SHELL SUTTON ELMS

Groundwater Monitoring Report

Shell UK Oil Products Limited

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DECEMBER 2023

SHELL SUTTON ELMS

Groundwater Monitoring Report

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Version Control

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01	14 December 2023	Sameer Kadukar	Jon Raven	Kate Eaton	NA – First issue

Executive Summary

Background	Arcadis (UK) Limited (Arcadis) was commissioned by Shell UK Oil Products Limited (Shell) to undertake a groundwater monitoring visit at Shell Sutton Elms, located at Coventry Road, Broughton, Leicester, LE9 6QD (hereafter 'the site').
Objectives	The objective of the groundwater monitoring works was to assess the presence, nature, and extent of Constituents of Potential Concern (COPC) in groundwater beneath the site and further characterize potential contaminant linkages at the site.
Scope of Works	• Well development of four monitoring wells to remove silt, conducted on 31 August 2023; • Groundwater elevation gauging and sampling of four monitoring wells using a low flow sampling methodology on 13 and 14 September 2023; • Measurement of groundwater quality parameters during low flow sampling; • Submission of groundwater samples for laboratory analysis of COPC; • Aquifer permeability testing at four monitoring wells to estimate hydraulic conductivity within the aquifer beneath the site on 15 September 2023; • Installation of four automated water level loggers operational for 62 days; • A groundwater elevation survey conducted during retrieval of the data loggers on 17 November 2023; • Quantitative risk assessment comprising comparison of measured concentrations of COPC in groundwater to Arcadis' Generic Assessment Criteria (GAC) and Shell Universal Risk-Based Screening Levels (RBSL) for Shell Downstream (DS) sites; • Reporting of findings
Groundwater Elevation Survey	The depth to groundwater ranged from 1.60m below ground level (bgl) to 2.00m bgl recorded during the September 2023 groundwater monitoring visit. The associated groundwater elevations ranged from 74.07m Above Ordnance Datum (AOD) to 74.78m AOD. During the groundwater elevation survey conducted on 17 November 2023, depth to groundwater ranged from 0.63m bgl to 1.57m bgl, the corresponding groundwater elevations ranged from 74.98m to 75.44m AOD Based on the groundwater elevations recorded between 13 and 14 September, groundwater flow is inferred to be towards the east. However based on the results of long term groundwater level monitoring conducted between 15 September and 17 November and a groundwater elevation survey conducted on 17 November 2023, the groundwater flow within the River Terrace Deposits beneath the Site is considered towards west, which is consistent with elevations recorded during January 2023.
Groundwater Quality	No evidence of Light Non-Aqueous Phase Liquid (LNAPL) was encountered within the monitoring well network during the monitoring visits. No visual or olfactory evidence of hydrocarbon contamination was observed during the groundwater monitoring visits.

	Concentrations of COPC recorded in samples of groundwater collected in September 2023 were generally reduced in comparison with the previous groundwater monitoring visit completed in January 2023, in particular in MW106. None of the COPC concentrations were recorded above Method Detection Limits (MDL) within groundwater samples collected at MW101, MW104 and MW106. PAH concentrations were recorded above detection limits at MW105.
Risk Assessment	There were no exceedances of the human health GAC in groundwater samples collected during the September 2023 monitoring visit therefore the potential risk posed to on-site PFS workers from COPC in groundwater is considered to be low. Concentrations of benzo(b)fluoranthene and benzo(a)pyrene in the groundwater sample collected at MW105 were measured above the GAC protective of the Secondary A aquifer. However, considering the generally low solubility and mobility of these compounds and the relatively low margin of the exceedances recorded during the September 2023 monitoring visit, the risk to water resource receptors is considered low. There were no exceedances of the Shell Downstream (DS) Universal Risk Based Screening Levels (RBSL) in groundwater.

Contents

Appendices

Abbreviations

AOD	Above Ordnance Datum
Arcadis	Arcadis (UK) Limited
COPC	Constituents of Potential Concern
CPU	Continued Petroleum Use
CSM	Conceptual Site Model
DEFRA	Department for Environment, Food and Rural Affairs
DO	Dissolved Oxygen
EA	Environment Agency
GAC	Generic Assessment Criteria
LNAPL	Light Non-Aqueous Phase Liquid
m bgl	Meters Below Ground Level
MCerts	Monitoring Certification Scheme
MTBE	Methyl Tertiary Butyl Ether
NAPL	Non-Aqueous Phase Liquid
ORP	Oxidation-Reduction Potential
OS	Ordnance Survey
QA	Quality Assurance
QC	Quality Control
PAH	Polycyclic Aromatic Hydrocarbons
PFS	Petrol Filling Station
PID	Photo Ionization Detector
ppmV	Parts Per Milli Volume
Shell	Shell UK Oil Products Limited
SVOC	Semi-Volatile Organic Compounds
TPH	Total Petroleum Hydrocarbons
UST	Underground Storage Tanks
VOC	Volatile Organic Compounds

1 Introduction

Arcadis (UK) Limited (Arcadis) was commissioned by Shell UK Oil Products Limited (Shell) to undertake a Groundwater Monitoring Event (GME) at Shell Sutton Elms, located at Coventry Road, Broughton, Leicester, LE9 6QD (hereafter 'the site').

A site location plan is presented as Figure 1, Appendix A. The current site layout is presented as Figure 2, Appendix A.

The Site comprises an active Petrol Filling Station (PFS) and an area of undeveloped land adjoining the PFS immediately southwest.

The work documented in this report was carried out with reference to English legislation and regulatory guidance for the assessment of land contamination and in line with current Environment Agency (EA) Land Contamination Risk Management (LCRM) guidance.

1.1 Objectives

The objective of the groundwater monitoring works was to assess the presence, nature, and extent of Constituents of Potential Concern (COPC) in groundwater beneath the site and further characterize potential contaminant linkages at the Site.

1.2 Scope of Work

The groundwater monitoring tasks undertaken between 31 August and 17 November 2023 comprised the following scope of work:

- Groundwater monitoring well re-development works conducted on 31 August 2023;
- Groundwater elevation gauging and sampling of four monitoring wells using a low flow sampling methodology on 13 and 14 September 2023;
- Measurement of groundwater quality parameters during low flow sampling;
- Submission of groundwater samples for analysis of COPC;
- Aquifer permeability testing at four monitoring wells to estimate hydraulic conductivity within the aquifer beneath the site on 15 September 2023;
- Quantitative risk assessment comprising comparison of measured concentrations of COPC in groundwater to Arcadis' Generic Assessment Criteria (GAC) and Shell Universal Risk-Based Screening Levels (RBSL) for Shell Downstream (DS) sites;
- Installation of four automated water elevation loggers (recording for 62 days) and subsequent collection and download of logger data followed by groundwater elevation survey conducted on 17 November 2023;
- Reporting of findings.

1.3 Limitations

Arcadis' liability pursuant to the terms of the appointment of Arcadis by Shell, is strictly limited to the work undertaken and the matters contained and specifically referred to in this report. A copy of Arcadis' study limitations is presented as Appendix B.

This report is only valid when used in its entirety. Any information included in the report should not be relied upon until considered in the context of the whole report and previous work.

1.4 Reliance

It is understood that this report has been prepared for the use of Shell. The contents of this report may not be used or relied upon by any person other than this party without the express written consent and authorization of Arcadis.

2 Site Information

2.1 Site Description

Key information relating to the site and its surroundings is provided below:

Current land use	The site is currently an active PFS.	
Grid reference	Easting 450825, Northing 293755	
Area of Site	The forecourt area is approximately 2,500m^2, including the undeveloped portion of land to the southwest of forecourt the total area of the site area is approximately 5,500m^2.	
Land ownership	Arcadis understand that Shell own the freehold to the site.	
Ground elevation	Approximately 76m Above Ordnance Datum (AOD)	
Regional topography	The topography of the surrounding area generally slopes downwards toward the River Soar to the east.	
Site surroundings	**North:**	The Site is bounded to the north by a road transport depot, Cobley Transport (National and European Road Freight). The depot offices were 30m north of the Site boundary.
	East:	The Site is bounded to the east by the B4114 Coventry Road. Beyond this, approximately 37m east is a tributary of the River Soar, and approximately 50m east from the Site is a hotel and restaurant.
	South:	The Site is bounded to the south by the B4114 Coventry Road. Beyond this to the southeast are open fields, and approximately 37m southeast of the Site is the River Soar.
	West:	The Site is bounded to the west by open fields associated with Stanton Lodge Farm. Farm buildings are located approximately 250m west of the Site.
Nearest surface water features(s)	The nearest surface water feature is the River Soar flowing towards the north, a tributary of which is located approximately 37m southeast of the Site.	
Nearest surface water abstraction(s)	Previous phase 1 environmental assessment report prepared by Arcadis in August 2022 identified three surface water abstractions within 2km radius of the site. The nearest licensed surface water abstraction is by Foxon Brothers (Concrete Products) Ltd [License No: 03/28/50/0001] with permit start date 1 April 2000, located at Broughton Astley – Mill Stream (River Soar), 339m south of the site.	

2.2 Geology and Hydrogeology

A summary of ground conditions beneath the site encountered during intrusive environmental works undertaken by URS and Arcadis in 2011 and 2023 respectively are provided below. Borehole logs for the monitoring wells sampled during the September 2023 monitoring event are presented in Appendix C.

Geology	The site surfacing is comprised of concrete and asphalt underlain by Made Ground described as grey, slightly gravelly, sandy clay and grey to red brown, angular, fine to coarse gravel and cobbles. Made Ground was underlain by River Terrace Deposits (designated as a Secondary (A) Aquifer) comprising interbedded layers of soft, greyish dark brown, sandy, gravelly clay and brown speckled cream clayey gravelly sand and sandy gravel reported to a maximum depth of 6.50 metres below ground level (m bgl).
Hydrogeology	During previous groundwater level gauging undertaken by Arcadis in January 2023, groundwater has been recorded in monitoring wells resting between 0.55 to 1.46m bgl and groundwater elevations ranged from 75.09m to 75.51m AOD. The available historical groundwater elevation data indicates highly variable groundwater levels between 2011–2014 and 2023. The 2023 data generally shows a decrease in groundwater levels from January 2023 (winter) to August 2023 (summer) indicating a seasonal variation in groundwater level of approximately 0.5m. The historically inferred groundwater flow direction fluctuates between east and west.
Nearest groundwater abstraction(s)	The previous Phase 1 Environmental Site Assessment report prepared by Arcadis in August 2022 (Ref: GB-10019140-20220818-SA-Phase 1 ESA) identified four groundwater abstractions within a 2km radius of the site; The nearest groundwater abstraction is located approximately 473m northwest of the site operated by Mr. J Sutton, with license number 03/28/50/0044, used for general farming and domestic usage. Despite uncertainty in the groundwater flow direction, this abstraction is considered unlikely to be affected by groundwater quality at the site based on the distance and variable nature of the Secondary Aquifer.

3 Field Work Methodology

A groundwater monitoring event was undertaken on 13 and 14 September 2023, comprising a groundwater elevation survey and collection of groundwater samples for laboratory analysis.

3.1 Groundwater Elevation Survey Methodology

Date	13 to14 September 2023 and 17 November 2023
Monitoring wells surveyed	MW101, MW104, MW105 and MW106 installed during Arcadis intrusive investigation works conducted between 18 and 25 November 2022 (Report Ref: GB-10019140-20230801-SA-Phase II ESA)
Equipment used	Oil / water interface probe, which was decontaminated between monitoring locations.
Details recorded	Depth to NAPL, if present; Depth to groundwater; Depth to base of monitoring well.

3.2 Groundwater Sampling Methodology

Date	13 and 14 September 2023
Monitoring wells sampled	MW101, MW104, MW105 and MW106
Sampling method	Purging and sampling was carried out by a battery-powered peristaltic pump, using dedicated sample tubing lowered into the well to the sample depth. The flow rate was set to low (generally <5l/min) to reduce turbidity and thus variability in results. New tubing was used for each monitoring well location. Sampling was undertaken from the approximate mid-point in the water column.
Data recorded	Water quality parameters, Dissolved Oxygen (DO), Oxidation Reduction Potential (ORP), electrical conductivity and pH, were measured using a multi-parameter meter. Readings were taken at approximately five-minute intervals until the electrical conductivity, DO, and ORP from three consecutive readings differed by less than 10%. Once the readings had stabilised, the purged water was considered to be representative of the surrounding aquifer and groundwater samples were collected in containers supplied by the laboratory.

3.3 Aquifer Permeability Testing

Aquifer permeability tests in the form of rising head tests were performed on 15 September 2023 to provide an estimate of the hydraulic conductivity of the underlying aquifer. The rising head tests were conducted in a manner whereby a volume of water was removed from the well and the groundwater recovery rate recorded at regular time intervals. Groundwater levels during the tests were monitored using a sealed datalogger. Given the short duration of the test, no barometric compensation has been carried out.

Rising head tests were undertaken in monitoring wells MW101, MW104, MW105 and MW106 by removal of a volume of water from the well using a bailer. Between two and three tests were carried out at each of the four monitoring wells.

The recovery data was used to estimate the hydraulic conductivity by using the Bouwer and Rice method for a partially penetrating well in an unconfined aquifer.

The detailed methodology for the hydraulic conductivity tests is presented in Appendix D.

3.4 Analytical Strategy

Analytical Laboratory	Element Materials Technology Environmental UK Limited (Element)
Accreditation	Element is United Kingdom Accreditation Service (UKAS) certified and is an approved Arcadis subcontractor.
Chemical Analyses (groundwater samples)	• Total Petroleum Hydrocarbons Criteria Working Group (TPH CWG) by Gas Chromatography-Flame Ionisation Detection (GC-FID) • Benzene, Toluene, Ethylbenzene, Total Xylenes (BTEX) and fuel oxygenates by Gas Chromatography-Mass Spectrometry (GC-MS) • United States Environmental Protection Agency (US EPA) 16 Polycyclic Aromatic Hydrocarbon compounds (PAH) by GC MS • pH by GLpH meter • VOC by GC-MS

3.5 Storage, Preservation and Transport of Samples

Task	Details
Storage	Glass vials supplied by the laboratory were used for the collection of groundwater samples to be analysed for volatile compounds. Samples to be analysed for lower volatility compounds were stored in laboratory-prepared glass bottles. Samples were stored in dedicated sample boxes provided by the laboratory.
Preservation	Sample containers were filled as far as practicable to minimise headspace and kept at a low storage temperature to minimise the potential for volatilisation and biodegradation of petroleum hydrocarbon compounds, VOC and Semi-Volatile Organic Compounds (SVOC) prior to analysis. Samples were stored in insulated cool boxes provided by the laboratory to minimise the potential for volatilisation and biodegradation of petroleum hydrocarbon compounds prior to analysis
Decontamination	Groundwater samples were collected using dedicated, disposable which was changed between monitoring well locations and decontaminated sampling equipment in order to prevent cross-contamination.
Transport	Samples were stored in dedicated sample cool boxes with cooling aids following collection and during transit to the laboratory. Sample details and analytical requests were recorded on the laboratory chain of custody form included with the samples, prior to dispatching to laboratory for analysis. Samples were dispatched to the laboratory on the day of sampling, where practicable.

3.6 Quality Assurance and Quality Control

The following measures were taken in order to assure the quality of the laboratory data received from the laboratory:

Transportation	A trip blank supplied by the laboratory and not opened on site, was included with the groundwater samples dispatched to the laboratory for analysis for volatile compounds. A copy of the full chain of custody documentation was included with the samples in transit to the laboratory.
Field Duplicate	A field duplicate sample was collected from MW101 and labelled as DUPLICATE. The duplicate sample was submitted with the groundwater samples to the laboratory for analysis.
Equipment Blank	An equipment blank was collected by running deionized water supplied by the laboratory through the sampling equipment. The equipment blank was submitted with the groundwater samples to the laboratory for analysis.
Laboratory QA/QC	Full details of the Arcadis laboratory QA/QC policy are provided in Appendix E.

3.7 Long-Term Groundwater Level Monitoring

Automated water level data loggers were installed in four monitoring wells (MW101, MW104, MW105 and MW106) between 15th September and 17th November 2023 (62 days), in order to collect a continuous record of groundwater elevation across the site. Atmospheric pressure data from an on-site barometric logger was used to compensate the groundwater level data for fluctuations in atmospheric pressure during the monitoring period. The loggers were set up to record data every 60 minutes and depth to groundwater was recorded on installation and retrieval.

4 Field Work Findings

4.1 Monitoring Well Development

Well development	All four on-site monitoring wells were developed on 31 August 2023 using hand-operated inertial pump tubing. Between 18 and 30 litres of groundwater and silt/sediment were purged from the wells. Depth to groundwater prior to development ranged from 1.29m bgl to 2.00m bgl; and on completion of development the groundwater levels were ranged from 1.81m bgl to 5.56m bgl. MW105 was purged dry during redevelopment indicating slow groundwater recharge in this location. Depths to well base were recorded pre- and post-development. The recorded siltation was in the range from 0.57m to 1.55m prior to well development; with maximum siltation of 1.55m in MW104 (Table 1). Between 0.67 and 1.11m of silt was removed during the well redevelopment.

4.2 Groundwater Elevation Survey

Range in groundwater elevations	During the groundwater elevation survey conducted on 13 and 14 September 2023, depth to groundwater ranged from 1.60m bgl to 2.00m bgl . The corresponding groundwater elevations ranged from 74.07m to 74.78m AOD. During the groundwater elevation survey conducted on 17 November 2023, depth to groundwater ranged from 0.63m bgl to 1.57m bgl The corresponding groundwater elevations ranged from 74.98m to 75.44m AOD. The complete groundwater elevation dataset is presented in Table 1, Appendix F.
Groundwater flow direction	The groundwater elevation contour plans presenting results of groundwater elevation survey conducted on 13-14 September and 17 November 2023 are presented as Figure 2 and Figure 3, Appendix A respectively. Based on the available data, the groundwater flow direction beneath the site is inferred towards the east for the 13 September 2023 monitoring event, however the groundwater elevation data from the 17 November 2023 groundwater elevation survey indicates a groundwater flow direction towards the southwest. The hydraulic gradient of the groundwater elevations recorded on 13 September is approximately 0.012.. The results of long-term groundwater level monitoring are discussed in detail in section 4.6 and 4.7 below.

4.3 Groundwater Quality

Visual or olfactory evidence of contamination	No visual or olfactory evidence of contamination was identified during the monitoring visit.
NAPL	No evidence of NAPL was encountered within the monitoring well network during the monitoring visit.
Hydrogeochemical data	The hydrogeochemical parameters recorded during low flow monitoring are presented in Table 2, Appendix F.

Laboratory analysis	The laboratory data for the groundwater analysis are presented in Table 3, Appendix F. Laboratory certificates are presented in Appendix H.

4.4 Quality Assurance and Quality Control Parameters

The analytical data have been reviewed for QA/QC purposes:

- Concentrations of COPC in the equipment blank sample were below the laboratory limit of detection;
- Concentrations of VOC in the trip blank sample were below the limit of laboratory limit of detection;
- Sampling variability as measured by the Relative Percent Difference (RPD) from duplicate analysis of the sample collected from MW101 is within acceptable limits[1];

Based on the results of the QA/QC sampling, the dataset is considered appropriate for use.

4.5 Aquifer Permeability Testing

Rising head tests were performed on monitoring wells MW101, MW104, MW105 and MW106 to provide an estimate of the hydraulic conductivity of the underlying River Terrace Deposits, which are designated as a Secondary A Aquifer. Hydraulic conductivity values were estimated using Bouwer and Rice's method for a partially penetrating well in an unconfined aquifer and are summarized in the table below.

Monitoring well	Estimated Hydraulic Conductivity (m/day)
MW101	0.37 – 0.55
MW104	1.29 – 1.46
MW105	0.002 – 0.005
MW106	0.02 – 0.63

Full details of the aquifer permeability testing methodology and results, including data interpretation are presented as Appendix D.

The wide range of hydraulic conductivity values indicate the groundwater flow rates within the River Terrace Deposits is highly variable. Groundwater flow is probably dominated by granular sand and gravel lenses or layers within the dominant clay lithology. Notably sand and gravel units are prevalent below 3m bgl in MW104 (Appendix C).

4.6 Long-Term Groundwater Level Monitoring

Automated groundwater level data loggers were installed in four monitoring wells (MW101, MW104, MW105 and MW106) between 15th September and 17th November 2023, to collect a continuous record of groundwater elevation across the Site. The continuous groundwater elevation data indicates a gradually increasing trend in groundwater elevation recorded in monitoring wells MW101, MW104 and MW106.

[1] Acceptable RPD for each Method Detection Limit (MDL) multiplier range are: 80 (1-10 x MDL); 50 (10-20 x MDL); 30 (>20 x MDL)

A more variable trend in groundwater elevation is observed at MW105, with significant rise in groundwater elevation recorded on 13th, 19th and 20th October 2023, which is then stabilised at an elevation approximately 1.3m higher. It should be noted that loggers were installed on 15 September following the rising head tests carried out on the same day and the initial readings may have been affected by the tets; in particular for MW105 where the initial curve in the graph probably reflects the groundwater recovery from the rising head testing. The sharp increases in groundwater level in MW105 could be related to rainfall rate whereby surface water infiltrates past the thin bentonite seal above the response zone, also MW105 is the only monitoring well in the grassed areas. The logger data for MW105 suggests the ground may have been fully saturated to surface (groundwater depth 0 m bgl) recorded around 21st October. Therefore, the groundwater elevation records collected from the data logger installed at MW105 have been omitted during determination of groundwater flow direction based on this round of long team groundwater level monitoring.

A summary of water level logger data is presented below and the groundwater elevation trend is shown on the graph in Appendix G.

Monitoring well	Groundwater Level Range (m bgl)	Groundwater Elevation Range (m AOD)
MW101	1.41 to 1.92	74.62 to 75.14
MW104	0.83 to 1.31	75.07 to 75.55
MW105	0.00 to 2.04	74.55 to 76.91
MW106	3.56 to 3.88	74.44 to 74.98

4.7 Hydrogeology Discussion

Groundwater flow within the River Terrace Deposits Secondary A aquifer appears to be complex, with highly variable lithology comprising alternating units of sandy or gravelly clay, with more permeable layers of clayey sandy and gravelly sand, up to 1-2m thick and generally present below 3m bgl. Groundwater flow is likely dominated by the more permeable granular layers, which may vary in depth, thickness, and connectivity across the site.

Groundwater in the aquifer is shallow and shows significant variability in depth, gradient, and flow direction between monitoring rounds, on a daily and seasonal basis. The table below summarises manual groundwater gauging carried out between 2011 and 2023.

Date of gauging (no. of rounds)	Groundwater depth range (m bgl)	Flow direction (towards)
Jan-2011 (1)	0.59 to 1.31	East
Jul-2011 to Oct-2013 (4)	0.47 to 2.15	East to Southeast
Jul-2014 (1)	1.02 to 1.59	East
Jan-2023 (1)	0.61 to 1.49	West

Date of gauging (no. of rounds)	Groundwater depth range (m bgl)	Flow direction (towards)
Mar-2023 (1)	0.55 to 1.46	Southwest
Sep-2023 (1)	1.60 to 2.00	East
Nov-2023 (1)	0.63 to 1.57	Southwest

The long-term groundwater elevation trend for MW105 suggests that the function of this monitoring well may only have limited hydraulic continuity with the surrounding groundwater. This is also likely to be a function of the very low hydraulic conductivity determined from the rising head tests, and absence of significant sand/gravel units in the borehole log (Appendix C).

Groundwater levels and flow direction could be affected by multiple factors, including rainfall rate, local recharge through unsurfaced areas on and adjacent to site, leakage and preferential flow through site drainage and utility ducting, and variation in the surface water features associated with the River Soar approximately 37m east of the site. The site surface is approximately 74m AOD and are therefore likely to be in continuity with shallow groundwater. The trends in the long-term monitoring data for show an increasing over rise in the groundwater level suggest seasonal variations associated with groundwater recharge. There may be some localised surface water recharge in the grassed area of the site, although the ground conditions in this are were observed to comprise clay which may restriction infiltration. Most of the land use surrounding the site comprises farmland and therefore there may be surface water recharge to the shallow groundwater which is influence the groundwater flow directions beneath the site.

Groundwater flow direction has been recorded between east and southwest. The long-term monitoring graph in Appendix G indicates a consistent southwest direction over a two-month period. However, there are limited data points available, and the regional flow is likely to be towards the surface water features to the east.

5 Risk Assessment

The measured concentrations of COPC in groundwater have been compared to Arcadis' GAC for Continued Petroleum Use, considering the following human health and water resource receptors:

Human Health:

- On-site commercial workers based on Continued Petroleum Use of the Site

Water Resources:

- Aquifers (Rive Terrace Deposits - Secondary A aquifer)
- Surface waters (River Soar and associated tributaries)

The GAC were derived in line with guidance provided by the Environment Agency (EA). The derivation of the GAC is presented in Appendix I and the Arcadis GAC for CPU are presented in Appendix J.

The concentrations of COPC in groundwater were also compared with the Shell Universal RBSL where the RBSL are more conservative than the human health GAC (applicable for naphthalene and xylene only).

5.1 Comparison to Generic Assessment Criteria

The maximum measured concentration of COPC did not exceed the relevant assessment criteria derived for the protection of human health and environmental receptors when considering a CPU end-use except for benzo(b)fluoranthene and benzo(a)pyrene, which exceeded the water resources GAC protective of the aquifer at MW105.

5.2 Comparison to Shell Universal Risk Based Screening Levels (RBSL)

The maximum measured concentrations of COPC did not exceed the Shell Universal RBSL.

6 Conclusions

The environmental work summarized in this report comprises groundwater monitoring of four monitoring wells on 13 to 14 September 2023, rising head testing and long-term elevation monitoring over a two month period. The findings of the groundwater monitoring indicated the following:

Groundwater Elevations

Groundwater was recorded within the four existing monitoring wells at depths ranging from 1.60m bgl to 2.00m bgl in September 2023. The associated groundwater elevations ranged from 74.07m AOD to 74.78m AOD.

Based on the groundwater elevations recorded on 13 and 14 September 2023, groundwater flow is inferred to be towards the east. However, a south-westerly flow direction was inferred during the long-term groundwater monitoring elevation between 15 September and 17 November 2023 and a groundwater elevation survey conducted during retrieval of the data loggers on 17 November 2023. Groundwater flow within the River Terrace Deposits is likely to be highly variable, and mainly confined to more permeable sand and gravel units within the Deposit, with well MW105 in poor hydraulic continuity. The shallow groundwater may be affected by surface water recharge in the wider site are which alters groundwater levels and flow direction over time.

Groundwater Quality

No LNAPL was observed within the groundwater monitoring wells gauged. No visual or olfactory evidence of hydrocarbon contamination was observed during the groundwater monitoring event.

The concentration of COPCs within groundwater samples collected across the site in September 2023 indicated a decline in COPC concentrations from those observed in January 2023. The highest COPC concentrations recorded in monitoring well MW106 in January 2023 comprised predominantly BTEX and mid-heavy end TPH constituents, as well as concentrations of TPH and PAH recorded above Method Detection Limits (MDL) at MW104 and MW105. In September 2023 these COPC were not recorded above MDL, except for some PAH compounds in well MW105.

Risk Assessment

None of the measured concentrations of COPC in groundwater samples collected in September 2023 exceeded the human health GAC, therefore the potential risk to human health receptors is low.

Concentrations of benzo(b)fluoranthene and benzo(a)pyrene in the groundwater sample collected from MW105 were measured above the GAC protective of the Secondary A aquifer, indicating that a contaminant linkage associated with migration of COPC in groundwater beneath the site to water resource receptors (aquifers) is potentially active. However, considering the generally low solubility and mobility of these compounds and the relatively low margin of the exceedances recorded during the September 2023 monitoring visit, the risk to the Secondary A aquifer can be considered as low.

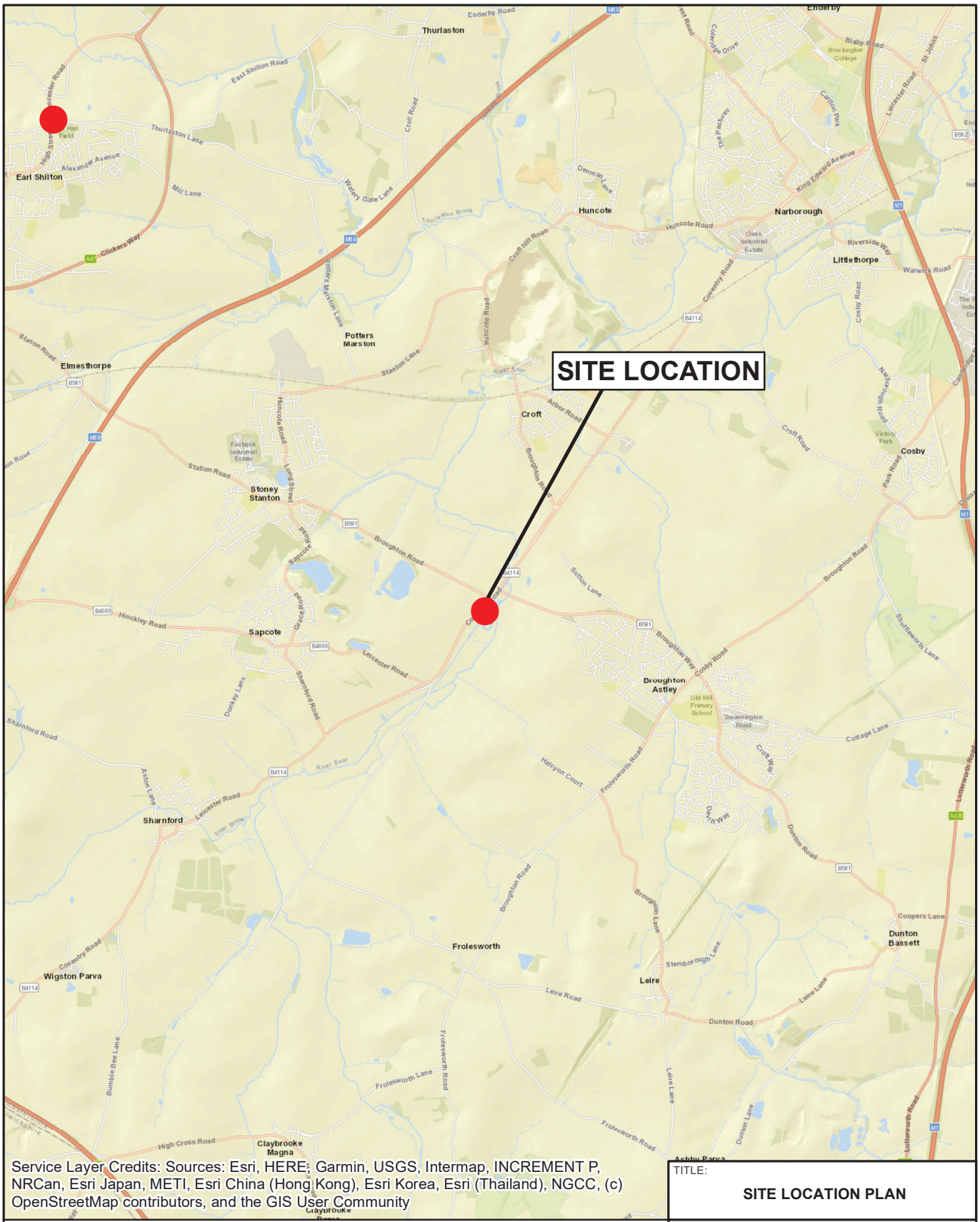
Appendix A

Report Figures

Figure 1 – Site Location Plan

Figure 2 – Groundwater Elevation Plan September 2023

Figure 3 – Groundwater Elevation Plan November 2023



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LEGEND

SITE LOCATION

NOTES

SYMBOLS FOR BOREHOLES, TRIAL PITS AND OTHER SPECIFIC FEATURES ARE REPRESENTATIONS OF LOCATION ONLY AND UNLESS OTHERWISE SPECIFIED, DO NOT REPRESENT THE TRUE SIZE OF THE FEATURE.

0 0.2 0.4 0.8 1.2 1.6 2 Kilometres

N

TITLE: **SITE LOCATION PLAN**

SITE : **SHELL SUTTON ELMS**

CLIENT : **SHELL UK OIL PRODUCTS LIMITED**

PROJECT : **10044284** | **FIGURE 1**

DATE : 06/07/22 | DRAWN BY : AP

DRG No. : 10044284-AUK-SHSE-XX-DR-ZZ-0412-P1.GIS

SCALE : **1 : 50,000** | PRINT : **A4**

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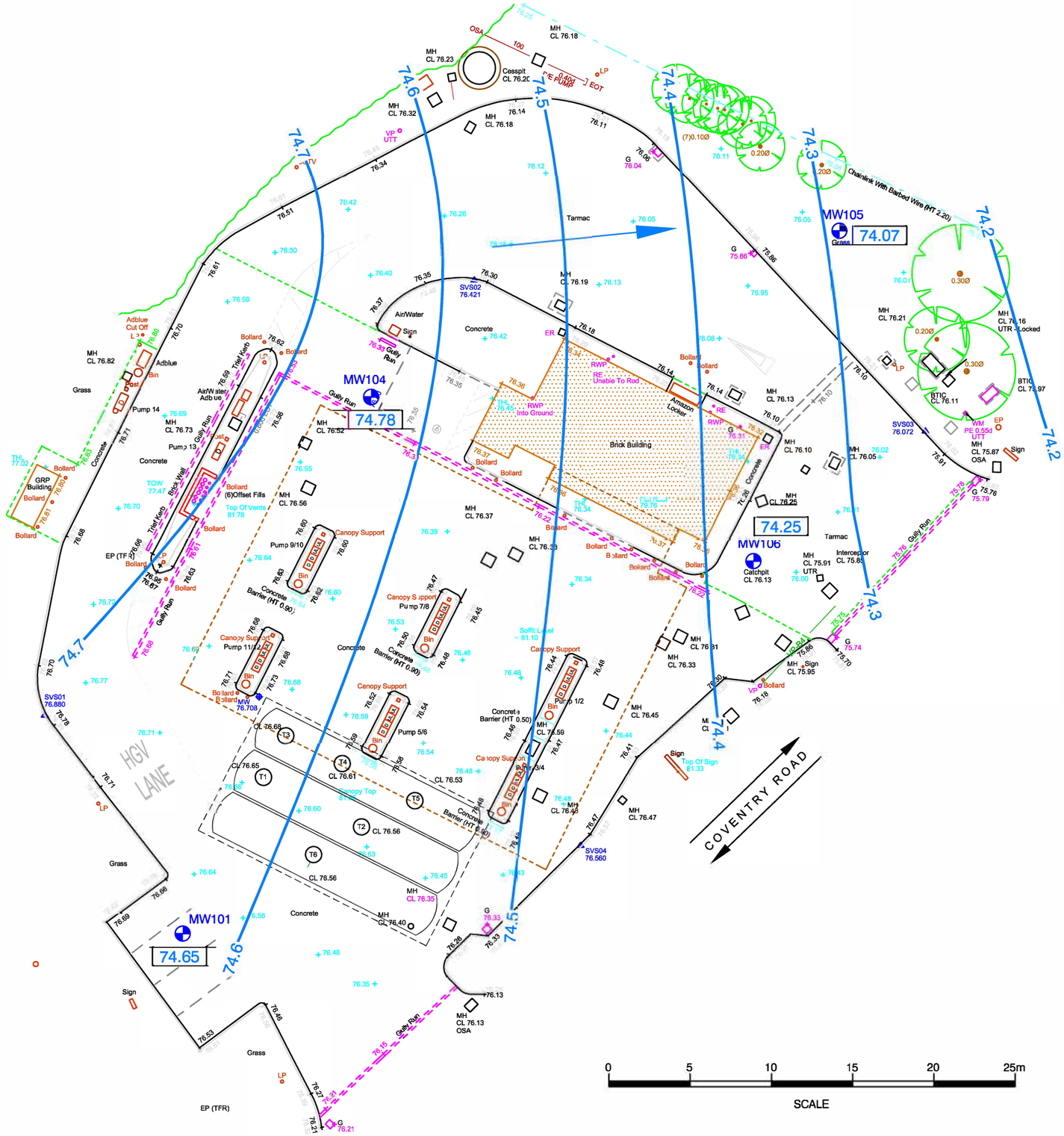

KEY

- BOREHOLE LOCATION
- GROUNDWATER CONTOUR (mAOD)
- 99.99 GROUNDWATER ELEVATION (mAOD) MEASURED IN SEPTEMBER 2023
- GROUNDWATER FLOW DIRECTION

NOTES

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NO UNDERGROUND UTILITIES HAVE BEEN INCLUDED ON THIS PLAN.

REV	DATE	COMMENT	CAD

TITLE: GROUNDWATER ELEVATION **CONTOUR** PLAN **SEPTEMBER 2023**

SITE: SHELL SUTTON ELMS

CLIENT: SHELL UK OIL PRODUCTS LTD

PROJECT: 10044284 | FIGURE 2

DATE: 04/10/23 | DRAWN: BNB | REV: -

DRG.No.: 10044284-AUK-SHSE-XX-DR-ZZ-0853-P1 | PRINT: A3

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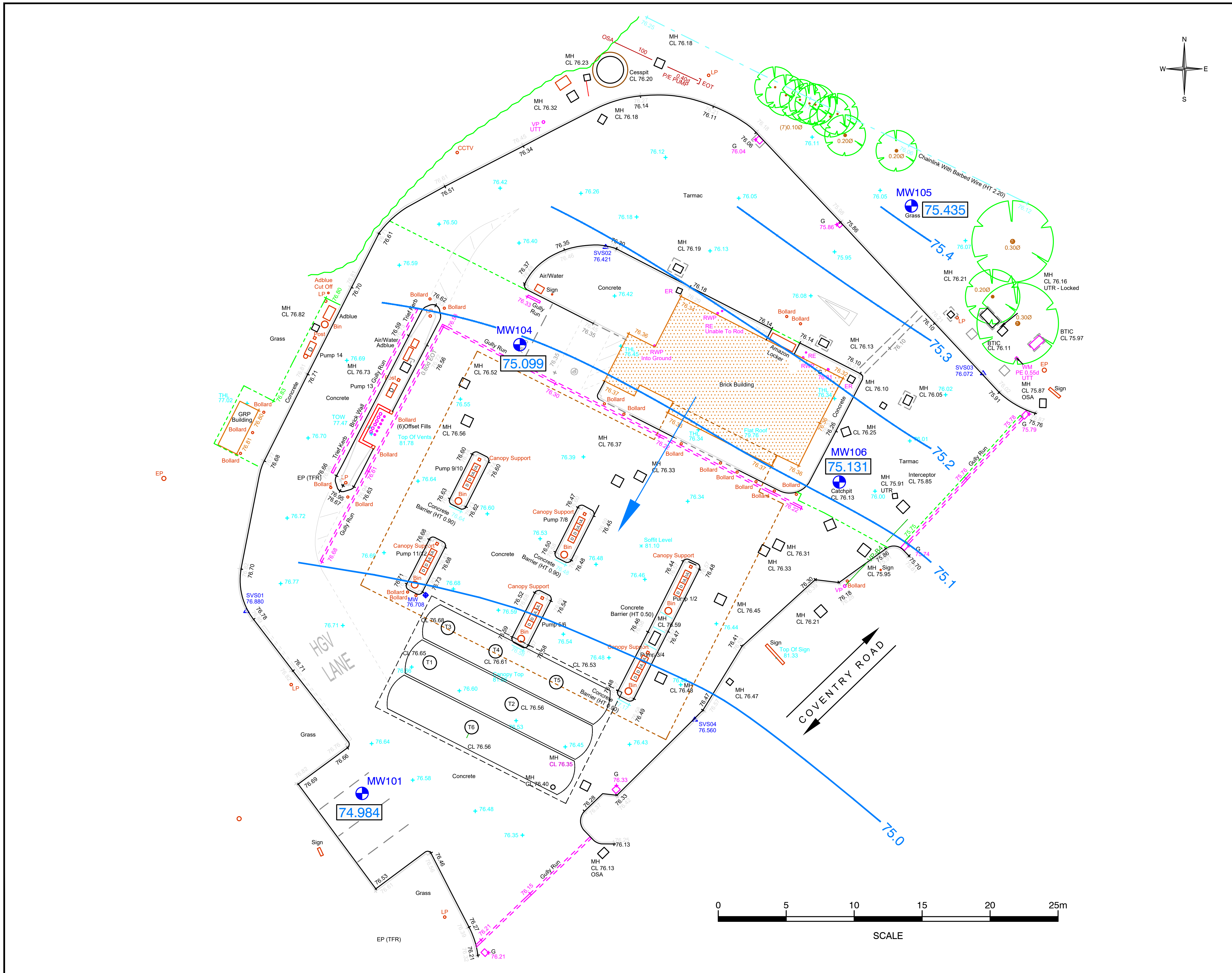

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KEY

- BOREHOLE LOCATION
- GROUNDWATER CONTOUR (mAOD)
- 99.99 GROUNDWATER ELEVATION (mAOD)
- GROUNDWATER FLOW DIRECTION

NOTES

NO UNDERGROUND UTILITIES HAVE BEEN INCLUDED ON THIS PLAN.

REV	DATE	COMMENT	CAD

TITLE: GROUNDWATER ELEVATION AND CONTOUR PLAN - NOVEMBER 2023

SITE: SHELL SUTTON ELMS

CLIENT: SHELL UK OIL PRODUCTS LTD

PROJECT: 10044284 FIGURE 3

DATE: 12/12/23 DRAWN: AP REV: -

DRG.No.: 10044284-AUK-SHSE-XX-DR-ZZ-0953-P1 PRINT: A3

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Appendix B

Study Limitations

IMPORTANT. This appendix should be read before reliance is placed on any of the information, opinions, advice, recommendations, or conclusions contained in this report.

1 This report has been prepared by Arcadis (UK) Limited ('Arcadis'), with all reasonable skill, care and diligence within the terms of the Appointment and with the resources and manpower agreed with Shell UK Oil Products Limited (the 'Client'). Arcadis does not accept responsibility for any matters outside the agreed scope.

2 This report has been prepared for the sole benefit of the Client unless agreed otherwise in writing. The contents of this report may not be used or relied upon by any person other than this party without the express written consent and authorisation of Arcadis.

3 Unless stated otherwise, no consultations with authorities or funders or other interested third parties have been carried out. Arcadis is unable to give categorical assurance that the findings will be accepted by these third parties as such bodies may have unpublished, more stringent objectives. Further work may be required by these parties.

4 All work carried out in preparing this report has used, and is based on, Arcadis' professional knowledge and understanding of current relevant legislation. Changes in legislation or regulatory guidance may cause the opinion or advice contained in this report to become inappropriate or incorrect. In giving opinions and advice, pending changes in legislation, of which Arcadis is aware, have been considered. Following delivery of the report, Arcadis has no obligation to advise the Client or any other party of such changes or their repercussions.

5 This report is only valid when used in its entirety. Any information or advice included in the report should not be relied upon until considered in the context of the whole report.

6 Whilst this report and the opinions made are correct to the best of Arcadis' belief, Arcadis cannot guarantee the accuracy or completeness of any information provided by third parties. provided by third parties. Arcadis has taken reasonable steps to ensure that the information sources used for this assessment provided accurate information and has therefore assumed this to be the case.

7 This report has been prepared based on the information reasonably available during the project programme. All information relevant to the scope may not have been received.

8 This report refers, within the limitations stated, to the condition of the site at the time of the inspection. No warranty is given as to the possibility of changes in the condition of the site since the time of the investigation.

9 The content of this report represents the professional opinion of experienced environmental consultants. Arcadis does not provide specialist legal or other professional advice. The advice of other professionals may be required.

10 Where intrusive investigation techniques have been employed, they have been designed to provide a reasonable level of assurance on the conditions. Given the discrete nature of sampling, no investigation technique is capable of identifying all conditions present in all areas. In some cases, the investigation is further limited by site operations, underground obstructions and above ground structures. Unless otherwise stated, areas beyond the boundary of the site have not been investigated.

11 If below ground intrusive investigations have been conducted as part of the scope, safe location of exploratory holes has been carried out with reference to the Arcadis ground disturbances procedure. No guarantee can be given that all services have been identified. Additional services, structures or other below ground obstructions, not indicated on the drawing, may be present on site.

12 Unless otherwise stated the report provides no comment on the nature of building materials, operational integrity of the facility or on any regulatory compliance issues.

13 Unless otherwise stated, an inspection of the site has not been undertaken and there may be conditions present at the site which have not been identified within the scope of this assessment.

14 Unless otherwise stated, samples from the site (soil, groundwater, building fabric or other samples) have not been obtained.

15 Arcadis has relied upon the accuracy of documents, oral information and other material and information provided by the Client and others, and Arcadis assumes no liability for the accuracy of such data, although in the event of apparent conflicts in information, Arcadis would highlight this and seek to resolve.

16 Unless otherwise stated, the scope of works has not included an environmental compliance review, health and safety compliance review, hazardous building materials assessment, interviews or contacting Local Authority, requests for information to the petroleum officer, sampling or analyses of soil, ground water, surface water, air or hazardous building materials or a chain of title review.

17 Unless otherwise stated, this assessment has considered the ongoing use of the site and has not been prepared for the purposes of redevelopment which may act as a trigger for site investigation and remediation works not needed for ongoing use.

Appendix C

Borehole Logs

Dynamic Sampling to Rotary Coring Log

MW101

Project	Project No.	Ground Level (mAOD)	Start Date	Scale
Shell Sutton Elms	**10044284**	**76.54**	**15/11/2022**	**1:50**
Client	Easting (OS mE)	Northing (OS mN)	End Date	
Shell UK Oil Products Ltd.	**450804.79**	**293728.24**	**24/11/2022**	**Sheet 1 of 1**

Progress	Samples	Tests and Measurements		Strata				
Date / Time Casing / DTW	Type - Depth (m)	Type - Depth (m) - Result	Fracture Details / TCR SCR RQD	Description	Legend	Depth (Thickness)	Level	Install/ Backfill
2022/11/15 14:20 - / -	(1) 0.20	PID 0.20m <1ppm		MADE GROUND: CONCRETE with rebar and plastic membrane.		(0.19) 0.19	76.35	
		PID 0.50m <1ppm		MADE GROUND: SUB BASE MATERIAL - Grey sandy gravel. Gravel is fine to coarse subangular of granite .		(0.46) 0.65	75.89	
	(2) 1.00	PID 1.00m <1ppm		Soft mottled orangish brown and brown sandy CLAY.		(0.76) 1.41	75.13	
		PID 1.20m <1ppm						
		PID 1.50m <1ppm		Soft light brown mottled grey speckled white sandy gravelly CLAY. Gravel is fine to coarse subangular of flint chalk and sandstone.		(0.96) 2.37	74.17	
		PID 2.00m <1ppm SPT() 2.00m N>50 *(0 for 0mm/0 for 0mm)*						
		PID 2.50m <1ppm		Soft to Firm mottled brown and grey speckled white sandy CLAY with occasional fine gravel of chalk.		(1.71) 4.08	72.46	
		PID 3.00m <1ppm SPT() 3.00m N>50 *(0 for 0mm/0 for 0mm)*						
		PID 3.50m <1ppm						
		PID 4.00m <1ppm						
	(ES3) 4.20-4.50	PID 4.20m <1ppm		Brown speckled cream clayey gravelly SAND. Sand is fine to coarse. Gravel is fine to coarse subrounded of flint and chalk.		(0.51) 4.59	71.95	
		PID 4.50m <1ppm		Brown slightly clayey gravelly SAND. Gravel is fine to medium subangular to subrounded of flint and chalk.		(0.45) 5.04	71.50	
		PID 5.00m <1ppm		*Mottled cream and brown sandy gravel. Gravel is fine to coarse subangular to subrounded of flint, chalk and sandstone. 4.67-4.7m bgl*		5.12	71.42	
		PID 5.50m <1ppm		*Mottled cream and brown sandy gravel. Gravel is fine to coarse subangular to subrounded of flint, chalk and sandstone. 4.77-4.81m bgl*		(0.58) 5.70	70.84	
2022/11/24 11:18 - / -				Dark brown mottled black sandy GRAVEL. Gravel is fine to coarse subrounded of flint, chalk and black rock.				
				Brown slightly clayey SAND.				
				Becomes gravelly. Gravelbis subangular fine to medium of flint. 5.25-5.28m bgl				
				Black banding 5.39-5.41m bgl				
				Becomes gravelly. Gravel is subangular fine to coarse of flint and chalk 5.54-5.57m bgl				

DRILLING TECHNIQUE			HOLE / CASING DIAMETER				CHISELLING			WATER OBSERVATIONS						FLUSH DETAILS				WATER ADDED		
From	To	Type	Hole Dia.	Depth	Casing Dia.	Depth	From	To	Duration	Date/Time	Strike	Rest	Mins	Casing	Sealed	From	To	Rtn%	Type	From	To	Litres
0.00	1.23	Inspection Pit	300	1.23						15/11/2022 15:00	1.20	1.14										
1.23	5.70	Dynamic Sample								24/11/2022 09:38	1.56											

INSTRUMENTS			WELL SCREEN DESIGN				REMARKS
Name	Type	m AGL	Well Name	From	To	Dia.	
MW101	Standpipe	0.000	MW101	0.50	5.50	50	

Unless otherwise stated:
Depth (m), Diameter (mm), Time (hhmm), Thickness (m), Level (mAOD), Height Above Ground Level (m AGL)

Equipment Used	Termination Depth	Logged By	Checked By
Vac Ex, Comacchio 205	**5.70m**	**RM**	**SB**

Dynamic Sampling to Rotary Coring Log

MW104

Project	Project No.	Ground Level (mAOD)	Start Date	Scale
Shell Sutton Elms	**10044284**	**76.38**	**16/11/2022**	**1:50**
Client	Easting (OS mE)	Northing (OS mN)	End Date	
Shell UK Oil Products Ltd.	**450816.42**	**293761.17**	**25/11/2022**	**Sheet 1 of 1**

Progress	Samples	Tests and Measurements			Strata				
Date / Time Casing / DTW	Type - Depth (m)	Type - Depth (m) - Result	Fracture Details	TCR SCR RQD	Description	Legend	Depth (Thickness)	Level	Install/ Backfill
2022/11/16 09:00 - / -					MADE GROUND: CONCRETE.		(0.16) 0.16	76.22	
					Rebar 0.08m bgl				
					MADE GROUND: SUB BASE MATERIAL - Brown sandy GRAVEL. Gravel is fine to coarse subangular of granite.		(0.45) 0.61	75.77	
	(ES1) 0.50	PID 0.50m <1ppm							
					MADE GROUND: Soft mottled greenish grey and light brown sandy gravelly CLAY. Gravel is medium to coarse subangular of granite and red brick.		(0.14) 0.75	75.63	
	(ES2) 1.00	PID 1.00m <1ppm							
		PID 1.20m <1ppm			Soft greenish grey mottled brown sandy slightly gravelly CLAY. Gravel is medium subrounded of flint.		(0.70)		
		PID 1.50m <1ppm					1.45	74.93	
					Soft mottled brown and grey sandy gravelly CLAY. Gravel is fine to coarse subrounded of chalk.		(0.25) 1.70	74.68	
					Reddish brown slightly clayey SAND with rare flint gravel.		(0.30)		
		PID 2.00m <1ppm SPT() 2.00m N>50 *(0 for 0mm/0 for 0mm)*					2.00	74.38	
					Soft mottled grey and brown sandy slightly gravelly CLAY. Gravel is fine to coarse subangular to subrounded of flint and chalk.				
		PID 2.50m <1ppm					(1.09)		
		PID 3.00m <1ppm							
					Soft brownish speckled white grey sandy CLAY.		3.09	73.29	
		PID 3.50m <1ppm SPT() 3.50m N>50 *(0 for 0mm/0 for 0mm)*					(0.72)		
	(ES3) 3.80-4.20						3.81	72.57	
		PID 4.00m <1ppm			Brown mottled cream clayey sandy GRAVEL. Gravel is subangular to subrounded of chalk and flint.		(0.44)		
							4.25	72.13	
		PID 4.50m <1ppm			Brown speckled white slightly clayey slightly gravelly SAND. Gravel is fine to coarse subangular of flint and chalk.		(0.60)		
					Becomes gravelly 4.6-4.7m bgl				
					Becomes gravelly 4.8-4.85m bgl		4.85	71.53	
		PID 5.00m <1ppm			Brown clayey SAND with rare chalk and flint fine gravel and black banding.				
		PID 5.50m <1ppm					(1.06)		
		PID 6.00m <1ppm			Soft greyish brown sandy CLAY.		5.91	70.47	
							(0.39)		
2022/11/25 09:03 6.30 / -		PID 6.30m <1ppm					6.30	70.08	

DRILLING TECHNIQUE			HOLE / CASING DIAMETER				CHISELLING			WATER OBSERVATIONS						FLUSH DETAILS				WATER ADDED		
From	To	Type	Hole Dia.	Depth	Casing Dia.	Depth	From	To	Duration	Date/Time	Strike	Rest	Mins	Casing	Sealed	From	To	Rtn%	Type	From	To	Litres
0.00	1.20	Inspection Pit	300	1.20						25/11/2022 08:09	1.20			5.00								
1.20	6.30	Dynamic Sample																				

INSTRUMENTS			WELL SCREEN DESIGN				REMARKS
Name	Type	m AGL	Well Name	From	To	Dia.	
MW104	Standpipe	0.000	MW104	0.50	5.50	50	

Unless otherwise stated:
Depth (m), Diameter (mm), Time (hhmm), Thickness (m), Level (mAOD), Height Above Ground Level (m AGL)

Equipment Used	Termination Depth	Logged By	Checked By
Comacchio 205, Vac ex	**6.30m**	**RM**	**SB**

Dynamic Sampling to Rotary Coring Log

MW105

Project	Project No.	Ground Level (mAOD)	Start Date	Scale
Shell Sutton Elms	**10044284**	**76.06**	**17/11/2022**	**1:50**
Client	Easting (OS mE)	Northing (OS mN)	End Date	
Shell UK Oil Products Ltd.	**450845.16**	**293771.35**	**22/11/2022**	**Sheet 1 of 1**

Progress	Samples	Tests and Measurements			Strata				
Date / Time Casing / DTW	Type - Depth (m)	Type - Depth (m) - Result	Fracture Details	TCR SCR RQD	Description	Legend	Depth (Thickness)	Level	Install/ Backfill
2022/11/16 14:40 - / -					MADE GROUND: Grass over very soft light brown sandy gravelly CLAY with frequent cobbles of brick concrete red brick and bituminous material. Frequent roots and rootlets.		(1.25)		
	(ES1) 1.00-1.20	PID 1.00m <1ppm							
		PID 1.20m <1ppm							
		PID 1.30m <1ppm			Soft mottled grey and brown CLAY.		1.25 (0.21) 1.46	74.81 74.60	
					Light yellowish brown SAND pocket 1.45-1.47m bgl				
		PID 1.60m <1ppm			Soft grey mottled brown and speckled white/light grey gravelly CLAY. Gravel is fine to medium subrounded of quartz and chalk.		(0.25) 1.71	74.35	
	(ES2) 1.80-2.00								
		PID 2.00m <1ppm			Very soft to light brown sandy gravelly CLAY. Gravel is fine to coarse subangular to subrounded of flint, chalk, quartz and sandstone.		(0.69)		
		SPT() 2.00m N>50 *(0 for 0mm/0 for 0mm)*							
					Grey speckled white gravelly CLAY pocket. Gravel is fine. 1.92-1.93m bgl		2.40	73.66	
	(3) 2.50-2.70	PID 2.50m <1ppm			Soft grey banded brown sandy CLAY with rare fine chalk gravel.				
		PID 3.00m <1ppm					(1.55)		
		PID 3.50m <1ppm							
		SPT() 3.50m N>50 *(0 for 0mm/0 for 0mm)*							
		PID 4.00m <1ppm			Soft grey CLAY with occasional brownish grey sandy clay/ clayey sand bands.		3.95	72.11	
					Brown banding becomes less frequent 3.95m bgl				
		PID 4.50m <1ppm							
					Becomes very soft 4.6-4.9m bgl				
		PID 5.00m <1ppm					(2.25)		
		PID 5.50m <1ppm							
		PID 6.00m <1ppm							
2022/11/23 11:06 - / -							6.20	69.86	

DRILLING TECHNIQUE			HOLE / CASING DIAMETER				CHISELLING		
From	To	Type	Hole Dia.	Depth	Casing Dia.	Depth	From	To	Duration
1.20	6.20	Dynamic Sample	300	1.20					

WATER OBSERVATIONS						FLUSH DETAILS				WATER ADDED		
Date/Time	Strike	Rest	Mins	Casing	Sealed	From	To	Rtn%	Type	From	To	Litres
16/11/2022 14:50	1.20											
22/11/2022 09:00	0.65											
22/11/2022 11:11	3.54	3.51		2.10								

INSTRUMENTS			WELL SCREEN DESIGN			
Name	Type	m AGL	Well Name	From	To	Dia.
MW105	Standpipe	0.000	MW105	0.50	5.50	50

REMARKS

Unless otherwise stated:
Depth (m), Diameter (mm), Time (hhmm), Thickness (m), Level (mAOD), Height Above Ground Level (m AGL)

Equipment Used	Termination Depth	Logged By	Checked By
Comacchio 305	**6.20m**	**RM**	**SB**

Dynamic Sampling to Rotary Coring Log

MW106

Project	Project No.	Ground Level (mAOD)	Start Date	Scale
Shell Sutton Elms	**10044284**	**76.14**	**16/11/2022**	**1:50**
Client	Easting (OS mE)	Northing (OS mN)	End Date	
Shell UK Oil Products Ltd.	**450839.88**	**293751.14**	**22/11/2022**	**Sheet 1 of 1**

Progress	Samples	Tests and Measurements			Strata				
Date / Time Casing / DTW	Type - Depth (m)	Type - Depth (m) - Result	Fracture Details	TCR SCR RQD	Description	Legend	Depth (Thickness)	Level	Install/ Backfill
2022/11/16 11:15 - / -					MADE GROUND: ASPHALT.		(0.15) 0.15	75.99	
		PID 0.50m <1ppm			MADE GROUND: Dark grey to dark brown clayey gravelly SAND with frequent cobbles of brick and red brick. Gravel is fine to coarse subangular of brick, bituminous material and granite. Hydrocarbon odour noted.		(1.21)		
	(ES1) 1.00	PID 1.00m 61.3ppm							
		PID 1.30m 216.3ppm					1.36	74.78	
	(ES2) 1.50-1.80	PID 1.50m Over 5000ppm			Brown clayey gravelly SAND. Gravel is fine to coarse subrounded of flint. Hydrocarbon odour noted.		(0.48)		
		PID 1.70m Over 5000ppm			*Dark grey to black staining.*				
					Sheen noted 1.59-1.79m bgl		1.84	74.30	
		PID 2.00m 223.9ppm SPT() 2.00m N>50 *(0 for 0mm/0 for 0mm)*			Soft mottled grey and brown speckled white sandy gravelly CLAY. Gravel is fine to medium subrounded of chalk. Frequent roots and rootlets		(0.72)		
	(ES3) 2.30-2.50								
		PID 2.50m 1.6ppm			Soft brownish grey to greyish brown sandy CLAY.		2.56	73.58	
		PID 3.00m <1ppm							
		PID 3.50m <1ppm SPT() 3.50m N>50 *(0 for 0mm/0 for 0mm)*							
		PID 4.00m 1.2ppm							
		PID 4.50m <1ppm					(3.94)		
		PID 5.00m 1.9ppm							
		PID 5.50m <1ppm							
		PID 6.00m 1.0ppm							
		PID 6.40m <1ppm					6.50	69.64	

DRILLING TECHNIQUE			HOLE / CASING DIAMETER				CHISELLING			WATER OBSERVATIONS						FLUSH DETAILS				WATER ADDED		
From	To	Type	Hole Dia.	Depth	Casing Dia.	Depth	From	To	Duration	Date/Time	Strike	Rest	Mins	Casing	Sealed	From	To	Rtn%	Type	From	To	Litres
0.00	1.20	Inspection Pit	300	1.20						22/11/2022 14:23	1.57			2.20								
1.20	6.50	Dynamic Sample								22/11/2022 14:54	2.59			2.10								
										22/11/2022 15:48	4.81			3.81								

INSTRUMENTS			WELL SCREEN DESIGN				REMARKS
Name	Type	m AGL	Well Name	From	To	Dia.	
MW106	Standpipe	-	MW106	0.50	5.50	50	

Unless otherwise stated:
Depth (m), Diameter (mm), Time (hhmm), Thickness (m), Level (mAOD), Height Above Ground Level (m AGL)

Equipment Used	Termination Depth	Logged By	Checked By
Comacchio 305, Vac ex	**6.50m**	**RM**	**SB**

Appendix D

Hydraulic Conductivity Test

Aquifer Permeability Testing

The aim of the rising head test is to determine an estimate for the hydraulic conductivity within the screened interval of a monitoring well. The estimated value for hydraulic conductivity in this unit will be used in determining parameter values in the site specific risk assessment, if required.

Methodology

In a rising head test, a small volume of water is suddenly withdrawn from a well, after which the rate of increase in the groundwater level in the well is measured. From these measurements, the aquifer's hydraulic conductivity can be determined. In a rising head test it is only possible to determine the characteristics of a small volume of aquifer material surrounding the well, and this volume may have been disturbed during well installation. Nevertheless, some authors state that fairly accurate transmissivity values can be obtained from rising head tests.

The methodology used at Shell Sutton Elms involved the removal of a known volume of water. The subsequent recovery groundwater level was measured electronically using a pressure transducer and the difference in head between either the static groundwater level and the rising head of water or resting groundwater level and rising groundwater level calculated.

The falling head tests were undertaken on monitoring wells MW101, MW104, MW105 and MW106 on 15 September 2023.

Data Interpretation – Bouwer-Rice

To determine the hydraulic conductivity of an unconfined aquifer from a rising head test, Bouwer and Rice (1976) presented a method that is based on Thiem's equation. Using this methodology, the data collected from the field is plotted on a graph showing natural logarithm of head versus time. The best-fit line of this graph defines the head change at time zero (h0) and the head at an arbitrary time t (ht). From this data and the specific monitoring well parameters hydraulic conductivity is calculated.

Field Rising Head Test Results

Rising head tests were conducted in MW101, MW104, MW105 and MW106, to provide an estimate of the hydraulic conductivity of the River Terrace Deposit aquifer unit beneath the site. The technique used was to withdraw a known volume of water from each well and monitor groundwater level recovery electronically using a pressure transducer.

From this data the depths to groundwater were calculated and combined with data on the physical properties of the well, calculations for the derivation of the value for hydraulic conductivities were calculated using Bouwer and Rice's method for a partially penetrating well in an unconfined aquifer.

The hydraulic conductivity estimated from the tests conducted in monitoring wells MW102, MW104, MW105 and MW106 indicated a range in conductivity from 0.03 to 1.46 m/day. All four wells were screening a sandy gravelly clay, considered to be the River Terrace Deposits underlying the site.

Rising Head Test Calculations - 10044284 Shell Sutton Elms

NB - set to 2 decimal places as a default

Calculations using Bouwer & Rice assuming a PARTIALLY penetrating well.

Well ID	MW101	MW101	MW101	**Well ID**	MW104	MW104	MW104	**Well ID**	MW105	MW105	**Well ID**	MW106	MW106	MW106
Value from equation when t=0	-2.374	-2.2402	-2.4059	Value from equation when t=0	-1.2277	-1.4212	-1.3612	Value from equation when t=0	-1.5944	-1.7594	equation when t=0	-2.3928	0.0232	-2.3684
h_0	0.09310755	0.106437215	0.090184293	h_0	0.292965624	0.241424134	0.256352969	h_0	0.20303031	0.172148122	h_0	0.091373	1.023471	0.09363
Value from equation at selected t	-2.3938	-2.2642	-2.422	Value from equation at selected t	-1.2968	-1.4823	-1.4262	Value from equation at selected t	-1.5945	-1.7596	Value from equation at selected t	-2.3936	-0.00001	-2.3695
h_t	0.091282152	0.103913132	0.088743952	h_t	0.273405292	0.227114723	0.240220026	h_t	0.203010008	0.172113696	h_t	0.0913	0.99999	0.093527
Selected t	1	1	1	Selected t	1	1	1	Selected t	1	1	Selected t	1	1	1
1/t Ln h_0/h_t	0.0198	0.024	0.0161	1/t Ln h_0/h_t	0.0691	0.0611	0.065	1/t Ln h_0/h_t	1E-04	0.0002	1/t Ln h_0/h_t	0.0008	0.02321	0.0011
d	3.18	3.18	3.18	d	3.34	3.34	3.34	d	3.09	3.09	d	2.22	2.22	2.22
r_w	0.069	0.069	0.069	r_w	0.08	0.08	0.08	r_w	0.058	0.058	r_w	0.085	0.085	0.085
d/r_w	46.08695652	46.08695652	46.08695652	d/r_w	41.75	41.75	41.75	d/r_w	53.27586207	53.27586207	d/r_w	26.11765	26.11765	26.11765
A	3.06	3.06	3.06	A	2.93	2.93	2.93	A	3.28	3.28	A	2.43	2.43	2.43
B	0.51	0.51	0.51	B	0.49	0.49	0.49	B	0.55	0.55	B	0.40	0.40	0.40
D	3.498	3.498	3.498	D	3.674	3.674	3.674	D	3.399	3.399	D	2.442	2.442	2.442
b	3.18	3.18	3.18	b	3.34	3.34	3.34	b	3.09	3.09	b	2.22	2.22	2.22
1.1/(ln(b/r_w))	0.28716653	0.28716653	0.28716653	1.1/(ln(b/r_w))	0.294771863	0.294771863	0.294771863	1.1/(ln(b/r_w))	0.276695914	0.276695914	1.1/(ln(b/r_w))	0.337153	0.337153	0.337153
A+B(ln((D-b)/r_w))	3.847397824	3.847397824	3.847397824	A+B(ln((D-b)/r_w))	3.631644369	3.631644369	3.631644369	A+B(ln((D-b)/r_w))	4.196406963	4.196406963	A+B(ln((D-b)/r_w))	2.821438	2.821438	2.821438
Ln R_e/r_w	2.697979026	2.697979026	2.697979026	Ln R_e/r_w	2.619464908	2.619464908	2.619464908	Ln R_e/r_w	2.813228973	2.813228973	Ln R_e/r_w	2.246276	2.246276	2.246276
r_c	0.025	0.025	0.025	r_c	0.025	0.025	0.025	r_c	0.025	0.025	r_c	0.025	0.025	0.025
r_c^2	0.000625	0.000625	0.000625	r_c^2	0.000625	0.000625	0.000625	r_c^2	0.000625	0.000625	r_c^2	0.000625	0.000625	0.000625
K (m/sec)	5.2E-06	6.4E-06	4.3E-06	K (m/sec)	1.7E-05	1.5E-05	1.6E-05	K (m/sec)	2.8E-08	5.7E-08	K (m/sec)	2.5E-07	7.3E-06	3.5E-07
K (m/day)	0.45	0.55	0.37	K (m/day)	1.46	1.29	1.38	K (m/day)	0.00	0.00	K (m/day)	0.02	0.63	0.03

h_0	Head in the well at time t= t_0 (m)
d	Length of the well screen or open section of the well (m)
t	Time (seconds)
r_w	Horizontal distance from well centre to undisturbed aquifer (metres)- ie radius of the HOLE (M)
A	Dimensionless parameter (function of d/r_w) - from curves graph
B	Dimensionless parameter (function of d/r_w) - from curves graph
D	Saturated aquifer thickness (m)
b	Water column in well before test commences (metres)
R_e	Radial distance over which the difference in head, h_0, is dissipated in the aquifer
r_c	Radius of the well (metres)
K	Hydraulic Conductivity

Appendix E

Arcadis QA/QC Policy

Arcadis Laboratory Quality Assurance / Quality Control Policy

Arcadis is committed to providing our clients and regulators with robust investigative or monitoring results within the confines of the project. We recognise that a report is only as good as the data that is used to draw conclusions and thus it is important that the consultant and the client be able to have full confidence in data provided by laboratories that we use for analysis.

The first step in assuring said confidence is to ensure that our consultants on site are using appropriate sampling methodologies and are storing collected samples in the appropriate sample containers and under correct conditions. Laboratories are contacted prior to site works commencing and required analysis discussed, so that the laboratory can provide the necessary sample containers appropriate for sample storage and testing, as well as any preservatives that may be required. On delivery receipt the site consultant will visually check the containers to make sure the correct number have been delivered and verify that their condition is appropriate for use.

Once collected, samples are shipped to the laboratory in sealed cold boxes/containers provided by the laboratory with cooling aids and a Chain of Custody attached. The Chain of Custody identifies Arcadis as the client, the Arcadis Project Number, the Consultant/Project Manager, the type of sample e.g. groundwater, soil etc., the parameters to be tested and turnaround required for the analysis. Samples boxes are either hand delivered to the laboratory, picked up directly by the laboratory or picked up by a courier sent by the laboratory.

QA/QC of Laboratories

Arcadis has a preferred supplier program, and contract laboratories are expected to have analytical test methods UKAS accredited and to use the MCertS standard as far as possible. The MCertS accreditation was initially developed for the analysis of soils but is also now applied to some water types (e.g. effluent water), but is not available on groundwater analysis. The Environment Agency (EA) requires MCertS accredited data for sites that are within the regulatory process i.e. Part 2A designated contaminated land sites. For sites in which work is being undertaken voluntarily or through Planning it is recommended that the analysis be conducted following the MCertS standard wherever possible.

Data quality control is extremely important to Arcadis because we must be able to rely on the data provided in order to make our interpretations and recommendations. Data provided by the laboratory are provided digital formats to minimise potential for transcription errors during reporting. The data and laboratory QA results submitted by the laboratory are reviewed by the Arcadis Project Manager who has support from the Arcadis Analytical Chemistry Technical Lead. As part of the project execution plan the Project Manager will determine if QA/QC samples are required which could include:

• Duplicate samples (recommended for groundwater sampling only as soil samples are heterogeneous)

• Trip Blank Samples

• Field Blank Samples

• Equipment Rinse Blanks

• Certified Reference Materials submitted as samples.

Arcadis monitor laboratory performance as part of our Integrated Observation (IO) management process. Project teams are encouraged to submit an IO if they experience positive or negative performance during project implementation, the IO's are then reviewed on a monthly basis and if repeat issues are identified with one or more laboratory suppliers a meeting will be convened with the supplier to understand the root cause of the issues experienced.

Appendix F

Report Tables

Table 1: Groundwater Monitoring Well Installation Details and Groundwater Elevation Survey

Table 2: Stabilised Hydrogeochemical Parameters in Groundwater

Table 3: Comparison of COPC Concentrations in Groundwater with Arcadis GAC for Continued Petroleum Use and Shell Universal RBSL

Project: 10044284
Site Name: Shell Sutton Elms

ARCADIS

Table 1
Groundwater Monitoring Installation Details and Elevation Survey

Monitoring Well	Installation Type	Date Installed	Dip Point Elevation (m AOD)	Dip Point Description	Response Zone (m bgl)	Response Zone (m AOD)	Depth to Well Base on Install (m bgl)	Depth to NAPL (m bgl)	Depth to Water (m bgl)	Depth to Well Base (m bgl)	NAPL Thickness	Groundwater Elevation (m AOD)	Head of Water Above Base (m)	Difference from Installed Depth/ Silt Thickness (m)
Prior to well redevelopment (31/08/2023)														
MW101	50mm ID HDPE Standpipe	18-11-2022	76.55	Ground level	0.5 to 5.5	76.05 to 71.05	5.50	NMP	2.00	4.04	NMP	74.55	2.04	-1.46
MW104	50mm ID HDPE Standpipe	25-11-2022	76.39	Ground level	0.5 to 5.5	75.89 to 70.89	5.50	NMP	1.66	3.95	NMP	74.73	2.30	-1.55
MW105	50mm ID HDPE Standpipe	18-11-2022	76.06	Ground level	0.5 to 5.5	78.56 to 70.56	5.50	NMP	1.96	4.93	NMP	74.10	2.97	-0.57
MW106	50mm ID HDPE Standpipe	22-11-2022	76.14	Ground level	0.5 to 5.5	75.64 to 70.64	5.50	NMP	1.29	4.85	NMP	74.85	3.56	-0.65
Post well redevelopment (31/08/2023)														
MW101	50mm ID HDPE Standpipe	18-11-2022	76.55	Ground level	0.5 to 5.5	76.05 to 71.05	5.50	NMP	2.34	5.13	NMP	74.21	2.79	-0.37
MW104	50mm ID HDPE Standpipe	25-11-2022	76.39	Ground level	0.5 to 5.5	75.89 to 70.89	5.50	NMP	1.81	5.06	NMP	74.58	3.25	-0.44
MW105	50mm ID HDPE Standpipe	18-11-2022	76.06	Ground level	0.5 to 5.5	78.56 to 70.56	5.50	NMP	5.50	5.50	NMP	70.56	0.00	0.00
MW106	50mm ID HDPE Standpipe	22-11-2022	76.14	Ground level	0.5 to 5.5	75.64 to 70.64	5.50	NMP	2.82	5.52	NMP	73.32	2.70	0.02
Groundwater Monitoring Event (13&14/09/2023)														
MW101	50mm ID HDPE Standpipe	18-11-2022	76.55	Ground level	0.5 to 5.5	76.05 to 71.05	5.50	NMP	1.90	NR	NMP	74.65	NR	NR
MW104	50mm ID HDPE Standpipe	25-11-2022	76.39	Ground level	0.5 to 5.5	75.89 to 70.89	5.50	NMP	1.60	4.99	NMP	74.78	3.39	-0.51
MW105	50mm ID HDPE Standpipe	18-11-2022	76.06	Ground level	0.5 to 5.5	78.56 to 70.56	5.50	NMP	2.00	NR	NMP	74.07	NR	NR
MW106	50mm ID HDPE Standpipe	22-11-2022	76.14	Ground level	0.5 to 5.5	75.64 to 70.64	5.50	NMP	1.90	NR	NMP	74.25	NR	NR
Logger Retrieval (17/11/2023)														
MW101	50mm ID HDPE Standpipe	18-11-2022	76.55	Ground level	0.5 to 5.5	76.05 to 71.05	5.50	NMP	1.57	5.06	NMP	74.98	3.50	-0.44
MW104	50mm ID HDPE Standpipe	25-11-2022	76.39	Ground level	0.5 to 5.5	75.89 to 70.89	5.50	NMP	1.29	4.95	NMP	75.10	3.66	-0.55
MW105	50mm ID HDPE Standpipe	18-11-2022	76.06	Ground level	0.5 to 5.5	78.56 to 70.56	5.50	NMP	0.63	5.50	NMP	75.44	4.87	0.00
MW106	50mm ID HDPE Standpipe	22-11-2022	76.14	Ground level	0.5 to 5.5	75.64 to 70.64	5.50	NMP	1.01	5.46	NMP	75.13	4.45	-0.04

Notes:

m AOD	Meters Above Ordanance Datum
m bgl	Meters Below Ground Level
NAPL	Non-Aqueous Phase Liquid
NR	Not recorded
HDPE	High-Density Polyethylene
NMP	No Measurable Product thickness recorded

Project: 10044284
Site Name: Shell Sutton Elms

Table 2
Stabilised Hydrogeochemical Parameters in Groundwater

Monitoring Well	Date	Sampled Time	Sampling Method	Sample Depth (m bgl)	Temperature (°C)	Dissolved Oxygen (%)	Dissolved Oxygen (mg/l)	Specific Conductivity (µS/cm)	Conductivity (µS/cm)	pH	ORP (mV)	Sample Comments
MW101	13-09-2023	03:15 PM	Multiprobe / Peristaltic	2.00	15.40	13.50	1.36	866.00	711.00	7.10	223.40	Overcast
MW104	13-09-2023	05:05 PM	Multiprobe / Peristaltic	2.50	17.50	4.20	0.42	1160.00	995.00	7.37	153.10	Overcast
MW105	14-09-2023	12:00 PM	Multiprobe / Bladder	2.50	15.10	4.10	0.44	900.00	729.00	7.18	200.10	Heavy Rain
MW106	14-09-2023	02:00 PM	Multiprobe / Bladder	2.50	17.40	39.50	3.80	NR	891.10	7.50	298.90	Heavy Rain

Notes:

mg/l	milligrammes per litre
mV	millivolts
µs/cm	micro-Siemens per centimeter
m bgl	meters below ground level
ORP	Oxidation-Reduction Potential
-	Not applicable
NR	Not recorded

Project: 10044284
Site Name: Shell Sutton Elms

Table 3
Comparison of Measured Concentrations of Contaminants in Groundwater (µg/l) to Arcadis GAC for Continued Petroleum Use

Location Code							MW101	MW101[DUP]	MW104	MW105	MW106	TB	EB
Date			Arcadis GAC - Human Health - Continued Petroleum Use	Arcadis GAC - Water Resources - Aquifers - England & Wales	Arcadis GAC - Water Resources - Surface Water - England & Wales	Shell RBSL	13-09-2023	14-09-2023	13-09-2023	14-09-2023	14-09-2023	14-09-2023	14-09-2023
Sample Depth							2.00	2.00	2.50	2.50	2.50	NA	NA
Analyte Group	Analyte	MDL											
TPH CWG	>C5-C6 Aliphatics	10	>SOL [#1]	See TPH[#5]	See TPH[#5]		<10	<10	<10	<10	<10	---	---
	>C6-C8 Aliphatics	10	>SOL [#1]	See TPH[#5]	See TPH[#5]		<10	<10	<10	<10	<10	---	---
	>C8-C10 Aliphatics	10	>SOL [#1]	See TPH[#5]	See TPH[#5]		<10	<10	<10	<10	<10	---	---
	>C10-C12 Aliphatics	5	>SOL [#1]	See TPH[#5]	See TPH[#5]		<5	<5	<5	<5	<5	---	---
	>C12-C16 Aliphatics	10	>SOL [#1]	See TPH[#5]	See TPH[#5]		<10	<10	<10	<10	<10	---	---
	>C16-C21 Aliphatics	10	NR [#2]	See TPH[#5]	See TPH[#5]		<10	<10	<10	<10	<10	---	---
	>C21-C35 Aliphatics	10	NR [#2]	See TPH[#5]	See TPH[#5]		<10	<10	<10	<10	<10	---	---
	Total >C5-C35 Aliphatics	10	-	-	-		<10	<10	<10	<10	<10	---	---
	>EC8-EC10 Aromatics	10	>SOL [#1]	See TPH[#5]	See TPH[#5]		<10	<10	<10	<10	<10	---	---
	>EC10-EC12 Aromatics	5	>SOL [#1]	See TPH[#5]	See TPH[#5]		<5	<5	<5	<5	<5	---	---
	>EC8-EC40 Aromatics	10	-	-	-		<10	<10	<10	<10	<10	---	<10
	>EC12-EC16 Aromatics	10	>SOL [#1]	See TPH[#5]	See TPH[#5]		<10	<10	<10	<10	<10	---	---
	>EC16-EC21 Aromatics	10	NR [#2]	See TPH[#5]	See TPH[#5]		<10	<10	<10	<10	<10	---	---
	>EC21-EC35 Aromatics	10	NR [#2]	See TPH[#5]	See TPH[#5]		<10	<10	<10	<10	<10	---	---
	Total >EC5-EC35 Aromatics	10	-	-	-		<10	<10	<10	<10	<10	---	---
	TPH >C5-C35 Aliphatics/Aromatics	10	na [#3]	10	10		<10	<10	<10	<10	<10	---	---
BTEX													
	Benzene	0.5	12,000	1	10		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Toluene	5	>SOL [#1]	700	74		<5	<5	<5	<5	<5	<5	<5
	Ethylbenzene	1	>SOL [#1]	300	20		<1	<1	<1	<1	<1	<1	<1
	Xylene (m & p)	2	>SOL [#1]	250[#4]	15[#4]		<2	<2	<2	<2	<2	<2	<2
	Xylene (o)	1	>SOL [#1]	250[#4]	15[#4]	93000 #6	<1	<1	<1	<1	<1	<1	<1
Fuel oxygenates													
	Diisopropyl ether	1	-	-	-	2700000 [#6]	<1	<1	<1	<1	<1	---	<1
	Ethanol	100	-	-	-		<100	<100	<100	<100	<100	---	<100
	Ethyl tertiary butyl ether	1	460,000	47	47	4200000 [#6]	<1	<1	<1	<1	<1	---	<1
	MTBE	0.1	5,200,000	15	15		<0.1	<0.1	0.4	<0.1	0.2	<0.1	<0.1
	tert-Amyl methyl ether	1	-	-	-	280000 [#6]	<1	<1	<1	<1	<1	---	<1
	tert-Butyl alcoho	100	20,000,000	12	12		<100	<100	<100	<100	<100	---	<100
TPH													
	GRO (>C4-C12) #	10	-	-	-		<10	<10	<10	<10	<10	---	<10
	GRO (>C4-C8) #	10	-	-	-		<10	<10	<10	<10	<10	---	<10
	GRO (>C8-C12) #	10	-	-	-		<10	<10	<10	<10	<10	---	<10
PAH 16													
	Naphthalene	0.1	>SOL [#1]	2	2	15000 [#6]	<0.1	<0.1	<0.1	<0.1	<0.1	---	---
	Acenaphthene	0.005	>SOL [#1]	- [#6]	- [#6]		<0.005	<0.005	<0.005	<0.005	<0.005	---	---
	Acenaphthylene	0.005	>SOL [#1]	- [#6]	- [#6]		<0.005	<0.005	<0.005	<0.005	<0.005	---	---
	Fluoranthene	0.005	>SOL [#1]	- [#6]	- [#6]		<0.005	<0.005	<0.005	0.044	<0.005	---	---
	Anthracene	0.005	>SOL [#1]	- [#6]	- [#6]		<0.005	<0.005	<0.005	0.006	<0.005	---	---
	Phenanthrene	0.005	>SOL [#1]	- [#6]	- [#6]		<0.005	<0.005	<0.005	0.011	<0.005	---	---
	Fluorene	0.005	>SOL [#1]	- [#6]	- [#6]		<0.005	<0.005	<0.005	<0.005	<0.005	---	---
	Chrysene	0.005	>SOL [#1]	- [#6]	- [#6]		<0.005	<0.005	<0.005	0.03	<0.005	---	---
	Pyrene	0.005	>SOL [#1]	- [#6]	- [#6]		<0.005	<0.005	0.007	0.047	0.005	---	---
	Benzo(a)anthracene	0.005	>SOL [#1]	- [#6]	- [#6]		<0.005	<0.005	<0.005	0.028	<0.005	---	---
	Benzo(b)fluoranthene	0.008	>SOL [#1]	0.025	- [#6]		<0.008	<0.008	<0.008	0.032	<0.008	---	---
	Benzo(k)fluoranthene	0.008	>SOL [#1]	0.025	- [#6]		<0.008	<0.008	<0.008	0.012	<0.008	---	---
	Benzo(a)pyrene	0.005	>SOL [#1]	0.01	0.00017		<0.005	<0.005	<0.005	0.023	<0.005	---	---
	Dibenz(a,h)anthracene	0.005	>SOL [#1]	- [#6]	- [#6]		<0.005	<0.005	<0.005	<0.005	<0.005	---	---
	Benzo(g,h,i)perylene	0.005	>SOL [#1]	0.025	- [#6]		<0.005	<0.005	<0.005	0.013	<0.005	---	---
	Indeno(1,2,3-c,d)pyrene	0.005	>SOL [#1]	0.025	- [#6]		<0.005	<0.005	<0.005	0.022	<0.005	---	---
	PAH 16 Total	0.173	-	-	-		<0.173	<0.173	<0.173	0.268	<0.173	---	---
	Benzo(b+k)fluoranthene	0.008	-	-	-		<0.008	<0.008	<0.008	0.044	<0.008	---	---
VOC													
	Hexane	50	-	-	-		<50	<50	<50	<50	<50	---	---
SVOC													
	2-methylnaphthalene	1	-	-	-		<1	<1	<1	<1	<1	---	---

Comments:

#1 >SOL - Target acceptable risk not exceeded at theoretical solubility concentration

#2 NR - No appropriate inhalation reference dose identified during review of toxicological data

#3 na - Comprises multiple contaminants - no GAC derived

#4 Criteria derived for sum xylenes split between isomers. Requires summation of m,p & o isomers to use sum xylenes criteri

#5 No GAC for individual TPH fractions given that the compliance criteria is for sum TPH

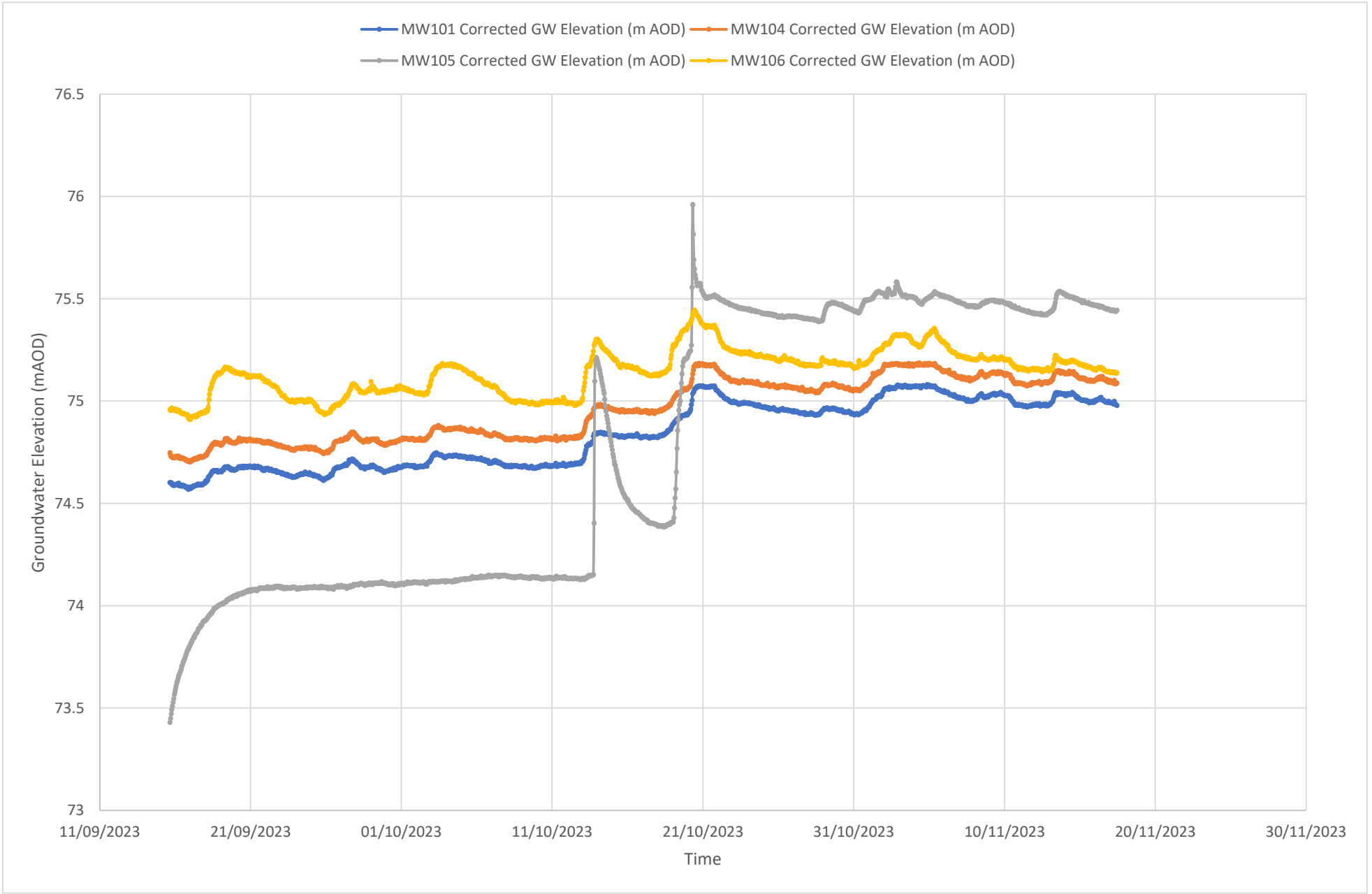
#6 Universal Human Health Risk-Based Screening Levels (RBSL) Tables for Shell Downstream. SR.14.13826 Rev 2. March 2021

Notes:

MDL	Method Detection Limit
NA	Data not applicable
m bgl	Meters Below Ground Leve
---	Analysis not scheduled/ not applicable
<0.123	Result less than Effective Quantification Limit
0.123	Result above Effective Quantification Limit
EB	Equpment Blank Sample
DUP	Duplicate Sample

Appendix G

Water level Logger plot



10044284
Shell Sutton Elms
Groundwater Elevation 15 September to 17 November 2023

Appendix H

Laboratory Certificates

Element Materials Technology
Unit 3 Deeside Point
Zone 3
Deeside Industrial Park
Deeside
CH5 2UA

P: +44 (0) 1244 833780
F: +44 (0) 1244 833781
W: www.element.com

Arcadis
Part 3rd Floor
Charter House
62-68 Hills Road
Cambridge
Cambridgeshire
United Kingdom
CB2 1LA

Attention :	Jon Raven
Date :	25th September, 2023
Your reference :	10044284
Our reference :	Test Report 23/15298 Batch 1
Location :	Sutton EIMS
Date samples received :	16th September, 2023
Status :	Final Report
Issue :	1

Seven samples were received for analysis on 16th September, 2023 of which seven were scheduled for analysis. Please find attached our Test Report which should be read with notes at the end of the report and should include all sections if reproduced. Interpretations and opinions are outside the scope of any accreditation, and all results relate only to samples supplied.
All analysis is carried out on as received samples and reported on a dry weight basis unless stated otherwise. Results are not surrogate corrected.

The greenhouse gas emissions generated (in Carbon – Co2e) to obtain the results in this report are estimated as:

Scope 1&2 emissions - 10.57 kg of CO2

Scope 1&2&3 emissions - 24.981 kg of CO2

Authorised By:

Simon Gomery BSc
Senior Project Manager

Client Name: Arcadis
Reference: 10044284
Location: Sutton EIMS
Contact: Jon Raven
EMT Job No: 23/15298

Report : Liquid

Liquids/products: V=40ml vial, G=glass bottle, P=plastic bottle
H=H_2SO_4, Z=ZnAc, N=NaOH, HN=$HN0_3$

EMT Sample No.	1-5	6-10	11-15	16-20	21-25	26	27-31				LOD/LOR	Units	Method No.
Sample ID	01MW101130 923WG1515	02MW104130 923WG1705	03MW105140 923WG1200	04MW106140 923WG1415	05DUPLICATE	06TB0114092 3WG1700	EB						
Depth													
COC No / misc													
Containers	V P G	V P G	V P G	V P G	V P G	V	V P G						
Sample Date	13/09/2023 15:15	13/09/2023 17:05	14/09/2023 12:00	14/09/2023 14:15	<>	14/09/2023 17:00	<>						
Sample Type	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water						
Batch Number	1	1	1	1	1	1	1						
Date of Receipt	16/09/2023	16/09/2023	16/09/2023	16/09/2023	16/09/2023	16/09/2023	16/09/2023						
PAH MS													
Naphthalene #	<0.1	<0.1	<0.1	<0.1	<0.1	-	-				<0.1	ug/l	TM4/PM30
Acenaphthylene #	<0.005	<0.005	<0.005	<0.005	<0.005	-	-				<0.005	ug/l	TM4/PM30
Acenaphthene #	<0.005	<0.005	<0.005	<0.005	<0.005	-	-				<0.005	ug/l	TM4/PM30
Fluorene #	<0.005	<0.005	<0.005	<0.005	<0.005	-	-				<0.005	ug/l	TM4/PM30
Phenanthrene #	<0.005	<0.005	0.011	<0.005	<0.005	-	-				<0.005	ug/l	TM4/PM30
Anthracene #	<0.005	<0.005	0.006	<0.005	<0.005	-	-				<0.005	ug/l	TM4/PM30
Fluoranthene #	<0.005	<0.005	0.044	<0.005	<0.005	-	-				<0.005	ug/l	TM4/PM30
Pyrene #	<0.005	0.007	0.047	0.005	<0.005	-	-				<0.005	ug/l	TM4/PM30
Benzo(a)anthracene #	<0.005	<0.005	0.028	<0.005	<0.005	-	-				<0.005	ug/l	TM4/PM30
Chrysene #	<0.005	<0.005	0.030	<0.005	<0.005	-	-				<0.005	ug/l	TM4/PM30
Benzo(bk)fluoranthene #	<0.008	<0.008	0.044	<0.008	<0.008	-	-				<0.008	ug/l	TM4/PM30
Benzo(a)pyrene #	<0.005	<0.005	0.023	<0.005	<0.005	-	-				<0.005	ug/l	TM4/PM30
Indeno(123cd)pyrene #	<0.005	<0.005	0.022	<0.005	<0.005	-	-				<0.005	ug/l	TM4/PM30
Dibenzo(ah)anthracene #	<0.005	<0.005	<0.005	<0.005	<0.005	-	-				<0.005	ug/l	TM4/PM30
Benzo(ghi)perylene #	<0.005	<0.005	0.013	<0.005	<0.005	-	-				<0.005	ug/l	TM4/PM30
PAH 16 Total #	<0.173	<0.173	0.268	<0.173	<0.173	-	-				<0.173	ug/l	TM4/PM30
Benzo(b)fluoranthene	<0.008	<0.008	0.032	<0.008	<0.008	-	-				<0.008	ug/l	TM4/PM30
Benzo(k)fluoranthene	<0.008	<0.008	0.012	<0.008	<0.008	-	-				<0.008	ug/l	TM4/PM30
PAH Surrogate % Recovery	78	83	71	67 SV	79	-	-				<0	%	TM4/PM30
Methyl Tertiary Butyl Ether #	<0.1	0.4	<0.1	0.2	<0.1	<0.1	<0.1				<0.1	ug/l	TM15/PM10
Benzene #	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5				<0.5	ug/l	TM15/PM10
Toluene #	<5	<5	<5	<5	<5	<5	<5				<5	ug/l	TM15/PM10
Ethylbenzene #	<1	<1	<1	<1	<1	<1	<1				<1	ug/l	TM15/PM10
m/p-Xylene #	<2	<2	<2	<2	<2	<2	<2				<2	ug/l	TM15/PM10
o-Xylene #	<1	<1	<1	<1	<1	<1	<1				<1	ug/l	TM15/PM10
n-Hexane	<50	<50	<50	<50	<50	-	-				<50	ug/l	TM15/PM10
Surrogate Recovery Toluene D8	99	107	105	110	105	108	106				<0	%	TM15/PM10
Surrogate Recovery 4-Bromofluorobenzene	103	102	99	100	99	100	99				<0	%	TM15/PM10
2-Methylnaphthalene #	<1	<1	<1	<1	<1	-	-				<1	ug/l	TM16/PM30
Surrogate Recovery 2-Fluorobiphenyl	107	120	105	106	112	-	-				<0	%	TM16/PM30
Surrogate Recovery p-Terphenyl-d14	105	119	104	104	112	-	-				<0	%	TM16/PM30
GRO (>C4-C8) #	<10	<10	<10	<10	<10	-	<10				<10	ug/l	TM36/PM12
GRO (>C8-C12) #	<10	<10	<10	<10	<10	-	<10				<10	ug/l	TM36/PM12
GRO (>C4-C12) #	<10	<10	<10	<10	<10	-	<10				<10	ug/l	TM36/PM12
EPH (C8-C40) #	<10	<10	<10	<10	<10	-	<10				<10	ug/l	TM5/PM30

Please see attached notes for all abbreviations and acronyms

Element Materials Technology

Client Name: Arcadis
Reference: 10044284
Location: Sutton EIMS
Contact: Jon Raven
EMT Job No: 23/15298

Report : Liquid

Liquids/products: V=40ml vial, G=glass bottle, P=plastic bottle
H=H_2SO_4, Z=ZnAc, N=NaOH, HN=$HN0_3$

EMT Sample No.	1-5	6-10	11-15	16-20	21-25	26	27-31				LOD/LOR	Units	Method No.
Sample ID	01MW101130 923WG1515	02MW104130 923WG1705	03MW105140 923WG1200	04MW106140 923WG1415	05DUPLICATE	06TB0114092 3WG1700	EB						
Depth													
COC No / misc													
Containers	V P G	V P G	V P G	V P G	V P G	V	V P G						
Sample Date	13/09/2023 15:15	13/09/2023 17:05	14/09/2023 12:00	14/09/2023 14:15	<>	14/09/2023 17:00	<>						
Sample Type	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water						
Batch Number	1	1	1	1	1	1	1						
Date of Receipt	16/09/2023	16/09/2023	16/09/2023	16/09/2023	16/09/2023	16/09/2023	16/09/2023						
TPH CWG													
Aliphatics													
>C5-C6 #	<10	<10	<10	<10	<10	-	-				<10	ug/l	TM36/PM12
>C6-C8 #	<10	<10	<10	<10	<10	-	-				<10	ug/l	TM36/PM12
>C8-C10 #	<10	<10	<10	<10	<10	-	-				<10	ug/l	TM36/PM12
>C10-C12 #	<5	<5	<5	<5	<5	-	-				<5	ug/l	TM5/PM16/PM30
>C12-C16 #	<10	<10	<10	<10	<10	-	-				<10	ug/l	TM5/PM16/PM30
>C16-C21 #	<10	<10	<10	<10	<10	-	-				<10	ug/l	TM5/PM16/PM30
>C21-C35 #	<10	<10	<10	<10	<10	-	-				<10	ug/l	TM5/PM16/PM30
Total aliphatics C5-35 #	<10	<10	<10	<10	<10	-	-				<10	ug/l	TM5/TM36/PM12/PM16/PM30
Aromatics													
>C5-EC7 #	<10	<10	<10	<10	<10	-	-				<10	ug/l	TM36/PM12
>EC7-EC8 #	<10	<10	<10	<10	<10	-	-				<10	ug/l	TM36/PM12
>EC8-EC10 #	<10	<10	<10	<10	<10	-	-				<10	ug/l	TM36/PM12
>EC10-EC12 #	<5	<5 SV	<5	<5	<5	-	-				<5	ug/l	TM5/PM16/PM30
>EC12-EC16 #	<10	<10 SV	<10	<10	<10	-	-				<10	ug/l	TM5/PM16/PM30
>EC16-EC21 #	<10	<10 SV	<10	<10	<10	-	-				<10	ug/l	TM5/PM16/PM30
>EC21-EC35 #	<10	<10 SV	<10	<10	<10	-	-				<10	ug/l	TM5/PM16/PM30
Total aromatics C5-35 #	<10	<10	<10	<10	<10	-	-				<10	ug/l	TM5/TM36/PM12/PM16/PM30
Total aliphatics and aromatics(C5-35) #	<10	<10	<10	<10	<10	-	-				<10	ug/l	TM5/TM36/PM12/PM16/PM30
Ethyl Tert Butyl Ether (ETBE) #	<1	<1	<1	<1	<1	-	<1				<1	ug/l	TM83/PM10
Di isopropyl Ether (DIPE) #	<1	<1	<1	<1	<1	-	<1				<1	ug/l	TM83/PM10
Tert Butyl Alcohol (TBA)	<100	<100	<100	<100	<100	-	<100				<100	ug/l	TM83/PM10
Tert Amyl Methyl Ether (TAME) #	<1	<1	<1	<1	<1	-	<1				<1	ug/l	TM83/PM10
Ethanol	<100	<100	<100	<100	<100	-	<100				<100	ug/l	TM83/PM10

Please see attached notes for all abbreviations and acronyms

Client Name: Arcadis

Matrix : Liquid

Reference: 10044284

Location: Sutton EIMS

Contact: Jon Raven

EMT Job No.	Batch	Sample ID	Depth	EMT Sample No.	Analysis	Reason
23/15298	1	05DUPLICATE		21-25	All analyses	No sampling date given
23/15298	1	EB		27-31	All analyses	No sampling date given

Please note that only samples that are deviating are mentioned in this report. If no samples are listed it is because none were deviating. Only analyses which are accredited are recorded as deviating if set criteria are not met.

It is a requirement under ISO 17025 that we inform clients if samples are deviating i.e. outside what is expected. A deviating sample indicates that the sample 'may' be compromised but not necessarily will be compromised. The result is still accredited and our analytical reports will still show accreditation on the relevant analytes.

NOTES TO ACCOMPANY ALL SCHEDULES AND REPORTS

EMT Job No.: 23/15298

SOILS and ASH

Please note we are only MCERTS accredited (UK soils only) for sand, loam and clay and any other matrix is outside our scope of accreditation.

Where an MCERTS report has been requested, you will be notified within 48 hours of any samples that have been identified as being outside our MCERTS scope. As validation has been performed on clay, sand and loam, only samples that are predominantly these matrices, or combinations of them will be within our MCERTS scope. If samples are not one of a combination of the above matrices they will not be marked as MCERTS accredited.

It is assumed that you have taken representative samples on site and require analysis on a representative subsample. Stones will generally be included unless we are requested to remove them.

All samples will be discarded one month after the date of reporting, unless we are instructed to the contrary. Asbestos samples are retained for 6 months.

If you have not already done so, please send us a purchase order if this is required by your company.

Where appropriate please make sure that our detection limits are suitable for your needs, if they are not, please notify us immediately.

All analysis is reported on a dry weight basis unless stated otherwise. Limits of detection for analyses carried out on as received samples are not moisture content corrected. Results are not surrogate corrected. Samples are dried at 35°C ±5°C unless otherwise stated. Moisture content for CEN Leachate tests are dried at 105°C ±5°C. Ash samples are dried at 37°C ±5°C.

Where Mineral Oil or Fats, Oils and Grease is quoted, this refers to Total Aliphatics C10-C40.

Where a CEN 10:1 ZERO Headspace VOC test has been carried out, a 10:1 ratio of water to wet (as received) soil has been used.

% Asbestos in Asbestos Containing Materials (ACMs) is determined by reference to HSG 264 The Survey Guide - Appendix 2 : ACMs in buildings listed in order of ease of fibre release.

Sufficient amount of sample must be received to carry out the testing specified. Where an insufficient amount of sample has been received the testing may not meet the requirements of our accredited methods, as such accreditation may be removed.

Negative Neutralization Potential (NP) values are obtained when the volume of NaOH (0.1N) titrated (pH 8.3) is greater than the volume of HCl (1N) to reduce the pH of the sample to 2.0 - 2.5. Any negative NP values are corrected to 0.

The calculation of Pyrite content assumes that all oxidisable sulphides present in the sample are pyrite. This may not be the case. The calculation may be an overesitimate when other sulphides such as Barite (Barium Sulphate) are present.

WATERS

Please note we are not a UK Drinking Water Inspectorate (DWI) Approved Laboratory .

ISO17025 accreditation applies to surface water and groundwater and usually one other matrix which is analysis specific, any other liquids are outside our scope of accreditation.

As surface waters require different sample preparation to groundwaters the laboratory must be informed of the water type when submitting samples.

Where Mineral Oil or Fats, Oils and Grease is quoted, this refers to Total Aliphatics C10-C40.

STACK EMISSIONS

Where an MCERTS report has been requested, you will be notified within 48 hours of any samples that have been identified as being outside our MCERTS scope. As validation for Dioxins and Furans and Dioxin like PCBs has been performed on XAD-2 Resin, only samples which use this resin will be within our MCERTS scope.

Where appropriate please make sure that our detection limits are suitable for your needs, if they are not, please notify us immediately.

DEVIATING SAMPLES

All samples should be submitted to the laboratory in suitable containers with sufficient ice packs to sustain an appropriate temperature for the requested analysis. The temperature of sample receipt is recorded on the confirmation schedules in order that the client can make an informed decision as to whether testing should still be undertaken.

SURROGATES

Surrogate compounds are added during the preparation process to monitor recovery of analytes. However low recovery in soils is often due to peat, clay or other organic rich matrices. For waters this can be due to oxidants, surfactants, organic rich sediments or remediation fluids. Acceptable limits for most organic methods are 70 - 130% and for VOCs are 50 - 150%. When surrogate recoveries are outside the performance criteria but the associated AQC passes this is assumed to be due to matrix effect. Results are not surrogate corrected.

DILUTIONS

A dilution suffix indicates a dilution has been performed and the reported result takes this into account. No further calculation is required.

BLANKS

Where analytes have been found in the blank, the sample will be treated in accordance with our laboratory procedure for dealing with contaminated blanks.

NOTE

Data is only reported if the laboratory is confident that the data is a true reflection of the samples analysed. Data is only reported as accredited when all the requirements of our Quality System have been met. In certain circumstances where all the requirements of the Quality System have not been met, for instance if the associated AQC has failed, the reason is fully investigated and documented. The sample data is then evaluated alongside the other quality control checks performed during analysis to determine its suitability. Following this evaluation, provided the sample results have not been effected, the data is reported but accreditation is removed. It is a requirement of our Accreditation Body for data not reported as accredited to be considered indicative only, but this does not mean the data is not valid.
Where possible, and if requested, samples will be re-extracted and a revised report issued with accredited results. Please do not hesitate to contact the laboratory if further details are required of the circumstances which have led to the removal of accreditation.
Laboratory records are kept for a period of no less than 6 years.

REPORTS FROM THE SOUTH AFRICA LABORATORY

Any method number not prefixed with SA has been undertaken in our UK laboratory unless reported as subcontracted.

Measurement Uncertainty

Measurement uncertainty defines the range of values that could reasonably be attributed to the measured quantity. This range of values has not been included within the reported results. Uncertainty expressed as a percentage can be provided upon request.

Customer Provided Information

Sample ID and depth is information provided by the customer.

ABBREVIATIONS and ACRONYMS USED

#	ISO17025 (UKAS Ref No. 4225) accredited - UK.
SA	ISO17025 (SANAS Ref No.T0729) accredited - South Africa
B	Indicates analyte found in associated method blank.
DR	Dilution required.
M	MCERTS accredited.
NA	Not applicable
NAD	No Asbestos Detected.
ND	None Detected (usually refers to VOC and/SVOC TICs).
NDP	No Determination Possible
SS	Calibrated against a single substance
SV	Surrogate recovery outside performance criteria. This may be due to a matrix effect.
W	Results expressed on as received basis.
+	AQC failure, accreditation has been removed from this result, if appropriate, see 'Note' on previous page.
>>	Results above quantitative calibration range. The result should be considered the minimum value and is indicative only. The actual result could be significantly higher.
*	Analysis subcontracted to an Element Materials Technology approved laboratory.
AD	Samples are dried at 35°C ±5°C
CO	Suspected carry over
LOD/LOR	Limit of Detection (Limit of Reporting) in line with ISO 17025 and MCERTS
ME	Matrix Effect
NFD	No Fibres Detected
BS	AQC Sample
LB	Blank Sample
N	Client Sample
TB	Trip Blank Sample
OC	Outside Calibration Range

HWOL ACRONYMS AND OPERATORS USED

HS	Headspace Analysis.
EH	Extractable Hydrocarbons - i.e. everything extracted by the solvent.
CU	Clean-up - e.g. by florisil, silica gel.
1D	GC - Single coil gas chromatography.
Total	Aliphatics & Aromatics.
AL	Aliphatics only.
AR	Aromatics only.
2D	GC-GC - Double coil gas chromatography.
#1	EH_Total but with humics mathematically subtracted
#2	EU_Total but with fatty acids mathematically subtracted
_	Operator - underscore to separate acronyms (exception for +).
+	Operator to indicate cumulative e.g. EH+HS_Total or EH_CU+HS_Total
MS	Mass Spectrometry.

EMT Job No: 23/15298

Test Method No.	Description	Prep Method No. (if appropriate)	Description	ISO 17025 (UKAS/SANAS)	MCERTS (UK soils only)	Analysis done on As Received (AR) or Dried (AD)	Reported on dry weight basis
TM4	Modified USEPA 8270D v5:2014 method for the solvent extraction and determination of PAHs by GC-MS.	PM30	Water samples are extracted with solvent using a magnetic stirrer to create a vortex.				
TM4	Modified USEPA 8270D v5:2014 method for the solvent extraction and determination of PAHs by GC-MS.	PM30	Water samples are extracted with solvent using a magnetic stirrer to create a vortex.	Yes			
TM5	Modified 8015B v2:1996 method for the determination of solvent Extractable Petroleum Hydrocarbons (EPH) within the range C8-C40 by GCFID. For waters the solvent extracts dissolved phase plus a sheen if present.	PM16/PM30	Fractionation into aliphatic and aromatic fractions using a Rapid Trace SPE/Water samples are extracted with solvent using a magnetic stirrer to create a vortex.	Yes			
TM5	Modified 8015B v2:1996 method for the determination of solvent Extractable Petroleum Hydrocarbons (EPH) within the range C8-C40 by GCFID. For waters the solvent extracts dissolved phase plus a sheen if present.	PM30	Water samples are extracted with solvent using a magnetic stirrer to create a vortex.	Yes			
TM5/TM36	please refer to TM5 and TM36 for method details	PM12/PM16/PM30	please refer to PM16/PM30 and PM12 for method details	Yes			
TM15	Modified USEPA 8260B v2:1996. Quantitative Determination of Volatile Organic Compounds (VOCs) by Headspace GC-MS.	PM10	Modified US EPA method 5021A v2:2014. Preparation of solid and liquid samples for GC headspace analysis.				
TM15	Modified USEPA 8260B v2:1996. Quantitative Determination of Volatile Organic Compounds (VOCs) by Headspace GC-MS.	PM10	Modified US EPA method 5021A v2:2014. Preparation of solid and liquid samples for GC headspace analysis.	Yes			
TM16	Modified USEPA 8270D v5:2014. Quantitative determination of Semi-Volatile Organic compounds (SVOCs) by GC-MS.	PM30	Water samples are extracted with solvent using a magnetic stirrer to create a vortex.				
TM16	Modified USEPA 8270D v5:2014. Quantitative determination of Semi-Volatile Organic compounds (SVOCs) by GC-MS.	PM30	Water samples are extracted with solvent using a magnetic stirrer to create a vortex.	Yes			
TM36	Modified US EPA method 8015B v2:1996. Determination of Gasoline Range Organics (GRO) in the carbon chain range of C4-12 by headspace GC-FID. MTBE by GCFID co-elutes with 3-methylpentane if present and therefore can give a false positive. Positive MTBE results will be re-run using GC-MS to double check, when requested.	PM12	Modified US EPA method 5021A v2:2014. Preparation of solid and liquid samples for GC headspace analysis.	Yes			

EMT Job No: 23/15298

Test Method No.	Description	Prep Method No. (if appropriate)	Description	ISO 17025 (UKAS/SANAS)	MCERTS (UK soils only)	Analysis done on As Received (AR) or Dried (AD)	Reported on dry weight basis
TM83	Modified USEPA method 8260B v2:1996. Determination of Alcohols, Acetates, Acetone, Fuel Oxygenates, THF and Cyclohexane by Headspace GC-MS	PM10	Modified US EPA method 5021A v2:2014. Preparation of solid and liquid samples for GC headspace analysis.				
TM83	Modified USEPA method 8260B v2:1996. Determination of Alcohols, Acetates, Acetone, Fuel Oxygenates, THF and Cyclohexane by Headspace GC-MS	PM10	Modified US EPA method 5021A v2:2014. Preparation of solid and liquid samples for GC headspace analysis.	Yes			

Appendix I

Arcadis GAC for CPU

ARCADIS GENERIC ASSESSMENT CRITERIA FOR GROUNDWATER

- CONTINUED PETROLEUM USE -

Compound	Human Health - CPU		Water Resources	
	Petrol Filling Station Worker	Neighbouring Resident	Surface Waters	Aquifers
	µg/l	µg/l	µg/l	µg/l
Benzene	1.20E+04	1010	10	1
Toluene	>SOL	>SOL	74	700
Ethylbenzene	>SOL	5.87E+04	20	300
Xylenes	>SOL	4.99E+04	30	500
MTBE	5.20E+06	4.00E+05	15	15
ETBE	4.60E+05	3.80E+04	47	47
TBA	2.00E+07	1.38E+06	12	12
Aliphatic >C5-6	>SOL	>SOL	#	#
Aliphatic >C6-8	>SOL	>SOL	#	#
Aliphatic >C8-10	>SOL	>SOL	#	#
Aliphatic >C10-12	>SOL	>SOL	#	#
Aliphatic >C12-16	>SOL	>SOL	#	#
Aliphatic >C16-35	NR	NR	#	#
Aromatic >C5-C7 (as benzene)	1.20E+04	1010	10	1
Aromatic >C7-C8 (as toluene)	>SOL	>SOL	74	700
Aromatic >C8-10	>SOL	1.15E+04	#	#
Aromatic >C10-12	>SOL	9490	#	#
Aromatic >C12-16	>SOL	>SOL	#	#
Aromatic >C16-21	NR	NR	#	#
Aromatic >C21-35	NR	NR	#	#
TPH	na	na	10	10
Naphthalene	>SOL	4110	2	2
Acenaphthylene	>SOL	>SOL	-	-
Acenaphthene	>SOL	>SOL	-	-
Fluorene	>SOL	>SOL	-	-
Phenanthrene	>SOL	>SOL	-	-
Anthracene	>SOL	>SOL	-	-
Fluoranthene	>SOL	>SOL	-	-
Pyrene	>SOL	>SOL	-	-
Benzo(a)anthracene	>SOL	>SOL	-	-
Chrysene	>SOL	>SOL	-	-
Benzo(b)fluoranthene	>SOL	>SOL	-	0.025
Benzo(k)fluoranthene	>SOL	>SOL	-	0.025
Benzo(a)pyrene	>SOL	>SOL	0.00017	0.01
Indeno(123cd)pyrene	>SOL	>SOL	-	0.025
Dibenzo(ah)anthracene	>SOL	>SOL	-	-
Benzo(ghi)perylene	>SOL	>SOL	-	0.025
Dichloroethane (1,1)	3.70E+05	3.33E+04	2.7	2.7
Dichloroethane (1,2)	820	69.8	10	3
Trichloroethane (111)	>SOL	2.97E+05	100	2000
Dichloroethene (1,1)	1.70E+05	1.42E+04	7	140
Dichloroethene (cis 1,2)	2.70E+04	2240	25 [3]	25 [3]
Dichloroethene (trans 1,2)	9.50E+04	7220	25 [3]	25 [3]
Trichloroethene	3200	274	5 [3]	5 [3]
Tetrachloroethene	3.30E+04	2840	5 [3]	5 [3]
Chloroform (Trichloromethane)	1.90E+05	1.54E+04	2.5	100 [4]
Vinyl Chloride (chloroethene)	1200	108	0.5	0.5
Chlorobenzene	2.90E+04	2850	100	100
Phenol	2.50E+07	1.42E+06	7.7	7.7
Arsenic (inorganic)	NVP	NVP	50	10
Barium	NVP	NVP	700	700
Boron	NVP	NVP	2000	1000
Cadmium	NVP	NVP	0.08 - 0.25	5
Chromium (as VI)	NVP	NVP	3.4	50
Chromium (as III)	NVP	NVP	4.7	
Copper	NVP	NVP	1 [1]	2000
Lead	NVP	NVP	1.2 [1]	10
Mercury (inorganic)	NVP	NVP		
Mercury (elemental)	>SOL	9.7	0.07	1
Mercury (methylated)	>SOL	1.90E+04		
Molybdenum	NVP	NVP	70	70
Nickel	NVP	NVP	4 [1]	20
Selenium	NVP	NVP	10	10
Zinc	NVP	NVP	12.1 [1,2]	3000

Notes:

>SOL	Target acceptable risk not exceeded at theoretical solubility concentration
NR	No appropriate inhalation reference dose identified during review of toxicological data
#	No GAC for individual TPH fractions given that the compliance criteria is for sum TPH
na	Comprises multiple contaminants - no GAC derived
-	No water quality standard identified as suitable for deriving generic assessment criteria
NVP	Contaminant has only a low vapour pressure in groundwater
1	Bioavailable fraction. The fraction of the dissolved concentration likely to result in toxic effects as determined using the UKTAG Metal Bioavailability Assessment Tool (also
2	Adjusted to account for background concentrations
3	Based on values of 10µg/l combined for TCE and PCE and 50µg/l combined for cis-DCE and trans-DCE
4	Total value for trihalomethanes (chloroform, bromoform, dibromochloromethane and bromodichloromethane).

Appendix J

Derivation of Arcadis GAC for CPU

SUMMARY

The purpose of this document is to describe the general principles adopted in the derivation of the Arcadis' Generic Assessment Criteria (GAC). The document and associated GAC underpins the generic quantitative risk assessments Arcadis undertakes for its clients and is not intended for any other use or use by others. Guidance has been provided by the EA to aid development of GAC which are appropriate for a typical England or Wales site, incorporating conservatism where warranted. Arcadis has used the EA guidance to develop in-house GAC to aid assessment of land contamination sites, and in particular to assess risks to human health receptors from chronic health effects and risks to water resource receptors. The GAC do not consider potential risks to ecological receptors, which may need to be assessed on specific sites. The following non-statutory technical guidance has been referred to in deriving the GAC.

- EA Science Reports SC050021/SR2, SC050021/SR3 and SC050021/SR7.
- Related Toxicity and Soil Guideline Value reports
- EA Remedial Targets Methodology: Hydrogeological Risk Assessment for Land Contamination
- EA. Groundwater Protection and Water Quality, March 2017 (accessible online https://www.gov.uk/government/collections/groundwater-protection)
- SP1010: Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination

The GAC used within this report have been derived for "continued petroleum end use". Based on the typical use and design of these sites, with buildings and/or hard standing present across the majority of the site, direct exposure to shallow soils is not considered active. A building typical of a petrol filling station shop (represented by the size of a bungalow) is adopted in the derivation of the GAC. A neighbouring resident is assumed present, comprising a small terraced house without basement.

Arcadis has undertaken environmental works on hundreds of potentially contaminated sites across the UK. The typical shallow geology encountered comprises granular soils or made ground, with a low organic matter content. As such, Arcadis has taken the decision to derive in-house GAC for a *sand* rather than sandy loam soil-type used by the EA to derive Soil Guideline Values, with an organic matter content of 0.34% (fraction of organic carbon content 0.002, typical of many sites).

To derive Human Health GAC (HH-GAC), the following exposure pathways are considered active for potential soil, groundwater or soil gas exposures:

Site End-Use	On-Site Pathways
Continued petroleum use	• Inhalation of vapours outside from a soil or groundwater source • Inhalation of vapours inside from a soil, groundwater or soil gas source
Neighbouring resident	• Inhalation of vapours inside from a soil gas source (assumed that the neighbouring residential property directly overlies the soil gas source); and, Migration of impacted groundwater beneath neighbouring property, and subsequently: • Inhalation of indoor air in an off-site property (originating from an on-site soil or groundwater source) • Inhalation of outdoor air in an off-site garden (originating from an on-site soil or groundwater source)

Two levels of water quality standard have been considered to enable Water Resource GAC (WR-GAC) to be developed depending on the environmental setting of a site. The WR-GAC have been derived based on adopted Environmental Quality Standards and Drinking Water Standards. No attenuation with transport off-site is assumed.

The following modelling tools have been utilised in the derivation of the GAC:

HH-GAC (on-site): CLEA 1.07 and RBCA Toolkit v2.6
HH-GAC (off-site): CLEA 1.07, RBCA Toolkit v2.6 and Remedial Targets Worksheet v3.2
WR-GAC: Remedial Targets Worksheet v3.2

Selected model inputs and outputs are presented in the following tables.

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	Air-water partition co-efficient		Diffusion co-efficient in air		Diffusion co-efficient in water		Relative molecular mass		Vapour pressure		Water solubility		Koc	
	cm3 cm3	Notes	m2 s-1	Notes	m2 s-1	Notes	g mol-1	Notes	Pa	Notes	mg L-1	Notes	Log (dimensior	Notes
Benzene	1.16E-01	Science Report – SC050021/SR7	8.77E-06	Science Report – SC050021/SR7	6.64E-10	Science Report – SC050021/SR7	78.11	Science Report – SC050021/SR7	6.24E+03	Science Report – SC050021/SR7	1.78E+03	Science Report – SC050021/SR7	1.83E+00	Science Report – SC050021/SR7
Toluene	1.15E-01	Science Report – SC050021/SR7	7.78E-06	Science Report – SC050021/SR7	5.88E-10	Science Report – SC050021/SR7	92.14	Science Report – SC050021/SR7	1.73E+03	Science Report – SC050021/SR7	5.90E+02	Science Report – SC050021/SR7	2.31E+00	Science Report – SC050021/SR7
Ethylbenzene	1.39E-01	Science Report – SC050021/SR7	7.04E-06	Science Report – SC050021/SR7	5.31E-10	Science Report – SC050021/SR7	106.17	Science Report – SC050021/SR7	5.53E+02	Science Report – SC050021/SR7	1.80E+02	Science Report – SC050021/SR7	2.65E+00	Science Report – SC050021/SR7
Sum xylenes	1.04E-01	Average for three xylenes	7.03E-06	Average for three xylenes	5.3E-10	Average for three xylenes	106.17	Average for three xylenes	4.52E+02	Average for three xylenes	1.91E+02	Average for three xylenes	2.66E+00	Average for three xylenes
MTBE	2.04E-02	Literature review	7.10E-06	Literature review	9.00E-10	Literature review	88.17	Literature review	3.45E+04	Literature review	4.80E+04	Literature review	1.08E+00	Literature review
Aliphatic >C5-6	3.40E+01	TPHCWG	1.00E-05	Literature review	0.000000001	Literature review	81	Literature review	3.60E+04	Literature review	3.60E+01	Literature review	2.90E+00	Literature review
Aliphatic>C6-8	5.10E+01	TPHCWG	1.00E-05	Literature review	0.000000001	Literature review	100	Literature review	6.40E+03	Literature review	5.40E+00	Literature review	3.60E+00	Literature review
Aliphatic>C8-10	8.20E+01	TPHCWG	1.00E-05	Literature review	0.000000001	Literature review	130	Literature review	6.40E+02	Literature review	4.30E-01	Literature review	4.51E+00	Literature review
Aliphatic>C10-12	1.30E+02	TPHCWG	1.00E-05	Literature review	0.000000001	Literature review	160	Literature review	6.50E+01	Literature review	3.40E-02	Literature review	5.40E+00	Literature review
Aliphatic>C12-16	5.40E+02	TPHCWG	1.00E-05	Literature review	0.000000001	Literature review	200	Literature review	4.80E+00	Literature review	7.60E-04	Literature review	6.70E+00	Literature review
Aliphatic>C16-35	6.40E+03	TPHCWG	1.00E-05	Literature review	0.000000001	Literature review	270	Literature review	7.70E-01	Literature review	1.30E-06	Literature review	9.00E+00	Literature review
Aromatic >C8-10	4.90E-01	TPHCWG	1.00E-05	Literature review	0.000000001	Literature review	120	Literature review	6.40E+02	Literature review	6.50E+01	Literature review	3.20E+00	Literature review
Aromatic >C10-12	1.40E-01	TPHCWG	1.00E-05	Literature review	0.000000001	Literature review	130	Literature review	6.40E+01	Literature review	2.50E+01	Literature review	3.40E+00	Literature review
Aromatic >C12-16	5.40E-02	TPHCWG	1.00E-05	Literature review	0.000000001	Literature review	150	Literature review	4.80E+00	Literature review	5.80E+00	Literature review	3.70E+00	Literature review
Aromatic >C16-21	1.30E-02	TPHCWG	1.00E-05	Literature review	0.000000001	Literature review	190	Literature review	7.70E-01	Literature review	5.10E-01	Literature review	4.20E+00	Literature review
Aromatic >C21-35	6.80E-04	TPHCWG	1.00E-05	Literature review	0.000000001	Literature review	240	Literature review	4.40E-04	Literature review	6.60E-03	Literature review	5.11E+00	Literature review

Chemical Name	Chemical Type	Oral HCV						Inhalation HCV						Combine oral and inhalation AC	Oral MDI for adults		Inhalation MDI for adults	
		Type	µg kg-1 BW day-1	Notes	Oral exposure	Dermal exposure	Inhalation exposure	Type	µg kg-1 BW day-1	Notes	Oral exposure	Dermal exposure	Inhalation exposure		µg kg-1 BW day-1	Notes	µg kg-1 BW day-1	Notes
Benzene	organic	ID	2.90E-01	UK TOX (March 2009)	Yes	Yes	No	ID	1.40E+00	UK TOX (March 2009)	No	No	Yes	Yes	NR	NA	NR	NA
Toluene	organic	TDI	2.23E+02	UK TOX (March 2009)	Yes	Yes	No	TDI	1.40E+03	UK TOX (March 2009)	No	No	Yes	Yes	1.00E+01	UK TOX (March 2009)	5.20E+02	UK TOX (March 2009)
Ethylbenzene	organic	TDI	1.00E+02	UK TOX (March 2009)	Yes	Yes	No	TDI	7.43E+01	Literature review	No	No	Yes	Yes	5.00E+00	UK TOX (March 2009)	1.30E+02	UK TOX (March 2009)
Sum xylenes	organic	TDI	1.80E+02	UK TOX (March 2009)	Yes	Yes	No	TDI	6.00E+01	UK TOX (March 2009)	No	No	Yes	Yes	1.10E+01	UK TOX (March 2009)	1.40E+02	UK TOX (March 2009)
MTBE	organic	TDI	8.60E+02	Literature review	Yes	Yes	No	TDI	8.60E+02	Literature review	No	No	Yes	Yes	3.00E+01	EU Risk Assessment Report	1.89E+02	EU Risk Assessment Report
Aliphatic >C5-6	organic	TDI	5.00E+03	TPHCWG	Yes	Yes	No	TDI	5.26E+03	TPHCWG	No	No	Yes	Yes	3.50E+05	TDI x 70kg (MDI unknown)	3.68E+05	TDI x 70kg (MDI unknown)
Aliphatic>C6-8	organic	TDI	5.00E+03	TPHCWG	Yes	Yes	No	TDI	5.26E+03	TPHCWG	No	No	Yes	Yes	3.50E+05	TDI x 70kg (MDI unknown)	3.68E+05	TDI x 70kg (MDI unknown)
Aliphatic>C8-10	organic	TDI	1.00E+02	TPHCWG	Yes	Yes	No	TDI	2.70E+02	TPHCWG	No	No	Yes	Yes	7.00E+03	TDI x 70kg (MDI unknown)	1.89E+04	TDI x 70kg (MDI unknown)
Aliphatic>C10-12	organic	TDI	1.00E+02	TPHCWG	Yes	Yes	No	TDI	2.70E+02	TPHCWG	No	No	Yes	Yes	7.00E+03	TDI x 70kg (MDI unknown)	1.89E+04	TDI x 70kg (MDI unknown)
Aliphatic>C12-16	organic	TDI	1.00E+02	TPHCWG	Yes	Yes	No	TDI	2.70E+02	TPHCWG	No	No	Yes	Yes	7.00E+03	TDI x 70kg (MDI unknown)	1.89E+04	TDI x 70kg (MDI unknown)
Aliphatic>C16-35	organic	TDI	2.00E+03	TPHCWG	Yes	Yes	No	NR			NR	NR	NR	NR	1.40E+05	TDI x 70kg (MDI unknown)		
Aromatic >C8-10	organic	TDI	4.00E+01	TPHCWG	Yes	Yes	No	TDI	5.50E+01	TPHCWG	No	No	Yes	Yes	2.80E+03	TDI x 70kg (MDI unknown)	3.85E+03	TDI x 70kg (MDI unknown)
Aromatic >C10-12	organic	TDI	4.00E+01	TPHCWG	Yes	Yes	No	TDI	5.50E+01	TPHCWG	No	No	Yes	Yes	2.80E+03	TDI x 70kg (MDI unknown)	3.85E+03	TDI x 70kg (MDI unknown)
Aromatic >C12-16	organic	TDI	4.00E+01	TPHCWG	Yes	Yes	No	TDI	5.50E+01	TPHCWG	No	No	Yes	Yes	2.80E+03	TDI x 70kg (MDI unknown)	3.85E+03	TDI x 70kg (MDI unknown)
Aromatic >C16-21	organic	TDI	3.00E+01	TPHCWG	Yes	Yes	No	NR			NR	NR	NR	NR	2.10E+03	TDI x 70kg (MDI unknown)		
Aromatic >C21-35	organic	TDI	3.00E+01	TPHCWG	Yes	Yes	No	NR			NR	NR	NR	NR	2.10E+03	TDI x 70kg (MDI unknown)		

PHYSICAL PROPERTIES

		Commercial Land Use	Source
Soil type	na	Sand	Professional experience
Porosity (total)	cm3 cm-3	0.54	SC050021/SR3
Porosity (air-filled)*	cm3 cm-3	0.30	SC050021/SR3
Porosity (water-filled)*	cm3 cm-3	0.24	SC050021/SR3
Capillary fringe porosity (air-filled)	cm3 cm-3	0.01	Literature value
Capillary fringe porosity (water-filled)	cm3 cm-3	0.53	Literature value
Thickness of capillary fringe	m	0.1	Literature value
Residual soil water content	cm3 cm-3	0.07	SC050021/SR3
Saturated hydraulic conductivity	cm s-1	7.36E-03	SC050021/SR3
van Genuchten shape parameter	dimensionless	3.51E-01	SC050021/SR3
Bulk density	g cm-3	1.18	SC050021/SR3
Soil organic matter content	%	0.34	Professional experience
Threshold value of wind speed at 10m	m s-1	7.20	SC050021/SR3
Ambient soil temperature	K	283	SC050021/SR3
Mean annual windspeed (10m)	m s-1	5.00	SC050021/SR3
Fraction of site with hard or vegetative cover	m2 m-2	1.00	Conceptual Site Model
Depth to groundwater (RBCA)	m	1	Assumption
Infiltration rate in vadose zone	m day-1	6.80E-04	Likely worst-case

Aquifer type**	na	Sand	Assumption
Source width	m	40	Likely worst-case
Source length	m	40	Likely worst-case
Saturated aquifer thickness	m	10	Assumption
Mixing zone depth	m	5.5	Calculated in RTW
Hydraulic conductivity	m day-1	20	Literature value
Hydraulic gradient	m m-1	0.001	Typical value for sand
Aquifer soil organic matter content	%	0.34	Professional experience
Effective Porosity (total)**	cm3 cm-3	0.3	Literature value
Aquifer bulk density**	g cm-3	1.18	SC050021/SR3
Distance to neighbouring resident**	m	5	Likely worst-case

Notes:

* Assumed to be present in foundation cracks when modelling in RBCA Toolkit

** Only used to generate GAC for neighbouring residents through off-site migration of impact in groundwater

For the purpose of assessing the risk to on-Site commercial workers from impacts in soil it is assumed that the soil source is present 50cm below the grounds surface (based on the typical minimum depth of petroleum infrastructure beneath the ground). For soil gas it is assumed that the source is present 20cm beneath the grounds surface (in relation to both on-Site commercial worker and off-Site residents).

BUILDING PROPERTIES

		Neighbouring Residential	Continued Petroleum Use	Source
Building footprint	m2	2.80E+01	7.80E+01	SC050021/SR3
Living space air exchange rate	hr-1	0.50	1.00	SC050021/SR3
Living space height (above ground)	m	4.8	2.4	SC050021/SR3
Living space height (below ground)	m	0.0	0.0	SC050021/SR3
Pressure difference	Pa	3.1	2.6	SC050021/SR3
Foundation thickness	m	1.50E-01	1.50E-01	SC050021/SR3
Floor crack area	cm2	4.23E+02	7.07E+02	SC050021/SR3

Notes:
Petrol filling station shop modelled as a bungalow, with increased ventilation

CLEA 1.07 EXPOSURE DATA

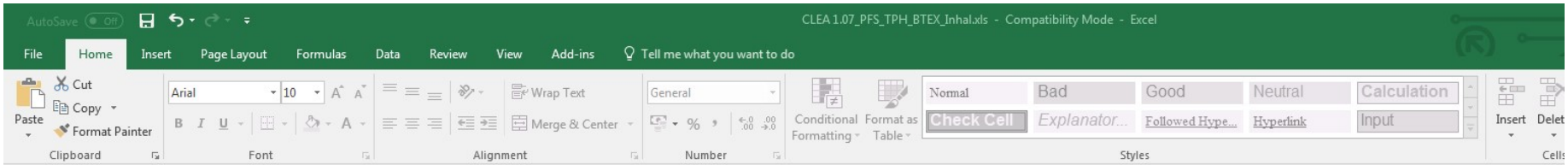
		Age Class						
		Residents						Commercial Worker
Age class	-	1	2	3	4	5	6	17
Frequency of inhalation (dust and vapour indoors)	days yr-1	365	365	365	365	365	365	230
Frequency of inhalation (dust and vapour outdoors)	days yr-1	365	365	365	365	365	365	170
Occupancy period (indoors)	hr day-1	23	23	23	23	19	19	8.3
Occupancy period (outdoors)	hr day-1	1	1	1	1	1	1	0.7
Body weight	kg	5.6	9.8	12.7	15.1	16.9	19.7	70
Body height	m	0.7	0.8	0.9	0.9	1	1.1	1.6
Inhalation rate*	m3 day-1	5.4	8	8.9	10.1	10.1	10.1	15.7

* Inhalation rate adopted from Category 4 Screening Levels

RBCA Toolkit EXPOSURE DATA		Age Class	
		0-6	17
Averaging time	yrs	6	49
Body weight	kg	13.3	70
Exposure duration	yrs	6	49
Averaging time (vapour flux)	yrs	6	49
Exposure frequency (indoors)*	days yr-1	365	29.9
Exposure frequency (outdoors)*	days yr-1	16.8	1.87

Notes:
Time-weighted average used for 0-6 year old female child

* RBCA Toolkit compares an acceptable air concentration to a predicted air concentration. Only the exposure frequency can be modified (i.e. inhalation rate, time exposed cannot). As such, the TDSI (or ID) was converted to an acceptable indoor air concentration using the time-weighted properties for a 0-6 year old female child as defined within the Category 4 Screening Levels. The exposure frequency for other scenarios was modified to account for the differing exposure scenarios for the remaining pathways, to be equivalent to modifying the inhalation rate and time exposed.



STEP 5: RESULTS

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		Ratio of ADE to relevant Health Criteria Value			Soil Assessment Criteria			SAC Flag	Soil Saturation Limit	Pathway Contributions (%)						
		oral HCV	inhal HCV	Combined	oral HCV	inhal HCV	Combined	Current SAC used for determining pathway contributions		direct soil ingestion	sum of consumption of homegrown produce and attached soil	dermal contact (indoor)	dermal contact (outdoor)	inhalation of dust (indoor)	inhalation of dust (outdoor)	inhalation of vapour (indoor)
Number	Chemical	(dimensionless)	(dimensionless)	(dimensionless)	mg kg^{-1}	mg kg^{-1}	mg kg^{-1}	(unitless)	mg kg^{-1}	%	%	%	%	%	%	%
1	Benzene	0.00	1.00	1.00	NR	1.50E+00	1.50E+00	Combined	6.52E+02	0.00	0.00	0.00	0.00	0.00	0.00	99.96
2	Toluene	0.00	1.00	1.00	NR	2.75E+03	2.75E+03	Combined	3.74E+02	0.00	0.00	0.00	0.00	0.00	0.00	99.86
3	Ethylbenzene	0.00	1.00	1.00	NR	2.21E+02	2.21E+02	Combined	2.01E+02	0.00	0.00	0.00	0.00	0.00	0.00	99.59
4	Sum xylenes	0.00	1.00	1.00	NR	2.36E+02	2.36E+02	Combined	2.16E+02	0.00	0.00	0.00	0.00	0.00	0.00	97.46
5	MTBE	0.00	1.00	1.00	NR	3.60E+02	3.60E+02	Combined	1.11E+04	0.00	0.00	0.00	0.00	0.00	0.00	99.68
6	ETBE	0.00	1.00	1.00	NR	1.58E+01	1.58E+01	Combined	3.50E+03	0.00	0.00	0.00	0.00	0.00	0.00	100.00
7	TBA	0.00	1.00	1.00	NR	3.70E+03	3.70E+03	Combined	2.35E+05	0.00	0.00	0.00	0.00	0.00	0.00	99.92
8																
9	Aliphatic >C5-C6	0.00	1.00	1.00	NR	2.61E+02	2.61E+02	Combined	3.75E+02	0.00	0.00	0.00	0.00	0.00	0.00	49.99
10	Aliphatic >C6-C8	0.00	1.00	1.00	NR	3.51E+02	3.51E+02	Combined	1.12E+02	0.00	0.00	0.00	0.00	0.00	0.00	49.99
11	Aliphatic >C8-C10	0.00	1.00	1.00	NR	4.53E+01	4.53E+01	Combined	3.65E+01	0.00	0.00	0.00	0.00	0.00	0.00	49.99
12	Aliphatic >C10-C12	0.00	1.00	1.00	NR	1.78E+02	1.78E+02	Combined	1.80E+01	0.00	0.00	0.00	0.00	0.00	0.00	49.98
13	Aliphatic >C12-C16	0.00	1.00	1.00	NR	8.12E+02	8.12E+02	Combined	7.57E+00	0.00	0.00	0.00	0.00	0.00	0.00	49.96
14	Aliphatic >C16-C35	0.00	NR	NR	NR	NR	NR		2.57E+00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15	Aromatic >EC5-EC7	0.00	1.00	1.00	NR	3.24E+01	3.24E+01	Combined	7.53E+02	0.00	0.00	0.00	0.00	0.00	0.00	49.99
16	Aromatic >EC7-EC8	0.00	1.00	1.00	NR	5.07E+01	5.07E+01	Combined	3.99E+02	0.00	0.00	0.00	0.00	0.00	0.00	49.98
17	Aromatic >EC8-EC10	0.00	1.00	1.00	NR	6.28E+01	6.28E+01	Combined	2.24E+02	0.00	0.00	0.00	0.00	0.00	0.00	49.97
18	Aromatic >EC10-EC12	0.00	1.00	1.00	NR	3.30E+02	3.30E+02	Combined	1.30E+02	0.00	0.00	0.00	0.00	0.00	0.00	49.94
19	Aromatic >EC12-EC16	0.00	1.00	1.00	NR	1.66E+03	1.66E+03	Combined	5.72E+01	0.00	0.00	0.00	0.00	0.00	0.00	49.86
20	Aromatic >EC16-EC21	0.00	NR	NR	NR	NR	NR		1.60E+01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21	Aromatic >EC21-EC35	0.00	NR	NR	NR	NR	NR		1.68E+00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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