.
- Potentially unacceptable risks to groundwater in the underlying Chalk Principal aquifer were identified from reported concentrations of benzene at a 50m compliance point however this assessment is based on a number of assumptions in the absence of site specific data.

1. INTRODUCTION

URS Infrastructure and Environment Limited (URS) has undertaken a Comprehensive Environmental Site Assessment (ESA) of Shell Hitchin located at Bedford Road, Hitchin, Hertfordshire, SG5 2TY at the request of Shell UK Oil Products Ltd. (Shell). The information contained herein is in accordance with Shell's requirements for a Comprehensive ESA report.

1.1. Objectives

The objective of this Phase II ESA report is to collect data to refine the current conceptual site model (CSM) for the site. The aim of this ESA is to:

- Assess the hydrogeological characteristics of the site;
- Assess the extent, magnitude and nature of impact, if any;
- Refine the conceptual site model (CSM); and
- Produce a combined Environmental Site Assessment (ESA) and Detailed Quantitative Risk Assessment (DQRA) Report.

1.2. Scope of Work

The Scope of Work for this ESA includes:

Preliminary Works

- Preparation of a site specific Health, Safety and Environmental Plan (HSEP).
- Submission of a Management of Business Interference (MBI) form to the nominated site contacts.
- Review of the URS Phase 1 Site Investigation Report (Reference 1).

Phase 2 Activities

- Service clearance and initial site walkover with URS' subcontractor to undertake on-site robust sub-scan of the site.
- Clearance of eight (8) locations by vacuum excavation to a depth of at least 1.2 metres (m) below ground level (bgl) at 150% diameter of the proposed borehole.
- Further advancement of five (5) of the cleared holes to total depths of between 6.3m and 9.0m bgl.
- Installation of six (5) groundwater monitoring wells (BH101 to BH103, BH105 and BH106) and three (3) vapour monitoring wells (VP101, VP102 and VP103).

- Levelling of groundwater wells.
- Collection of soil samples from targeted locations to evaluate the presence of potential impact.
- Collection of two (2) soil samples for WAC analysis to enable waste disposal of borehole arisings.
- Conduct SPT tests at two (2) locations (BH101 and BH105).
- Collection of six (6) geotechnical soil samples for Particle Size Distribution (PSD), effective porosity, sulfate and Atterberg Limits to assist with site design.
- Collection of groundwater samples from four (4) monitoring wells.
- Collection of potable water samples from the site tap.
- Monitoring of groundwater levels and soil vapour concentrations from new wells.
- Hydraulic conductivity testing of three (3) groundwater monitoring wells (BH101, BH102 and BH103).
- Assessment of the magnitude, type and extent of Chemicals of Potential Concern (COPC) present through the performance of laboratory and/or on-site analysis of soil, groundwater and vapour for various chemical indicators associated with operation as a petrol filling station.
- Screening of analytical results against Generic Assessment Criteria (GAC) to determine the requirement for a DQRA.

Detailed Quantitative Risk Assessment (DQRA)

- Assessment of the significance of identified potential Pollutant Linkages.
- Completion and submission of this ESA report.

2. BACKGROUND INFORMATION

2.1. Site Identification Details

Table A - Site Information	
Site Name	Shell Hitchin
Network Planning System ID	10019011
Site Address	Shell Hitchin, Bedford Road, Hitchin, Hertfordshire, SG5 2TY Figure 1 provides a site location map.
Grid Reference (Easting, Northing)	517920, 229840
Approximate Site Area	1,500m ² (calculated by Envirocheck). Figure 2 provides a summary plan of the site layout.
Freehold/Leasehold	URS understands the site is owned by Shell.
Land Use Zoning	Continued Petroleum Use (CPU)
Surrounding Land Use	North: STS Tyre Pros (Tyre Dealers) is situated approximately 5m north of the site beyond an access road. A three story apartment block with surrounding garden lies approximately 30m north of the site. South: The Fir Hotel lies approximately 5m south of the site beyond a small car parking area. Residential properties are situated approximately 30m south of the site. East: The site is bounded to the east by the A550 Bedford Road. Hitchin Town FC football ground is approximately 20m east of the site. West: The site is bounded to the west by a Garage and car park. Residential properties with gardens lie approximately 20m west the site.

2.2. Chronology of Activities

Table B – Chronology of Activities		
Activity	Date	Summary
Previous site investigations and/or remediation	Not applicable	Previous investigations and projects at the site to date include the following: - GeoDelft Tier 1 soil gas survey, May 1999 - URS Phase 1 Environmental Site Assessment, September 2011
<u>Review of Historical Reports by GeoDelft (Reference 1)</u> A GeoDelft Tier 1 report identified no historical known pollution incidents at the site. Concentrations of VOC <50ppm were recorded at the site. Minimal impact was identified at the site. <u>Review of URS Phase 1 Environmental Site Assessment Report (Reference 2)</u> A Phase 1 Investigation was undertaken by URS in September 2011 and included an initial desk based investigation and site walkover to provide information on the environmental site setting. An initial conceptual site model and Preliminary Risk Assessment (PRA) was undertaken. The preliminary risk assessment identified a number of potential pollutant linkages, summarised as follows: Human Health - Migration of hydrocarbon vapours from potentially impacted shallow soils and/or groundwater to on-site workers within the shop area and off-site workers to the north and east of the site. - Permeation of hydrocarbons from potentially impacted soil into plastic water supply pipes followed by ingestion by on-site shop staff. Controlled Waters - Vertical migration of COPC from potentially impacted shallow soils into perched water and/or the shallow groundwater within the shallow Drift Deposits that border the site (Secondary A Aquifer), and potentially deeper groundwater in the underlying Zig Zag Chalk Formation (Principal Aquifer). - Migration of COPC from potentially impacted shallow soils into perched water and/or the shallow groundwater followed by lateral migration to Surface Waters (Bearton Pond located 200m north of the site, The River Oughton located 1km north of the site, the River Purwell located approximately 1.2km north-east of the site and the River Hiz located approximately 1.8km north/north-east of the site).		

2.3. Site Equipment – Storage Tank Summary

Table C: Summary of On-site Fuel Tank / Compartments							
Tank number or identification	Tank / Compartment 1	Tank / Compartment 2	Tank / Compartment 3	Tank / Compartment 4	Tank / Compartment 5	Tank Compartment 6	Tank Compartment 7
Tank type (b)	Single walled Dual Chamber	Single walled Dual Chamber	Single walled	Single walled	Single walled Dual Chamber	Single walled	Single walled Dual Chamber
Tank size (a, b)	13,190	13,190	26,190	26,190	12,363	26,190	12,121
Product stored (a)	V-Power UL	V-Power Diesel	Unleaded	Diesel	Unleaded	Unleaded	V-Power UL
Status (a)	In use	In use	In use	In use	In use	In use	In use
Date of installation (b)	1970	1970	1970	1970	1970	1970	1970
Removal date or abandonment date	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
Relative level (RL) of tank base (c)	Assumed to be 4.5 m bgl	Assumed to be 4.5 m bgl	Assumed to be 4.5 m bgl	Assumed to be 4.5 m bgl	Assumed to be 4.5 m bgl	Assumed to be 4.5 m bgl	Assumed to be 4.5 m bgl

NOTES:

- a - Information from site inspection
- b - Information from petroleum officer's report
- c - Estimate based upon tank size

3. FIELD WORK

3.1. Summary of Field Work

Table D – Summary of Fieldwork	
Date of Field Work	Field work was undertaken between 26 September and 13 October 2011.
Site Activities	Field works included the following key tasks: • Excavation/drilling of 8 boreholes followed by the installation of 5 groundwater and 3 soil vapour monitoring wells (Glover GB); • Environmental soil sampling; • Groundwater and soil vapour monitoring event; • Hydraulic conductivity testing; and • Potable water supply sampling.
Service Clearance	Prior to commencing works all excavation locations were pre-cleared for the potential presence of subsurface utilities by Glover GB. Utility and as-built plans were reviewed and a site-wide robust underground utilities subscan was conducted, utilising a cable avoidance tool with generator (CAT & genny) and Ground Penetrating Radar (GPR). Each bore was then cleared by URS subcontractor Glover GB Ltd by vacuum excavation to 150% of auger diameter and to a depth of no less than 1.2m below ground level (bgl) prior to mechanical drilling.
Borehole Drilling Methodology	Glovers GB Ltd on subcontract to, and supervised by URS advanced the boreholes using a Hollow Stem Auger (HSA) methodology. Each well was installed using 50-millimetre (mm) diameter, 1mm-slotted, flush-threaded high-density polyethylene (HDPE) well screen and finished with a sufficient length of compatible HDPE riser. The annulus surrounding each well was filled with clean, washed gravel to a minimum of 0.2m (groundwater monitoring wells) or 0.15m (vapour wells) above the top of the screened interval, and topped with a layer of activated bentonite to act as a seal. Each well was finished in a protective well vault placed flush to surface and set in a concrete pad. URS personnel logged and screened all soil arising during excavation. The borehole logs are presented in Appendix B, and photographs taken during drilling are presented in Appendix C.
Borehole Location Rationale	A total of 5 boreholes were excavated to a maximum depth of 9.0m bgl prior to the installation of groundwater monitoring wells, and 3 boreholes were excavated to a maximum depth of 1.1m bgl prior to the installation of vapour monitoring wells. Drilling locations were designed to evaluate the soil, groundwater and soil vapour conditions associated with the target locations described below. The monitoring well and borehole locations are illustrated on Figure 2. At proposed location BH104 multiple refusals on a thick layer of brick and concrete at 1.1m bgl prevented further advancement and the location had to be abandoned. Excavations were backfilled with a bentonite and cement mix and sealed with a concrete layer at the surface.

Table D – Summary of Fieldwork

	Borehole ID	Target Location	Completion Depth (m bgl)	Monitoring Well (y/n)
	BH101	Located in the north-east corner of the site adjacent to the site interceptor.	9.0	Y
	BH102	Located on the eastern boundary of the site, approximately 7m from the pump islands.	9.0	Y
	BH103	Located in the south-east corner of the site approximately 5m from the tanks.	9.0	Y
	BH104	Located in the south-western corner of the site approximately 5m west of the car wash.	NA (refusal upon concrete and bricks)	N
	BH105	Located in the western area of the site, approximately 5m west of the off-set fill points.	6.3	Y
	BH106	Located in the north-west corner of the site approximately 3m from the shop.	7.2	Y
	VP101	Located approximately 2m from the shop front.	1.0	Y
	VP102	Located in the south-east corner of the site approximately 5m from the tanks.	1.1	Y
	VP103	Located in the south-western corner of the site approximately 5m west of the car wash.	1.0	Y
Soil Sampling	In total 13 soil samples, 6 geotechnical samples and 2 WAC samples were collected during the site investigation programme. In general, one to two soil samples were taken from each borehole based on potential field evidence of impact for laboratory analysis. Soil analytical results are presented in Appendix A . The location and depth of each soil sample is highlighted on the drilling logs provided in Appendix B .			
Soil Vapour Sampling	In total, three soil vapour samples were collected from monitoring locations VP101, VP102 and VP103 using vapour tubes. Soil vapour sampling was undertaken on 13 October 2011. Before a soil vapour sample was taken, each well was purged of three well volumes using an air pump to remove standing ambient air from the well. Soil gas measurements are presented in Appendix A – Table 2 .			
Surveying	The elevation of the groundwater monitoring standpipes has been surveyed to metres above Ordinance Datum (mAOD) by URS subcontractor Glover GB Ltd.			

Table D – Summary of Fieldwork

Groundwater Elevation Monitoring	On 12 October 2011, URS field personnel measured liquid levels in all monitoring wells associated with the site using an interface probe (IP), which is capable of distinguishing Phase Separated Hydrocarbons (PSH) from water. The IP was cleaned by washing with a non-phosphate soap solution and rinsing with deionised water before each measuring event. Liquid levels were measured to the nearest 0.01m from the top of each well casing, so that they could be directly compared to a common datum. Measurements made in the field included depth to water, depth to PSH (if present), and depth to the base of each well. Where the underlying Chalk Principal Aquifer was encountered during drilling works, the borehole was backfilled with a bentonite seal to 0.5m above the chalk strike to prevent potential pathways into the Chalk. Monitoring wells were installed into the superficial deposits above the Chalk. On 12 October 2011, depth to groundwater ranged from 7.3m bgl in BH102 to 7.6m bgl in BH101. Groundwater was encountered in BH101 – BH103 which run in a line along the eastern boundary of the site. No groundwater (apart from a small amount of perched water in BH105) was present in wells BH105 or BH106 installed in the superficial deposits above the Chalk. Due to the locations of boreholes BH 101-103, it was not possible to calculate an inferred groundwater flow at the site. However, regional topography suggests that underlying groundwater flow is to the north east. A small amount of perched water was encountered at BH105. PSH were not encountered in any well. Liquid level data collected on 12 October 2011 are summarised in Appendix A. The groundwater levels for the October 2011 gauging event is illustrated on Figure 3.
Groundwater Sampling	The groundwater wells were purged and sampled using a low-flow sampling method incorporating a flow through cell and dedicated tubing. During well purging activities, water was periodically monitored for temperature, pH, conductivity, dissolved oxygen (DO), and oxidation/reduction potential (ORP or Redox) using a water quality meter to determine when representative formation waters were being encountered. Following sufficient recharge, groundwater samples were collected. All groundwater samples were collected into laboratory supplied, glass containers, labelled, and placed on ice. BH106 was found dry during the September monitoring round and BH105 only had 0.12m of water. As such, limited sampling could be completed for groundwater collected at this location.
Field Quality Control Sampling	The following field quality control samples were collected as part of this ESA: • 1 trip blank (for groundwater samples); • 3 field duplicates (2 soil and 1 groundwater).; and • 1 triplicate (of duplicate groundwater sample).
Hydraulic Conductivity Testing	On 13 October 2011, rising and falling head tests using a slug were conducted in wells BH101, BH102 and BH103 within the Lowestoft Formation. The data were interpreted using the Bouwer Rice method. Hydraulic conductivity data are presented in Appendix H.

3.2. Field Screening Results / Observations

Table E – Field Screening	
Soil Observations	During excavation of boreholes, soil vapour screening of arisings using a field-calibrated photo-ionisation detector (PID) equipped with a 10.6 electron-volt (eV) lamp was undertaken. PID readings were documented and are presented in the borehole logs provided in Appendix B . PID readings was recorded at <5 ppm in all boreholes across the site with the exception of BH102 where readings of 1207 was reported at the top of the groundwater table. No visible black staining or odour was found.
Groundwater Observations	Groundwater extracted from monitoring wells BH101 and BH102 had a slight sheen and hydrocarbon odour.
Phase Separate Hydrocarbons (PSH)	PSH were not detected during the October 2011 monitoring round.
Field Groundwater Quality Parameters	Details of field groundwater quality parameters are presented in Appendix A. During the groundwater monitoring event (GME) the following were noted: - Dissolved oxygen concentrations range from 0.58 to 6.30 milligrams per litre (mg/L) - Redox potential of groundwater ranged from 82.3 to 196.4 millivolts (mV) indicating oxidising/aerobic conditions; - Electrical conductivity of groundwater ranged from 581 to 990 microsiemens per centimetre (mS/cm); - Groundwater pH ranged from 6.34 to 6.77; - Groundwater temperature ranged from 14.6 to 15.9°C.

3.3. Hydrogeological Information

Table F – Hydrogeological Information	
Made Ground and Superficial Geology	The site consists of made ground underlain by the Lowestoft Formation. This formation forms an extensive sheet of chalky till, together with outwash sands and gravels, silts and clays. The till is characterised by its chalk and flint content. The carbonate content of the till matrix is about 30%, and tills within the underlying Happisburgh Formation have less than 20%. The Environment Agency website classifies the superficial Lowestoft formation as Unproductive Strata. These are rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow. The site lies on the boundary of the Gault Formation which is a layer of pale to dark grey or blue-grey clay or mudstone, glauconitic in part, with a sandy base. Discrete bands of phosphatic nodules (commonly preserving fossils), some pyrite and calcareous nodules. The Environment Agency website classifies the superficial Gault Formation as a Secondary-A Aquifer. These are permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers.

Table F – Hydrogeological Information

Solid Geology	The Bedrock Geology of the site is reported to be the Zig Zag Chalk Formation. This consists of mostly firm, pale grey to off-white blocky chalk with a lower part characterised by rhythmic alternations of marls and marly chalks with firm white chalk. Thin gritty, silty chalk beds act as markers in the sequence. The thickness is typically 35–50 m bgl. The Environment Agency Website classifies the Zig Zag Chalk Formation as a Principal Aquifer. These are layers of rock or drift deposits that have high inter-granular and/or fracture permeability - meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale. In most cases, principal aquifers are aquifers previously designated as major aquifer. The site is reported by BGS (Hitchin Sheet 221) to lie on the border of a buried sediment-filled channel that reaches depths of 100m deep in the centre of the channel. During intrusive works in September 2011, Chalk was encountered at a depth of 5.4m bgl at boreholes BH105 and BH106 located in the western area of the site. Chalk was not encountered in BH101 – BH103 drilled to a depth of 9.0m bgl located in the eastern area of site.
Groundwater	Perched water was encountered during drilling works at a depth of 5.8m bgl above the Chalk formation at the western side of site, and at depths of between 7.3 and 7.6m bgl in the overlying superficial deposits in the eastern area of site. The site is not located within a Source Protection Zone and there are no groundwater abstractions within 1km of the site. There are four current groundwater abstractions between 1 and 2km from the site: • Pilkington Farms 1.4km west of the site is licensed to abstract groundwater from chalk sourced from a well and borehole. Abstraction is currently unspecified but previous permit was for Household Water Supply: Drinking, Cooking, Sanitary, Washing; (Small Garden). Status: Perpetuity. • Environment Agency 1.7km south of the site is licensed to abstract groundwater from a well for Environmental use: Remedial/Wetland Support: Transfer Between Sources. Status: Not Supplied. • DPH Parker 2km north west of the site is licensed to abstract groundwater from chalk for General Farming and Domestic use. Status: Perpetuity. • Veolia Water Central Limited 2km west of the site are licensed to abstract groundwater from chalk for Public Water Supply: Potable Water Supply – Direct. Status: Perpetuity. License was previously held by Three Valleys Water Plc.
Surface Water Features	The closest surface water feature is the Bearton Pond Located approximately 200 m north of the site. The River Oughton is located 1km north of the site, the River Purwell is located approximately 1.2km north-east of the site and the River Hiz is located approximately 1.8km north/north-east of the site. There is one active and one historical surface water abstraction identified within 1km of the site. • William Ransom and Sons between 835m and 1.1km south from the site,

Table F – Hydrogeological Information

	licensed to abstract water from the River Hiz for cooling. Status: Current. • G W Russell & Son 720m south east of the site, licensed to abstract water from the River Hiz for cooling. Status: Revoked. There are a further 4 additional current surface water abstractions between 1km and 2km from the site.
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3.4. Preliminary Conceptual Site Model

Following review of the available data regarding site history, environmental setting, and proposed future use, a preliminary CSM was developed, as presented in Table G below. The CSM illustrates the potential sources, pathways and receptors for the evaluation of potential risk at the site.

Table G: Human Health			
Source	Pathway	Receptor	Likelihood of Potentially Significant Pollutant Linkage
Potentially impacted shallow soils / groundwater from the site and identified potential off-site sources (AST and Garage)	Vapours - Migration of hydrocarbon vapours through made ground to above ground buildings	On-site shop staff	Potential Linkage
		Off-site workers in garages adjacent to the west and 5m north of the site and hotel 5m south of the site	Potential Linkage
		Occupants in residential properties adjacent the southern site boundary, 30m to the north of the site and 20m to the west of the site	Potential Linkage
	Particulate - Ingestion, inhalation, dermal contact, with soil particulates	Visiting contractors excavating ground	Unlikely – The use of personal protective equipment by contractors excavating ground would break the pathway between source and receptor. As the majority of the site is covered in hardstanding it is unlikely visitors and shop workers would come into contact with impacted soil.
		On-site employees of the retail petroleum shop and site visitors	
	Permeation of hydrocarbon substances through plastic potable water supply pipes	On-site shop staff (ingestion of drinking water on-site)	Potential Linkage

Table H: Controlled Waters			
Source	Pathway	Receptor	Pollutant Linkage
Potentially impacted soils / groundwater from the site and identified potential off-site sources	Leaching - Migration of COPC from soils into groundwater.	Groundwater within The Zig Zag Chalk Formation (Bedrock) Principal Aquifer and Superficial Deposits that border the site boundary.	Potential Linkage
	Migration of impacted perched water into shallow and deeper groundwater.		Potential Linkage
	Leaching - Migration of COPC from soils into shallow groundwater, followed by migration to surface water	Bearton Pond Located approximately 200 m north of the site. The River Oughton located 1km north of the site, the River Purwell located approximately 1.2km north-east of the site and the River Hiz located approximately 1.8km north/north-east of the site. Surface water abstraction.	Potential Linkage (Bearton Pond)
	Migration of impacted perched water into shallow groundwater, followed by migration to surface water		Unlikely (River Oughton, Purwell and Hiz) - based on distance of the river from the site.

4. LABORATORY ANALYTICAL RESULTS

4.1. Analytical Schedules & QA/QC

Table I – Analytical Information					
Analytical Laboratory	Analytical samples were analysed by Alcontrol Laboratories of Chester. Copies of the Chain of Custodies (COCs) and laboratory certificates are presented in Appendix D and E respectively.				
Analytical Schedule	The following schedule of analysis was completed for this ESA, Appendix E provides the results and details of the analytical methodology				
	Analysis	Number of soil samples	Number of groundwater samples	Number of potable supply samples	Number of soil vapour samples
	Total Petroleum Hydrocarbon (TPH) Health Risk Assessment Fractions	13	4	2	n/a
	Polycyclic Aromatic Hydrocarbons (PAHs)	8	4	2	n/a
	Benzene, toluene, ethylbenzene, xylenes (BTEX), TPH, 6 Fuel Oxygenates (methyl tertiary butyl ether (MtBE), tert-butyl ethyl ether (ETBE), di-isopropyl ether (DIPE), tert butanol (TBA), tert-amyl methyl ether (TAME), Ethanol)	13	4	2	n/a
	Heavy metals	8	n/a	n/a	n/a
	Fraction of Organic Carbon (FOC)	13	n/a	n/a	n/a
	Polychlorinated biphenyls (PCBs)	2	n/a	n/a	n/a
	Volatile Organic Compounds (VOC)	n/a	n/a	n/a	3
	Total Volatile Hydrocarbons (C6 – C12)	n/a	n/a	n/a	3
	Geotechnical Testing	6	n/a	n/a	n/a

Table I – Analytical Information

Field Quality Control Sampling	The analytical data have been reviewed for quality assurance and control purposes (QA/QC), and the results of these reviews are documented on the data validation forms included in Appendix F. Holding times for soil samples exceeded the seven day holding time by one day for three samples collected. The relative percentage difference (RPD) between detected concentrations in the soil duplicate sample (DUP01) and its parent (BH105) were within acceptable limits with the exception of high end TPH Aliphatic bands. The RPD exceedances are likely due to heterogeneity within the soil sample. The laboratory blanks were also within acceptable limits. In general, the data are considered appropriate for reporting. The RPD between detected concentrations in the groundwater duplicate sample (DO1) and its parent (BH102) were within acceptable limits. The laboratory blanks were also within acceptable limits. In general, the data are considered appropriate for reporting.
Laboratory Quality Control Sampling	Results of laboratory quality control sampling suggest that the results obtained are suitable for use for this ESA.

4.2. Soil Gas Results

The following provides a summary of the Landfill Gas monitoring results. Results are presented in **Appendix A, Table 2**.

- VOC concentrations were not recorded above the instrument detection limit (<0.1ppm) in any of the three vapour monitoring locations pre or post purging.
- Methane concentrations were not recorded above the instrument detection limit (<0.1ppm) in any of the three vapour monitoring locations pre or post purging.
- Carbon dioxide concentrations were recorded at a maximum concentration of 0.7% v/v in VP101.
- Oxygen concentrations were recorded at greater than 19%v/v in all sampled locations.

5. STAGE 2 GENERIC QUANTITATIVE RISK ASSESSMENT

5.1. Introduction

The risk based methodology adopted in this report is based upon the UK DEFRA and EA "best practice" in regard to the assessment of contaminated land. An overview of the methodologies adopted as part of this assessment is provided in URS Technical Document 'Shell UK Controlled Waters & Human Health Risk Assessment Method'¹. The approach taken reflects that promoted in CLR11² and R&D Publication 66³ and the supporting guidance referenced within them.

5.1.1. On-site Scenario

URS has screened the soil, groundwater and vapour data collected in September and October 2011 against URS generic assessment criteria (GAC) for:

- Human Health: Continued Petroleum Use (CPU), protective of on-site petroleum workers;
- Controlled waters receptors (protective of the Principal Chalk Aquifer and Secondary A Aquifer underlying the site).

The human health CPU GAC are derived assuming vapour only pathways are viable, and that there is no risk of exposure to soil impact via direct contact pathways including dermal contact and dust inhalation/ingestion as the site is fully covered in hardstanding/building footprint. From the URS site walkover the site was found to be covered in 100% hard standing and the human health CPU assessing vapour inhalation pathways only are therefore considered appropriate to use.

The URS human health GAC were derived assuming soils beneath the site typically contained 0.58% total organic carbon (TOC). Values for TOC in unsaturated soil samples collected from the site by URS ranged from 0.2% to 2.09% with an average of 0.73%, which is greater than that used in the derivation of the GAC. Consequently, the human health screening criteria are conservative when applied to the site and may over-estimate potential risks to the identified human health receptors.

The reported analyte concentrations in soil, groundwater and soil vapour samples that exceed the GAC are highlighted in **Appendix H, Tables 10 to 14**.

¹ URS Technical Document – 'Shell UK Controlled Waters & Human Health Risk Assessment Method', Dated September 2010, Ref: Issue 1.

² Model Procedures for the Management of Land Contamination, Contaminated Land Report (CLR) 11, Environment Agency & DEFRA, Dated September 2004.

³ Guidance for the Safe Development of Housing on Land Affected by Contamination, R&D Publication 66: 2008 (Volume 1), NHBC and the Environment Agency 2008.

5.1.2. Off-site Scenario

The land use in the vicinity of the site which is potentially more sensitive than the on-site CPU scenario is considered to be the low density residential houses with gardens located approximately 20 m west of the site and Firs Hotel located approximately 5m from the southern site boundary.

URS has screened the soil, groundwater and vapour data collected in September and October 2011 against URS generic assessment criteria (GAC) for:

- Human Health receptors: High Density Residential (HDR) GAC protective of off-site residents to the west of the site and live-in hotel staff in Firs Hotel to the south of the site.
- Controlled waters receptors (protective of the Principal Chalk Aquifer and Secondary A Aquifer underlying the site).

The human health HDR GAC are derived assuming vapour only pathways are viable, and that there is no risk of exposure to soil impact via direct contact pathways including dermal contact and dust inhalation/ingestion as the site is fully covered in hardstanding/building footprint. It is assumed that soil sources only extend to the site boundary. From the URS site walkover the site was found to be covered in 100% hard standing and the human health HDR GAC assessing vapour inhalation pathways only are therefore considered appropriate to use.

The URS human health HDR GAC were derived assuming soils beneath the site typically contained 0.58% total organic carbon (TOC). Values for TOC in unsaturated soil samples collected from the site by URS ranged from 0.2% to 2.09% with an average of 0.73%, which is greater than that used in the derivation of the GAC. Consequently, the human health screening criteria are conservative when applied to the site and may over-estimate potential risks to the identified human health receptors.

The reported analyte concentrations in soil, groundwater and soil vapour samples that exceed the GAC are highlighted in **Appendix H, Tables 10 to 14**.

5.2. Soil Analytical Results

Soil results are screened against GAC in **Appendix H - Table 10 and 11**. The GAC selected for comparison with soil analytical results are the following:

- Human Health: Continued Petroleum Use (CPU) protective of on-site workers.
- Human Health: High Density Residential GAC protective of off-site residents to the north and west of the site and live-in hotel staff in Firs Hotel to the south of the site.
- Controlled Waters: Drinking Water Standards (DWS) protective of the Principal Chalk Aquifer and Secondary A Aquifer underlying the site

The following soil results are deemed to be potentially significant for the stated objective of this ESA:

Human Health – CPU protective of on-site workers

No Soil Concentrations were reported above the CPU GAC protective of on-site workers in any of the soil samples collected and analysed.

Human Health – HDR GAC protective of off-site residents

Naphthalene concentrations were reported in excess of the Stage 2 HDR GAC in shallow soil samples collected from BH105 and BH106. BH105 exceeded the GAC by a factor of 5.1, BH106 exceeded by a factor of 7.1.

Controlled Waters

It should be noted that the laboratory reporting limits for cadmium, hexavalent chromium, mercury, several PAH compounds, DIPE, MTBE, TBE, and aromatic TPH >C6-C7 exceeded the respective controlled waters GAC. This does not significantly affect interpretation of the data because the controlled waters GAC are conservative and the GAC are generally within one order of magnitude of the laboratory reporting limits.

- Concentrations of 11 or more PAH compounds were detected in excess of the GAC derived to be protective of controlled waters in three of the soil samples analysed. Greatest exceedances were found in a shallow soil sample collected from BH105 which failed the GAC by over three orders of magnitude;
- Concentrations of 4 or more metals were detected in excess of the controlled waters GAC in three of the soil samples analysed.
- Reported soil concentrations of benzene exceeded the controlled waters GAC in a shallow soil sample collected from BH105 at 0.6m bgl;
- Multiple TPH bands in soils exceeded the controlled waters GAC in 10 soil samples collected.

5.3. Groundwater Analytical Results

Groundwater results are screened against GAC in **Appendix H – Tables 13 and 14**. The assessment criteria selected for comparison with soil analytical results are the following:

- Human Health: Continued Petroleum Use (CPU) protective of on-site workers.
- Human Health: High Density Residential GAC protective of off-site residents to the north and west of the site and live-in hotel staff in Firs Hotel to the south of the site.
- Controlled Waters: Drinking Water Standards (DWS) protective of the Principal Chalk Aquifer and Secondary A Aquifer underlying the site.

Human Health – CPU protective of on-site workers

Based on the generic screening, reported groundwater concentrations from the October 2011 groundwater monitoring round did not exceed the CPU human health GAC protective of on-site workers.

Human Health –HDR GAC protective of off-site residents

One groundwater sample collected and analysed from BH102 located approximately 7m from the pump islands exceeded the human health HDR GAC for Benzene by a factor of 1.3 and had a reported TPH Hazard Index of 3.1 which exceeded the Stage 2 target value of 1.

Controlled Waters

- Concentrations of benzene, ethylbenzene and xylenes were reported in excess of the Stage 2 controlled waters GAC from a sample collected and analysed from BH102.
- Naphthalene was reported at a concentration of 175µg/l from a groundwater sample collected from BH102 which exceeded the DWS of 1µg/l.
- Multiple TPH bands exceeded the Stage 2 controlled waters GAC in one sample collected and analysed from BH102.

5.4. Soil Leachate Analytical Results

Soil leachate results are screened against GAC in **Appendix H – Table 12**. The assessment criteria selected for comparison with vapour analytical results are the following:

- Controlled Waters: Drinking Water Standards (DWS) protective of the Principal Chalk Aquifer and Secondary A Aquifer underlying the site

No exceedances of the Stage 2 GAC were found in soil leachate samples collected at the site.

5.5. Soil Vapour Analytical Results

Vapour results are screened against GAC in **Appendix A – Tables 7 and 8**. The assessment criteria selected for comparison with vapour analytical results are the following:

- Human Health: Continued Petroleum Use (CPU) protective of on-site workers for shallow and deep soils.
- Human Health: High Density Residential GAC protective of off-site residents to the west of the site and live-in hotel staff in Firs Hotel to the south of the site.

No exceedances for shallow or deep soil protective of on-site workers or off-site residents were found in vapour samples collected in all monitoring wells.

5.6. Potable Water Analytical Results

Potable water sample analytical results for the static and active samples are screened against drinking water standards in **Appendix A – Table 9**.

Phenanthrene was detected in the static water sample (STATIC 01) at a concentration of 0.0225 µg/L which is three orders of magnitude below the drinking water standard. No other COPC were reported above the laboratory method detection limit (MDL).

No exceedances of the drinking water standards were reported in either of the samples analysed.

5.7. Summary

The COPC which exceeded controlled waters GAC have been further assessed in the DQRA presented in Section 7 of this report.

Reported concentrations of naphthalene from soil samples collected from BH105 at 0.5m and BH106 at 0.6m bgl have not been assessed further for potential human health risks to off-site residents for the following reasons:

- 1) The primary exposure pathway for risks to off-site residents from naphthalene in shallow soils is via vapour migration and subsequent inhalation. The nearest residents to the site are located approximately 5m from the southern boundary of the site in a Firs Hotel. The soil impacts identified at BH105 and BH106 are located approximately 20m and 35m respectively north of these off-site residents. The potential attenuation of vapours over a minimum compliance point distance of 20m has also not been included within the generic assessment. This would be expected to result in significant vapour attenuation and resultant significant decrease in potential risk.
- 2) The data from on-site vapour wells (VP101 to VP103) are three orders of magnitude lower than the soil vapour GAC. The results from VP103 provide an indication of the degree to which the soil GAC overestimates vapour intrusion risk at this particular site.
- 3) The site-specific TOC values were higher than the TOC values used to generate the URS human health GAC (0.58%). As such, vapours theoretically partitioning from soils would be expected to be lower than predicted for GAC.

Reported concentrations of benzene and TPH from groundwater samples collected and analysed from BH102 have not been assessed further for potential human health risks to off-site residents for the following reasons:

- 1) The groundwater GAC were derived assuming a depth to the groundwater table of 1.0m bgl. The geometric mean depth to groundwater measured by URS in

October 2011 was 7.47m bgl. As such, the CSM assumed for the GAC is likely to be more sensitive than at the site. A greater unsaturated zone thickness will typically allow a greater degradation of vapours and ground gas oxygen concentrations appear indicative of such degradation conditions.

- 2) The primary exposure pathway for risks to off-site residents from benzene and TPH in groundwater is via vapour migration and subsequent inhalation. The average depth to groundwater at the site is 7.47m bgl. The nearest residents to the site are located approximately 5m from the southern boundary of the site in a Firs Hotel. The groundwater impacts identified at BH102 are located approximately 25m north of these off-site residents. The potential attenuation of vapours over a minimum compliance point distance of 25m has also not been included within the generic assessment. This would be expected to result in significant vapour attenuation and resultant significant decrease in potential risk.
- 3) The data from on-site vapour wells (VP101 to VP103) are three orders of magnitude lower than the soil vapour GAC. The results from VP102, located 12m south of BH102, provides an indication of the degree to which the groundwater GAC overestimate vapour intrusion risk at this particular site. Furthermore, the soil and groundwater GAC assume no degradation. Ground gas results show oxygen above the critical 5% and hence biodegradation is likely to be occurring at the site.
- 4) The site-specific TOC values were higher than the TOC values used to generate the URS human health GAC (0.58%). As such, vapours theoretically partitioning from soils would be expected to be lower than predicted for GAC.

6. CONCEPTUAL SITE MODEL

6.1. Introduction

The CSM presented in this section is based on the preliminary CSM described in the URS Phase 1 Site Investigation and on observations made during the URS site investigation activities.

For a risk from a given source to be considered plausible, a mechanism (or 'pathway') must be present by which COPC can reach a given receptor. Such complete Source ⇒ Pathway ⇒ Receptor (SPR) exposure mechanisms are commonly termed 'pollutant linkages'.

The CSM presented in Sections 6.2 and 6.3 below is intended as a means of identifying and describing the potential pollutant linkages at the site. Potentially *significant* pollutant linkages will be listed in Section 6.4 and will be investigated further as part of the Stage 3 DQRA.

6.2. Controlled Waters CSM

Sources, pathways and receptors relevant to the Stage 3 controlled waters (CW) DQRA are summarised in Table J below:

Table J – Overview of CW Sources, Pathways & Receptors		
Potential Source(s)	Potential Pathway(s)	Potential Receptor(s)
Impacted Soils (above URS Stage 2 CW GAC) Impacted Groundwater (above URS Stage 2 CW GAC)	• Partitioning between soil and pore water; • Infiltration of impacted pore water down to the saturated zone (water table); • Dilution of impacted pore water within the saturated zone; and • Horizontal migration of impacted groundwater.	• Zig Zag Chalk (Principal Aquifer) • Superficial Deposits – Gault Formation (Secondary A Aquifer)

Potential source areas assessed as part of the Stage 3 CW DQRA are as follows:

- Soil Source 1 – Multiple TPH fractions were reported at concentrations above their respective Stage 2 CW GAC in soil samples collected from across the site analysed for these parameters. Therefore a site-wide 40m x 40m source area has conservatively been assumed for Soil Source 1.
- Soil Source 2 – PAH compounds and heavy metals (arsenic, cadmium, chromium, cobalt, copper, lead, mercury, molybdenum, nickel, selenium, tin, and zinc) were reported at concentrations above their respective Stage 2 CW GAC in soil samples collected from BH101, BH103 and BH106. A 25m x 30m source zone has been assumed.

- Soil Source 3 – benzene was reported at concentrations in excess of its respective Stage 2 CW GAC in one soil sample collected and analysed from BH102 which is located southeast of the tank farm. Given the distance to adjacent borings where these COPC were not reported within shallow or deep soils above the Stage 2 CW GAC, a 10m by 20m source zone has been assumed for Soil Source 3.
- Groundwater Source 1 – reported concentrations of BTEX, naphthalene and TPH bands exceeded the Stage 2 controlled waters GAC at BH102. Given the distance to adjacent borings where these COPC were not reported within groundwater above the Stage 2 CW GAC, a 10m by 20m source zone has been assumed for Soil Source 2.

Maximum reported concentrations from the October 2011 dataset were used as source concentrations for the model.

6.2.1. Pathways

Migration pathways that are considered viable at site include:

- Leaching of COPC from unsaturated soils beneath the site into the pore water;
- Infiltration of impacted pore water to the water table and dilution within the saturated zone;
- Horizontal migration within the superficial deposits, which directly underlies the site, towards Bearton Pond located approximately 200m north of the site; and
- Vertical migration within the superficial deposits, which directly underlies the site to the underlying Chalk formation.

These pathways have been selected as the key COPC migration pathways for the CW assessment for the following reasons:

- COPC were reported at concentrations above their Stage 2 CW GAC in soil samples collected from the Made Ground, and unsaturated soil samples from superficial deposits beneath the site;
- COPC have been identified at concentrations in excess of their respective Stage 2 CW GAC within samples of groundwater indicating that there is potential for leaching to occur from COPC found in the soil at the site; and
- Vertical migration of COPC within the superficial deposits has been modelled separately as a migration pathway into the deeper Chalk aquifer units.

6.2.2. Receptors

The principal controlled waters receptor for the site is the underlying Zig Zag Chalk Principal Aquifer and Superficial Deposits that border the site boundary. Other potential receptors include surface water features in the vicinity of the site which consist Bearton Pond approximately 200m north of the site, and the River Oughton, River Purwell and

River Hiz, located greater than 1km north/north-east of the site. The local groundwater flow direction is currently unknown at the site, however, regional flow is expected to flow towards the north east. Considering the presence of permeable geology (mainly silty sand) in the surrounding areas and beneath the site, it is considered that a plausible receptor for COPC may be present.

Groundwater in the superficial deposits underlying the site has been selected as the first compliance point for this assessment. The superficial deposits of the Lowestoft formation have been described by the EA as unproductive strata, however for the purpose of this assessment this has conservatively been modelled as a Secondary-A aquifer as the exact boundary of the Gault formation (classified as a Secondary-A aquifer) is currently unknown. An arbitrary Compliance Point of 50m is also selected based on the draft guidance issued by the Environment Agency, 'Selecting Compliance Points for use in Land Contamination Risk Assessments', which states that 'the distance to a set compliance point *should not* exceed 50m for hazardous substances. This is considered appropriate given the presence of a Principle Aquifer beneath the superficial deposits, and the current uncertainty in groundwater flow directions and gradient.

Groundwater in the underlying Zig Zag Chalk formation has been selected as the second compliance point for this assessment and has been modelled assuming a direct vertical pathway is present to the Principal aquifer. A Compliance Point of 50m has been selected to model the potential risks to the Principal aquifer assuming groundwater in the Chalk is in continuity with that encountered in the superficial deposits at the site. Conservative assumptions were made about the groundwater flow in the Chalk, with an assumed hydraulic conductivity of 15m/d, an assumed hydraulic gradient of 0.005, and an assumed effective thickness of 10m.

The surface water features are considered secondary potential receptors and have not been modelled separately. The likelihood of these potential receptors being impacted by on-site concentrations of COPC is considered to be low due to the distance from the site.

The assessment of potential risks to the Secondary-A and Primary Aquifer is considered sufficiently protective of the surface water features and the groundwater abstraction based on the information currently available to URS.

Results from the Stage 3 assessment of the sources detailed above are presented in Section 7.2. Stage 3 CW DQRA model parameters and rationales are provided in **Appendix G**.

6.2.3. Summary of Viable Pollutant Linkages

Potentially viable Controlled Waters pollutant linkages modelled as part of this assessment are summarised in Table K below:

Table K – Modelled CW Pollutant Linkages

Assessment	Source	Pathway(s)	Receptor
CW Pollutant Linkage No. 1	Impacted Soils (above URS Stage 2 CW GAC)	- Partitioning between soil and pore water - Infiltration of impacted pore water down to the saturated zone (water table) - Dilution of impacted pore water within the saturated zone - Horizontal migration of impacted groundwater	Groundwater within the Gault Formation (Secondary-A Aquifer) and the Zig Zag Chalk Formation bedrock (Principal Aquifer).
CW Pollutant Linkage No. 2	Impacted Groundwater (above URS Stage 2 CW GAC)	- Horizontal migration of impacted groundwater. - Vertical migration of impacted groundwater.	Groundwater within the Gault Formation (Secondary-A Aquifer) and the Zig Zag Chalk Formation bedrock (Principal Aquifer).

Based on the primary receptor of concern, the Zig Zag Chalk, Drinking Water Standards (DWS) have been selected as the appropriate screening criteria for the assessment.

6.3. Human Health CSM

Sources, pathways and receptors relevant to the Stage 3 human health (HH) DQRA receptors are summarised in Table L below:

Table L – Overview of HH Sources, Pathways and Receptors

Potential Source(s)	Potential Pathway(s)	Potential Receptor(s)
No soil or groundwater source identified at Stage 2.	Inhalation of vapours (indoor and outdoor)	On site workers during future construction

Key observations with regard to viable pollutant linkages at the subject site are as follows:

- Areas of exposed soils were not identified at the subject site. Therefore, assuming continued use as a CPU and retention of the current layout, exposure to COPC via dermal contact, dust and/or ingestion is considered unlikely.

Reported concentrations of COPC in soils and groundwater were not reported above the Stage 2 CPU or Residential GAC. As such, Stage 3 HH DQRA modelling was not undertaken.

6.4. Summary of Modelled Pollutant Linkages

Potentially viable Controlled Waters and Human Health pollutant linkages modelled as part of this assessment are presented on Figure 4 and summarised in Table M below:

Table M – Modelled Pollutant Linkages			
Assessment	Source	Pathway(s)	Receptor
CW Pollutant Linkage No. 1	Impacted Soils (above URS Stage 2 CW GAC)	• Partitioning between soil and pore water • Infiltration of impacted pore water down to the saturated zone (water table) • Dilution of impacted pore water within the saturated zone • Horizontal migration of impacted groundwater	• Groundwater within the Gault Formation (Secondary-A Aquifer) and the Zig Zag Chalk Formation (Principal Aquifer).
CW Pollutant Linkage No. 2	Impacted groundwater (above URS Stage 2 CW GAC)	• Horizontal migration of impacted groundwater. • Vertical migration of impacted groundwater.	

7. STAGE 3 DQRA

7.1. Introduction

Groundwater in the superficial deposits (Secondary-A Aquifer) and Chalk (Principal Aquifer) beneath the site is considered to be the most sensitive receptor. Horizontal migration of COPC in the Secondary-A aquifer and vertical migration of COPC into the Principal Aquifer have been modelled separately.

An arbitrary compliance point of 50m has been selected to be protective of the underlying Secondary A aquifer based on the draft guidance issued by the Environment Agency, 'Selecting Compliance Points for use in Land Contamination Risk Assessments', which states that 'the distance to a set compliance point *should not* exceed 50m for hazardous substances'. An additional compliance point within the aquifer of 250m has been selected which is considered to be protective of the Bearton Pond and River Oughton.

A compliance point of 0m has been set to model vertical migration of COPC into the underlying Principal aquifer. The model has been simulated to assume that groundwater in the superficial deposits is in continuity with the Principal Chalk aquifer.

Results of the Stage 3 CW DQRA are presented and discussed below.

Outputs from the Stage 3 CW model are presented in **Appendix G**. Soil and groundwater data are presented with the applicable SSAC in **Appendix A Tables 3 - 6**.

7.2. Stage 3 Controlled Waters DQRA Results

Table N – Summary of Stage 3 CW DQRA Results							
Linkage No.	Source	Receptor	Metals	BTEX	Oxyg-enates*	PAH	TPH
CW Pollutant Linkage No. 1	Impacted Soils (above URS Stage 2 CW GAC)	Secondary A aquifer (superficial deposits)	x	x	x	x	x
CW Pollutant Linkage No. 2	Impacted Groundwater (above URS Stage 2 CW GAC)	Secondary A aquifer (superficial deposits)	x	✓	x	✓	x
CW Pollutant Linkage No. 1	Impacted Soils (above URS Stage 2 CW GAC)	Principal aquifer (Chalk)	x	x	x	x	x
CW Pollutant Linkage No. 2	Impacted Groundwater (above URS Stage 2 CW GAC)	Principal aquifer (Chalk)	x	✓	x	x	x

Note

* - Includes MtBE, ETBE, DIPE, TBA, TAME and Ethanol.

N/A - not modelled as no risks generated at Stage 2

x - Significant risk not identified.

✓ - Potentially significant risk identified.

The following COPC and/or COPC groups were simulated by the Stage 3 CW DQRA model to present a theoretical risk to the identified CW receptors:

7.3. Soils – Horizontal migration in the superficial deposits (Secondary-A aquifer)

Of the COPC groups assessed, naphthalene, arsenic and cobalt were simulated to present a theoretical risk to the Secondary-A aquifer at a 50m compliance point.

Naphthalene simulated a theoretical risk to the Secondary-A aquifer after 10 years and was reported at concentrations above the Stage 3 criteria in shallow soil samples collected and analysed from BH105 (0.6m bgl) and BH106 (0.5m bgl). The greatest exceedance was reported in BH106 located approximately 5m west of the tank farm at a concentration of 4.2 mg/kg which exceeded the SSAC of 0.944 mg/kg by a factor of 4.5. For the soil data, the Stage 3 criteria were based on the 95th percentile or 'worst-case' scenario. If the 50th percentile or 'most-likely' scenario or the 80th percentile is applied, no exceedances remain.

Arsenic and cobalt were simulated to exceed their respective Water Target Values (WTVs) after 10,000 and 1,000 years following the start of the simulation. Hazard Indices were calculated at 1.01 for arsenic and 6.08 for cobalt. On the basis of travel time, arsenic and cobalt are not considered to represent a significant risk. It should be noted that with respect to simulated controlled waters exceedances for heavy metals, the model typically over estimates leaching of inorganics from soil.

7.4. Soils – Vertical migration into the Chalk (Principal Aquifer)

No risks were simulated from soil sources to the underlying Principal Chalk aquifer at a 0m compliance point.

7.5. Groundwater – Horizontal migration in the superficial deposits (Secondary-A Aquifer)

Of the COPC groups assessed, groundwater concentrations of benzene⁴, TPH Aromatics <C5-C7 and naphthalene from BH102 were simulated to present a theoretical risk at the 50m compliance point protective of the aquifer at a 95% confidence level.

For benzene WTV exceedances are simulated to occur within one year at the 50m compliance point, with steady state concentrations within ten years. At 95% confidence the Hazard Index (HI) at the 50m compliance point at steady state was calculated at 152. At the 50th percentile ('most likely'), the model simulated concentrations of benzene of 13.7 µg/l at the 50m compliance point with an HI of 13.7. Simulated concentrations of benzene (including C5-C7 aromatics) at 200m exceeded the WTV, but by 250m the simulated concentration of 0.46 µg/l, did not exceed the WTV of 1 µg/l.

⁴ Also includes TPH aromatics <C5-C7 (benzene) exceedances in the model output.

Naphthalene was simulated to exceed its WTV after ten years from the start of the simulation with steady state concentrations within 50 years. At a 95% confidence level the Hazard Index (HI) at the 50m compliance point at steady state was calculated at 2.29 µg/l which exceeded the WTV of 1µg/l. Simulated concentrations of naphthalene did not exceed the WTV by 75m.

It has been assumed that the aquifer is aerobic based on the geology, depth to groundwater, ferrous iron, nitrate and sulphate concentrations and field groundwater measurements.

Outputs from the Stage 3 CW DQRA model including CWHI and SSAC are presented in Appendix G.

7.6. Groundwater – Vertical migration into the Chalk (Principal aquifer)

Of the COPC groups assessed, groundwater concentrations of benzene were simulated to present a theoretical risk to the Principal Chalk aquifer at a 95% confidence level.

Simulated concentrations of benzene following dilution in the Principal Aquifer directly beneath the site were 7.18 µg/l, and at the 50m compliance point 2.17 µg/l with an associated Hazard Index of 2.17. This assessment assumes that the groundwater at BH02 is in continuity with groundwater in the Principal Aquifer and is based on a number of assumptions about the groundwater flow in the Chalk in the absence of site specific data.

8. CONCLUSIONS

Boreholes on the eastern site boundary were advanced to a maximum depth of 9.0m bgl at the site into the superficial deposits of the Lowestoft Formation classified by the Environment Agency as unproductive strata. These boreholes encountered groundwater between 7.3m bgl and 7.6m bgl. Chalk was encountered at the western side of the site in BH105 and BH106 at depths of 5.3m bgl. Monitoring wells were installed into the overlying superficial deposits, and did not contain groundwater. Due to the location of the boreholes which contained water, it was not possible to calculate an inferred groundwater flow at the site. However, regional topography suggests that underlying groundwater flow is to the north east.

The principal controlled waters receptor for the site is the underlying Zig Zag Chalk Principal Aquifer and Superficial Deposits that border the site boundary. Other potential receptors include surface water features in the vicinity of the site which consist Bearton Pond approximately 200m north of the site, and the River Oughton, the River Purwell, and River Hiz, located greater than 1km north/north-east of the site.

Phase separate hydrocarbons (PSH) or visual evidence of soil staining were not identified at the site, however mild hydrocarbon odours and a slight sheen was noted on groundwater samples collected from BH102.

Suggested potential source areas identified by the current CSM consist of seven known operational USTs at the site located south of the pump islands which date back to 1970, a three stage interceptor located near the north-eastern corner of the site. Underground drainage and fuel pipelines and accidental releases at below ground off-set fill points and fuel pumps.

The principal conclusions of the ESA and Controlled Waters DQRA are summarised below:

- No significant risks to human health (on site workers or off-site residents) were identified.
- Shallow soil concentrations of naphthalene exceeded the human health high density residential GAC at BH105 and BH106 located in close proximity to the fuel dispensers, and groundwater concentrations of benzene and TPH exceeded the exceeded the human health high density residential GAC at BH102 located approximately 5m east of the tank farm. Potential risks to human health for naphthalene, benzene and TPH is likely to be driven by inhalation of volatile vapours. Given the distance to the nearest residential receptor, depth to groundwater and site specific TOC concentrations these exceedances of the GAC are not considered significant.
- Vapour analytical data collected from three areas of the site in October 2011 were compared with URS GAC protective of human health for a high density residential scenario. No COPC were reported above the relevant human health GAC suggesting the theoretical risk from soil and groundwater is not significant.

- Potentially unacceptable risks to groundwater in the underlying superficial deposits were identified from reported concentrations of benzene, TPH Aromatics <C5-C7 and naphthalene in groundwater at a 50m compliance point. The 50m compliance point was selected based on the hazardous classification of these substances, the presence of the Principal Aquifer beneath the superficial deposits and the uncertainty in groundwater flow direction and gradient.
- Potentially unacceptable risks to groundwater in the underlying Chalk Principal aquifer were identified from reported concentrations of benzene at a 50m compliance point, however this assessment is based on a number of assumptions in the absence of site specific data.

9. REFERENCES

- Reference 1** GeoDelft. Tier 1 Report: Soil Gas Survey – Shell Hitchin. May 1999.
C1402.SG474.8008
- Reference 2** URS, Phase 1 Environmental Site Investigation - Shell Hitchin. October 2011.
R46370079-001

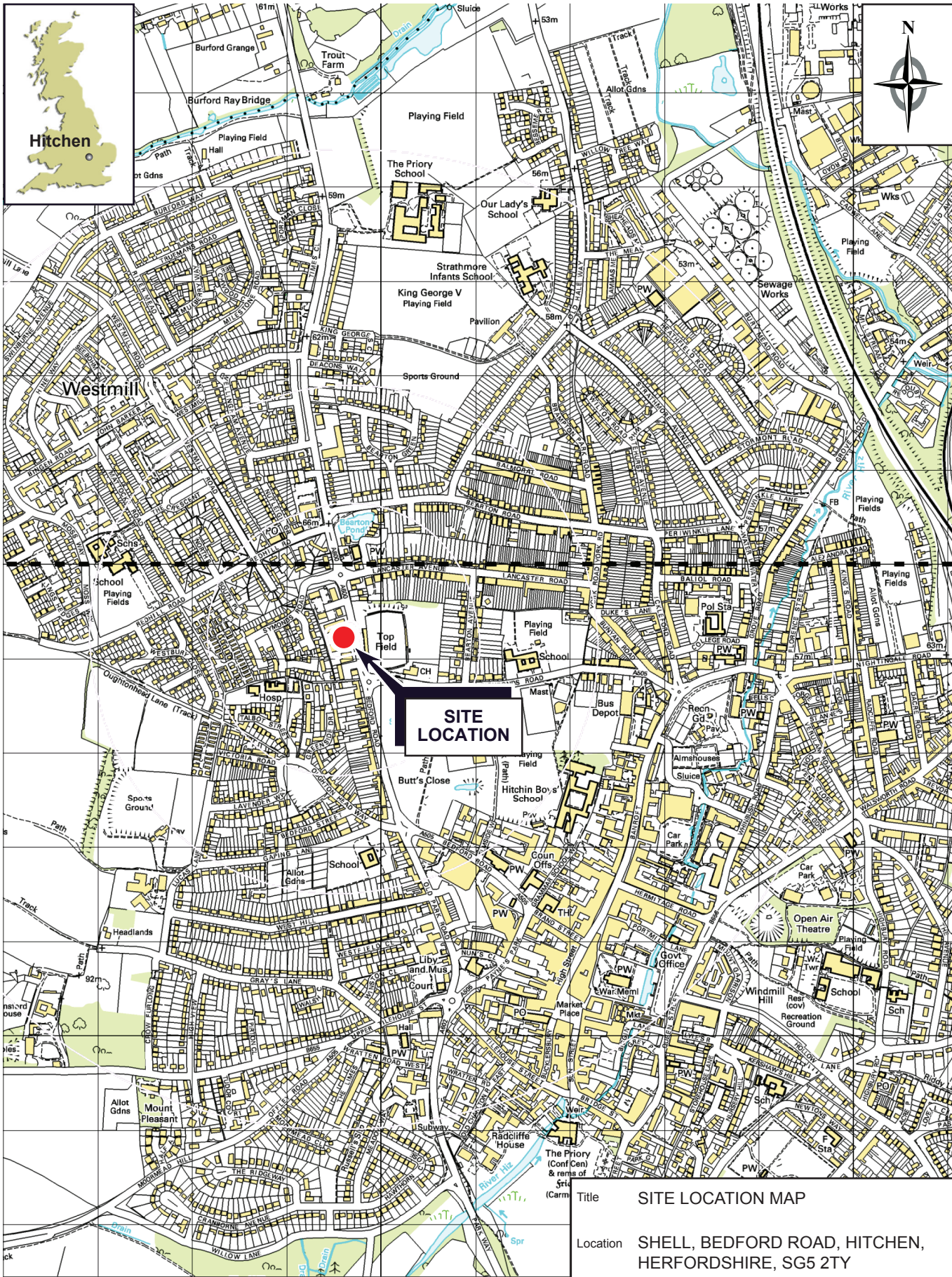
Figures

Figure 1 – Site Location Map

Figure 2 – Site Features Plan

Figure 3 – Potentiometric Surface Map

Figure 4 – Conceptual Site Model



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Title SITE LOCATION MAP

Location SHELL, BEDFORD ROAD, HITCHEN, HERFORDSHIRE, SG5 2TY

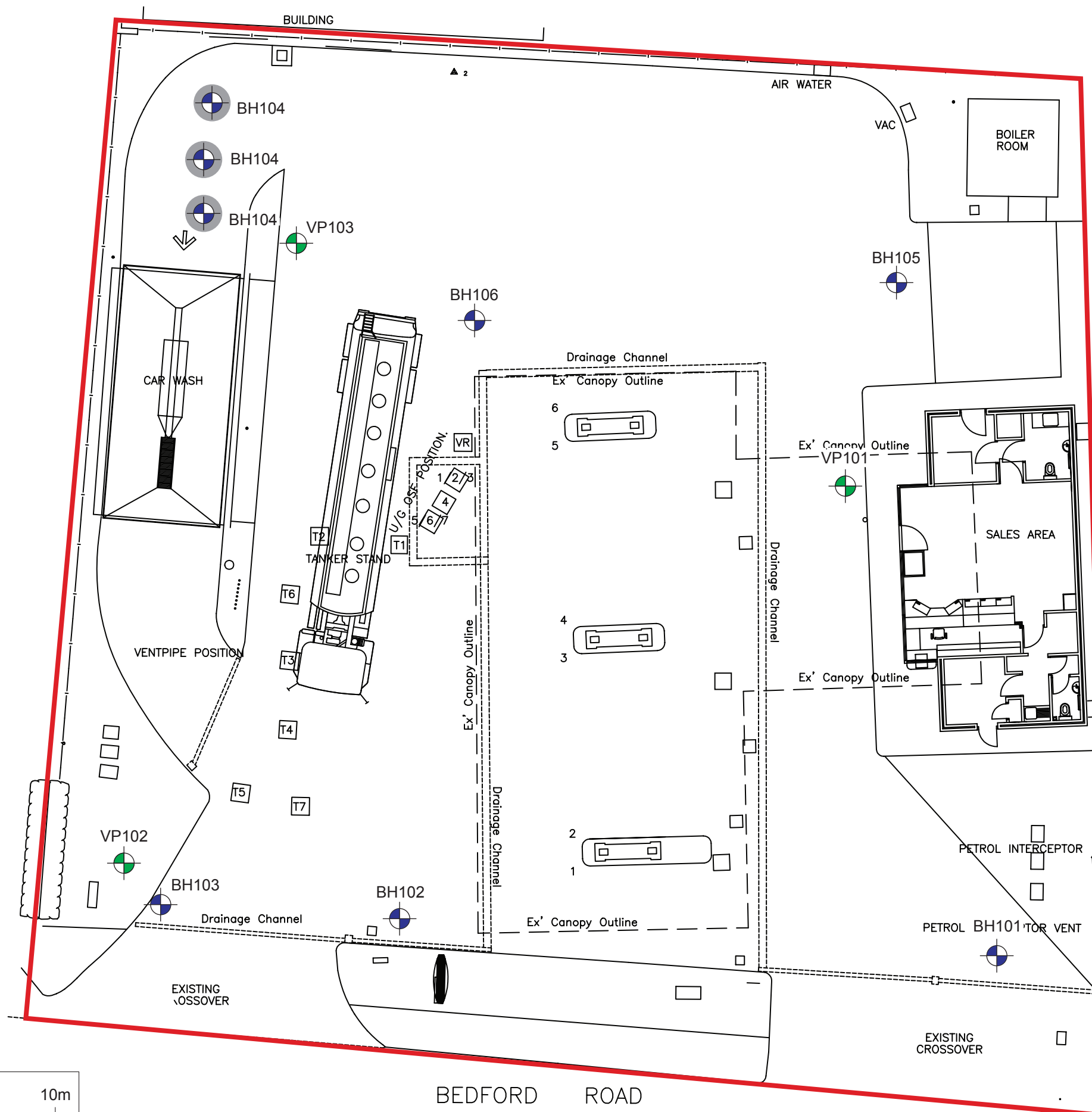
Client SHELL UK OIL PRODUCTS LTD



App'd: BS	Drawn: BS	TI Ch'kd: LCH	Drg.Size: A4
Status: DRAFT	Ref: BS/LON/LCH/CFD		
Scale: AS SHOWN	Job No: 46370079		
Date: SEPT 2011	FIGURE 1		



- KEY
- SITE BOUNDARY
 - BOREHOLE LOCATION
 - BOREHOLE LOCATION (REFUSALS)
 - VAPOUR WELL LOCATION



CONSULTING ENGINEERS

URS

Scott
Wilson

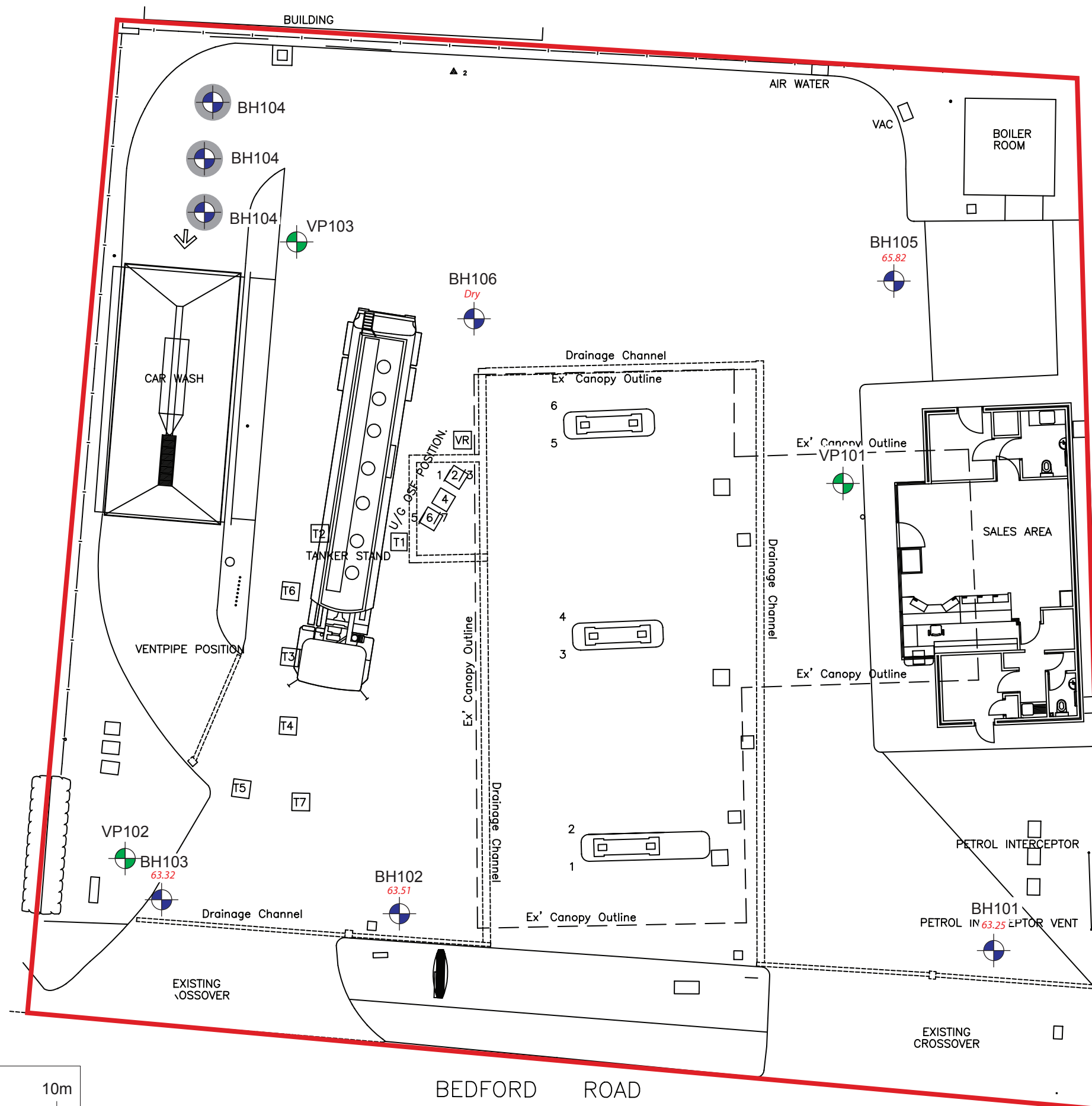
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TEL - 020 8944 3300 FAX - 020 8944 3301

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STAINES
TW18 3ZB

PROJECT
SHELL, BEDFORD ROAD, HITCHEN,
HERFORDSHIRE, SG5 2TY

DRAWING TITLE
FIGURE 2 - SITE FEATURES & BOREHOLE LOCATION
PLAN

DRAWN LCH	TRACED LCH	CHECKED BS	APPROVED BS	DATE OCT 2011
SCALE NTS	DRG NO. 46370079 / FIGURE 2			REV.



KEY

■ SITE BOUNDARY



BOREHOLE LOCATION



POTENTIOMETRIC SURFACE
BOREHOLE LOCATION (REFUSALS)
LEVEL



VAPOUR WELL LOCATION

CONSULTING ENGINEERS



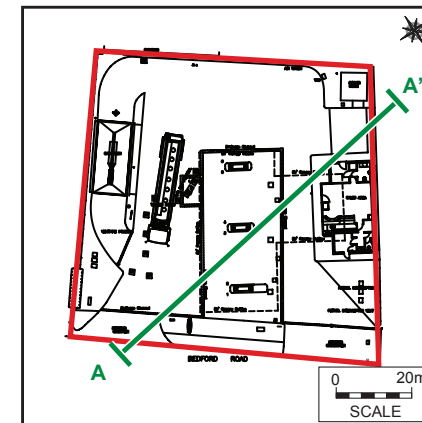
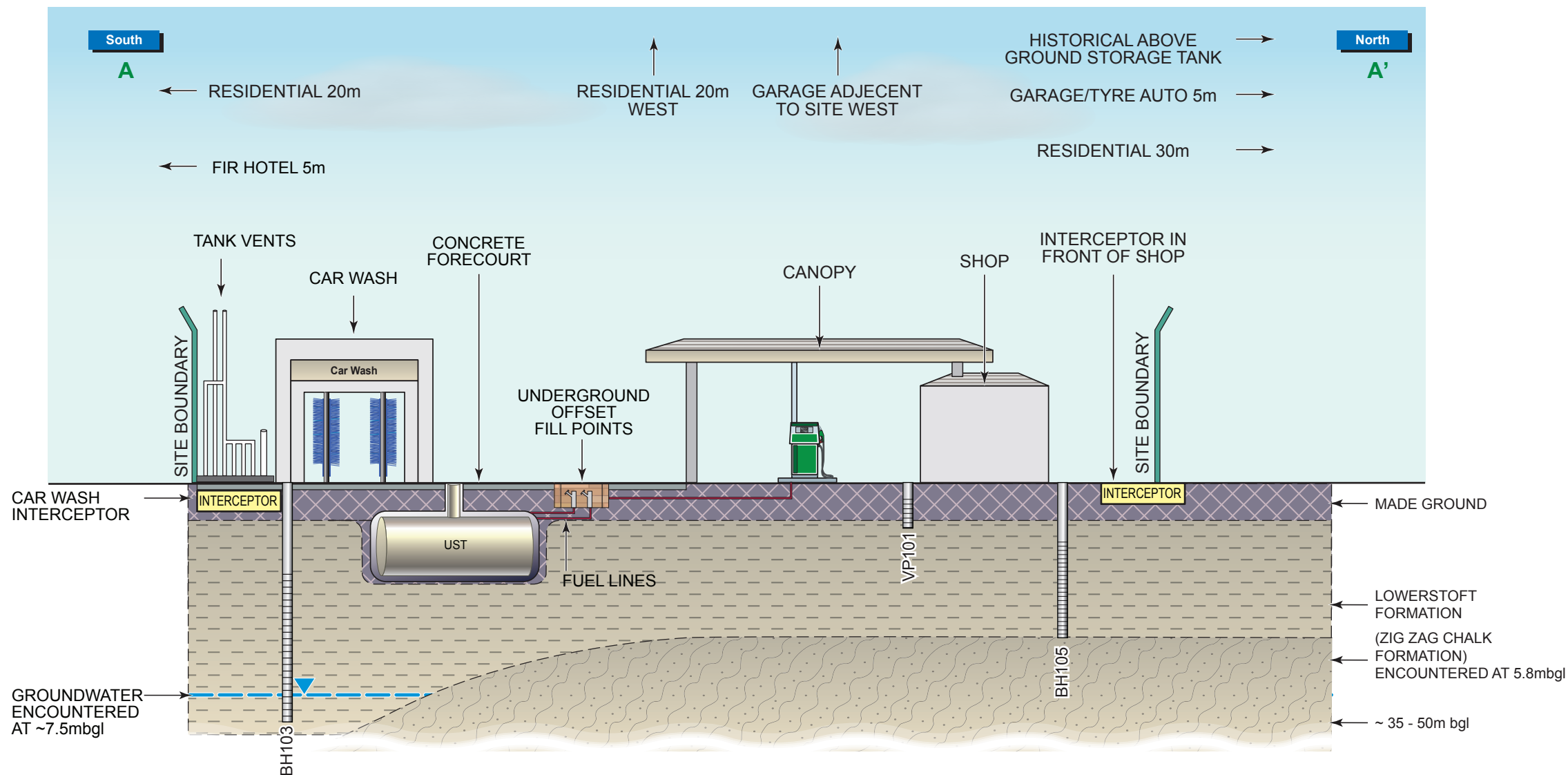
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DRAWING TITLE
FIGURE 3 - POTENTIOMETRIC SURFACE MAP

DRAWN LCH	TRACED LCH	CHECKED BS	APPROVED BS	DATE OCT 2011
SCALE NTS	DRG NO. 46370079 / FIGURE 3			REV.



AREA OF POTENTIAL CONCERN

On-site

Historical

- Historical use of the site as a petrol filling station since 1970.
- Leaking and joints were noted during an inspection of the pumps and pipework by the Petroleum Officer in October 1986.
- A leak on pump 8/9 noted by the Petroleum Officer in January 1991.

Current

- Operational underground storage tanks (URSSW understands there are no historic / decommissioned storage tanks on-site).
- Accidental releases to ground from off-set fill points, located to the south of the forecourt.
- Accidental releases to ground from dispenser pumps: 3 car fuel islands under the canopy and cracks in concrete surface of the forecourt.
- Accidental releases from fuel lines: Present between the tanks, offset fill points and fuel islands.
- Site interceptors (main forecourt interceptor located at the north east of the site, and interceptor associated with the car wash at the south of the site) and associated drainage lines.
- Drainage from the car wash.

Off-site

Historical

- An Aboveground Storage Tank (AST) associated with a warehouse is shown approximately 30m north of the site boundary.
- Garage (later shown as depot) approximately 5m north of the site boundary.
- Current
- Garage adjacent to the site boundary at the west of the site.
- Tyre Centre/Garage approximately 5m north of the site boundary.

CHEMICALS OF POTENTIAL CONCERN

Historical sources of contamination

- Metals – arsenic, boron, cadmium, chromium, cobalt, copper, lead, mercury, molybdenum, nickel, selenium and zinc.
- VOCs

Current Potential On-site Sources

- TPH - Petroleum hydrocarbons.
- BTEX- Benzene, toluene, ethylbenzene and xylenes.
- Petroleum Additives- Methyl tertiary butyl ether (MTBE) and tertiary amyl methyl ether (TAME).
- PAHs- Polycyclic aromatic hydrocarbons.
- Metals – arsenic, boron, cadmium, chromium, cobalt, copper, lead, mercury, molybdenum, nickel, selenium and zinc.

POTENTIAL PATHWAYS

Human Health

- Vapours – Migration of vapours through made ground to above ground buildings.
- Particulate – Ingestion, inhalation, dermal contact, with soil particulates.
- Permeation – Migration of hydrocarbon substances through plastic potable water supply pipes.

Controlled Waters

- Leaching – Migration of hydrocarbon substances from soils into shallow (and potentially deep) aquifers.
- Migration of impacted perched water into shallow (and potentially deep) aquifers

POTENTIAL RECEPTORS

Human Health

- Shop staff.
- The general public and visiting staff (such as contractors, including those conducting excavation works).
- Workers in the garage adjacent to the east of the site, tyre centre approximately 5m north of the site and workers and guests at the Fir Hotel approximately 5m south of the site.
- Occupants of residential properties approximately 30m north and south of the site and 20m to the west of the site

Controlled Waters

- Groundwater within the Superficial Deposits on-site (Potentially a Secondary A Aquifer).
- Groundwater within the Zig Zag Chalk Formation (Principal Aquifer).

Human Health

- Potentially impacted shallow soils / groundwater, followed by vapour migration to on-site workers within the shop area and off-site workers to the north and east of the site.
- Potentially impacted shallow soils / groundwater, followed by permeation through plastic pipes into the site potable water supply.

Controlled Waters

- Potentially impacted shallow soils / groundwater, followed by vertical migration into the shallow groundwater within the shallow Drift Deposits that border the site, and potentially deeper groundwater in the underlying Zig Zag Chalk Formation Principal Aquifer
- Potentially impacted shallow soils / groundwater: migration of chemicals of potential concern (COPC) from soils into shallow groundwater.

COMPLETE POLLUTANT LINKAGES:

- Horizontal migration of impacted groundwater.
- Vertical migration of impacted groundwater

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DRAWING TITLE
FIGURE 4 - CONCEPTUAL SITE MODEL

DRAWN LCH	TRACED LCH	CHECKED BS	APPROVED BS	DATE NOV 2011
SCALE NTS	DRG NO. 46370079 / FIGURE 4	REV.		

Appendix A - Tables

Table 1 – Groundwater Elevations and Quality Measurements

Table 2 – Landfill Gas Monitoring Summary

Table 3 – Soil Analytical Results with Stage 3 Horizontal Migration SSAC

Table 4 – Soil Analytical Results with Stage 3 Vertical Migration SSAC

Table 5 – Groundwater Analytical Results with Stage 3 Horizontal Migration SSAC

Table 6 – Groundwater Analytical Results with Stage 3 Vertical Migration SSAC

Table 7 – Soil Vapour Analytical Results with CPU GAC

Table 8 – Soil Vapour Analytical Results with HDR GAC

Table 9 – Potable Water Analytical Results with DWS

TABLE 1
GROUNDWATER ELEVATIONS AND QUALITY MEASUREMENTS

Site	Shell Hitchin
Sample Round	Oct-11
Sample Date	12 October 2011

Borehole	Screened Section ¹	Depth to base (mb TOC)	Depth to product (mb TOC)	Depth to water (mb TOC)	Borehole elevation (m AAD)	Groundwater elevation (m AAD)	Sample Date	Purge Volume (l)	pH	Temperature (°C)	Conductivity (mS/cm)	ORP (mV)	ORP (mV) Corrected	Dissolved Oxygen (mg/L)	Comments
BH101	7.5 - 9.0	8.72	-	7.615	70.860	63.245	12/10/2011	3	6.6	15.8	990	-105.7	111.3	2.07	Orange, turbid with slight odour and sheen
								4	6.62	15.9	960	-109.4	107.6	1.95	
								5.5	6.6	15	920	-107.5	109.5	3.37	
								9	6.59	15.1	927	-104.3	112.7	3.63	
BH102 (DUP02)	7.5 - 9.0	8.04	-	7.320	70.830	63.510	12/10/2011	2	6.51	15.10	827	-115.6	101.4	0.89	Orange, turbid with odour. Slow recharge
								3.5	6.63	15.10	809	-125.2	91.8	0.70	
								5.5	6.76	15.10	778	-129.4	87.6	0.58	
								6.5	6.77	15.80	791	-134.7	82.3	0.58	
BH103	7.5 - 9.0	8.40	-	7.460	70.780	63.320	12/10/2011	2	6.34	14.60	581	-20.6	196.4	6.30	Orange colour, very slow recharge. NVO
								5	6.55	14.60	581	-24.7	192.3	5.24	
								7	6.54	14.60	581	-77.1	139.9	5.11	
BH105	3.3 - 5.3	5.23	-	5.210	71.030	65.820	12/10/2011	-	-	-	-	-	-	-	Borehole was reported as dry,
BH106	3.0 - 5.0	4.66	-	DRY	70.980	DRY	12/10/2011	-	-	-	-	-	-	-	Borehole was reported with insufficient water to sample.

Legend

°C - degrees celsius
L - Litres
m AAD - metres Above Arbitrary Datum
NVO - no visible or olfactory evidence of impact

mb TOC - metres below Top of Casing
mg/L - milligrams per litre
mS - milli siemens
mV - milli volts

ORP - Oxidation Reduction Potential
pH - potential of Hydrogen (dimensionless)

Notes

Borehole elevations were measured to mAOD by URS subcontractor Glover GB.

TABLE 2
LANDFILL GAS MONITORING SUMMARY

Site	Shell Hitchin
Sample Round	Oct-11
Sample Date	13/10/2011

Sample Location	Sample Date	Sample Tube ID	PID Reading (ppm)		Atmospheric Pressure	Methane (CH ₄) %v/v		Methane (CH ₄) %LEL		Carbon Dioxide (CO ₂) %v/v		Oxygen (O ₂) % v/v		Sample Time (minutes)	Sample rate
			pre-purge	post-purge		Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady		
VP101	13/10/2011	15	<0.1	<0.1	1018	<0.1	<0.1	<0.1	<0.1	0.7	0.7	19.2	19	60	50ml/min
VP102	13/10/2011	4823	<0.1	<0.1	1018	<0.1	<0.1	<0.1	<0.1	0.6	0.6	20.5	20.3	60	50ml/min
VP103	13/10/2011	7459	<0.1	<0.1	1018	<0.1	<0.1	<0.1	<0.1	0.4	0.4	20.3	20.3	60	50ml/min
ambient	13/10/2011	27	<0.1	<0.1	1018	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	21.3	21.3	62	50ml/min

Legend

ppm = parts per million
L/min = litres per minute
LEL = lower explosive limit
>>> = reading over range

TABLE 3 -
SOIL ANALYTICAL RESULTS WITH STAGE 3 HORIZONTAL MIGRATION SSAC

Stage2 Human Health GAC	Human Health High Density Residential
Stage2 Controlled Waters GAC	Low fcc <1% DWS
Sample Round	Hitchin October 2011
Site	Hitchin

					BH101		BH102		BH103		BH105		BH106		UP101	VP102	VP103
					0.8	0.5	0.8	2.7	1	3.2	0.6	4.1	0.5	3.9	0.6	0.4	0.7
Chem Class	Analyte	HH	CW	Units	27/09/2011	03/10/2011	27/09/2011	30/09/2011	27/09/2011	29/09/2011	27/09/2011	29/09/2011	28/09/2011	04/10/2011	28/09/2011	27/09/2011	26/09/2011
BTEX	BENZENE	0.0928	0.0649	mg/kg	ND	ND	ND	ND	ND	ND	0.00222	ND	ND	ND	ND	ND	ND
	222	IR		mg/kg	ND	ND	ND	ND	ND	ND	0.0113	ND	ND	ND	ND	ND	ND
	ETHYLBENZENE	60.1	IR	mg/kg	ND	ND	ND	ND	ND	ND	0.00792	ND	ND	ND	ND	ND	ND
	M_P_XYLENE	19.7	IR	mg/kg	ND	ND	ND	ND	ND	ND	0.0163	ND	ND	ND	ND	ND	ND
	O_XYLENE	21.1	IR	mg/kg	ND	ND	ND	ND	ND	ND	0.0139	ND	ND	ND	ND	ND	ND
METALTOT	TOTAL ARSENIC	NP	21.6	mg/kg	19.6	NT	NT	NT	21.9	NT	21.2	NT	13.9	NT	NT	NT	NT
	TOTAL BORON	NP	35.1	mg/kg	10.4	NT	NT	NT	10.7	NT	13.6	NT	9.31	NT	NT	NT	NT
	TOTAL CADMIUM	NP	1.75	mg/kg	0.751	NT	NT	NT	0.875	NT	0.779	NT	0.367	NT	NT	NT	NT
	TOTAL CHROMIUM	NP	IR	mg/kg	31.1	NT	NT	NT	22.9	NT	22	NT	17.5	NT	NT	NT	NT
	TOTAL COBALT	NP	1.73	mg/kg	10.5	NT	NT	NT	7.58	NT	6.19	NT	5.63	NT	NT	NT	NT
	TOTAL COPPER	NP	701	mg/kg	18	NT	NT	NT	15	NT	106	NT	13.8	NT	NT	NT	NT
	TOTAL HEXAVALENT_CHROMIUM	NP	IR	mg/kg	ND	NT	NT	NT	ND	NT	ND	NT	ND	NT	NT	NT	NT
	TOTAL LEAD	NP	IR	mg/kg	15.2	NT	NT	NT	24	NT	128	NT	37.1	NT	NT	NT	NT
	TOTAL MERCURY	NP	IR	mg/kg	ND	NT	NT	NT	ND	NT	ND	NT	ND	NT	NT	NT	NT
	TOTAL MOLYBDENUM	NP	1.4	mg/kg	0.217	NT	NT	NT	ND	NT	0.294	NT	ND	NT	NT	NT	NT
	TOTAL NICKEL	NP	43.3	mg/kg	37.5	NT	NT	NT	25.4	NT	25.3	NT	17.1	NT	NT	NT	NT
	TOTAL SELENIUM	NP	IR	mg/kg	ND	NT	NT	NT	ND	NT	ND	NT	ND	NT	NT	NT	NT
	TOTAL TIN	NP	IR	mg/kg	ND	NT	NT	NT	0.817	NT	12.2	NT	0.89	NT	NT	NT	NT
	TOTAL ZINC	NP	663	mg/kg	81.3	NT	NT	NT	230	NT	200	NT	85.9	NT	NT	NT	NT
MISC	Total Organic Carbon	(blank)	(blank)	%	0.371	0.438	0.334	ND	0.746	0.288	2.09	ND	0.702	ND	1.23	0.766	1.87
	TEMPERATURE	(blank)	(blank)	°C	22.9	21.2	NT	NT	20.6	21.1	20.6	21.2	21.2	21.4	NT	NT	NT
PAH	Acenaphthene	>Sat	IR	mg/kg	0.179	NT	NT	NT	0.0115	NT	5.89	NT	20.9	NT	NT	NT	NT
	Acenaphthylene	>Sat	IR	mg/kg	ND	NT	NT	NT	0.0609	NT	1.76	NT	1.29	NT	NT	NT	NT
	Anthracene	>Sat	IR	mg/kg	0.09	NT	NT	NT	0.0667	NT	11.8	NT	17.8	NT	NT	NT	NT
	BENZO_A_ ANTHRACENE	>Sat	IR	mg/kg	0.0883	NT	NT	NT	0.432	NT	23.4	NT	14.8	NT	NT	NT	NT
	BENZO_A_PYRENE	>Sat	IR	mg/kg	0.077	NT	NT	NT	0.554	NT	23.9	NT	13.6	NT	NT	NT	NT
	BENZO_B_FLUORANTHENE	>Sat	IR	mg/kg	0.0938	NT	NT	NT	0.79	NT	26.7	NT	16.2	NT	NT	NT	NT
	BENZO_G_H_I_PERYLENE	>Sat	IR	mg/kg	0.0489	NT	NT	NT	0.467	NT	13.7	NT	6.88	NT	NT	NT	NT
	BENZO_K_FLUORANTHENE	>Sat	IR	mg/kg	0.0426	NT	NT	NT	0.339	NT	9.62	NT	5.79	NT	NT	NT	NT
	Chrysene	>Sat	IR	mg/kg	0.0748	NT	NT	NT	0.481	NT	17.3	NT	12.4	NT	NT	NT	NT
	DIBENZ_A_H_ ANTHRACENE	>Sat	IR	mg/kg	ND	NT	NT	NT	0.0957	NT	3.44	NT	1.86	NT	NT	NT	NT
	Fluoranthene	>Sat	IR	mg/kg	0.211	NT	NT	NT	0.851	NT	55.6	NT	53.9	NT	NT	NT	NT
	Fluorene	>Sat	IR	mg/kg	0.127	NT	NT	NT	0.0129	NT	6.7	NT	17.7	NT	NT	NT	NT
	INDENO_1_2_3_CD_PYRENE	>Sat	IR	mg/kg	0.0398	NT	NT	NT	0.358	NT	11.7	NT	5.78	NT	NT	NT	NT
	Naphthalene	0.599	0.944	mg/kg	ND	NT	NT	NT	0.0201	NT	3.08	NT	4.2	NT	NT	NT	NT
	Phenanthrene	>Sat	IR	mg/kg	0.298	NT	NT	NT	0.241	NT	35.6	NT	62.7	NT	NT	NT	NT
	Pyrene	>Sat	IR	mg/kg	0.168	NT	NT	NT	0.735	NT	46.5	NT	41.8	NT	NT	NT	NT
	TOTAL PAH	(blank)	(blank)	mg/kg	1.54	NT	NT	NT	5.52	NT	297	NT	297	NT	NT	NT	NT
RISKTPH	RISK TPH C6_C7_AROM	92	IR	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	RISK TPH C7_C8_AROM	222	IR	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	RISK TPH C8_C10_AROM	12.9	IR	mg/kg	ND	ND	ND	ND	ND	ND	0.311	ND	0.252	ND	ND	ND	0.0285
	RISK TPH C10_C12_AROM	70.6	IR	mg/kg	0.0131	ND	ND	ND	ND	ND	0.301	ND	0.365	ND	ND	ND	0.0161
	RISK TPH C12_C16_AROM	>Sat	IR	mg/kg	8.16	7.32	9.82	3.51	1.6	19.8	52.4	ND	16.5	2.92	3.6	1.41	36.7
	RISK TPH C16_C21_AROM	>Sat	IR	mg/kg	12.8	4.9	10.1	1.73	5.68	101	271	ND	65	2.58	35.7	2.27	115
	RISK TPH C21_C35_AROM	>Sat	IR	mg/kg	32.1	7.07	43.8	0.692	28.1	175	641	ND	183	6.11	146	18.4	616
	RISK TPH C5_C6_ALI	14	IR	mg/kg	ND	ND	ND	ND	ND	ND	0.0203	ND	ND	ND	ND	ND	ND
	RISK TPH C6_C8_ALI	30.7	IR	mg/kg	0.0107	ND	ND	ND	ND	ND	0.148	ND	0.052	ND	ND	ND	ND
	RISK TPH C8_C10_ALI	7.46	IR	mg/kg	0.0107	ND	ND	ND	ND	ND	0.357	ND	0.378	ND	ND	ND	0.0422
	RISK TPH C10_C12_ALI	36.4	IR	mg/kg	0.019	ND	ND	ND	ND	ND	0.451	ND	0.547	ND	ND	ND	0.0248
	RISK TPH C12_C16_ALI	>Sat	IR	mg/kg	7.25	17.6	23.3	6.66	2.48	77.7	24.5	7.29	8.93	2.57	8.07	2.46	13.8
	RISK TPH C16_C21_ALI	>Sat	IR	mg/kg	5.31	7	11.9	6.37	2.87	223	44.1	5.6	21.6	2.15	15.8	2.73	27.3
	RISK TPH C21_C35_ALI	>Sat	IR	mg/kg	12.3	7.79	38.4	1.08	12.5	303	411	ND	125	6.64	117	16.1	359
	RISK TPH C35_C44_ALI	>Sat	IR	mg/kg	3.13	1.42	17.6	ND	2.43	86.8	160	ND	83.9	1.49	72.7	3.53	438
	TPH_STAGE2_HI	1	(blank)	ratio	0.038874	0.0712508	0.0933111	0.0301831	0.0617843	0.1081551	0.2406315	0.028008	0.1447994	0.016138	0.0360549	0.0138464	0.1030854
VOC	DIPE	1.52	0.00484	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	ETHANOL	(blank)	0.584	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	MTBE	23.5	0.00302	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	TAME	0.738	0.00517	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
		11700	(blank)	µg/l	ND	ND	NT	NT	ND	ND	ND	ND	ND	ND	NT	NT	NT
	TBA	111	0.00164	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	ETBE	2.31	0.00507	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MISC_CEN21	PH	(blank)	(blank)	pH Units	8.64	8.43	NT	NT	8.6	8.46	9.18	8.61	9.71	6.84	NT	NT	NT
	CONDUCTIVITY	(blank)	(blank)	µS/cm	400	756	NT	NT	415	227	466	274	468	190	NT	NT	NT
VOCSURR	TOLUENE_D8	(blank)	(blank)	%	100	97.6	97.5	NT	98.6	104	90.2	104	101	99	103	98.8	94.5

XX	Exceeds Human Health & Controlled Waters
XX	Exceeds Human Health Criteria
XX	Exceeds Controlled Waters Criteria

CSM / Assumptions:
Soil 1% SOM (0.58% TOC)
Soil properties for "sand"
Commercial site area 0.5ha
Soil gas ingress rates calculated by model
Infinite groundwater source at 1m.bgl for groundwater GAC
High density residential assume vapour exposure pathways only
CPU scenario modified from modelled commercial scenario by:
Building dimensions (l x w x h): 14m x 6.5m x 2.4m
Differential pressure: 2.6 pascals
Only vapour exposure pathways considered viable
Derived November 2010 using Human7.1 Issue9. MTF.

ND: Not detected above MDL
HH: Human Health
GAC: Generic Assessment Criteria
(blank): No criteria
NP: No pathway
>Sat: Unacceptable risk not achieved due to calculated saturation of vapour pathway
NT: Not tested

TABLE 4 -
SOIL ANALYTICAL RESULTS WITH STAGE 3 VERTICAL MIGRATION SSAC

Stage2 Human Health GAC	Human Health High Density Residential
Stage2 Controlled Waters GAC	Low foc <1% DWS
Sample Round	Hitchin October 2011
Site	Hitchin

					BH101		BH102		BH103		BH105		BH106		UP101	VP102	VP103
					0.8	0.5	0.8	0.5	1	3.2	0.6	4.1	0.5	3.9	0.6	0.4	0.7
Chem Class	Analyte	HH	CW	Units	27/09/2011	03/10/2011	27/09/2011	30/09/2011	27/09/2011	29/09/2011	27/09/2011	29/09/2011	28/09/2011	04/10/2011	28/09/2011	27/09/2011	26/09/2011
BTEX	BENZENE	0.0928	IR	mg/kg	ND	ND	ND	ND	ND	ND	0.00222	ND	ND	ND	ND	ND	ND
	222		IR	mg/kg	ND	ND	ND	ND	ND	ND	0.0113	ND	ND	ND	ND	ND	ND
	ETHYLBENZENE	60.1	IR	mg/kg	ND	ND	ND	ND	ND	ND	0.00792	ND	ND	ND	ND	ND	ND
	M_P_XYLENE	19.7	IR	mg/kg	ND	ND	ND	ND	ND	ND	0.0163	ND	ND	ND	ND	ND	ND
	O_XYLENE	21.1	IR	mg/kg	ND	ND	ND	ND	ND	ND	0.0139	ND	ND	ND	ND	ND	ND
METALTOT	TOTAL ARSENIC	NP	IR	mg/kg	19.6	NT	NT	NT	21.9	NT	21.2	NT	13.9	NT	NT	NT	NT
	TOTAL BORON	NP	IR	mg/kg	10.4	NT	NT	NT	10.7	NT	13.6	NT	9.31	NT	NT	NT	NT
	TOTAL CADMIUM	NP	IR	mg/kg	0.751	NT	NT	NT	0.875	NT	0.779	NT	0.367	NT	NT	NT	NT
	TOTAL CHROMIUM	NP	IR	mg/kg	31.1	NT	NT	NT	22.9	NT	22	NT	17.5	NT	NT	NT	NT
	TOTAL COBALT	NP	IR	mg/kg	10.5	NT	NT	NT	7.58	NT	6.19	NT	5.63	NT	NT	NT	NT
	TOTAL COPPER	NP	IR	mg/kg	18	NT	NT	NT	15	NT	106	NT	13.8	NT	NT	NT	NT
	TOTAL HEXAVALENT_CHROMIUM	NP	IR	mg/kg	ND	NT	NT	NT	ND	NT	ND	NT	ND	NT	NT	NT	NT
	TOTAL LEAD	NP	IR	mg/kg	15.2	NT	NT	NT	24	NT	128	NT	37.1	NT	NT	NT	NT
	TOTAL MERCURY	NP	IR	mg/kg	ND	NT	NT	NT	ND	NT	ND	NT	ND	NT	NT	NT	NT
	TOTAL MOLYBDENUM	NP	IR	mg/kg	0.217	NT	NT	NT	ND	NT	0.294	NT	ND	NT	NT	NT	NT
	TOTAL NICKEL	NP	IR	mg/kg	37.5	NT	NT	NT	25.4	NT	25.3	NT	17.1	NT	NT	NT	NT
	TOTAL SELENIUM	NP	IR	mg/kg	ND	NT	NT	NT	ND	NT	ND	NT	ND	NT	NT	NT	NT
	TOTAL TIN	NP	IR	mg/kg	ND	NT	NT	NT	0.817	NT	12.2	NT	0.89	NT	NT	NT	NT
	TOTAL ZINC	NP	643	mg/kg	81.3	NT	NT	NT	230	NT	200	NT	85.9	NT	NT	NT	NT
MISC	Total Organic Carbon	(blank)	(blank)	%	0.371	0.438	0.334	ND	0.746	0.288	2.09	ND	0.702	ND	1.23	0.766	1.87
	TEMPERATURE	(blank)	(blank)	°C	22.9	21.2	NT	NT	20.6	21.1	20.6	21.2	21.2	21.4	NT	NT	NT
PAH	Acenaphthene	>Sat	IR	mg/kg	0.179	NT	NT	NT	0.0115	NT	5.89	NT	20.9	NT	NT	NT	NT
	Acenaphthylene	>Sat	IR	mg/kg	ND	NT	NT	NT	0.0609	NT	1.76	NT	1.29	NT	NT	NT	NT
	Anthracene	>Sat	IR	mg/kg	0.09	NT	NT	NT	0.0667	NT	11.8	NT	17.8	NT	NT	NT	NT
	BENZO_A_ ANTHRACENE	>Sat	IR	mg/kg	0.0883	NT	NT	NT	0.432	NT	23.4	NT	14.8	NT	NT	NT	NT
	BENZO_A_PYRENE	>Sat	IR	mg/kg	0.077	NT	NT	NT	0.554	NT	23.9	NT	13.6	NT	NT	NT	NT
	BENZO_B_FLUORANTHENE	>Sat	IR	mg/kg	0.0938	NT	NT	NT	0.79	NT	26.7	NT	16.2	NT	NT	NT	NT
	BENZO_G_H_I_PERYLENE	>Sat	IR	mg/kg	0.0489	NT	NT	NT	0.467	NT	13.7	NT	6.88	NT	NT	NT	NT
	BENZO_K_FLUORANTHENE	>Sat	IR	mg/kg	0.0426	NT	NT	NT	0.339	NT	9.62	NT	5.79	NT	NT	NT	NT
	Chrysene	>Sat	IR	mg/kg	0.0748	NT	NT	NT	0.481	NT	17.3	NT	12.4	NT	NT	NT	NT
	DIBENZ_A_H_ ANTHRACENE	>Sat	IR	mg/kg	ND	NT	NT	NT	0.0957	NT	3.44	NT	1.86	NT	NT	NT	NT
	Fluoranthene	>Sat	172	mg/kg	0.211	NT	NT	NT	0.851	NT	55.6	NT	53.9	NT	NT	NT	NT
	Fluorene	>Sat	IR	mg/kg	0.127	NT	NT	NT	0.0129	NT	6.7	NT	17.7	NT	NT	NT	NT
	INDENO_1_2_3_CD_PYRENE	>Sat	IR	mg/kg	0.0398	NT	NT	NT	0.358	NT	11.7	NT	5.78	NT	NT	NT	NT
	Naphthalene	0.599	12.9	mg/kg	ND	NT	NT	NT	0.0201	NT	3.08	NT	4.2	NT	NT	NT	NT
	Phenanthrene	>Sat	1880	mg/kg	0.298	NT	NT	NT	0.241	NT	35.6	NT	62.7	NT	NT	NT	NT
	Pyrene	>Sat	IR	mg/kg	0.168	NT	NT	NT	0.735	NT	46.5	NT	41.8	NT	NT	NT	NT
	TOTAL PAH	(blank)	(blank)	mg/kg	1.54	NT	NT	NT	5.52	NT	297	NT	297	NT	NT	NT	NT
RISKTPH	RISK TPH C6_C7_AROM	92	IR	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	RISK TPH C7_C8_AROM	222	IR	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	RISK TPH C8_C10_AROM	12.9	IR	mg/kg	ND	ND	ND	ND	ND	ND	0.311	ND	0.252	ND	ND	ND	0.0285
	RISK TPH C10_C12_AROM	70.6	IR	mg/kg	0.0131	ND	ND	ND	ND	ND	0.301	ND	0.365	ND	ND	ND	0.0161
	RISK TPH C12_C16_AROM	>Sat	3910	mg/kg	8.16	7.32	9.82	3.51	1.6	19.8	52.4	ND	16.5	2.92	3.6	1.41	36.7
	RISK TPH C16_C21_AROM	>Sat	IR	mg/kg	12.8	4.9	10.1	1.73	5.68	101	271	ND	65	2.58	35.7	2.27	115
	RISK TPH C21_C35_AROM	>Sat	IR	mg/kg	32.1	7.07	43.8	0.692	28.1	175	641	ND	183	6.11	146	18.4	616
	RISK TPH C5_C6_ALI	14	IR	mg/kg	ND	ND	ND	ND	ND	ND	0.0203	ND	ND	ND	ND	ND	ND
	RISK TPH C6_C8_ALI	30.7	IR	mg/kg	0.0107	ND	ND	ND	ND	ND	0.148	ND	0.052	ND	ND	ND	ND
	RISK TPH C8_C10_ALI	7.46	IR	mg/kg	0.0107	ND	ND	ND	ND	ND	0.357	ND	0.378	ND	ND	ND	0.0422
	RISK TPH C10_C12_ALI	36.4	IR	mg/kg	0.019	ND	ND	ND	ND	ND	0.451	ND	0.547	ND	ND	ND	0.0248
	RISK TPH C12_C16_ALI	>Sat	IR	mg/kg	7.25	17.6	23.3	6.66	2.48	77.7	24.5	7.29	8.93	2.57	8.07	2.46	13.8
	RISK TPH C16_C21_ALI	>Sat	IR	mg/kg	5.31	7	11.9	6.37	2.87	223	44.1	5.6	21.6	2.15	15.8	2.73	27.3
	RISK TPH C21_C35_ALI	>Sat	IR	mg/kg	12.3	7.79	38.4	1.08	12.5	303	411	ND	125	6.64	117	16.1	359
	RISK TPH C35_C44_ALI	>Sat	IR	mg/kg	3.13	1.42	17.6	ND	2.43	86.8	160	ND	83.9	1.49	72.7	3.53	438
	TPH_STAGE2_HI	1	(blank)	ratio	0.038874	0.0712508	0.0933111	0.0301831	0.0617843	0.1081551	0.2406315	0.028008	0.1447994	0.016138	0.0360549	0.0138464	0.1030854
VOC	DIPE	1.52	0.00484	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	ETHANOL	(blank)	0.584	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	MTBE	23.5	0.00302	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	TAME	0.738	0.00517	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
		11700	(blank)	µg/l	ND	ND	NT	NT	ND	ND	ND	ND	ND	ND	NT	NT	NT
	TBA	111	0.00164	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	ETBE	2.31	0.00507	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MISC_CEN21	PH	(blank)	(blank)	pH Units	8.64	8.43	NT	NT	8.6	8.46	9.18	8.61	9.71	6.84	NT	NT	NT
	CONDUCTIVITY	(blank)	(blank)	µS/cm	400	756	NT	NT	415	227	466	274	468	190	NT	NT	NT
VOCSURR	TOLUENE_D8	(blank)	(blank)	%	100	97.6	97.5	NT	98.6	104	90.2	104	101	99	103	98.8	94.5

XX	Exceeds Human Health & Controlled Waters
XX	Exceeds Human Health Criteria
XX	Exceeds Controlled Waters Criteria

CSM / Assumptions:
Soil 1% SOM (0.58% TOC)
Soil properties for "sand"
Commercial site area 0.5ha
Soil gas ingress rates calculated by model
Infinite groundwater source at 1m.bgl for groundwater GAC
High density residential assume vapour exposure pathways only
CPU scenario modified from modelled commercial scenario by:
Building dimensions (l x w x h): 14m x 6.5m x 2.4m
Differential pressure: 2.6 pascals
Only vapour exposure pathways considered viable
Derived November 2010 using Human7.1 Issue9. MTF.

ND: Not detected above MDL
HH: Human Health
GAC: Generic Assessment Criteria
(blank): No criteria
NP: No pathway
>Sat: Unacceptable risk not achieved due to calculated saturation of vapour pathway
NT: Not tested

TABLE 5 -
GROUNDWATER ANALYTICAL RESULTS WITH STAGE 3 HORIZONTAL MIGRATION SSAC

Stage2 Human Health	Human Health High Density Residential
Stage2 Controlled Waters	DWS
Sample Round	Hitchin October 2011
Site	Hitchin

Chem Class	Analyte	HH	CW	MDL	Units	BH101	BH102	BH103	BH105
						12/10/2011	12/10/2011	12/10/2011	12/10/2011
BTEX						W	W	W	W
	BENZENE	1100	9.59	1	µg/l	ND	1460	ND	ND
	TOLUENE	>Sat	IR	1	µg/l	ND	465	ND	ND
	ETHYLBENZENE	173000	103000	1	µg/l	ND	2350	ND	ND
	M P XYLENE	51600	188000	1	µg/l	ND	6480	ND	ND
	O XYLENE	62100	188000	1	µg/l	ND	2460	ND	ND
PAH	Acenaphthene	>Sat	IR	0.015	µg/l	ND	ND	ND	NT
	Acenaphthylene	>Sat	IR	0.011	µg/l	ND	ND	ND	NT
	Anthracene	>Sat	IR	0.015	µg/l	ND	ND	ND	NT
	BENZO A ANTHRACENE	>Sat	IR	0.017	µg/l	ND	ND	ND	NT
	BENZO A PYRENE	>Sat	IR	0.009	µg/l	ND	ND	ND	NT
	BENZO B FLUORANTHENE	>Sat	IR	0.023	µg/l	ND	ND	ND	NT
	BENZO G H I PERYLENE	>Sat	IR	0.016	µg/l	ND	ND	ND	NT
	BENZO K FLUORANTHENE	>Sat	IR	0.027	µg/l	ND	ND	ND	NT
	Chrysene	>Sat	IR	0.013	µg/l	ND	ND	ND	NT
	DIBENZ A H ANTHRACENE	>Sat	IR	0.016	µg/l	ND	ND	ND	NT
	Fluoranthene	>Sat	IR	0.017	µg/l	ND	ND	ND	NT
	Fluorene	>Sat	IR	0.014	µg/l	ND	0.205	ND	NT
	INDENO 1 2 3 CD PYRENE	>Sat	IR	0.014	µg/l	ND	ND	ND	NT
	Naphthalene	640	76.3	0.1	µg/l	ND	175	ND	NT
	Phenanthrene	>Sat	IR	0.022	µg/l	ND	ND	ND	NT
	Pyrene	>Sat	IR	0.015	µg/l	ND	ND	ND	NT
	TOTAL_PAH	(blank)	(blank)	0.247	µg/l	ND	176	ND	NT
VOC	DIPE	25300	IR	1	µg/l	ND	ND	ND	ND
	ETBE	34600	IR	1	µg/l	ND	ND	ND	ND
	ETHANOL	(blank)	IR	50	µg/l	ND	ND	ND	ND
	MTBE	331000	IR	1	µg/l	ND	ND	ND	ND
	TAME	11700	IR	1	µg/l	ND	ND	ND	ND
	TBA	628000	IR	10	µg/l	ND	ND	ND	ND
RISKTPH	RISK TPH C6 C7 AROM	1090000	97.5	10	µg/l	ND	1210	ND	ND
	RISK TPH C7 C8 AROM	>Sat	IR	10	µg/l	17	392	14	ND
	RISK TPH C8 C10 AROM	9830	IR	10	µg/l	12	13300	12	ND
	RISK TPH C10 C12 AROM	>Sat	IR	10	µg/l	ND	1010	ND	ND
	RISK TPH C12 C16 AROM	>Sat	IR	10	µg/l	ND	143	ND	NT
	RISK TPH C16 C21 AROM	>Sat	IR	10	µg/l	ND	ND	ND	NT
	RISK TPH C21 C35 AROM	>Sat	IR	10	µg/l	ND	ND	ND	NT
	RISK TPH C5 C6 ALI	10300	IR	10	µg/l	ND	308	ND	ND
	RISK TPH C6 C8 ALI	>Sat	IR	10	µg/l	ND	697	ND	ND
	RISK TPH C8 C10 ALI	302	IR	10	µg/l	ND	3220	ND	ND
	RISK TPH C10 C12 ALI	>Sat	IR	10	µg/l	ND	1510	ND	ND
	RISK TPH C12 C16 ALI	>Sat	IR	10	µg/l	ND	ND	ND	NT
	RISK TPH C16 C21 ALI	>Sat	IR	10	µg/l	ND	ND	ND	NT
	RISK TPH C21 C35 ALI	>Sat	IR	10	µg/l	ND	ND	ND	NT
	TPH_STAGE2_HI	1	(blank)	10	ratio	0.0986376	3.1001248	0.0986351	0.0879971

XX	Exceeds Human Health & Controlled Waters
XX	Exceeds Human Health Criteria
XX	Exceeds Controlled Waters Criteria

CSM / Assumptions:

Soil 1% SOM (0.58% TOC)
 Soil properties for "sand"
 Commercial site area 0.5ha
 Soil gas ingress rates calculated by model
 Infinite groundwater source at 1m.bgl for groundwater GAC
 High density residential assume vapour exposure pathways only
 CPU scenario modified from modelled commercial scenario by:
 Building dimensions (l x w x h): 14m x 6.5m x 2.4m
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 Only vapour exposure pathways considered viable
 Derived November 2010 using Human7.1 Issue9. MTF.

ND: Not detected above MDL
 HH: Human Health
 CW: Controlled Waters
 NP: No pathway
 NT: Not tested
 >Sat: Unacceptable risk not achieved due to calculated saturation of vapour pathway
 (blank): No criteria

TABLE 6 -
GROUNDWATER ANALYTICAL RESULTS WITH STAGE 3 VERTICAL MIGRATION SSAC

Stage2 Human Health	Human Health High Density Residential
Stage2 Controlled Waters	DWS
Sample Round	Hitchin October 2011
Site	Hitchin

Chem Class	Analyte	HH	CW	MDL	Units	BH101	BH102	BH103	BH105
						12/10/2011	12/10/2011	12/10/2011	12/10/2011
BTEX	BENZENE	1100	203	1	µg/l	ND	1460	ND	ND
	TOLUENE	>Sat	IR	1	µg/l	ND	465	ND	ND
	ETHYLBENZENE	173000	81800	1	µg/l	ND	2350	ND	ND
	M P XYLENE	51600	136000	1	µg/l	ND	6480	ND	ND
	O XYLENE	62100	136000	1	µg/l	ND	2460	ND	ND
PAH	Acenaphthene	>Sat	IR	0.015	µg/l	ND	ND	ND	NT
	Acenaphthylene	>Sat	IR	0.011	µg/l	ND	ND	ND	NT
	Anthracene	>Sat	IR	0.015	µg/l	ND	ND	ND	NT
	BENZO A ANTHRACENE	>Sat	IR	0.017	µg/l	ND	ND	ND	NT
	BENZO A PYRENE	>Sat	IR	0.009	µg/l	ND	ND	ND	NT
	BENZO B FLUORANTHENE	>Sat	IR	0.023	µg/l	ND	ND	ND	NT
	BENZO G H I PERYLENE	>Sat	IR	0.016	µg/l	ND	ND	ND	NT
	BENZO K FLUORANTHENE	>Sat	IR	0.027	µg/l	ND	ND	ND	NT
	Chrysene	>Sat	IR	0.013	µg/l	ND	ND	ND	NT
	DIBENZ A H ANTHRACENE	>Sat	IR	0.016	µg/l	ND	ND	ND	NT
	Fluoranthene	>Sat	IR	0.017	µg/l	ND	ND	ND	NT
	Fluorene	>Sat	IR	0.014	µg/l	ND	0.205	ND	NT
	INDENO 1 2 3 CD PYRENE	>Sat	IR	0.014	µg/l	ND	ND	ND	NT
	Naphthalene	640	232	0.1	µg/l	ND	175	ND	NT
	Phenanthrene	>Sat	IR	0.022	µg/l	ND	ND	ND	NT
	Pyrene	>Sat	IR	0.015	µg/l	ND	ND	ND	NT
	TOTAL_PAH	(blank)	(blank)	0.247	µg/l	ND	176	ND	NT
VOC	DIPE	25300	IR	1	µg/l	ND	ND	ND	ND
	ETBE	34600	IR	1	µg/l	ND	ND	ND	ND
	ETHANOL	(blank)	IR	50	µg/l	ND	ND	ND	ND
	MTBE	331000	IR	1	µg/l	ND	ND	ND	ND
	TAME	11700	IR	1	µg/l	ND	ND	ND	ND
RISKTPH	TBA	628000	IR	10	µg/l	ND	ND	ND	ND
	RISK TPH C6 C7 AROM	1090000	2040	10	µg/l	ND	1210	ND	ND
	RISK TPH C7 C8 AROM	>Sat	IR	10	µg/l	17	392	14	ND
	RISK TPH C8 C10 AROM	9830	153000	10	µg/l	12	13300	12	ND
	RISK TPH C10 C12 AROM	>Sat	35000	10	µg/l	ND	1010	ND	ND
	RISK TPH C12 C16 AROM	>Sat	IR	10	µg/l	ND	143	ND	NT
	RISK TPH C16 C21 AROM	>Sat	IR	10	µg/l	ND	ND	ND	NT
	RISK TPH C21 C35 AROM	>Sat	IR	10	µg/l	ND	ND	ND	NT
	RISK TPH C5 C6 ALI	10300	IR	10	µg/l	ND	308	ND	ND
	RISK TPH C6 C8 ALI	>Sat	IR	10	µg/l	ND	697	ND	ND
	RISK TPH C8 C10 ALI	302	IR	10	µg/l	ND	3220	ND	ND
	RISK TPH C10 C12 ALI	>Sat	IR	10	µg/l	ND	1510	ND	ND
	RISK TPH C12 C16 ALI	>Sat	IR	10	µg/l	ND	ND	ND	NT
	RISK TPH C16 C21 ALI	>Sat	IR	10	µg/l	ND	ND	ND	NT
	RISK TPH C21 C35 ALI	>Sat	IR	10	µg/l	ND	ND	ND	NT
	TPH_STAGE2_HI	1	(blank)	10	ratio	0.0986376	3.1001248	0.0986351	0.0879971

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 (blank): No criteria

TABLE 7
SOIL VAPOUR ANALYTICAL DATA with CPU GAC

Stage2 Human Health GAC	Human Health CPU
Sample Round	(All)
Site	Hitchin

Chem Class	Analyte	Units	Shallow	Deep	VP101	VP102	VP103
					0	0	0
					13/10/2011	13/10/2011	13/10/2011
VOC_GAS	BENZENE	mg/m3	45	63.6	0.00566	0.00416	0.0058
	TOLUENE	mg/m3	46400	67200	0.05772	0.04872	0.03278
	ETHYLBENZENE	mg/m3	7510	11100	0.00604	0.00583	0.003
	M_P_XYLENE	mg/m3	2000	2960	0.01621	0.0142	0.00705
	O_XYLENE	mg/m3	2000	2960	0.00553	0.00469	0.0023
	TOTAL_VOC_C6_12	mg/m3	931	1280	4.626	3.931	2.979
	HEXANE	mg/m3	77600	107000	0.03006	0.15933	0.1071
	OCTANE	mg/m3	>Sat	>Sat	0.23531	0.18876	0.05644
	DECANE	mg/m3	6180	77600	0.08299	0.10052	0.01227
	DODECANE	mg/m3	4500	>Sat	0.0074	0.01034	0.00109
	NAPHTHALENE	mg/m3	28.9	43.5	0.00048	0.00068	0.00048
	A_1_METHYLNAPHTHALENE	mg/m3	83.6	128	0.00049	0.00057	0.00031
	MTBE	mg/m3	23900	34600	ND	ND	ND
	DIPE	mg/m3	4630	6880	ND	ND	ND
	ETBE	mg/m3	4270	6360	ND	ND	ND
	TAME	mg/m3	2200	3270	ND	ND	ND
	A_1_2_3_TRIMETHYLBENZENE	mg/m3	35.5	53.5	0.00112	0.00106	0.00052

CROSS CHECK VOC	PROPORTION OF INDIVIDUALS IN VOC C6-C12	%
-----------------	---	---

9.7062257	13.707962	7.6918429
-----------	-----------	-----------

XX	Exceeds Shallow GAC
XX	Exceeds Deep GAC

CSM / Assumptions: Defaults as per SC050021/SR3 (2009) except:
 Soil 1% SOM (0.58% TOC)
 Soil properties for "sand"
 Commercial site area 0.5ha
 Soil gas ingress rates calculated by model
 Infinite soil vapour source at 0.5m.bgl for shallow vapour source and 1mbgl otherwise
 High density residential assume vapour exposure pathways only
 1,2,3-Trimethylbenzene is compared against criteria for 1,2,4-Trimethylbenzene
 Derived November 2010 using Human7.1 Issue9. SJC.
 CPU scenario modified from modelled commercial scenario by:
 Building dimensions (l x w x h): 14m x 6.5m x 2.4m
 Differential pressure: 2.6 pascals
 Only vapour exposure pathways considered viable

ND: Not detected above MDL
 NT: Not tested
 HH: Human Health
 GAC: Generic Assessment Criteria
 (blank): No criteria
 NP: No pathway
 >Sat: Unacceptable risk not achieved due to calculated saturation of vapour pathway

TABLE 8
SOIL VAPOUR ANALYTICAL DATA with HDR GAC

Stage2 Human Health GAC	Human Health High Density Residential
Sample Round	(All)
Site	Hitchin

						VP101	VP102	VP103
						0	0	0
Chem Class	Analyte	Units	Shallow	Deep		13/10/2011	13/10/2011	13/10/2011
VOC_GAS	BENZENE	mg/m3	1.45	2.37		0.00566	0.00416	0.0058
	TOLUENE	mg/m3	1490	2510		0.05772	0.04872	0.03278
	ETHYLBENZENE	mg/m3	243	417		0.00604	0.00583	0.003
	M_P_XYLENE	mg/m3	59	101		0.01621	0.0142	0.00705
	O_XYLENE	mg/m3	59.1	102		0.00553	0.00469	0.0023
	TOTAL VOC_C6_12	mg/m3	29.3	46.7		4.626	3.931	2.979
	HEXANE	mg/m3	2440	3890		0.03006	0.15933	0.1071
	OCTANE	mg/m3	142	3890		0.23531	0.18876	0.05644
	DECANE	mg/m3	2440	225		0.08299	0.10052	0.01227
	DODECANE	mg/m3	142	225		0.0074	0.01034	0.00109
	NAPHTHALENE	mg/m3	0.82	1.43		0.00048	0.00068	0.00048
	A_1_METHYLNAPHTHALENE	mg/m3	2.85	5.06		0.00049	0.00057	0.00031
	MTBE	mg/m3	772	1300		ND	ND	ND
	DIPE	mg/m3	155	267		ND	ND	ND
	ETBE	mg/m3	143	247		ND	ND	ND
	TAME	mg/m3	73.5	127		ND	ND	ND
	A_1_2_3_TRIMETHYLBENZENE	mg/m3	1.2	2.1		0.00112	0.00106	0.00052

CROSS CHECK VOC	PROPORTION OF INDIVIDUALS IN VOC C6-C14	%	9.7062257	13.707962	7.6918429
-----------------	---	---	-----------	-----------	-----------

XX	Exceeds Shallow GAC
XX	Exceeds Deep GAC

CSM / Assumptions: Defaults as per SC050021/SR3 (2009) except:
 Soil 1% SOM (0.58% TOC)
 Soil properties for "sand"
 Commercial site area 0.5ha
 Soil gas ingress rates calculated by model
 Infinite soil vapour source at 0.5m.bgl for shallow vapour source and 1mbgl otherw
 High density residential assume vapour exposure pathways only
 1,2,3-Trimethylbenzene is compared against criteria for 1,2,4-Trimethylbenzene
 Derived November 2010 using Human7.1 Issue9. SJC.
 CPU scenario modified from modelled commercial scenario by:
 Building dimensions (l x w x h): 14m x 6.5m x 2.4m
 Differential pressure: 2.6 pascals
 Only vapour exposure pathways considered viable

ND: Not detected above MDL
 NT: Not tested
 HH: Human Health
 GAC: Generic Assessment Criteria
 (blank): No criteria
 NP: No pathway
 >Sat: Unacceptable risk not achieved due to calculated saturation of vapour pathway

TABLE 9
POTABLE WATER ANALYTICAL RESULTS
with DWS

Sample Round	Nov-11
Site	Hitchin

						ACTIVE 01 15/11/2011	STATIC 01 15/11/2011
Chem Class	Analyte	Criteria	Units	MDL	Source	W	W
BTEX	BENZENE	1	µg/l	1	UK DWS (2010)	ND	ND
	TOLUENE	700	µg/l	1	SEPA GW RPV 2009 / WHO DWS	ND	ND
	ETHYLBENZENE	300	µg/l	1	SEPA GW RPV 2009 / WHO DWS	ND	ND
	M. P. XYLENE	500	µg/l	1	SEPA GW RPV 2009 / WHO DWS	ND	ND
	O. XYLENE	500	µg/l	1	SEPA GW RPV 2009 / WHO DWS	ND	ND
PAH	Acenaphthene	2200	µg/l	0.015	USEPA RSL	ND	ND
	Acenaphthylene	90	µg/l	0.011	WHO Petroleum Products in DW 2008	ND	ND
	Anthracene	10000	µg/l	0.015	Ireland IGV (2003)	ND	ND
	BENZO A ANTHRACENE	0.029	µg/l	0.017	USEPA RSL	ND	ND
	BENZO A PYRENE	0.01	µg/l	0.009	UK DWS (2010)	ND	ND
	BENZO B FLUORANTHENE	0.025	µg/l	0.023	0.25 x Sum 4 PAHs UK DWS (2010)	ND	ND
	BENZO G H I PERYLENE	0.025	µg/l	0.016	0.25 x Sum 4 PAHs UK DWS (2010)	ND	ND
	BENZO K FLUORANTHENE	0.025	µg/l	0.027	0.25 x Sum 4 PAHs UK DWS (2010)	ND	ND
	Chrysene	2.9	µg/l	0.013	USEPA RSL	ND	ND
	DIBENZ A H ANTHRACENE	0.0029	µg/l	0.016	USEPA RSL	ND	ND
	Fluoranthene	0.2	µg/l	0.017	UK DWS (2010)	ND	ND
	Fluorene	1500	µg/l	0.014	USEPA RSL	ND	ND
	INDENO 1 2 3 CD PYRENE	0.025	µg/l	0.014	0.25 x Sum 4 PAHs UK DWS (2010)	ND	ND
	Naphthalene	1	µg/l	0.1	Ireland IGV (2003)	ND	ND
	Phenanthrene	90	µg/l	0.022	WHO Petroleum Products in DW 2008	ND	0.0225
	Pyrene	1100	µg/l	0.015	USEPA RSL	ND	ND
VOC	MTBE	30	µg/l	1	Ireland IGV (2003)	ND	ND
	TAME	140	µg/l	1	Gasoline Oxygenate Additives: Health Information Summary, 2009, ref ARD-EHP-32	ND	ND
	DIPE	120	µg/l	1	Gasoline Oxygenate Additives: Health Information Summary, 2009, ref ARD-EHP-32	ND	ND
	ETBE	40	µg/l	1	Gasoline Oxygenate Additives: Health Information Summary, 2009, ref ARD-EHP-32	ND	ND
	ETHANOL	1100000	µg/l	50	ref ARD-EHP-32	ND	ND
	TBA	40	µg/l	10	Gasoline Oxygenate Additives: Health Information Summary, 2009, ref ARD-EHP-32	ND	ND
RISKTPH	RISK TPH C6 C7 AROM	1	µg/l	10	UK DWS (2010)	ND	ND
	RISK TPH C7 C8 AROM	700	µg/l	10	WHO Petroleum Products in DW 2008	ND	ND
	RISK TPH C8 C10 AROM	300	µg/l	10	WHO Petroleum Products in DW 2008	ND	ND
	RISK TPH C10 C12 AROM	90	µg/l	10	WHO Petroleum Products in DW 2008	ND	ND
	RISK TPH C12 C16 AROM	90	µg/l	10	WHO Petroleum Products in DW 2008	ND	ND
	RISK TPH C16 C21 AROM	90	µg/l	10	WHO Petroleum Products in DW 2008	ND	ND
	RISK TPH C21 C35 AROM	90	µg/l	10	WHO Petroleum Products in DW 2008	ND	ND
	RISK TPH C5 C6 ALI	15000	µg/l	10	WHO Petroleum Products in DW 2008	ND	ND
	RISK TPH C6 C8 ALI	15000	µg/l	10	WHO Petroleum Products in DW 2008	ND	ND
	RISK TPH C8 C10 ALI	300	µg/l	10	WHO Petroleum Products in DW 2008	ND	ND
	RISK TPH C10 C12 ALI	300	µg/l	10	WHO Petroleum Products in DW 2008	ND	ND
	RISK TPH C12 C16 ALI	300	µg/l	10	WHO Petroleum Products in DW 2008	ND	ND
	RISK TPH C16 C21 ALI	300	µg/l	10	WHO Petroleum Products in DW 2008	ND	ND
	RISK TPH C21 C35 ALI	300	µg/l	10	WHO Petroleum Products in DW 2008	ND	ND

ND: Not detected above MDL
NT: Not tested
(blank): No criteria

Appendix B - Borehole Logs

Monitoring Well Log

Project Name and Site Location Shell Hitchin		Client Shell UK Oil Products Ltd		BOREHOLE No BH101
Job No 46370079	Date Start Date 27-09-11 End Date 27-09-11	Ground Level (m)	Co-Ordinates ()	
Contractor Glover		Method / Plant Used Vacex and Hollow Stem Auger		Sheet 1 of 2

Depth BGL	Sample / Test Details	PID (ppm)	Water	STRATA			Instrument / Backfill
				Legend	Depth (Thickness)	DESCRIPTION	
					0.30	Concrete and rebar	
0.5		<0.1			0.50	MADE GROUND: Tarmac and bricks	NVO
1.0	BH101_0.8	0.9			(0.70)	Dark grey/brown sandy slightly gravelly SILT. Gravels are subrounded to subangular of flint and chalk.	Minor black staining, NVO
1.5					1.20		
2.0		<0.1			(1.80)	Dark brown slightly sandy SILT with 1-3cm bands of chalk and occasional gravels.	Dry, NVO
2.5							
3.0		<0.1			3.00		
3.5						Dark brown/dark grey slightly sandy firm CLAY with occasional chalk gravels.	Dry, NVO
4.0		0.3			(3.20)		
4.5							
5.0		0.2					
5.5	BH101_5.4						
6.0		1			6.20		
6.5					(0.80)	Orange sandy SILT.	Dry, NVO
7.0		0.4			7.00		
7.5						Orange/yellow grey medium to coarse SAND with occasional chalk gravels.	Wet, NVO
8.0							

Backfill Cement seal riser Bentonite seal riser Filter pack riser Filter pack screen	Sample Details Environmental Sample	Legend Concrete Made Ground Gravelly Sandy Silt Sandy gravelly CLAY Silt Gravelly Sand Groundwater Table Groundwater Strike	GENERAL REMARKS m bgl = metres below ground level NVO = No visual or olfactory evidence of impact. Cleared by vacuum excavation to 2m bgl.
		Logged By JT	Approved By BS

Monitoring Well Log

Project Name and Site Location Shell Hitchin			Client Shell UK Oil Products Ltd		BOREHOLE No BH101
Job No 46370079	Date Start Date 27-09-11 End Date 27-09-11	Ground Level (m)	Co-Ordinates ()		
Contractor Glover			Method / Plant Used Vacex and Hollow Stem Auger		Sheet 2 of 2

Depth BGL	Sample / Test Details	PID (ppm)	Water	STRATA			
				Legend	Depth (Thickness)	DESCRIPTION	COMMENTS
8.5		5.2			(2.00)	Orange/yellow grey medium to coarse SAND with occasional chalk gravels. <i>(continued)</i>	Wet, NVO <i>(continued)</i>
9.0		0.3			9.00	EOH at 9.0m bgl	

Backfill ☐ Cement seal riser ☐ Bentonite seal riser ☐ Filter pack riser ☐ Filter pack screen	Sample Details ☒ Environmental Sample	Legend Concrete Made Ground Gravelly Sandy Silt Sandy gravelly CLAY Silt Gravelly Sand Groundwater Table Groundwater Strike	GENERAL REMARKS m bgl = metres below ground level NVO = No visual or olfactory evidence of impact. Cleared by vacuum excavation to 2m bgl.
		Logged By JT	Approved By BS

Monitoring Well Log

Project Name and Site Location Shell Hitchin		Client Shell UK Oil Products Ltd		BOREHOLE No BH102
Job No 46370079	Date Start Date 27-09-11 End Date 27-09-11	Ground Level (m)	Co-Ordinates ()	
Contractor Glover		Method / Plant Used Vacex and Hollow Stem Auger		Sheet 1 of 2

Depth BGL	Sample / Test Details	PID (ppm)	Water	STRATA			Instrument / Backfill
				Legend	Depth (Thickness)	DESCRIPTION	
0.5	BH102_0.8	<0.1			0.30	Concrete and rebar	
0.9					(0.60)	Orange/brown silty slightly gravelly SAND. Contains fragments of sub-rounded to subangular flint and chalk.	NVO
1.8		0.4			0.90	Orange/grey silty SAND. Sand is fine to medium.	Dry, NVO
2.7	BH102_2.7	1.1			(1.80)		
4.0					2.70		
4.3		0.8			(1.30)	Orange/brown coarse SAND with rare gravels.	Dry, NVO
5.2		1.7			4.00	Orange/grey banded SAND. Sand is fine to medium	Dry, NVO
5.5		2.1			(1.20)		
6.0		419			5.20	Dark orange/brown slightly silty SAND and GRAVELS. Sand is fine to coarse, gravel is subrounded to subangular of flint and chalk.	Dry, NVO
6.5					(0.80)		
6.8					6.00	Yellow/orange/grey very silty SAND.	Dry, NVO
7.1					(0.50)		
7.4		1207			6.50	Grey sandy SILT.	Dry, NVO
7.7					(0.60)		
8.0					7.10	Orange/grey very silty SAND.	Wet, NVO

Backfill Cement seal riser Bentonite seal riser Filter pack riser Filter pack screen	Sample Details Environmental Sample	Legend Concrete Gravelly Sand Silty Sand Sandy Gravel Sand Sandy Silt Groundwater Table Groundwater Strike	GENERAL REMARKS m bgl = metres below ground level NVO = No visual or olfactory evidence of impact.
Logged By JT		Approved By BS	



Monitoring Well Log

Project Name and Site Location Shell Hitchin			Client Shell UK Oil Products Ltd		BOREHOLE No BH102
Job No 46370079	Date Start Date 27-09-11 End Date 27-09-11	Ground Level (m)	Co-Ordinates ()		
Contractor Glover		Method / Plant Used Vacex and Hollow Stem Auger		Sheet 2 of 2	

[illegible]

Backfill  Cement seal riser  Bentonite seal riser  Filter pack riser  Filter pack screen		Sample Details  Environmental Sample	Legend  Concrete  Gravelly Sand  Silty Sand  Sand  Sandy Gravel  Sandy Silt  Groundwater Table  Groundwater Strike		GENERAL REMARKS m bgl = metres below ground level NVO = No visual or olfactory evidence of impact.
			Logged By JT	Approved By BS	

JRS ENVIRONMENTAL TRIAL PIT LOG 21/09/07 HITCHIN LOGS SEPT 2011.GPJ AGS3 ALL.GDT 17/10/11

Monitoring Well Log

Project Name and Site Location Shell Hitchin			Client Shell UK Oil Products Ltd		BOREHOLE No BH103
Job No 46370079	Date Start Date 27-09-11 End Date 29-09-11		Ground Level (m)	Co-Ordinates ()	
Contractor Glover			Method / Plant Used Vacex and Hollow Stem Auger		Sheet 1 of 2

Depth BGL	Sample / Test Details	PID (ppm)	Water	STRATA			Instrument / Backfill
				Legend	Depth (Thickness)	DESCRIPTION	
0.30					0.30	Concrete and rebar	
0.5		<0.1			(0.80)	MADE GROUND: Brown sandy gavels. Gravels are brick, clinker and concrete.	
1.0	BH103_1.0	<0.1			1.10		
1.5		0.4				Orange/brown fine to medium SAND.	
2.0	BH103_1.8 N=18 BH103_2.0	<0.1			(1.40)		
2.5					2.50		
3.0		0.7				Dark orange/brown SAND and GRAVELS. Sand is fine to coarse, gravel is subangular to angular of chalk.	
3.5	BH103_3.2				(2.00)		
4.0	BH103_3.6 N=23 BH103_4.0	0.9			4.50		
4.5					(0.50)	Orange/brown silty SAND.	
5.0		0.3			5.00		
5.5	BH103_5.4 N=41				(0.40)	Orange/grey/brown sandy SILT.	
6.0	BH103_6.0	0.2			5.40		
6.5					(0.60)	Orange/brown SAND and GRAVELS. Gravel is chalk and flint.	
7.0		1.6			6.00		
7.5	BH103_7.2 N=15				(3.00)	Orange/grey brown sandy SILT.	
8.0						Becoming wet at 7.1m bgl	

Backfill		Sample Details		Legend		GENERAL REMARKS
Cement seal riser	Bentonite seal riser	Environmental Sample	Standard Penetration Test	Concrete	Made Ground	
Filter pack riser	Filter pack screen	Small Disturbed Sample		Sand	Gravelly Sand	m bgl = metres below ground level NVO = No visual or olfactory evidence of impact.
				Silty Sand	Sandy Silt	
				Groundwater Table	Groundwater Strike	
Logged By			JT		Approved By	BS



Monitoring Well Log

Project Name and Site Location Shell Hitchin		Client Shell UK Oil Products Ltd		BOREHOLE No BH103
Job No 46370079	Date Start Date 27-09-11 End Date 29-09-11	Ground Level (m)	Co-Ordinates ()	
Contractor Glover		Method / Plant Used Vacex and Hollow Stem Auger		

[illegible]

Backfill  Cement seal riser  Bentonite seal riser  Filter pack riser  Filter pack screen		Sample Details  Environmental Sample  Standard Penetration Test  Small Disturbed Sample	Legend  Concrete  Made Ground  Sand  Gravelly Sand  Silty Sand  Sandy Silt  Groundwater Table  Groundwater Strike		GENERAL REMARKS m bgl = metres below ground level NVO = No visual or olfactory evidence of impact.
		Logged By	JT	Approved By	BS

JRS ENVIRONMENTAL TRIAL PIT LOG 21/09/07 HITCHIN LOGS SEPT 2011.GPJ AGS3_ALL.GDT 17/10/11

Monitoring Well Log

Project Name and Site Location Shell Hitchin			Client Shell UK Oil Products Ltd		BOREHOLE No BH105
Job No 46370079	Date Start Date 26-09-11 End Date 29-09-11		Ground Level (m)	Co-Ordinates ()	
Contractor Glover			Method / Plant Used Vacex and Hollow Stem Auger		Sheet 1 of 1

Depth BGL	Sample / Test Details	PID (ppm)	Water	STRATA			
				Legend	Depth (Thickness)	DESCRIPTION	COMMENTS
0.5	BH105_0.6	1.7			0.30	Concrete	
					0.50	Tarmac	
1.0		0.9			(0.40) 0.90	MADE GROUND: Dark brown gravels of fragments of brick, clinker, wood and concrete cobbles.	Wet from Vacex, NVO
1.5	BH105_4.1	<0.1			(0.90)	MADE GROUND: Dark brown sandy gravels.	Wet from Vacex, NVO
2.0		0.3			1.80	Light orange/grey silty SAND. Sand is fine to medium.	Dry, NVO
2.5							
3.0		<0.1			(2.40)		
3.5							
4.0	BH105_4.1	<0.1			4.20	Orange/light grey sandy SILT.	Dry, NVO
4.5						Becoming wet at 4.5m bgl	Wet, NVO
5.0		<0.1			(1.60)		
5.5					5.80		
6.0		<0.1			(0.50) 6.30	CHALK	Wet, NVO
						EOH at 6.3m bgl	

Backfill		Sample Details		Legend		GENERAL REMARKS
	Cement seal riser		Environmental Sample		Concrete	
	Bentonite seal riser				Tarmac	m bgl = metres below ground level NVO = No visual or olfactory evidence of impact.
	Filter pack riser				Made Ground	
	Filter pack screen				Silty Sand	
	Bentonite: Bottom of hole/well				Sandy Silt	
					Chalk	
					Groundwater Table	
					Groundwater Strike	
Logged By			JT	Approved By		
				BS		

Monitoring Well Log

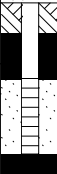
Project Name and Site Location Shell Hitchin			Client Shell UK Oil Products Ltd		BOREHOLE No BH106
Job No 46370079	Date Start Date 28-09-11 End Date 04-10-11		Ground Level (m)	Co-Ordinates ()	
Contractor Glover			Method / Plant Used Vacex and Hollow Stem Auger		Sheet 1 of 1

Depth BGL	Sample / Test Details	PID (ppm)	Water	STRATA			
				Legend	Depth (Thickness)	DESCRIPTION	COMMENTS
0.5	BH106_0.5	1.2			(0.40) 0.40 0.50	Concrete and rebar	
1.0		0.9			(0.70) 1.20	Bricks and tarmac MADE GROUND: Black and grey/brpwm silty slightly sandy gravel. Gravels are brick and concrete fragments.	NVO Black staining, NVO
1.5						Orange/brown silty SAND. Becoming wet from 1.4 to 2.0m bgl	Dry, NVO Wet, NVO
2.0	BH106 1.8 N=22 BH106_2.0	0.2					Dry, NVO
2.5							
3.0		0.4					
3.5	BH106 3.6 N=19				(4.20)	Becoming wet from 3.5m bgl	Wet, NVO
4.0	BH106 3.9 BH106_4.0	0.1					
4.5							
5.0		<0.1					
5.5	BH106 5.4 N=31				5.40	CHALK with small amounts of orange silty sand.	Wet, NVO
6.0	BH106_6.0	<0.1			(0.60) 6.00	CHALK	
6.5					(1.20)		
7.0		<0.1			7.20	EOH at 7.2m bgl	

Backfill		Sample Details		Legend		GENERAL REMARKS
Cement seal riser	Bentonite seal riser	Environmental Sample	Standard Penetration Test	Concrete	Made Ground	
Filter pack riser	Filter pack screen	Small Disturbed Sample		Silty Sand	Chalk	
Bentonite: Bottom of hole/well				Groundwater Table	Groundwater Strike	m bgl = metres below ground level NVO = No visual or olfactory evidence of impact.
			Logged By	JT	Approved By	BS

Monitoring Well Log

Project Name and Site Location Shell Hitchin			Client Shell UK Oil Products Ltd		BOREHOLE No VP101
Job No 46370079	Date Start Date 29-09-11 End Date 29-09-11	Ground Level (m)	Co-Ordinates ()		
Contractor Glover			Method / Plant Used Vacex		Sheet 1 of 1

Depth BGL	Sample / Test Details	PID (ppm)	Water	STRATA				Instrument / Backfill
				Legend	Depth (Thickness)	DESCRIPTION	COMMENTS	
0.5 1.0					(0.40) 0.40	Concrete and rebar		
					0.60	MADE GROUND: Light brown silty sands and gravels of fragments of brick, concrete and clinker.	NVO	
					(0.60)	Light grey/brown sandy SILT with occasional gravels.	NVO	
					1.20	End of vapour well at 1.2m bgl		

Backfill  Cement seal riser  Bentonite seal riser  Filter pack screen  Bentonite: Bottom of hole/well	Sample Details	Legend  Concrete  Made Ground  Gravelly Silt  Groundwater Table  Groundwater Strike	GENERAL REMARKS m bgl = metres below ground level NVO = No visual or olfactory evidence of impact.
Logged By JT		Approved By BS	

Monitoring Well Log

Project Name and Site Location Shell Hitchin		Client Shell UK Oil Products Ltd		BOREHOLE No VP102
Job No 46370079	Date Start Date 27-09-11 End Date 27-09-11	Ground Level (m)	Co-Ordinates ()	
Contractor Glover		Method / Plant Used Vacex		Sheet 1 of 1

Depth BGL	Sample / Test Details	PID (ppm)	Water	STRATA			
				Legend	Depth (Thickness)	DESCRIPTION	COMMENTS
0.5	VP102_0.4	<0.1			0.20	Grass and topsoil with roots	
					(0.40) 0.60	MADE GROUND: Brown silty slightly gravelly sand. Gravels are fine to medium of brick and concrete fragments.	Minor black staining, NVO
					0.80	Tarmac and bricks	
1.0					(0.40) 1.20	Orange/brown silty sandy CLAY.	Minor black staining, NVO
						End of vapour well at 1.2m bgl	

Backfill  Cement seal riser  Bentonite seal riser  Filter pack screen  Bentonite: Bottom of hole/well	Sample Details  Environmental Sample	Legend  Topsoil  Tarmac  Groundwater Table  Made Ground  Sandy Silt/Clay  Groundwater Strike	GENERAL REMARKS m bgl = metres below ground level NVO = No visual or olfactory evidence of impact.
Logged By JT		Approved By BS	

Monitoring Well Log

Project Name and Site Location Shell Hitchin			Client Shell UK Oil Products Ltd		BOREHOLE No VP103
Job No 46370079	Date Start Date 29-09-11 End Date 29-09-11	Ground Level (m)	Co-Ordinates ()		
Contractor Glover		Method / Plant Used Vacex		Sheet 1 of 1	

Depth BGL		Sample / Test Details	PID (ppm)	Water	STRATA			
					Legend	Depth (Thickness)	DESCRIPTION	COMMENTS
0.5		VP103_0.7	1.2		0.30	Concrete		
					0.40	Tarmac		
					(0.40)	MADE GROUND: Orange/brown gravels. Gravels are subangular to angular of brick, clinker and concrete cobbles with some tree roots.	Wet from Vacex, NVO	
					0.80			
1.0			1.4		1.00	MADE GROUND: Red bricks and cobbles.	Wet from Vacex, NVO	
						End of vapour well at 1.0m bgl		

Backfill		Sample Details		Legend		GENERAL REMARKS	
	Cement seal riser		Environmental Sample		Concrete		Tarmac
	Bentonite seal riser				Made Ground		Gravelly Sand
	Filter pack screen						
					Groundwater Table		Groundwater Strike
				Logged By JT		Approved By BS	

Appendix C - Photographs