

Environmental Verification Report

Shell Hitchin

NPS: 10019011



Prepared for:
Shell UK Oil Products Ltd.

Prepared by:
URS Infrastructure &
Environment UK Limited

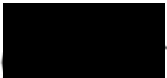
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EXECUTIVE SUMMARY

Shell Hitchin is a petrol filling station, located Bedford Road, Hitchin, Hertfordshire, SG5 2TY that has undergone a tank replacement and partial site redevelopment commencing in March 2013 and completed in August 2013. Approval of town planning application (ref: 11/02584/1) for the redevelopment was granted by Hertfordshire District Council on 29th March 2012. As part of these works, the existing USTs, fuel lines, fuel dispensers, interceptor, drainage, canopy and surface hardstanding were removed and replaced.

URS Infrastructure and Environment UK Ltd. (URS) was requested by Shell UK Oil Products (Shell) to provide environmental support during the redevelopment in accordance with the URS Environmental Strategy Plan (Report reference R46370079-0004, dated March 2013).

Whilst the British Geological Survey map indicates that the site to be underlain by the Lowestoft (classified as an Unproductive Strata), Boreholes advanced at the site in 2012 and 2013 identified Glaciofluvial Deposits which are classified as a Secondary-A aquifer. The Zig Zag Chalk Formation is present beneath, which is classified as Principal aquifer. The assumed Controlled Waters receptors for the site are therefore the Zig Zag Chalk (Principal aquifer) and the Glaciofluvial Deposits (Secondary-A aquifer). The vertical and horizontal extent of the Lowestoft Till and the Glaciofluvial Deposit units within the permeable drift are not known.

The site is not located within a Source Protection Zone. There are no reported licensed groundwater abstractions within 1km of the site and no reported private groundwater abstractions within 2km of the site. The closest surface water feature is the Bearton Pond located approximately 200 m north of the site. The River Hiz is located approximately 850m east of the site, the River Oughton is located 1km north of the site and the River Purwell is located approximately 1.2km north-east of the site.

Land use surrounding the site consists of mixed commercial and residential and recreational areas.

During laboratory analysis of shallow soil samples collected from the Made Ground across the forecourt, asbestos containing materials (ACMs) were identified beneath pumps 5 and 6. DMW Environmental Safety Ltd (DMW) attended the site to provide asbestos remediation safety and monitoring services in relation to proposed ground works. ACMs were segregated and disposed of at a hazardous landfill facility (Thornhaugh Landfill, Peterborough).

As part of the construction programme five active tanks (comprising seven compartments) and one solid filled decommissioned tank were removed from the site and replaced with two new double walled 65KL split compartment tanks. In conjunction with the fuel infrastructure removal, URS undertook validation sampling of excavations advanced for the removal of the underground storage tanks (USTs), the removal of the fuel infrastructure and the excavation for the new tank farm. A total of 59 soil samples were collected.

Field observations noted strong hydrocarbon odours and black staining during the removal of the base of the existing USTs at approximately 4.5 m bgl. The depth of the tank excavation was extended by an additional 1.3m to a depth of 6.8m bgl where no visual signs of hydrocarbon impact and only mild hydrocarbon odours were reported. Soil impacts were not reported in soil samples collected from

excavations for the new tank farm or the replacement of the site interceptor. Phase Separated Hydrocarbons (PSH) were not found at any location on-site.

In total approximately 1,705 m³ of material was excavated and disposed of as inert and non-hazardous waste. 11 m³ of asbestos impacted material was removed from site as hazardous waste. Resultant excavations were backfilled with approximately 1,070 m³ material (excluding poured concrete and tarmac).

Following completion of the construction works post construction groundwater monitoring was undertaken at the site. No visual or olfactory signs of hydrocarbon impact were reported in any of the monitoring wells sampled.

A risk assessment was undertaken on validation samples collected from soil left in-situ underlying the site and post construction groundwater monitoring data. No potentially significant risks to human health (protective of on-site workers and off-site residents) were identified. No potentially significant risks were identified to groundwater quality within the Drift Deposits Secondary-A aquifer or the underlying Chalk Principal aquifer.

The site is considered suitable for on-going oil use.

1. INTRODUCTION

URS Infrastructure & Environment UK Limited (URS) was requested by Shell UK Oil Products Ltd. (Shell) to support the redevelopment of Shell Hitchin located on Bedford Road, Hitchin, Hertfordshire, SG5 2TY (hereafter referred to as 'the Site').

The redevelopment programme at Hitchin was managed by Shell Engineering Construction PMC (Artelia) on behalf of Shell. The programme commenced in March 2013 and was completed at the end of August 2013. A town planning application (ref: 11/02584/1) for the redevelopment was made by Artelia's architect RLDM Architects Ltd. North Hertfordshire District Council granted consent for the redevelopment on 29th March 2012. A revision of this application (ref: 12/02678/1) to allow the verification report to be submitted and approved in writing within 3 months following completion of the site works was approved on 22nd January 2013. Details of the environmental conditions attached to the consent are provided in Appendix A.

Redevelopment works comprised removal and replacement of the canopy, existing USTs, fuel lines, fuel dispensers, interceptor, drainage, and surface hardstanding. The retail shop interior was also refurbished.

This Environmental Verification Report has been completed in accordance with URS Environmental Strategy Plan (Ref: R46370079-004 FINAL rev 1, dated 11 March 2013).

The URS Environmental Strategy Plan is outlined in Section 2.2, Table B.

1.1. Objectives

The objectives of the Verification report detailed herein were as follows:

- To obtain soil validation data from the vicinity of removed Underground Storage Tanks (USTs) and other fuel infrastructure at the site.
- To assess the presence of any residual hydrocarbons left in the soil following redevelopment.
- To advise on soil removal if required.
- To demonstrate completion of the works set out in the Environmental Strategy Plan. (The strategy is based on the assumption that the site would be remediated for Continued Oil Use, with redevelopment of the petrol station forecourt.)

1.2. Scope of Work

The scope of work for this Verification Report was based on URS' Environmental Strategy Plan for the site and included:

- Decommissioning of monitoring wells BH101, BH102 and VP103.

- Undertaking further site characterisation via five (5) trial pits in the west and north of the tank farm where previous site investigation was not able to be undertaken.
- Validation of excavation areas following the removal of five operational and one decommissioned USTs.
- Validation of excavation areas following the removal of the interceptor, pump islands and fuel lines.
- Assessment of evidence of hydrocarbon-impacted soils during excavation.
- Field screening of soils within the excavations for volatile organic compounds.
- Subject to field screening results, removal of significantly hydrocarbon-impacted soils in association with infrastructure removal.
- Collection and chemical analysis of soil verification samples from the base and sides of excavations and from imported fill material, to characterise the material left in situ.
- As required, risk assessment of material left in situ that could not be safely or practically removed.
- Reinstatement of monitoring well BH102.
- Post construction groundwater monitoring.
- Provision of this Verification Report.

2. BACKGROUND INFORMATION

2.1. Site Identification Details

Table A: Site Information	
Site Name	Shell Hitchin
Network Planning System ID	10019011
Site Address	Bedford Road, Hitchin, Hertfordshire, SG5 2TY Figure 1 provides a site location plan.
Grid Reference (lat and long)	517920, 229840
Reported Site Area	The site area is approximately 1,500 square metres (m ²)
Freehold/Leasehold	URS understands the site is owned by Shell.
Land Use Zoning	Continued Oil Use.

2.2. Site Setting

North: A tyre dealership is situated approximately 5m north of the site beyond an access road. A three storey apartment block with surrounding garden lies approximately 30m north of the site.

South: A 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.

2.3. Previous Investigations

Table B presents environmental reports that have previously been prepared by Shell for the site and the chronology of recent activities:

Table B – Previous Site Investigations and Remedial Works	
Activity	Summary
Previous site investigations and/or remediation	- Ref 1: GeoDelft Tier 1 soil gas survey, May 1999 - Ref 2: URS Phase 1 Environmental Site Assessment, October 2011 - Ref 3: URS Phase 2 Environmental Site Assessment, April 2012 - Ref 4: URS Phase 2 Comprehensive Environmental Site Assessment – Further Investigation, February 2013 - Ref 5: URS Environmental Strategy Plan, March 2013.
<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	

Table B – Previous Site Investigations and Remedial Works

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 Hiz located approximately 850m east of the site, the River Oughton located 1km north of the site and the River Purwell located approximately 1.2km north-east of the site).

Review of URS Comprehensive Environmental Site Assessment Report (Reference 3)

A comprehensive investigation was undertaken by URS in December 2011. Intrusive works included the drilling and installation of 5 monitoring wells into the superficial deposits and 3 vapour wells at the site. A DQRA was carried out on available soil, groundwater and vapour data. The principal conclusions were:

- No significant risks to human health (on-site workers or off-site residents) were identified
- 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 was based on a number of assumptions in the absence of site specific data.

Table B – Previous Site Investigations and Remedial WorksReview of URS Comprehensive Environmental Site Assessment - Further Investigation Report (Reference 4)

To refine the DQRA, URS completed further intrusive works including the installation of two monitoring wells into the Zig Zag Chalk Formation, and one monitoring well into the superficial deposits.

URS conducted a Controlled Waters Detailed Quantitative Risk Assessment (DQRA) to assess the significance of identified potential pollutant linkages from soil and groundwater monitoring from both the December 2011 and February 2012 investigations and January 2013 GME. Two models were created for the site to assess potential risks to groundwater in the Chalk and groundwater in the Drift Deposits:

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

Model 1: Groundwater in the Chalk

Of the COPC groups assessed, soil concentrations of naphthalene and fluoranthene were simulated to present a theoretical risk to the Principal aquifer at a 50m compliance point considering a 3.6m mixing zone. At 95% confidence the simulated CWHI for naphthalene and fluoranthene were 15.2 and 3.54 respectively.

If additional dilution is considered within a 10m mixing zone, the hazard indices of the simulated concentrations decrease proportionally, indicating a marginal risk of naphthalene exceeding the GAC at 50m, and no risk of fluoranthene exceeding the withdrawn EEC MAC.

No significant risks were identified from concentrations of COPC in groundwater to the underlying Principal Chalk aquifer at a 50m compliance point.

Model 2: Groundwater in the Drift Deposits

No significant risks were identified from concentrations of chemicals of potential concern (COPC) in soil to the drift deposits Secondary-A aquifer.

Of the COPC groups assessed, groundwater concentrations of benzene were simulated to present a theoretical risk at the 50m compliance point protective of the Secondary-A aquifer at a 95% confidence level with a CWHI of 12.0. At the 50th percentile ('most likely'), the model did not simulate a risk from concentrations of benzene at the 50m compliance point with an HI of 0.371. No risks were simulated from benzene at the 100m compliance point.

Table B – Previous Site Investigations and Remedial Works

Given the low exploitation potential of the aquifer, an extended compliance point of 100m is considered appropriate. As no risks were simulated at the 95th percentile (worst case) at the extended compliance point, or at the 50th percentile ('most likely'), at the 50m compliance point, from a conservative DQRA, the theoretical risks simulated by the model were considered unlikely to pose a significant risk to controlled waters in the drift.

Review of URS Environmental Remedial Strategy Plan (Reference 5)

URS prepared an Environmental Remedial Strategy Plan (ESP) to support the environmental aspects of the planning process for a proposed site redevelopment. The ESP was submitted to the local Planning Department of North Hertfordshire District Council; this was accepted in March 2012 as an appropriate remedial strategy to manage identified impact. The findings of the site investigations and risk assessment indicate that no potentially significant risks to human health or controlled waters have been identified.

Site investigation was unable to be undertaken in close proximity to the tanks or pump islands at the site. As such it was considered likely that during the site redevelopment works hydrocarbon-impacted material may be encountered within the excavations, particularly those associated with the removal of underground fuel tank farm.

The following strategy was proposed in order to control the potential risks to site workers during the redevelopment phase; to improve the overall environmental condition of the site; and to allow for the assessment of material left in situ. The strategy was based on the assumption that the site would be remediated for Continued Oil Use, with redevelopment of the petrol station forecourt.

- Removal of existing USTs as far as practically possible and installation of new USTs in the area;
- Removal of potentially hydrocarbon-impacted groundwater that may ingress into excavations (if required);
- Collection and chemical analysis of soil verification samples from the base and sides of excavations and from imported fill material, to characterise the material left in situ;
- If required, risk assessment on material left in situ that could not be safely or practically removed; and
- Validation reporting.

2.4. Fuel Infrastructure (Prior to Site Redevelopment)

The following information regarding fuel infrastructure prior to site redevelopment was obtained from the URS Preliminary Site Investigation and Comprehensive Site Investigation Report (Refs.2,3 and 4).

Table C: General Information Regarding Fuel Infrastructure Prior to and Post Site Redevelopment		
Site Features	Pre-Construction	Post Construction
Site Age	Information obtained from the URS Phase 1 Site Assessment Report (Ref. 2) shows the earliest recorded date as a petrol filling station was 1970.	
Known Redevelopment on the site	2013	
Number of Fuel Islands and Dispensers (Cars and HGVs)	Cars: Three fuel islands (six dispensers).	Cars: Three fuel islands (six dispensers).
Gauge system currently operating	Veeder Root, TLS 350 R	Gilbarco Veeder-Root TLS 350R
LPG on the site	Not present.	Not present.
Number of above ground tanks, capacity and contents	None present.	None present.
Number of underground tanks / compartments	There were five (5) underground tanks and seven (7) compartments at the site. Two tanks were dual compartment.	Two new USTs; two 65,000L split compartment tanks (20,000/45,000L and 40,000/25,000L).
Number of off-set fill points	Seven off-set fill points located in three manholes to the west of the tank farm. Two of the manholes contained three off-set fill points and the centre manhole contained one off-set fill point.	Four offset fills for the USTs located to the south of the tank farm.
Evidence of abandoned underground tanks on-site	One abandoned underground tank was discovered during the redevelopment to the west of the tank farm which was removed during construction.	No evidence of abandoned underground tanks on site remaining.
Underground Tanks Installation	The tanks and fuel infrastructure were installed into the	The tanks and fuel infrastructure have been installed into

Table C: General Information Regarding Fuel Infrastructure Prior to and Post Site Redevelopment		
Site Features	Pre-Construction	Post Construction
Strata	Superficial Drift Deposits at the site.	the Superficial Drift Deposits at the site.
Design of the Tanks	The tanks were single skinned steel.	Tanks 1 – 4 are reported as doubled skinned steel
Tank Manholes	The manholes were brick lined.	All tank access chambers are Franklin GRP
Site Interceptor	The site contained two 3-stage interceptors. One was situated in the north east of the site and the other was at the south of the site to the east of the car wash.	The interceptor in the north east of the site was replaced with a one chamber superceptor near the site exit. The car wash interceptor remained.
Interceptor Drainage	The interceptor at the north east of the site discharged surface drainage into the main sewer. The interceptor at the south of the site discharged car wash waste water into the main sewer.	The interceptor at the north east of the site discharges surface drainage into the main sewer. The interceptor at the south of the site discharges car wash waste water into the main sewer.
Soakaway on the site	None Identified	None Identified
Known accidental release on-site or wet stock variance	According to the Petroleum Officer's report releases from faults at glands or joints were noted during an inspection of the pumps and pipework in October 1986. No information about repairs is available. In January 1991 the Petroleum Officer noted that there was a release of fuel from a faulty joint on pump 8/9. This was immediately repaired. In May 2001 a release of approximately 10 litres of petrol on the forecourt was reported to the Petroleum Officer. This was cleaned up using 2 spill kits.	

NOTES:

Origin of information – URS Phase I Environmental Site Investigation, September 2011 (Ref 2)

Table D: Summary of On-site Fuel Tank / Compartments – Pre-Development							
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) (litres)	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
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

All active tanks were decommissioned via uplifting fuel, jet cleaning and foam filled. Once safely removed, tanks were broken down for scrap metal.

Table E: Summary of Fuel Tank / Compartments – Post Development				
Tank number or identification	Tank 1		Tank 2	
Compartment Number	T1	T2	T3	T4
Tank type	Double skinned steel	Double skinned steel	Double skinned steel	Double skinned steel
Tank size (L)	45,000	20,000	40,000	25,000
Product stored	Unleaded	VP Unleaded	Diesel	VP Diesel
Status	Operational	Operational	Operational	Operational
Date of installation	2013	2013	2013	2013
Pipeline details	Fill point is offset	Fill point is offset	Fill point is offset	Fill point is offset

Information obtained from Shell drawing 1350-02 Proposed Site development plan

2.5. Geological, Hydrogeological and Hydrological Setting

From previous reports undertaken at the site (Ref. 2 - 4) and the British Geological Survey (BGS) map (sheet 221), the site is underlain by the Lowestoft Formation, which 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 EA 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 Glaciofluvial deposits which is located approximately 25m of the west of the site. The EA website classifies the superficial Glaciofluvial Deposits 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. The Glaciofluvial deposits were encountered in the eastern area of the site in boreholes BH101 to BH103

This is underlain by the Zig Zag Chalk Formation which 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 EA 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 not located within a Source Protection Zone and there are no reported licensed or private groundwater abstractions within 1km of the site. SPZ's are present 2km west, 2km south and 4km to the east 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.

It has been confirmed by North Hertfordshire District Council that there are no reported private water abstractions within 2km of the site.

The closest surface water feature is the Bearton Pond Located approximately 200 m north of the site. The River Hiz is located approximately 850m east of the site, the River Oughton is located 1km north of the site and the River Purwell is located approximately 1.2km north-east of the site. There is one active and one historical surface water abstraction identified within 1km of the site and an additional 4 current surface water abstractions between 1km and 2km from the site.

Based on the geology encountered during intrusive investigation conducted by URS's Comprehensive Environmental Site Assessment, the site is underlain by made ground to depths ranging between 0.3 and 1.8 m bgl. This is underlain by silty sands and gravels forming the superficial deposits. Chalk was encountered at a depth of 5.4m bgl at boreholes BH105 and BH106 located in the western area of the site and at 14.2m bgl at BH102A located in the eastern area of site.

The groundwater on site measured from the February 2012, December 2012, January 2013 and September 2013 groundwater monitoring events was recorded from 5.69m bgl to 7.18m bgl. Groundwater flow direction is inferred to be towards the south east towards the River Hiz with a hydraulic gradient of ranging from 0.004 to 0.005.

2.6. Future Development at the Site

After redevelopment of the site has been completed, the site will comprise a new canopy, refurbished shop, two (2 No.) new underground storage tanks (to the south of the site) consisting of four (4 No. compartments) and associated vents, above ground off-set fill points (to the south of the tank farm), a forecourt interceptor (in the northeast corner of the site), the pre-existing car wash interceptor, three (3 No.) pump islands and new fuel lines and site drainage/ services. A plan of the petrol station post-site redevelopment is presented as Figure 5.

3. FIELD WORK

3.1. Summary of Field Work

Table F – Summary of fieldwork	
Site Activities	The site was closed in March 2013 and re-opened in August 2013; the site redevelopment works were undertaken by Shell, under management of their Contractor, Artelia Group (Artelia). The demolition contractor 'Fox Construction' was contracted directly by Artelia to undertake the decommissioning works.
Date of Field Work	Field works were undertaken by URS between 26th March 2013 and 04th September 2013. Monitoring wells BH103, BH102 and VP101 were decommissioned on 26th March 2013; hydrocarbon delineation trial pits were completed on 17th April 2013; soil validation sampling during tank excavations was undertaken between 9th April 2013 and 22nd May 2013. Monitoring well BH102 was reinstated on 12th August 2013 and a post construction groundwater monitoring event was completed on 04th September 2013. Photographs taken during the validation works are presented in Appendix C.
Health & Safety	In advance of the site works, URS prepared a site-specific health and safety plan. All fieldwork was conducted by a holder of an SPA contractor's safety passport, and fieldwork was conducted in accordance with Shell's safety procedures and requirements. All of the excavation works were undertaken by Fox Construction supervised by the Fox Construction Site Manager or Foreman, under permits issued to Fox Construction by Artelia. The URS engineer observed the works being undertaken. As the works progressed, the URS engineer liaised with Artelia and Fox Construction to coordinate the validation sampling with the site infrastructure removal works.
Monitoring Well Decommissioning	Prior to commencing redevelopment works, monitoring wells BH101, BH102 and VP103 were decommissioned as they were located within the footprint of planned excavation areas. This work was completed by URS subcontractor ADP Group Ltd. under the supervision of a URS engineer. The monitoring wells were pumped with a bentonite/cement grout from the base to the surface using a tremmie pipe and grout pump.

Table F – Summary of fieldwork	
Trial Pits	Five trial pits were excavated to the west and north of the tank farm to determine soil conditions. Trial pits were excavated to a maximum depth of 6.5m below ground level (bgl) into the orange brown sands with occasional gravels forming the Lowestoft Formation and backfilled with the excavated material. No potentially hydrocarbon impacted material was identified during the excavation of the trial pits.
Asbestos	During the excavation of the pump islands 5 and 6, asbestos containing materials (ACM's) were identified in the made ground. DMW Environmental Safety Ltd (DMW) was subcontracted by URS to attend the site and supervise the removal of identified ACM's. Quantitative testing of the asbestos impacted soil samples showed the samples were below the critical value of 0.1% for hazardous waste. The analysis results suggested that debris from different ACM products were present including lower density materials containing amosite. DMW was instructed to provide asbestos remediation safety and monitoring services by URS in relation to proposed ground works. The services provided at Shell Hitchin between 20th May 2013 and 22nd May 2013 were as follows: • Asbestos awareness training delivered to site workforce prior to main works commencing. • Inspection of excavation work during removal of made-ground from site. Bagging and removal of 'nugget' ACM waste. • Provision of licensed removal crew and establishment of working decontamination unit (DCU) on site. Advice regarding asbestos safety matters during the operation. • Background perimeter and personal exposure air monitoring for duration of works. The made-ground removed from site was disposed of as non-hazardous waste. Larger quantities of visible fibrous debris were segregated and disposed of as hazardous waste.
Excavations	Five operational USTs (comprising 7 compartments) (T1 – T7) and one unchartered tanks (T6) were removed by Fox Construction. Due to the presence of an unchartered tank to the west of the tank farm, the old tank farm excavation was partially extended into the new tank farm excavation. The excavations are shown on Figure 3.

Table F – Summary of fieldwork

	<i>Excavation</i>	<i>Detail</i>
	EXA	Operational tanks T1 – T7 and uncharted tank T8 removed between 9 th April to 15 th April 2013. Soil Samples: VA101 - VA126. Additional soil samples VA148 – VA150 were taken when shallower soil samples from EXA failed screening criteria. The resultant excavation was reinstated with imported fill. Due to discovery of uncharted tank EXA extended into new tank farm excavation (EXB).
	EXB	New Tank Farm. Soil Samples VA125, VA133 - VA135, VA141 to VA143
	EXC	Area of pump islands and fuel line. Soil Samples: VA127 – VA132.
	EXD	Interceptor, Soil samples: VA151 – VA155.
	Trial Pits	Five trial pits were excavated across the site to delineate any further hydrocarbon impact. Soil Samples: VA136 - VA140, VA144 to VA147.
Extent of Excavation and Imported Fill	Approximately 1,716 tonnes of excavated material was removed from site which comprised: 1025 m³ of inert waste (crushed concrete) sent to Cainhoe Quarry Beadlow Beds SG17 5PJ; 680 m³ of Non-Hazardous Waste sent to FCC Bletchley Landfill MK3 5FR; and 11 m³ of hazardous ACM waste sent to Thornhaugh Landfill Site, Leicester Road, Thornhaugh, Nr Peterborough. The resultant excavations were backfilled with 220 m³ of Pea Shingle, 200 m³ of Type 1, and 650 m³ of 6F2 imported to the site from Hanson Aggregates. Import material certificates from the suppliers are presented in Appendix G. A total of 4 samples of backfill were collected and analysed by URS, the data are presented in Tables 1 & 2 (samples ref. Backfill 01 to Backfill 03 and fill). Waste transfer notes and Imported Fill Certificates are presented in Appendix F and G respectively.	
New Tank Installations	Two new tanks were installed at the site consisting of one 2.5m diameter steel double skinned tank with split compartment of 45KL and 20KL capacity, and one 2.5m diameter steel double skinned tank with split compartment of 40KL and 25KL capacity. The location of the new tank farm is detailed on Figure 5.	

Table F – Summary of fieldwork

Field Screening and Validation Sampling	Samples were collected from the walls and base of each excavation for logging and screening for the presence of volatile organic vapour. Based on visual and olfactory evidence, selected samples were submitted to the laboratory for chemical analysis. A total of 55 soil validation samples were taken at the site, designed to evaluate the soil conditions associated with the potential source areas described below. Sample locations are indicated on Figure 3. Soil sample descriptions and field observations are presented in the following sections. Analytical results are presented in Table 1. Copies of the laboratory analytical reports are presented in Appendix C.	
	Sample Locations	Number of Samples taken
	Trial Pits.	9 (VA136 - VA140, VA144 to VA147).
	Existing Underground Storage Tank excavation (EXA)	28 (VA101 – VA124, VA126, VA148 – VA150)
	New Tank Farm excavation (EXB)	7 (VA125, VA133 - VA135, VA141 to VA143).
	Pump Islands and Fuel Lines (EXC)	6 (VA127 – VA132).
	Interceptor Excavation (EXD)	5 (VA151 – VA155)
	Backfill Analysis.	4 (Backfill 01 – Backfill 03 and Fill)
Monitoring Well Reinstatement	Monitoring well BH102 was reinstated at the site on the 12th August 2013. Tor Drilling Ltd on subcontract to, and supervised by URS advanced the boreholes using hollow stem auger methodology. The well was drilled to 9m bgl and 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 well was finished in a protective well vault placed flush to surface and set in a concrete pad. Monitoring well BH101 was not reinstated at the site. COPC in groundwater from this location have been reported below the laboratory detection limit in all three pre-construction sampling events at the site. Validation samples collected from the interceptor (located up-gradient of the well) did not show any visual or olfactory signs of impact and validation samples collected were reported below the site screening criteria. URS personnel logged and screened all soil arising during excavation. The borehole logs are presented in Appendix H, and photographs taken during drilling are presented in Appendix B.	

Table F – Summary of fieldwork

Post Construction Groundwater Monitoring	A post construction groundwater monitoring event (GME) was completed at the site on the 4 th September 2013 once the site had reopened. Groundwater was encountered in all boreholes and was found to flow to the southeast of the site towards the River Hiz.
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3.2. Field Screening Results / Observations

Five (5) trial pits were excavated across the site in order to delineate any potentially impacted ground observed in the tank farm excavation (EXA). Trial pit locations are presented on Figure 3. Summary of field observations of trial pit samples are presented in Table G below.

Table G – Trial Pit Field Observations					
Sample ID	Depth (m)	Max PID (ppm)	Location	Sample Description	Visual and olfactory Observations
VA136	3.0	3.3	Trial pit 7m north of T5 (TP1)	Orange SAND. Sand is coarse.	Dry, No visual or olfactory evidence.
VA137	6.0	938.5	Trial pit 7m north of T5 (TP1)	Orange-brown clayey SAND. Sand is fine to medium.	Dry, HC odour
VA138	3.0	<0.1	Trial pit to the west of tank farm (TP2)	Orange SAND. Sand is medium.	Dry, No Visual or Olfactory Evidence
VA139	5.5	0.1	Trial pit to the west of tank farm (TP2)	Orange-brown SAND with gravels of chalk.	Dry, No Visual or Olfactory Evidence
VA140	3.0	13.6	Trial pit to the north west of tank farm (TP3)	Orange-brown clayey SAND. Sand is fine to medium.	Dry, No Visual or Olfactory Evidence
VA144	3.0	1.6	Trial pit to south east of shop (TP4)	Light orange SAND. Sand is fine to medium.	Dry, No Visual or Olfactory Evidence

Table G – Trial Pit Field Observations					
Sample ID	Depth (m)	Max PID (ppm)	Location	Sample Description	Visual and olfactory Observations
VA145	6.5	<0.1	Trial pit to south east of shop (TP4)	Orange-brown SAND. Sand is medium.	Dry, No Visual or Olfactory Evidence
VA146	3.0	<0.1	Trial pit beneath pump islands (TP6)	Orange-brown SAND. Sand is medium.	Dry, No Visual or Olfactory Evidence
VA147	6.5	37.7	Trial pit beneath pump islands (TP6)	Orange-brown SAND. Sand is medium.	Dry, No Visual or Olfactory Evidence

3.3. Field Screening – Excavations

Excavation areas and validation samples from tank removal locations and new tank locations are presented on Figure 3.

3.3.1. Excavation EXA (Tanks 1-7 and an unchartered tank)

Tanks 1 - 7 were removed from the excavation as well as an unchartered tank to the west of the tank farm (T8), designated as Excavation A (EXA). Field observations noted strong hydrocarbon odours and black staining during the removal of the base of the existing USTs at approximately 4.5 m bgl. The depth of the tank excavation was extended by an additional 1.3m to a depth of 6.8m bgl where no visual signs of hydrocarbon impact and only mild hydrocarbon odours were reported. Additional samples were collected (VA148 – VA150) to vertically delineate potentially impacted ground after the exceedance of screening criteria in shallower soil sample (VA115). Summary of field observations of validation samples from the walls and base of the excavation are presented in Table H below.

Table H – Excavation A Field Observations					
Sample ID	Depth (m)	Max PID (ppm)	Location	Sample Description	Visual and olfactory Observations
VA101	4.5	5.7	East wall south	Dark orange gravelly SAND. Gravels are fine, rounded to subangular.	Dry, No visual or olfactory evidence.
VA102	3.0	17.2	East wall north	Light orange SAND. Sand is fine to medium.	Dry, No visual or olfactory evidence.
VA103	3.0	0.4	South wall T5	Dark orange SAND. Sand is fine to medium.	Dry, No visual or olfactory evidence.
VA104	6.5	5.7	T5 base south	Dark orange SAND. Sand is fine to medium.	Dry, slight Hydrocarbon odour
VA105	6.5	1044	T5 base centre	Orange/light grey SAND. Sand is fine to medium.	Dry, strong Hydrocarbon odour
VA106	6.3	1016	T5 base north	Orange/light grey SAND. Sand is fine to medium.	Dry, Hydrocarbon odour
VA107	6.8	1250	T4 base south	Orange-brown SAND going into clay. Sand is fine to medium.	Dry, Hydrocarbon odour
VA108	6.7	735	T4 base centre	Orange-brown SAND. Sand is fine to medium.	Dry, Hydrocarbon odour
VA109	6.8	535.6	T4 base north	Orange-brown SAND. Sand is fine to medium.	Dry, Hydrocarbon odour

Table H – Excavation A Field Observations					
Sample ID	Depth (m)	Max PID (ppm)	Location	Sample Description	Visual and olfactory Observations
VA110	3.0	5.8	South wall T4	Orange SAND with occasional gravels. Sand is fine to medium. Gravels are fine, subangular to rounded.	Dry, No visual or olfactory evidence.
VA111	7.0	568.3	T3 base south	Grey-brown SAND. Sand if fine to medium.	Moist, Hydrocarbon odour
VA112	7.0	1482	T3 base centre	Brown gravelly SAND. Sand is fine to medium. Gravels are fine to medium, rounded to subangular.	Dry, Hydrocarbon odour
VA113	6.7	703.4	T3 base north	Brown-grey SAND with occasional gravels of fine chalk.	Dry, Hydrocarbon odour
VA114	3.0	3.6	South wall T3	Orange/dark orange SAND. Sand is fine to medium.	Dry, No visual or olfactory evidence.
VA115	6.5	283.5	T6 base south	Grey SAND coming into orange-brown clay. Sand is fine to medium.	Dry, Hydrocarbon odour
VA116	6.5	1216	T6 base centre	Dark orange-brown SAND with some silt/clay. Sand is fine to medium.	Dry, Hydrocarbon odour
VA117	6.5	510.6	T6 base north	Brown SAND with clay gravels and Brown silty/clayey SAND.	Dry, Hydrocarbon odour
VA118	3.0	17.3	South wall T6	Orange-dark orange SAND. Sand is fine to medium.	Dry, No visual or olfactory evidence.

Table H – Excavation A Field Observations					
Sample ID	Depth (m)	Max PID (ppm)	Location	Sample Description	Visual and olfactory Observations
VA119	6.5	1141	T2 base south	Brown SAND. Sand is fine to medium.	Moist, Hydrocarbon odour
VA120	6.5	970.4	T2 base north	Firm brown sandy CLAY. Sand is fine to medium.	Moist, Hydrocarbon odour
VA121	3.5	66.9	West wall centre T2	Orange-brown silty SAND with occasional gravels. Sand is fine to medium. Gravels are fine, rounded to subangular.	Dry, slight Hydrocarbon odour
VA122	3.0	1.7	West wall north T2	Orange SAND. Sand is fine to medium.	Dry, No visual or olfactory evidence.
VA123	2.5	1.7	South wall T2	Orange-dark orange SAND. Sand is fine to medium.	Dry, No visual or olfactory evidence.
VA124	6.7	10.1	Unknown tank base	Orange/grey SAND. Sand is fine to medium.	Dry, slight Hydrocarbon odour
VA126	3.0	25.8	South wall unknown tank	Orange-dark orange SAND. Sand is fine to medium.	Dry, No visual or olfactory evidence.
VA148	6.6	1277	T6 base south	Light brown medium SAND with occasional sub-rounded coarse gravel.	Black staining, Hydrocarbon odour
VA149	6.8	1781	T6 base south	Light brown medium SAND with occasional sub-rounded coarse gravel.	Black staining, Hydrocarbon odour
VA150	7.0	120	T6 base south	Orange-brown sand and gravels. Sand is medium, gravel is medium, sub angular of flints	Black staining, Hydrocarbon odour

Cells shaded in grey indicate that this material was removed from site. Cells in white are representative of material left in-situ.

3.3.2. Excavation EXB (New Tank Farm)

Summary of field observations of validation samples from the walls and base of the new tank farm excavation are presented in Table I below.

Table I – Excavation B Field Observations					
Sample ID	Depth (m)	Max PID (ppm)	Location	Sample Description	Visual and olfactory Observations
VA125	3.0	1.1	West wall new tank farm	Orange-dark orange SAND. Sand is fine to medium.	Dry, No visual or olfactory evidence.
VA133	1.2	3.1	East wall new tank farm	Orange-brown SAND with occasional gravels. Sand is fine to medium. Gravels are fine to medium, rounded to subangular.	Dry, NVO
VA134	6.0	658.2	Northern wall of new tank farm	Orange-brown gravelly SAND. Sand is coarse. Gravels are fine to medium rounded to subangular.	Dry, Hydrocarbon odour
VA135	6.0	200.1	Northern wall of new tank farm	Orange SAND. Sand is fine to medium.	Dry, Hydrocarbon odour
VA141	6.5	5.1	Base sample from new tank farm	Orange SAND. Sand is medium.	Dry, No Visual or Olfactory Evidence
VA142	3.0	660.2	Northern wall of new tank farm	Orange-brown and black stained SAND. Sand is fine to medium.	Dry, black stained and HC odour
VA143	6.5	416.7	Base sample from new tank farm	Orange SAND. Sand is medium.	Dry, HC odour

3.3.3. Excavation EXC (Pump Islands, Fuel Lines)

Validation samples were collected from beneath each pump island at the site and along the fuel lines. Summary of field observations of validation samples from the walls and base of the excavation are presented in Table J below.

Table J – Excavation B Field Observations					
Sample ID	Depth (m)	Max PID (ppm)	Location	Sample Description	Visual and olfactory Observations
VA127	0.8	24.4	Pump island 1-2	White gravelly sandy CHALK with orange-brown gravelly sand.	Moist, NVO
VA128	1.5	90.0	Pump island 3-4	Orange-brown SAND with gravels. Sand is fine to medium. Gravels are fine to medium subrounded to angular.	Moist, NVO
VA128A	0.6	292.3	Pump island 3-4	Dark brown gravelly SAND. Sand is fine to medium. Gravels are fine to medium, subrounded to angular of brick and natural stone.	Moist, Hydrocarbon odour
VA129	2.0	16.1	Pump island 5-6	Dark orange-brown. Sand is fine to medium.	Dry, NVO
VA129A	0.25	2.0	Pump island 5-6	Brown gravelly SAND. Sand is fine to medium. Gravels are fine to medium, rounded to subangular of brick and natural stone.	Dry, NVO
VA130	1.2	2.7	Lines between PI 1-2 and PI 3-4	Orange-brown SAND with some gravels. Sand is coarse. Gravels are fine rounded to subangular.	Dry, NVO
VA131	1.2	21.1	Lines west of PI 3-4	Orange-brown gravelly SAND. Sand is coarse. Gravels are fine to medium rounded to subangular of chalk and natural stone.	Dry, NVO

Table J – Excavation B Field Observations

Sample ID	Depth (m)	Max PID (ppm)	Location	Sample Description	Visual and olfactory Observations
VA132	1.2	54.2	Lines east of PI 5-6	Brown gravelly SAND. Sand is fine to medium. Gravels are fine to medium rounded to subangular.	Dry, slight Hydrocarbon odour

3.3.4. Excavation EXD (Interceptor)

The interceptor was removed from the excavation designated as Excavation D (EXD). The new interceptor will be placed in the same location. Summary of field observations of validation samples from the walls and base of the excavation are presented in Table K below.

Table K – Excavation EXD Field Observations

Sample ID	Depth	Max PID (ppm)	Location	Sample Description	Visual and olfactory Observations
VA151	1.2	9.3	North wall of interceptor	Light brown sandy gravelly CLAY with grey mottling. Gravel is fine to medium sub-rounded to sub-angular of flint and chalk. Possible MADE GROUND just below drainage pipe.	Dry, slight Hydrocarbon odour
VA152	1.2	0.7	South wall of interceptor	Light brown sandy gravelly CLAY with grey mottling. Gravel is fine to medium sub-rounded to sub-angular of flint and chalk. Possible MADE GROUND just below drainage pipe.	Dry, No visual or olfactory evidence
VA153	1.2	3.3	East wall of interceptor	Light brown sandy gravelly CLAY with grey mottling. Gravel is fine to medium sub-rounded to sub-angular of flint and chalk. Possible MADE GROUND just below drainage pipe.	Dry, slight Hydrocarbon odour

Table K – Excavation EXD Field Observations					
Sample ID	Depth	Max PID (ppm)	Location	Sample Description	Visual and olfactory Observations
VA154	1.2	31.1	West wall of interceptor	Light brown sandy gravelly CLAY with grey mottling. Gravel is fine to medium sub-rounded to sub-angular of flint and chalk.	Dry, slight Hydrocarbon odour
VA155	3.0	2.2	Base of interceptor	Dark brown medium firm CLAY with sub-rounded gravels of fine to medium chalk and medium flint.	Dry, slight Hydrocarbon odour

4. LABORATORY ANALYTICAL RESULTS

4.1. Analytical Schedules & QA/QC

Table L – Analytical Information		
Analytical Laboratory	Analytical samples were sent under Chain of Custody procedures for analysis at Alcontrol of Chester.	
Analytical Schedule	The following schedule of analysis was completed for this Verification Report, Appendix C provides the laboratory reports and details of the analytical methodology. Soil analytical results are presented in Tables 1 and 2.	
	Analysis	Number of soil samples
	Benzene, Toluene, Ethylbenzene, Xylenes, MTBE, TAME, DIPE, Ethanol, ETBE and TBA.	59
	Total Petroleum Hydrocarbons Criteria Working Group.	59
	Polycyclic Aromatic Hydrocarbons (PAHs).	54
Laboratory quality control sampling	Chain of Custody forms are provided in Appendix D. Holding times for selected validation samples collected in 2013 exceeded the recommended 7 days by a maximum of 3 days. The results of laboratory surrogate recovery data indicate that the results obtained are within tolerable limits. URS therefore considers the data acceptable for environmental interpretation.	

Table L – Analytical Information

Waste Classification	All material removed for off-site disposal was given a formal description and waste classification (i.e. Hazardous and Non-Hazardous) prior to disposal, as required by the Hazardous Waste (England and Wales) Regulations 2005. Approximately 1,716 tonnes of excavated material was removed from site which comprised: 1025 m³ of Inert waste (crushed concrete) sent to Cainhoe Quarry Beadlow Beds SG17 5PJ; 680 m³ of Non-Hazardous Waste sent to FCC Bletchley Landfill MK3 5FR; and 11 m³ sent to Thornhaugh Landfill Site, Leicester Road, Thornhaugh, Nr Peterborough. To determine the likely waste classification of the soils beneath the site, the chemical analysis results for soil samples were assessed using the criteria set out in: "Interpretation of the definition and classification of hazardous waste," Environment Agency, Technical Guidance WM2 (Second Edition, version 2.2). Composite soil samples, WAC, representative of made ground and Langley Silt Member were taken from trial pits across the site. The samples were collected by Fox Construction and analysed for Waste Acceptance Criteria (WAC) analysis, the reports are provided in Appendix E. Waste transfer documentation is provided in Appendix G.
Imported Material	220 m³ of Pea Shingle, 200 m³ of Type 1, and 650 m³ of 6F2 were imported to the site from Hanson Aggregates. Import material certificates from the suppliers are presented in Appendix G. A total of 4 samples of backfill were collected and analysed by URS, the data are presented in Tables 1 & 2 (samples ref. Backfill 01 to Backfill 03 and fill). Waste transfer notes and Imported Fill Certificates are presented in Appendix F and G respectively.

4.2. Human Health and Controlled Waters Screening

4.2.1. Screening Criteria

For each of the soil and groundwater samples analysed, results were screened against URS Stage 2 screening values protective of Human Health and Stage 3 Controlled Waters SSAC derived in the URS DQRA (Ref.4).

Human Health

The screening criteria protective of Human Health assumes a continued petroleum use (CPU) for the site and high density residential (HDR) land use for off-site receptors.

The human health CPU and 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. Following the completion of construction works it is understood that the site will be covered in 100% hard standing. The human health GAC 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.

Controlled Waters

Potential risks to groundwater underlying the site were assessed in the URS February CW DQRA (Ref.4) using two separate models:

- Model 1: Groundwater in the Chalk - Primary Receptor
- Model 2: Groundwater in the Drift Deposits – Secondary Receptor

Model 1 – Groundwater in the Chalk Principal aquifer

The Controlled Waters receptors for the site are the underlying Zig Zag Chalk (Principal Aquifer) and the Superficial Deposits. Although the site is underlain by superficial deposits of the Lowestoft Formation which are described by the EA as unproductive strata, the formation is shown on the 1:50,000 geological map to be underlain and surrounded by Glaciofluvial Deposits (classified

as a Secondary-A aquifer). It has been assumed for the model that the boreholes are installed in the more sensitive Secondary-A aquifer as the vertical and horizontal extent of the Lowestoft Till and Glaciofluvial Deposit units within the permeable drift are not known. The site is close to the edge of a significant buried valley feature with drift deposits reaching up to 80m in thickness within 1km to the north-west, north and north-east of the site.

Local flow in the Chalk Principal aquifer in the area has been inferred towards the southeast towards the River Hiz which feeds into the River Purwell. The 1:50,000 geological map indicates that the increasingly thick drift sequence may be directly underlain by the Gault Clay, with the Lower Chalk absent, within 300m of the west of the site, and within 1km to the north and north east.

Groundwater flowing laterally in the Chalk in the area of the site is therefore likely to discharge laterally to the drift sequence, as the top of the Chalk becomes increasingly deeper, for example the groundwater in the Chalk on site is assumed to flow eastwards with a gradient of approximately 0.005 at approximately 6.2m bgl however the depth to the Chalk increases from 5.4m bgl in the western area of the site to 14.2m bgl at BH102A located in the eastern area of site.

Groundwater in the underlying Zig Zag Chalk formation was selected as the primary compliance point for the assessment and was modelled assuming that impacted pore water from soils and groundwater could migrate into the Principal aquifer at a rate equal to infiltration, followed by horizontal migration within the aquifer. A Compliance Point of 50m was selected to model the potential risks from hazardous substances to groundwater. The assessment is considered appropriate for soils, as it effectively assumes that impacted soils directly overlie the Chalk, and disregards any dilution and attenuation in the drift.

Model 2 – Groundwater in the Drift Secondary-A aquifer

Groundwater in the superficial deposits underlying the site has been selected as the secondary compliance point. For the purpose of this assessment it has been conservatively assumed that the wells installed in the drift are installed in a Secondary-A aquifer, as the vertical and horizontal extent of the Lowestoft Formation and Glaciofluvial Deposits is not known.

Although the drift deposits are considered a controlled waters receptor, there are physical constraints on the ability to use the groundwater resource. The exploitation potential of the drift deposits beneath the site is considered likely to be low for the following reasons:

- Field tests indicate the drift deposits below the site are only slowly permeable
- There are no reported licensed groundwater abstractions within 1km of the site and no reported private groundwater abstractions within 2km of the site. The nearest surface water abstraction is located 835m south of the site; and

- The down-gradient area is a residential area with mains water supply.

An arbitrary Compliance Point of 50m in the drift deposits has been selected to be protective of the Secondary-A aquifer, however due to the low exploitation of the aquifer an extended compliance point of 100m has also been considered in the assessment to provide an indication of potential risks to the wider aquifer.

4.3. Soil Analytical Results

Soil analytical data are presented in Tables 1 and 2 and laboratory analytical reports are included in Appendix C. Table M below provides a summary of the analytical results. It should be noted that validation samples VA115, VA148 and VA149 were removed from the site as part of the extended tank farm excavation. These results have not been included in the summary of discussion of results below.

Table M – Summary of Analytical Soil Results								
Analyte	Units	MDL	URS Stage 2 GAC Human Health ¹	URS Stage 3 SSAC for Controlled Waters	Minimum	Maximum	No. Samples Exceeding Screening Criteria	
							Human Health ²	Controlled Waters
Volatile Organic Compounds								
Benzene	mg/kg	0.009	0.0928	0.12	ND	0.426	2 (0)	2
Toluene	mg/kg	0.005	222	77.3	ND	3.44	0 (0)	0
Ethylbenzene	mg/kg	0.004	60.1	76.2	ND	10.5	0 (0)	0
M,P-Xylene	mg/kg	0.014	19.7	133	ND	107	3 (1)	0
O-Xylene	mg/kg	0.01	21.1	133	ND	48	1 (0)	0
Total Petroleum Hydrocarbons								
TPH (C6-C7) aromatic	mg/kg	0.01	92	NA	ND	0.348	0 (0)	0
TPH (>EC7-8) aromatic	mg/kg	0.01	222	NA	ND	5.67	0 (0)	0
TPH (>EC8-10) aromatic	mg/kg	0.01	12.9	<Sat	ND	268	5 (1)	0
TPH (>EC10-12) aromatic	mg/kg	0.01	70.6	246	ND	84.5	1 (0)	0
TPH (>EC12-16) aromatic	mg/kg	0.1	<Sat	<Sat	ND	16.7	0 (0)	0

Table M – Summary of Analytical Soil Results								
Analyte	Units	MDL	URS Stage 2 GAC Human Health ¹	URS Stage 3 SSAC for Controlled Waters	Minimum	Maximum	No. Samples Exceeding Screening Criteria	
							Human ₂ Health	Controlled Waters
TPH (>EC16-21) aromatic	mg/kg	0.1	<Sat	<Sat	ND	70	0 (0)	0
TPH (>EC21-35) aromatic	mg/kg	0.1	<Sat	<Sat	ND	71.9	0 (0)	0
TPH (C5-C6) aliphatic	mg/kg	0.01	14	<Sat	ND	2.42	0 (0)	0
TPH (>EC6-8) aliphatic	mg/kg	0.01	30.7	<Sat	ND	51.7	2 (0)	0
TPH (>EC8-10) aliphatic	mg/kg	0.01	7.46	<Sat	ND	187	6 (0)	0
TPH (>EC10-12) aliphatic	mg/kg	0.01	36.4	<Sat	ND	127	2 (0)	0
TPH (>EC12-16) aliphatic	mg/kg	0.1	<Sat	<Sat	ND	38.5	0 (0)	0
TPH (>EC16-21) aliphatic	mg/kg	0.1	<Sat	<Sat	ND	169	0 (0)	0
TPH (EC21-35) aliphatic	mg/kg	0.1	<Sat	<Sat	ND	175	0 (0)	0
TPH (EC35-44) aliphatic	mg/kg	0.1	<Sat	<Sat	ND	84.7	0 (0)	0
TPH Hazard Index	ratio	NA	1	NA	0.0001	35.27	7 (1)	0
Fuel Oxygenates								
TBA	mg/kg	0.01	111	NA	ND	2.74	0 (0)	0
DIPE	mg/kg	0.001	1.52	NA	ND	ND	0 (0)	0
TAME	mg/kg	0.015	0.738	NA	ND	ND	0 (0)	0
ETBE	mg/kg	0.001	2.31	NA	ND	0.0794	0 (0)	0
MTBE	mg/kg	0.011	23.5	NA	ND	2.78	0 (0)	0
Polyaromatic Hydrocarbons								
Acenaphthene	mg/kg	0.008	>Sat	>Sat	ND	0.12	0 (0)	0
Acenaphthylene	mg/kg	0.012	>Sat	16.6	ND	0.0206	0 (0)	0
Anthracene	mg/kg	0.016	>Sat	>Sat	ND	0.215	0 (0)	0
Benzo[a]anthracene	mg/kg	0.014	>Sat	>Sat	ND	0.862	0 (0)	0
Benzo[a]pyrene	mg/kg	0.015	>Sat	>Sat	ND	1.15	0 (0)	0
Benzo[b]fluoranthene	mg/kg	0.015	>Sat	>Sat	ND	1.14	0 (0)	0
Benzo[g,h,i]perylene	mg/kg	0.024	>Sat	>Sat	ND	0.757	0 (0)	0

Table M – Summary of Analytical Soil Results								
Analyte	Units	MDL	URS Stage 2 GAC Human Health ¹	URS Stage 3 SSAC for Controlled Waters	Minimum	Maximum	No. Samples Exceeding Screening Criteria	
							Human ² Health	Controlled Waters
Benzo[k]fluoranthene	mg/kg	0.014	>Sat	>Sat	ND	0.541	0 (0)	0
Chrysene	mg/kg	0.01	>Sat	>Sat	ND	0.761	0 (0)	0
Dibenzo[a,h]anthracene	mg/kg	0.023	>Sat	>Sat	ND	0.167	0 (0)	0
Fluoranthene	mg/kg	0.017	>Sat	7.99	ND	1.16	0 (0)	0
Fluorene	mg/kg	0.01	>Sat	>Sat	ND	0.182	0 (0)	0
Indeno[1,2,3-cd]pyrene	mg/kg	0.018	>Sat	>Sat	ND	0.638	0 (0)	0
Naphthalene	mg/kg	0.009	0.599	0.28	ND	3.88	2 (1)	2
Phenanthrene	mg/kg	0.015	>Sat	>Sat	ND	0.671	0 (0)	0
Pyrene	mg/kg	0.015	>Sat	>Sat	ND	1.11	0 (0)	0

>Sat: unacceptable risk to receptor cannot be achieved due to calculated saturation of vapour pathway

¹ Minimum of Continued Petroleum Use and High Density Residential GAC

² HH exceedances are HDR, with CPU exceedances in brackets

NA – Analyte not modelled.

4.3.1. Human Health

CPU Land use– protective of on-site workers and visiting public

One soil validation samples collected from the base of the existing tank farm excavation exceeded the human health TPH Hazard Index (HI) of 1 by a factor of 1.18. This exceedance is considered marginal and has not been discussed further.

Residential Land Use – protective of residents to the south of the site.

Benzene exceeded the human health HDR GAC protective of off-site residents in two soil validation samples collected from the centre of the base of the existing tank farm excavation (VA116 and VA117). Hazard indices were reported at 4.61 and 3.77 respectively.

Xylene exceeded the HDR GAC in three samples (VA105, VA107 and VA116) collected from the base of the existing tank farm excavation at depths of 6.5m bgl with marginal reported hazard indices of 1.75, 3.43 and 2.38 respectively.

Naphthalene was reported at concentrations in excess of the human health GAC of 0.599 mg/kg in two samples collected from the existing tank farm: VA105 (6.5m bgl) exceeded by a factor of 1.99 and VA107 (6.8m bgl) exceeded by a factor of 6.48.

The TPH HI of 1 was exceeded in seven out of the 59 soil validation samples collected at the site. The greatest exceedances were reported from samples VA105 and VA116 which exceeded by a factor of 35.27 and 22.01 respectively. Both samples were collected from the base of the tank farm excavation at a depth of 6.5m bgl. The remaining exceedances were reported hazard indices >6.5.

4.3.2. Controlled Waters

Concentrations of benzene were detected in concentrations greater than the controlled waters GAC in two out of the 59 validation samples collected and analysed from the site. The exceedances were reported from VA116 and VA117 located at the base of the existing tanks farm at a depth of 6.5m bgl. Reported HI's were 3.52 and 2.89 respectively.

Naphthalene exceeded the controlled waters GAC in two out of the 59 samples analysed for PAH. The exceedances were reported from the base of the tank excavation at a depth of 6.5m bgl with HI of 4.25 and 13.86

4.4. Groundwater Analytical Results

Groundwater analytical data from pre-construction and post construction monitoring rounds are presented in Table 3 and laboratory analytical reports are included in Appendix C. Table N below provides a summary of the post construction analytical results.

Table N – Summary of Analytical Groundwater Results								
Analyte	Units	MDL	URS Stage 2 GAC Human Health ¹	URS Stage 3 SSAC for Controlled Waters ²	Minimum	Maximum	No. Samples Exceeding Screening Criteria	
							Human Health ³	Controlled Waters ⁴
Volatile Organic Compounds								
Benzene	µg/l	1	1100	63.7	ND	303	0 (0)	1 (0)
Toluene	µg/l	1	>Sat	>Sol	ND	35	0 (0)	0 (0)
Ethylbenzene	µg/l	1	173000	>Sol	ND	756	0 (0)	0 (0)
M,P-Xylene	µg/l	1	51600	>Sol	ND	1570	0 (0)	0 (0)
O-Xylene	µg/l	1	62100	>Sol	ND	389	0 (0)	0 (0)
Total Petroleum Hydrocarbons								
TPH (C6-C7) aromatic	µg/l	10	1090000	669	ND	241	0 (0)	0 (0)
TPH (>EC7-8) aromatic	µg/l	10	>Sat	>Sol	ND	29	0 (0)	0 (0)
TPH (>EC8-10) aromatic	µg/l	10	9830	>Sol	ND	2420	0 (0)	0 (0)
TPH (>EC10-12) aromatic	µg/l	10	>Sat	>Sol	ND	197	0 (0)	0 (0)
TPH (>EC12-16) aromatic	µg/l	10	>Sat	>Sol	ND	29	0 (0)	0 (0)
TPH (>EC16-21) aromatic	µg/l	10	>Sat	>Sol	ND	ND	0 (0)	0 (0)
TPH (>EC21-35) aromatic	µg/l	10	>Sat	>Sol	ND	ND	0 (0)	0 (0)
TPH (C5-C6) aliphatic	µg/l	10	10300	>Sol	ND	38	0 (0)	0 (0)

Table N – Summary of Analytical Groundwater Results								
Analyte	Units	MDL	URS Stage 2 GAC Human Health ¹	URS Stage 3 SSAC for Controlled Waters ²	Minimum	Maximum	No. Samples Exceeding Screening Criteria	
							Human Health ³	Controlled Waters ⁴
TPH (>EC6-8) aliphatic	µg/l	10	>Sat	>Sol	ND	104	0 (0)	0 (0)
TPH (>EC8-10) aliphatic	µg/l	10	302	>Sol	ND	611	1 (0)	0 (0)
TPH (>EC10-12) aliphatic	µg/l	10	>Sat	>Sol	ND	295	0 (0)	0 (0)
TPH (>EC12-16) aliphatic	µg/l	10	>Sat	>Sol	ND	ND	0 (0)	0 (0)
TPH (>EC16-21) aliphatic	µg/l	10	>Sat	>Sol	ND	ND	0 (0)	0 (0)
TPH (EC21-35) aliphatic	µg/l	10	>Sat	>Sol	ND	ND	0 (0)	0 (0)
TPH (EC35-44) aliphatic	µg/l	10	>Sat	>Sol	ND	ND	0 (0)	0 (0)
TPH Hazard Index	ratio	NA	1	NA	ND	1.012	0 (0)	0 (0)
Fuel Oxygenates								
TBA	µg/l	10	628000	>Sol	ND	ND	0 (0)	0 (0)
DIPE	µg/l	1	25300	>Sol	ND	ND	0 (0)	0 (0)
TAME	µg/l	1	11700	>Sol	ND	ND	0 (0)	0 (0)
ETBE	µg/l	1	34600	>Sol	ND	ND	0 (0)	0 (0)
MTBE	µg/l	1	331000	>Sol	ND	ND	0 (0)	0 (0)
Polyaromatic Hydrocarbons								
Acenaphthene	µg/l	0.015	>Sat	>Sol	ND	0.0771	0 (0)	0 (0)
Acenaphthylene	µg/l	0.011	>Sat	16000	ND	0.011	0 (0)	0 (0)
Anthracene	µg/l	0.015	>Sat	>Sol	ND	ND	0 (0)	0 (0)
Benzo[a]anthracene	µg/l	0.017	>Sat	>Sol	ND	0.0412	0 (0)	0 (0)
Benzo[a]pyrene	µg/l	0.009	>Sat	>Sol	ND	0.0412	0 (0)	0 (0)

Table N – Summary of Analytical Groundwater Results								
Analyte	Units	MDL	URS Stage 2 GAC Human Health ¹	URS Stage 3 SSAC for Controlled Waters ²	Minimum	Maximum	No. Samples Exceeding Screening Criteria	
							Human Health ³	Controlled Waters ⁴
Benzo[b]fluoranthene	µg/l	0.023	>Sat	>Sol	ND	0.0409	0 (0)	0 (0)
Benzo[g,h,i]perylene	µg/l	0.016	>Sat	>Sol	ND	0.0333	0 (0)	0 (0)
Benzo[k]fluoranthene	µg/l	0.027	>Sat	>Sol	ND	0.0476	0 (0)	0 (0)
Chrysene	µg/l	0.013	>Sat	>Sol	ND	0.0518	0 (0)	0 (0)
Dibenzo[a,h]anthracene	µg/l	0.016	>Sat	>Sol	ND	ND	0 (0)	0 (0)
Fluoranthene	µg/l	0.017	>Sat	>Sol	ND	0.0786	0 (0)	0 (0)
Fluorene	µg/l	0.014	>Sat	>Sol	ND	0.176	0 (0)	0 (0)
Indeno[1,2,3-cd]pyrene	µg/l	0.014	>Sat	>Sol	ND	0.0287	0 (0)	0 (0)
Naphthalene	µg/l	0.1	640	874	ND	67.3	0 (0)	0 (0)
Phenanthrene	µg/l	0.022	>Sat	>Sol	ND	0.148	0 (0)	0 (0)
Pyrene	µg/l	0.015	>Sat	>Sol	ND	0.0678	0 (0)	0 (0)

>Sat: unacceptable risk to receptor cannot be achieved due to calculated saturation of vapour pathway

>Sol: unacceptable risk to receptor cannot be achieved due to calculated solubility limit.

¹ Minimum of Continued Petroleum Use and High Density Residential GAC

² Minimum of Controlled waters drift and chalk model SSAC

³ HH exceedances are HDR, with CPU exceedances in brackets

⁴ CW exceedances are Drift model, with Chalk model exceedances in brackets

NA – Analyte not modelled.

4.4.1. Human Health

CPU Land use— protective of on-site workers and visiting public

No exceedances of the CPU human health GAC protective of on-site workers were reported from any of the post construction groundwater samples collected at the site.

Residential Land Use – protective of residents to the south of the site.

Groundwater sampled from BH102 marginally exceeded the TPH HI of 1 by a factor of 1.01. This is not considered significant and has not been assessed further.

4.4.2. Controlled Waters

Groundwater in the drift

Post construction concentrations of benzene were detected in concentrations greater than the controlled waters SSAC in groundwater sampled from BH102 with a reported HI of 4.76.

Groundwater in the chalk

No groundwater samples collected from the on-site monitoring wells were reported above the controlled waters SSAC protective of the Chalk Principal aquifer.

4.5. Screening Summary

Human Health

Human health exceedances of the HDR GAC in soil samples collected from the site have not been further assessed for the following reasons:

The primary exposure pathway for risks to off-site residents from benzene, xylene, naphthalene and TPH in soil is via vapour migration and subsequent inhalation. It is considered that in the assessment of potential risks from soil GAC exceedances for vapour only pathways, greater reliance should be placed upon the measured vapour data rather than theoretical risks based upon GAC derived using conservative assumptions about the site setting. These assumptions include:

- A soil source present at 1 m bgl, whereas the soil exceedances were reported at approximately 6.5m bgl. There will therefore be significantly greater attenuation of vertically migrating vapours.
- The GAC assume that the source is directly below the entire building, whereas the samples that exceed GAC are on site within the base of the tank farm excavation. Validation samples collected from the southern side wall of the tank excavation (VA101 at 4.5m bgl, VA103 at 3m bgl, VA110 at 3m bgl, VA114 at 3m bgl and VA118 at 3m bgl) in closer proximity to the off-site residents were not reported above the soil GAC. The presence of soil impact beneath the building has not been confirmed and significant impact beneath the building is considered unlikely.
- The GAC assume a total organic carbon content (TOC) of 0.58%. Values for TOC in unsaturated soil samples collected from the site by URS during site investigation works (Ref.3) 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 overestimate potential risks to the identified human health receptors.

The nearest residents to the site are located approximately 5m from the southern boundary of the site in the Firs Hotel. The soil impacts identified beneath the tank farm are located approximately 15m north of these off-site residents. The potential attenuation of vapours over a minimum compliance point distance of 15m has not been included within the generic assessment. This would be expected to result in significant vapour attenuation and resultant significant decrease in potential risk.

The data from on-site vapour wells (VP101 to VP103) were three orders of magnitude lower than the soil vapour GAC when sampled in the URS Comprehensive Site Investigation (Ref.3). The results from VP102 located approximately 10m from the off-site residents and 7m from the exceedance at VA105 provide an indication of the degree to which the soil GAC overestimates vapour intrusion risk at this particular site. Furthermore, the vapour monitoring was undertaken when impacted soil was in-situ at the site. Following the redevelopment works, impacted soils have been removed from beneath the tank farm and were not identified in other areas of the site. This would be expected to result in a further reduction of potential vapours at the site.

Controlled Waters

Post construction concentrations of benzene were detected in concentrations greater than the controlled waters SSAC protective of the drift deposits underlying the site in groundwater sampled from BH102 with a reported HI of 4.76.

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.

Although the drift deposits are considered a controlled waters receptor, there are physical constraints on the ability to use the groundwater resource. The exploitation potential of the drift deposits beneath the site is considered likely to be low as discussed in Section 4.2.1 above. Given the low exploitation potential of the aquifer, an extended compliance point of 100m is considered appropriate with a benzene water target value of 1000 µg/l. As no risks are simulated at the at the extended compliance point, and hazard indices are only marginal at the 50m compliance point from a conservative DQRA (Ref.4), the theoretical risks simulated by the model are considered unlikely to pose a significant risk to controlled waters in the drift. It should be noted that concentrations of benzene in BH102 have significantly decreased since the start of sampling in October 2011 from a concentration of 1,460 µg/l to 303 µg/l which was reported in the post construction sampling event.

COPC in groundwater sampled from BH102a (located approximately 3m west of BH102 closer to the tank farm and installed in the deeper chalk geology) were all reported below the laboratory detection limit. No risks have been simulated to groundwater quality within the Chalk Principal aquifer from post construction groundwater concentrations at the site.

5. CONCEPTUAL SITE MODEL

The CSM presented here is based on site specific information.

5.1. Conceptual Site Model

5.1.1. Chemicals of Potential Concern (COPC)

- 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.

5.1.2. Potential Sources

On-site

- New underground storage tanks.
- Accidental releases to ground from off-set fill points.
- Accidental releases from fuel lines: present between the new tanks and new fuel islands.
- Forecourt interceptor and associated drainage lines.
- Site drainage.

5.1.3. Potential Pathways

Human Health

- Vapours – Migration of vapours through made ground to above ground buildings.
- Particulate – Ingestion, inhalation, dermal contact, with soil particulates.

Controlled Waters

- Leaching – Potential migration of hydrocarbon substances from soils into shallow (and potentially deep) groundwater.
- Potential migration of impacted perched water into shallow (and potentially deep) groundwater.
- Leaching – Potential migration of hydrocarbon substances from soils into shallow (and potentially deep) groundwater, followed by migration to surface water.
- Potential migration of impacted perched water into shallow groundwater, followed by migration to surface water.

5.1.4. Potential Receptors

Human Health

- Shop staff.
- The general public and visiting staff (such as contractors, including those conducting excavation works).
- Off-site residents located to all sides of the site
- Possible future construction workers.
- Site potable water.

Controlled Waters

- Groundwater in the underlying Principal aquifer (Zig Zag chalk Formation)
- Surface water feature – Bearton Pond Located approximately 200 m north of the site and the River Hiz is located approximately 850m east of the site.
- Surface water abstraction - There is one surface water abstraction identified within 1km of the site.
- The Conceptual Site Model is presented in Figure 4.

5.2. Review of Potential Source-Pathway-Receptor Linkages

Based on the available information following site redevelopment, the following pollutant linkages have been evaluated. Refer also to Figure 4.

Table O: Human Health			
Source	Pathway	Receptor	Likelihood of Pollutant Linkage
Impacted soils from the site. Impacted groundwater	Vapours – Migration of vapours through made ground to above ground buildings.	On-site shop staff.	Unlikely – Vapour monitoring at the site was reported below the Stage 2 GAC protective of on-site workers or off-site residents.
		Visiting staff and general public.	
		Off-site residents	
		Visiting contractors excavating ground and future construction workers	
	Particulate – Ingestion, inhalation, dermal contact, with soil particulates.	Visiting contractors excavating ground and future construction workers	Potential Linkage – The use of PPE would mitigate this risk by breaking the pathway between source and receptor.

Table P: Controlled Waters			
Source	Pathway	Receptor	Likelihood of Pollutant Linkage
Impacted soils from the site.	Leaching – Migration of hydrocarbon substances from soils into shallow (and potentially deep) groundwater.	Superficial Deposits (Secondary A Aquifer)	Unlikely – No significant risks were identified from concentrations of COPC in soil or post-construction groundwater to the underlying Drift Deposits Secondary-A aquifer or underlying Principal Chalk aquifer.
	Migration of impacted perched water into shallow and potentially deeper groundwater.	Zig Zag Chalk Formation (Principal Aquifer)	
Impacted groundwater	Leaching – Migration of hydrocarbon substances from soils into shallow groundwater, followed by migration to surface water.	Surface water within the Bearton Pond located approximately 200m north and the River Hiz located approximately 850m east of the site.	

6. CONCLUSIONS

The site is an active retail petroleum site that has undergone a tank replacement and redevelopment commencing in March 2013 and completed in August 2013. As part of these works, the existing USTs, unchartered USTs, fuel lines, fuel dispensers, interceptor, drainage, and surface hardstanding were removed and replaced.

As part of the construction programme seven active tanks and one solid filled decommissioned tank were removed at the site and replaced with two new double walled 65KL split compartment tanks. In conjunction with the fuel infrastructure removal, URS undertook validation sampling of excavations advanced for the removal of the underground storage tanks (USTs). A total of 59 soil samples were collected.

Field observations noted strong hydrocarbon odours and black staining during the removal of the base of the existing USTs at approximately 4.5 m bgl. The depth of the tank excavation was extended by an additional 1.3m to a depth of 6.8m bgl where no visual signs of hydrocarbon impact and only mild hydrocarbon odours were reported. Soil impacts were not reported in soil samples collected from excavations for the new tank farm or the replacement of the site interceptor. Phase Separated Hydrocarbons (PSH) were not reported at any location on-site.

In total approximately 1,705 m³ of material was excavated and disposed of as Inert and Non-Hazardous material. 11 m³ of asbestos impacted material was removed from site as hazardous waste. Resultant excavations were backfilled with approximately 1,070 m³ material (excluding poured concrete and tarmac).

Following completion of the construction works post construction groundwater monitoring was undertaken at the site. No visual or olfactory signs of hydrocarbon impact were reported in any of the monitoring wells sampled.

A risk assessment was undertaken on validation samples collected from soil left in-situ underlying the site and post construction groundwater monitoring data. No potentially significant risks to human health (protective of on-site workers and off-site residents) were identified. No potentially significant risks were identified to groundwater quality within the Drift Deposits Secondary-A aquifer or the underlying Chalk Principal aquifer.

The site is considered suitable for on-going oil use.

7. 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 Final
- Reference 3** URS, Comprehensive Environmental Site Assessment - Shell Hitchin. January 2012. R46370079-002 Final
- Reference 4** URS, Comprehensive Environmental Site Assessment – Further Assessment- Shell Hitchin. February 2013. R46370079-003 Final
- Reference 5** URS, Environmental Strategy Plan - Shell Hitchin. March 2013. R46370079-004 Final

Figures

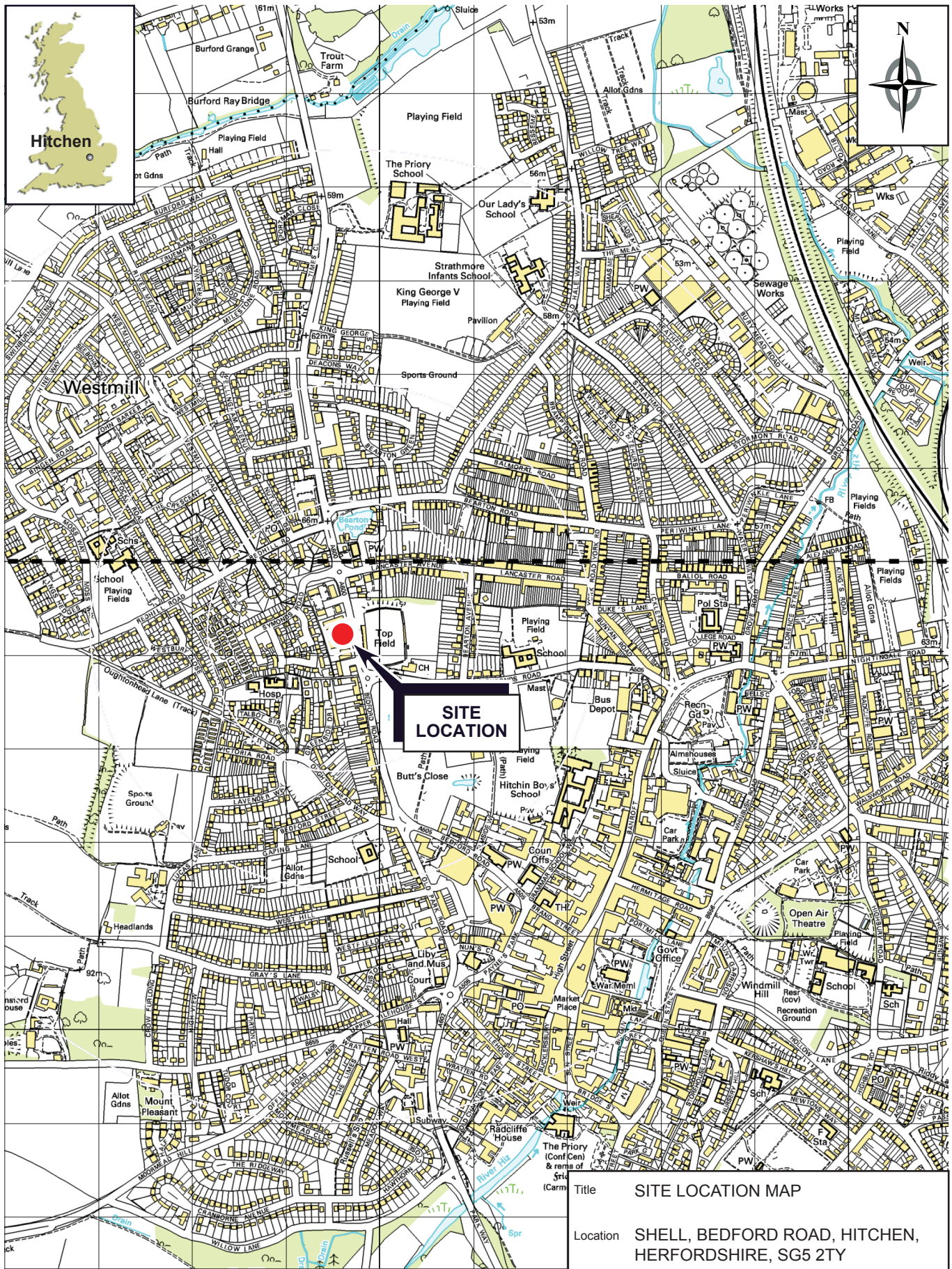
Figure 1 – Site Location Plan

Figure 2 – Site Features Plan (Pre – Redevelopment)

Figure 3 – Soil Validation Sample Locations

Figure 4 – Conceptual Site Model

Figure 5 – Site Features Plan (Post – Redevelopment)



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Title SITE LOCATION MAP

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

Client SHELL UK OIL PRODUCTS LTD

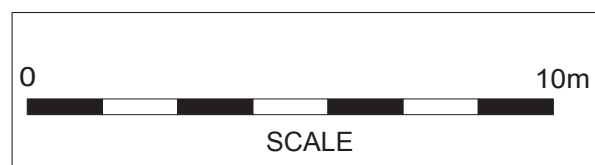
URS

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
- DECOMMISSIONED BOREHOLE LOCATION



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DRAWING TITLE
FIGURE 2 - SITE FEATURES - PRE CONSTRUCTION

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