

SHELL HITCHIN

Phase 1 Environmental Site Assessment

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Shell Hitchin

Phase 1 Environmental Site Assessment

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This report dated 06 December 2024 has been prepared for Shell UK Oil Products Limited (the “Client”) in accordance with the terms and conditions of appointment dated 01 October 2020 (the “Appointment”) between the Client and **Arcadis (UK) Limited** (“Arcadis”) for the purposes specified in the Appointment. For avoidance of doubt, no other person(s) may use or rely upon this report or its contents, and Arcadis accepts no responsibility for any such use or reliance thereon by any other third party.

Executive Summary

Introduction	Arcadis (UK) Limited (Arcadis) was commissioned by Shell UK Oil Products Limited (Shell) to carry out a Phase 1 Environmental Site Assessment at Shell Hitchen, Bedford Rd, Hitchin SG5 2TY (the "Site"). The Site comprises an active Petrol Filling Station (PFS). The intended end-use for the Site is understood to be Continued Petroleum Use (CPU)
Aim & Objectives	The overall aim of the environmental assessment process is to assess the potential for the presence, nature and extent of Constituents of Potential Concern (COPC) in the subsurface beneath the Site. The specific objectives of this report were: • To examine whether there have been potentially contaminative uses on the Site or nearby land and identify Potential Areas of Concern (PAOC) through desk top study; • To carry out a site walkover to provide additional information to support the development of an initial Conceptual Site Model (CSM); and, • To prepare a Preliminary Risk Assessment (PRA) to identify potentially active contaminant linkages warranting further consideration.
Scope of Work	The following scope of work was undertaken: • Desktop review of third-party environmental data from a proprietary database (Envirocheck® Report) and third-party environmental datasets, including historical, geological and hydrogeological maps; • Review of data provided by the Petroleum Officer (PO) and wetstock monitoring contractor. • Review of relevant data presented in environmental reports previously prepared by other environmental consultants. • Site walkover to identify current use of the Site and surrounding land, and to identify obvious areas of potential environmental concern; and, • Development of an initial CSM to characterise the Site in terms of potential sources of contamination, environmental and exposure pathways and receptors, and completion of a PRA.
Previous Site Investigation & Remediation	URS Scott Wilson Ltd. conducted a Phase 1 Investigation at Shell Hitchen in 2011, identifying potential pollutant linkages. Key risks include hydrocarbon vapor migration affecting on-site and nearby workers, and potential hydrocarbon permeation into water pipes, posing ingestion risks. For controlled waters, URS have identified the risks which include vertical migration of contaminants to the Drift Deposits (Secondary A Aquifer) and Zig Zag Chalk (Principal Aquifer), as well as lateral migration to nearby surface waters (Bearton Pond and River Hiz). URS undertook comprehensive investigations at the Site in 2012 and 2013, including drilling five monitoring wells into superficial deposits and three vapor wells in December 2012, followed by additional wells in February 2013 into the Zig Zag Chalk Formation and superficial deposits. These works supported a Detailed Quantitative Risk Assessment (DQRA) using soil, groundwater, and vapor data from multiple monitoring events. The investigations and DQRA concluded that while some theoretical risks exist to controlled waters under specific conditions, these are unlikely to pose significant risks to human health or the environment under site-specific conditions. Site redevelopment works were completed in 2013, where five active tanks (consisting of seven compartments) and one decommissioned, solid-filled tank were replaced by two new double-walled, 65KL split-compartment tanks. In addition to fuel infrastructure removal, URS undertook validation sampling in excavations related to the removal of the underground storage tanks (USTs), dismantling of the fuel infrastructure, and the

	excavation for the new tank farm. The investigation reported no visual or olfactory signs of hydrocarbon impact in monitoring wells. No significant risks to human health or groundwater quality in the Superficial Deposits (Secondary-A Aquifer) or Chalk Principal Aquifer were identified, deeming the site suitable for continued oil use. AECOM decommissioned all monitoring wells between 14 and 15 September 2016 by removing the existing headworks and well installations and backfilling with a cement/bentonite grout. The surface was reinstated with concrete/tarmac/topsoil. The former monitoring wells were all successfully decommissioned and no longer present a potential preferential pathway to the Glaciofluvial deposits or the underlying Zig Zag Chalk Formation.
Development of the Conceptual Site Model (CSM)	Following completion of the desk study and Site walkover survey, a preliminary CSM was prepared and is summarised below: Sources The current and historical use of the site as a PFS have been identified as potential on-site sources of contaminants and car garage located adjacent north and vehicle servicing garage located adjacent west of the Site have been identified as potential off-site sources of contamination. Receptors On-site commercial workers, site visitors and neighbouring residents were identified as potential human health receptors associated with the Site. Future on-site construction workers were also identified as a potential receptor, however the risks to construction workers may be managed by use of appropriate Personal Protective Equipment (PPE), risk assessments and method statements. Potential controlled waters receptors include the Groundwater within superficial deposits - Lowestoft Formation - Diamicton (Secondary Undifferentiated Aquifer) and Zig Zag Chalk Formation - Chalk (Principal Aquifer).
Preliminary Risk Assessment (PRA)	The identified source-pathway-receptor contaminant linkages, summarised below, have subsequently been assessed to evaluate the potential level of risk, summarised below. Human Health - Partitioning of COPC from contaminated soil or groundwater into soil vapour, prior to vertical and lateral migration and subsequent inhalation of vapours in indoor and outdoor air by future on-site commercial workers and visitors e.g. general public and visiting staff - moderate / low risk - Lateral migration of vapours or ground gases via preferential pathways (e.g. utility channels), followed by inhalation of vapours in indoor and outdoor air by neighbouring residents (located approximately 20m west, approximately 25m north and approximately 30m south of the Site)- moderate / low risk Controlled Waters - Leaching and vertical migration of COPC into groundwater within the Groundwater within superficial deposits - Lowestoft Formation - Diamicton (Secondary (Undifferentiated) Aquifer) and Zig Zag Chalk Formation - Chalk (Principal Aquifer) beneath the Site and subsequent on- and off-site migration within the aquifer- moderate / low risk
Potential Impact of Climate Change	The results of the Climate:CLEAR assessment has determined potential climatic changes that have the potential for medium/moderate (amber) impacts on the land contamination CSM. These include an increase in mean temperatures, an increase in extreme heat events and a net annual increase in precipitation events, affecting soil and groundwater pathways. However, based on the current CSM and available data, the likelihood of a viable shallow source in soils that could significantly mobilise contaminants in soil and groundwater, or present an increased risk of soil vapour generation following a rise in



temperatures and extreme heat events is considered to be low. Based on site-specific knowledge these impacts are moderated down to low.

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ABBREVIATIONS

AECOM	AECOM Infrastructure & Environment UK Limited
AONB	Area of Outstanding Natural Beauty
Arcadis	Arcadis (UK) Limited
BGS	British Geological Survey
BTEX	Benzene, Toluene, Ethylbenzene, Xylenes
CSM	Conceptual Site Model
COPC	Constituents of Potential Concern
CWHI	Controlled Waters Hazard Index
DoE	Department of Environment
DEFRA	Department for Environment, Food and Rural Affairs
DQRA	Detailed Quantitative Risk Assessment
EA	Environment Agency
ESA	Environmental Site Assessment
ESP	Environmental Strategy Plan
EV	Electric Vehicle
GAC	Generic Assessment Criteria
GME	Groundwater Monitoring Event
HDR	High Density Residential
HI	Hazard Index
LCRM	Land Contamination Risk Management
m AOD	meters Above Ordnance Datum
m bgl	meters below ground level
MTBE	Methyl Tertiary-Butyl Ether
OS	Ordnance Survey
PAH	Polycyclic Aromatic Hydrocarbons
PAOC	Potential Areas of Concern
PDSA	Pre-Desk Study Assessment
PFS	Petrol Filling Station
PO	Petroleum Officer
PPE	Personal Protective Equipment
PRA	Preliminary Risk Assessment
SAC	Special Area of Conservation
Shell	Shell UK Oil Products Limited
SSAC	Site-Specific Assessment Criteria.
SPA	Special Protection Area
SPZ	Source Protection Zone

SSSI	Site of Special Scientific Interest
TOC	Total Organic Carbon
URS	URS Scott Wilson Ltd
UXO	Unexploded Ordnance
VOC	Volatile Organic Compounds

1 INTRODUCTION

Arcadis (UK) Limited (Arcadis) was commissioned by Shell UK Oil Products Limited (Shell) to carry out a Phase 1 Environmental Site Assessment (ESA) at Shell Hitchin, Bedford Rd, Hitchin SG5 2TY (the "Site"). A Site Location Plan is presented as Figure 1.

The Site comprises an active Petrol Filling Station (PFS) located in a mixed commercial, residential and recreational area. A Site Boundary Plan, indicating the boundaries of the PFS is presented on Figure 2.

The assessment has been undertaken based on Continued Petroleum Use (CPU) of the Site.

1.1 Aim & Objectives

The overall aim of the environmental assessment process is to characterise the site in terms of potentially contaminative sources, potential exposure pathways and potential receptors and develop an initial conceptual model of the site to identify plausible contaminant linkages.

The specific objectives of the report are:

- To examine whether there have been potentially contaminative uses on the Site or on nearby land and identify Potential Areas of Concern (PAOC) through desktop study;
- To carry out a site walkover to provide additional information to support development of a preliminary Conceptual Site Model (CSM); and
- To prepare a Preliminary Risk Assessment (PRA) to identify potentially active contaminant linkages warranting further consideration.

1.2 Scope of Work

The scope of work has been prepared in accordance with the requirements of the Environment Agency's (EA) Land Contamination Risk Management (LCRM) guidance¹.

The scope of work detailed in this report comprised the following:

- Desktop review of environmental data from a proprietary database (Envirocheck® Report) and third-party environmental datasets, including historical, geological and hydrogeological maps;
- Site walkover survey comprising visual observations of the site setting and to identify obvious areas of potential environmental concern;
- Review data provided by the Petroleum Officer (PO) and wetstock monitoring contractor;
- Review relevant data presented in environmental reports previously prepared by other environmental consultants, where available; and,
- Prepare a preliminary CSM and evaluation of the level of risk associated with potentially active contaminant linkages.

1.3 Previous Environmental Works

Consultant, / Report Title	Report Date	Summary
URS, Phase 1 Investigation Report, Ref: R46370079-001 Final	September 2011	URS Scott Wilson Ltd. (URS) was commissioned by Shell to undertake a Phase 1 Investigation at Shell Hitchin. The following potential pollutant linkages were identified: <u>Human Health</u> • Migration of hydrocarbon vapours from potentially impacted shallow soils and/or groundwater to on-site workers within the shop area and off-site workers to the north and east of the site.

¹ Environment Agency, "Land Contamination Risk Management (LCRM)," Last Updated 20 July 2023. Available: <https://www.gov.uk/government/publications/land-contamination-risk-management-lcrm>.

Consultant, / Report Title	Report Date	Summary
		- Permeation of hydrocarbons from potentially impacted soil into plastic water supply pipes followed by ingestion by on-site shop staff. <u>Controlled Waters</u> - Vertical migration of Chemicals of Potential Concern from potentially impacted shallow soils into perched water and shallow groundwater within the shallow Drift Deposits that border the site (Secondary A Aquifer), and potentially deeper groundwater in the underlying Zig Zag Chalk Formation (Principal Aquifer). - Migration of Chemicals of Potential Concern from potentially impacted shallow soils into perched water and/or the shallow groundwater followed by lateral migration to Surface Waters (Bearton Pond located 200 m north of the site and River Hiz located 525 m east of the site).
URS, Comprehensive Environmental Site Assessment, Ref: R46370079-002 Final	September 2012	A comprehensive investigation works was undertaken by URS in October 2011 included the drilling and installation of 5 monitoring wells (BH101 to BH103, BH105 and BH106) into the superficial deposits and 3 vapour wells (VP101 and VP103) at the site. A Detailed Quantitative Risk Assessment (DQRA) was carried out on available soil, groundwater and vapour data. The main findings were as follows: - No significant risks to human health (on site workers or off-site residents) were identified. - Soil samples from BH105 and BH106, near the fuel dispensers, recorded naphthalene concentrations above the High-Density Residential (HDR) human health Generic Assessment Criteria (GAC), while groundwater at BH102, 5m east of the tank farm, recorded elevated benzene and Total Petroleum Hydrocarbon (TPH). Potential health risks, mainly from vapor inhalation, was considered minimal due to the distance to residential areas, groundwater depth, and site-specific Total Organic Carbon (TOC) levels. - Vapour analytical data from October 2011 were compared with URS GAC protective of human health for a high-density residential scenario. No chemicals of potential concern were reported above the relevant human health GAC suggesting the theoretical risk from soil and groundwater is not significant. - Potentially unacceptable risks to groundwater in the underlying superficial deposits were identified from recorded concentrations of benzene, TPH Aromatics <C5-C7 and naphthalene in groundwater at a 50m compliance point. The 50m compliance point was selected based on the hazardous classification of these substances the presence of the Principal Aquifer beneath the superficial deposits and the uncertainty in groundwater flow direction and gradient. - Potentially unacceptable risks to groundwater in the underlying Chalk Principal aquifer were identified based on the recorded concentrations of benzene at a 50m compliance point however the assessment was based on a number of assumptions in the absence of site-specific data.
URS, Comprehensive Environmental Site Assessment - Further Investigation, Ref:	February 2013	A further comprehensive investigation was undertaken by URS, Intrusive works included the installing two new groundwater monitoring wells (BH102A and BH106A) and the over drilling of one borehole (BH105) with subsequent monitoring well installation. The Zig Zag

Consultant, / Report Title	Report Date	Summary
R46370079-003 Final Rev 1		Chalk was encountered at 6.3m bgl in BH105A, 2.8m bgl in BH106A and 13.6m bgl in BH102A. URS conducted a Controlled Waters DQRA to assess the significance of identified potential pollutant linkages from soil and groundwater monitoring from both the December 2011 and February 2012 investigations and January 2013 Groundwater Monitoring Event (GME). The principal conclusions of the Controlled Waters DQRA are summarised below: <u>Model 1: Groundwater in the Chalk</u> - Of the COPC groups assessed, soil concentrations of naphthalene and fluoranthene were simulated to present a theoretical risk to the Principal Aquifer at a 50m compliance point considering a 3.6m mixing zone. At 95% confidence the simulated Controlled Waters Hazard Index (CWHI) for naphthalene and fluoranthene were 15.2 and 3.54 respectively. - If additional dilution is considered within a 10m mixing zone, the hazard indices of the simulated concentrations decrease proportionally, indicating a marginal risk of naphthalene exceeding the GAC at 50m, and no risk of fluoranthene exceeding the GAC. - No other risks were simulated from vertical migration of soil sources to the underlying Principal Chalk aquifer at a 50m compliance point. - No significant risks were identified from concentrations of COPC in groundwater to the underlying Principal Chalk aquifer at a 50m compliance point. <u>Model 2: Groundwater in the Drift Deposits</u> - No significant risks were identified from concentrations of COPC in soil to the drift deposits Secondary-A aquifer. - Of the COPC groups assessed, groundwater concentrations of benzene were simulated to present a theoretical risk at the 50m compliance point protective of the Secondary-A aquifer at a 95% confidence level with a CWHI of 12.0. At the 50th percentile ('most likely'), the model did not simulate a risk from concentrations of benzene at the 50m compliance point with an Hazard Index (HI) of 0.371. No risks were simulated from benzene at the 100m compliance point. - Given the low exploitation potential of the aquifer, an extended compliance point of 100m is considered appropriate. As no risks are simulated at the 95th percentile (worst case) at the extended 100m compliance point, or at the 50th percentile ('most likely'), at the 50m compliance point, from a conservative DQRA, the theoretical risks simulated by the model are considered unlikely to pose a significant risk to controlled waters in the superficial depositst.
URS, Environmental Strategy Plan, Ref: R46370079-004 Final Rev 1	March 2013	URS prepared an Environmental Remedial Strategy Plan (ESP) to support the environmental aspects of the planning process for proposed site redevelopment. The ESP was submitted to the local Planning Department of North Hertfordshire District Council; this was accepted in March 2013 as an appropriate remedial strategy to manage identified impact. The findings of the site investigations and risk assessment indicate that no

Consultant, / Report Title	Report Date	Summary
		potentially significant risks to human health or controlled waters have been identified.
URS, Environmental Verification Report, Ref: R46370079-005 Final	October 2013	URS provided environmental support during the construction phase, where five active tanks (consisting of seven compartments) and one decommissioned, solid-filled tank were replaced by two new double-walled, 65KL split-compartment tanks. In addition to fuel infrastructure removal, URS conducted validation sampling in excavations related to the removal of the underground storage tanks (USTs), dismantling of the fuel infrastructure, and the excavation for the new tank farm. A risk assessment undertaken on validation samples collected from soil left in-situ underlying the site and post construction groundwater monitoring data identified the following: - No visual or olfactory signs of hydrocarbon impact was reported in any of the monitoring wells sampled. A risk assessment was undertaken on validation samples collected from soil remaining in-situ underlying the site and post construction groundwater monitoring data. - No potentially significant risks to human health (protective of on-site workers and off-site residents) were identified. - No potentially significant risks were identified to groundwater quality within the Superficial Deposits Secondary-A Aquifer or the underlying Chalk Principal Aquifer. - The site was considered suitable for on-going oil use.
URS, Comprehensive Groundwater Monitoring Event, Ref: R46370079-006 Final	October 2014	URS undertook a post construction Ground Water Monitoring at Shell Hitchin. Two (2) GMEs were undertaken at the site in March and June 2014. - Mild hydrocarbon odours were observed during purging of well BH102 located adjacent to the eastern site boundary during the March and June 2014 monitoring events. - No evidence of hydrocarbon impact was observed in any other monitoring wells, including BH102A (located approximately 3m west of BH102 and closer to the tank farm). Phase-separate hydrocarbons (PSH) was not identified in any of the wells. Groundwater results were compared to Stage 2 human health GAC and Stage 3 controlled waters Site-Specific Assessment Criteria (SSAC). The principal conclusions were as follows: - Potentially significant risks to human health receptors (on-site workers, off-site workers and off-site residents) were not identified at the site, - Potentially significant risks to the underlying Secondary A Aquifer or Principal Aquifer was not identified at the site.
AECOM, Comprehensive Groundwater Monitoring Event, Ref: GB-10019011-20160610-MON	June 2016	AECOM Infrastructure & Environment UK Limited (AECOM) undertook a Comprehensive GME to provide a status of groundwater quality beneath the site following redevelopment works in 2013. The GME report detailed the results of the four (4) GMEs undertaken at the site in December 2014, May and November 2015 and February 2016. <u>Stage 2 Risk Assessment Results</u>

Consultant, / Report Title	Report Date	Summary
		- Groundwater concentrations were not considered to present an unacceptable risk to human health receptors <u>Stage 3 Risk Assessment Results</u> - No unacceptable risks were identified to groundwater quality within the Superficial Deposits Secondary A Aquifer or the underlying Chalk Principal Aquifer. - The site was considered suitable for continued oil use.
AECOM, Well Decommissioning Report, Ref: GB-10019011-20161018-OTH	October 2016	In alignment with Environment Agency guidance, AECOM successfully decommissioned all monitoring wells between 14 and 15 September 2016 by removing the existing headworks and well installations and backfilling with a cement/bentonite grout. The surface was reinstated with concrete/tarmac/topsoil as appropriate for the location. The former monitoring wells were all successfully decommissioned and no longer present a potential preferential pathway to the Glaciofluvial deposits or the underlying Zig Zag Chalk Formation.

1.4 Reliability of Information / Limitations

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 and previous work. Reference should be made to the Study Limitations presented in Appendix A.

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.

1.5 Reliance

It is understood that the current report will be 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 authorisation of Arcadis.

1.6 Data Sources

The following information sources were reviewed during the preparation of this Phase 1 ESA:

- British Geological Survey (BGS) Map Viewer [<https://mapapps2.bgs.ac.uk/geoindex/home.html>] (accessed 11/10/2024)];
- Department of Environment (DoE) website [Available: <https://www.claire.co.uk/useful-government-legislation-and-guidance-by-country/198-doe-industry-profiles>] (accessed 11/10/2024)];
- Department for Environment, Food and Rural Affairs (DEFRA) Magic Map Application [<https://magic.defra.gov.uk>] (accessed 11/10/2024)];
- Gov. UK Flood Map for Planning website [flood-map-for-planning.service.gov.uk] (accessed 11/10/2024)];
- Google Maps Satellite Imagery (accessed 11/10/2024)];
- Landmark Envirocheck® Report [report reference: 358692524_1_1, dated 20/09/2024 (presented in Appendix B)];
- Zetica Limited UXO Pre-Desk Study Assessment (presented in Appendix D)];
- Petroleum Officer Questionnaire (presented in Appendix F);
- Wetstock Management Contractor Letter (presented in Appendix G); and
- Information on private groundwater abstractions provided by the relevant local authorities (presented in Appendix C).

Phase 1 Environmental Site Assessment
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A site walkover, which included an informal interview with site staff, was undertaken by Arcadis on 11th October 2024.

2 ENVIRONMENTAL SETTING

2.1 Description of Site and Surroundings

The summary below has been developed based on information provided in the data sources listed in Section 1.6:

Item	Details
Site status	Active PFS
Intended end use	CPU
Ownership Type / Tenure	Freehold. Arcadis understands that the Site is owned by Shell.
Grid Reference (Easting and Northing)	E 517920, N 229840
Elevation	Approximately 70m Above Ordnance Datum (AOD)
Site size	Approximately 1430 m ² (Source: Evaluated based on Google Maps, accessed: 11/10/2024)
Topography	Based on the site walkover (11 th October 2024), the site features a predominantly flat topography, with a slight slope to the east of the Site near the crossovers of Bedford Rd. The surrounding topography decreases towards the River Oughton in the north and River Purwell in the east. (AECOM, Comprehensive Groundwater Monitoring Event, Ref: GB-10019011-20160610-MON, June 2016)
Surfacing	The majority of the surfacing across the PFS comprises concrete and bituminous surfacing.
Site Setting	North – Kwik Fit Plus (Car Garage) beyond which lies low-density residential properties with gardens. South – Firs Hotel beyond which lies residential properties with gardens. East – Bedford Road beyond which lies Hitchin Football Club. West – Bosch Vehicle Servicing (Car Service / Tuning), beyond which lies residential properties with gardens.

2.2 Site History

The historical use of the Site and surrounding area was determined from inspection of 1:2,500, 1:1,250, 1:10,000 and 1:10,560 scale OS maps and satellite imagery from Google Maps. Historical OS maps are presented with the Landmark Envirocheck® Report presented in Appendix B.

In brief, the history of the Site and surrounding land, as shown on the maps, is as follows:

Date	Site Use	Surrounding Land Use
1881	Undeveloped land.	The surrounding area was predominantly located within agricultural area, Bearton farm was located approximately 100m north of the Site. Bedford Road runs adjacent east of the Site. A property detailed as "The Firs" is located adjacent south of the Site. Brick work was located approximately 100m northeast of the Site. Hitchin Union workhouse was located approximately 120m south of the Site, which was later marked as residential area by c.1922 Bearton Pond is located approximately 170m north of the Site. Union workhouse was located approximately 400m south of the Site. Butts Close Park is located approximately 100m southeast, and Butts Close pond is located approximately 380m southeast of the Site.
1898	Undeveloped land.	No significant changes.
1922 - 1923	Undeveloped land.	Poor Law institution is developed approximately 100m southwest of the Site. Residential properties are developed approximately 100m south of the Site and 150m to the north east of the site.
1932 - 1939	Undeveloped land.	Surrounding area has generally become more urbanised with increased number of residential properties constructed.
1964-1965	Undeveloped land	A garage and a warehouse are located adjacent north of the Site. Hitching Town FC sports pitch is developed to the east of site. Residential properties with gardens are developed approximately 20m west of the Site. The First Hotel is located to the south of the site. St. Marks Church is located approximately 80m north of the Site. Tennis court was located approximately 80m southwest of the Site. The Leister Hospital was developed approximately 100m southwest of the Site, later named as Hitchin hospital by c.1966 Bearton farm located approximately 100m north of the Site was no longer mapped, and the area has been developed into residential properties with gardens. Hitchin Swim Park with is associated parking is located approximately 220m southeast of the Site.
1966 - 1981	Two (2) building developed in the central eastern region of the Site. Site is likely to be operating as a PFS / Garage.	The garage located adjacent north of the Site has undergone redevelopment and has been named as warehouse. An electricity substation is located approximately 80m southwest of the Site. Hitchin Hospital is developed approximately 100m southwest of the Site, located on the site of the previously named Leister Hospital.

Date	Site Use	Surrounding Land Use
1984-1985	The Site layout is unchanged.	Building adjacent to the north of the Site is named as depot. A tank was developed approximately 50m north of the Site. A tank is developed near the electricity substation located approximately 80m southwest of the Site.
1993 - 2024	The Site has been redeveloped and appears consistent with the current layout of the Site. The Site is labelled as a Filling Station	An additional buildings is located to the east of the site. (Car Service / Tuning) is developed adjacent east of the Site. Warehouse and tank located approximately 50m north of the Site are no longer present. By c.1994 Residential properties along with an electricity substation is marked. Tennis court, tank located approximately 80m southwest of the Site are no longer mapped. Buildings associated with Hitchin Hospital are no longer present from 1993 onwards. By c.1994 there are further developments of residential properties approximately 60m east of the Site in the location of the former Hitchin Hospital.

2.3 Geology

Geology	Unit	Thickness (m)	Aquifer Classification
Regional	Source: BGS GeoIndex (BGS) online viewer		
Superficial Deposits	Lowestoft Formation – Diamicton	Unknown	Secondary Undifferentiated Aquifer*
	Glaciofluvial Deposits, Mid Pleistocene - Sand and Gravel located approximately 50m west of the Site.		Secondary A Aquifer
Bedrock	Zig Zag Chalk Formation - Chalk	Unknown, considerable thickness variation	Principal Aquifer
Local	Source: URS Comprehensive Environmental Site Assessment (Report ref: R46370079-002 Final, September 2012).		
Made Ground	Concrete / Asphalt	0 to 0.50 m bgl	N/A
	Brown gravel or brown silty sandy gravelly clay. Gravel of brick and wood with concrete cobbles	0.50 – 1.30m	
Superficial Deposits – Lowestoft Formation	Bands of orange/brown/dark grey SAND, SILT and CLAY with occasional gravels of chalk and flint.	12.60m (maximum proved thickness)	Secondary (Undifferentiated) Aquifer*

Geology	Unit	Thickness (m)	Aquifer Classification
Bedrock – Zig Zag Chalk Formation	Structureless CHALK composed of stiff white SILT/ gravelly SILT	> 5.9m (maximum proved thickness)	Principal Aquifer

Note: * Based on Arcadis review of the geology, the site is underlain by the Lowestoft Formation, which URS had stated in an earlier Phase 1 report was designated as 'Unproductive Strata' although in later report referred to the site underlain by a Secondary A Aquifer. The Glaciofluvial deposits are designated a Secondary A aquifer although according to the geological maps are to the west of the site, however, based on the URS report, Glaciofluvial deposits were recorded on site in Boreholes BH101 to BH103.

2.4 Hydrogeology

Hydrogeology	Details
Groundwater depth	Groundwater wells were dipped prior to decommissioning in September 2016 and groundwater was recorded within the Drift Deposits in all five (5) monitoring wells at depths ranging from 4.585m bgl (MW102) to 6.213m bgl (MW105A). (AECOM, Well Decommissioning Report, Report ref: GB-10019011-20161025-OTH, October 2016).
Groundwater flow direction	Groundwater is inferred to flow in an easterly direction. (AECOM, Comprehensive Groundwater Monitoring Event, Report ref: GB-10019011-20160610-MON, June 2016).
Licensed potable groundwater abstractions	None within 1km (Envirocheck® Report, 2024). The nearest active potable groundwater abstraction is located approximately 1.4km west of the Site, operated by Pilkington Farms and used for Household Water Supply: Drinking; Cooking; Sanitary; Washing; (Small Garden), licence number: 6/33/13/*G/0025.
Licensed non-potable groundwater abstractions	One (1) abstraction licence for William Ransom & Son Plc, 6/33/13/*s/055 is recorded within 1km of the site, with the distances of the abstraction associated with the licence being recorded as being 846m, 909m, 913m, 920m and 1083m southeast of the Site. (Envirocheck® Report, 2024):
Unlicensed groundwater abstractions	The Hertfordshire County Council confirmed by email on 17 September 2024 that they do not hold records of any private groundwater abstraction and recommended that a search is undertaken with Environmental Health Teams of the district and borough councils of Hertfordshire. The North Herts Council confirmed by email on 16 December 2024 that they do not hold records of any private groundwater abstraction A copy of the correspondence with the Local Authority is presented in Appendix C.

Hydrogeology	Details
Groundwater Source Protection Zones (SPZ)	The Site is not located within a SPZ (Envirocheck® Report, 2024). The Envirocheck® report has identified a Zone 3 (Total Catchment) SPZ is identified as being 88m south-west of the site.

2.5 Hydrology

Item	Details
Nearest surface water feature	The nearest surface water feature is Bearton Pond, located approximately 170 m north of the site. The River Hiz is located approximately 770m east of the site, the River Oughton is located 1.1km north of the site and the River Purwell is located approximately 1.4km northeast of the site.
Licensed surface water abstractions	None within 1km (Envirocheck® Report, 2024).

2.6 Flood Risk

Item	Details
Groundwater flood risk	The BGS Groundwater Flooding Susceptibility Map indicates that the Site is located within an area where there limited potential for groundwater flooding to occur.
Surface water flood risk	The EA Long Term Flood Risk Map indicates that the majority of the Site is located within an area of very low risk of surface water flooding, defined as less than 0.1% chance of a flood each year. However, a small area of the western section of the site, is within a medium risk zone for surface water flooding, with an annual probability ranging between 1% and 3.3%.
Flood risk from rivers or sea	The EA Flood Map for Planning indicates that the Site is located within Flood Zone 1, indicating a low risk of flooding from rivers and the sea, defined as land having less than a 1 in 1,000 annual probability of river or sea flooding

2.7 Ground Hazards

Item	Details (Envirocheck® Report)
Ground stability hazards	Hazard levels: • Collapsible deposits: Very low • Running sands: Very low • Compressible deposits: No hazard • Landslides: Very low • Ground dissolution of soluble rocks: No hazard

Item	Details (Envirocheck® Report)
	Shrinking or swelling clay: Low
Mining, ground workings and natural cavities	- Coal mining: No records identified within 2km of the Site - Non-coal mining: No records identified within 2km of the Site, rare risk assigned on Site. - Natural Cavities: No records identified within 2km of the Site
Radon	The Site lies in an intermediate probability radon area where 1 to 3% of homes are estimated to be at or above the Action Level. Radon protective measures are not required for construction of new dwellings or extensions.

2.8 Ecologically Sensitive Sites

Item	Details (Envirocheck® Report)
Nitrate Vulnerable Zones (NVZ)	Two records of NVZ were identified on-site, with the details of this NVZ provided below: - Groundwater extracted from Zig Zag Chalk (Aquifer) (as referred to in the Envirocheck report) - Great Ouse catchment area (Surface Water)
Sites of Special Scientific Interest	Oughtonhead Lane is located approximately 622m west of the Site.

None of the following statutory designations have been identified within 1km of the Site: Areas of Outstanding Natural Beauty, Local Nature Reserves, National Nature Reserves, National Parks, Ramsar Sites, Special Areas of Conservation and Special Protection Areas.

3 POTENTIAL CONTAMINATION SOURCES & INFORMATION

3.1 Contemporary Trade Directory Entries

Three active contemporary trade directory entries were identified within 500m of the Site [Envirocheck® Report (Appendix B)], summarised in the table below.

Trade Entry	Classification	Distance and direction from the Site	Active/ Inactive
Shell	PFS	On site	Active
Kwik Fit Plus	Tyre Dealers	14m northwest	Active
Mobile Tyre Services Ltd Sgs Supertyres Group S T S Tyre Pros	Tyre Dealers	15m north	Inactive
Auto Service & Tuning Centre Ltd	Car Engine Tuning & Diagnostic Services	16m north	Active
Paint Removing	Paint & Varnish Stripping	64m west	Inactive
Park Home Show	Caravan Dealers & Manufacturers	84m north	Inactive
Morris Repair Services Presentation Systems Ltd Envirovision	Photographic Equipment Repairs Photographic Equipment Repairs Bathroom Fixtures - Manufacturers	108m northwest	Inactive
P A B Motors Hitchin Blinds	Garage Services Blinds, Awnings & Canopies	285m northeast	Inactive
Choice Vehicle	Commercial Vehicle Dealers	325m northeast	Inactive
Blitz Cleaning Services Ltd	Metal Workers	327m northwest	Active
Herts Fire Protection	Firefighting Equipment	337m west	Inactive
Hampden House	Hospitals	466m southeast	Inactive

3.2 Landfills

Landfill Gas Sources	Details (Envirocheck® Report)
Historical landfills	There are no historical landfills identified within 1km of the Site.
Registered landfills	There are no registered landfills identified within 1km of the Site.

Landfill Gas Sources	Details (Envirocheck® Report)
Local Authority Recorded Landfills	There are no Local Authority recorded landfills identified within 1km of the Site.

3.3 Discharge Consents

Item	Details (Envirocheck® Report)
Discharge consents for the Site	None reported
Discharge consents within 1km	Four (4) discharge consents identified within 1km of the Site. The nearest discharge consent is located approximately 713m southeast of the Site, operated by J Sainsbury Plc T/A Sainsburys Supermarkets Ltd and discharges trade discharge-process water into land/soakway.

3.4 Environmental Permits

Item	Details (Envirocheck® Report)
Environmental permits for the Site	One record identified: Name: Shell Hitchin Permit reference: EPA/10940/05/P3 Dated: 13th March 2016 Process Type: Local Authority Pollution Prevention and Control Description: PG1/14 Petrol Filling Station Status: Permitted
Environmental permits within 1km	Five environmental permits identified within 1km of the Site. The nearest environmental permit identified relates to: Name: Bp Westmill Filling Station Permit reference: EPA/10945/05/P1 Dated: 11th February 1999 Process Type: Local Authority Pollution Prevention and Control Description: PG1/14 Petrol Filling Station Status: Permitted

3.5 Registered Radioactive Substances

Item	Details (Envirocheck® Report)
Registered radioactive substances on site	None identified
Registered radioactive substances within 2km	None identified

3.6 Pollution Incidents to Controlled Waters

Item	Details (Envirocheck® Report)
Pollution incidents at the Site	None reported
Pollution incidents within 1km	20 pollution incidents reported within 1km radius of the Site. The nearest incident was located 203m west of the Site, associated with a tributary of the River Oughton: Incident date: on 5th December 1994 Incident severity: Category 3 Minor Incident.

3.7 Unexploded Ordnance

The Zetica UXO Pre-Desk Study Assessment indicates that the Site is located within an area of low UXO risk. During WWII the Site was located in Hitchin Urban District (UD), which officially recorded 28No. High Explosive (HE) bombs, with a density of 7.2 bombs per 405 hectares (ha).

No readily available records have been found indicating that the Site was bombed.

The UXO Pre-Desk Study Assessment is included in Appendix D.

4 PFS INFRASTRUCTURE

4.1 PFS Layout

A site walkover conducted on 11th October 2024. Photographs taken during the site walkover are presented in Appendix E.

The layout of the site based on the findings of the site walkover and review of the existing site layout plans, is summarised below:

- The sales building is located in the northern part of the PFS.
- The forecourt comprises three (3) pump islands, located in the centre of the PFS.
- Two (2) underground storage tanks consisting of four (4) compartments is located in the southern part of the PFS.
- Above ground offset fills and vent stacks are located to the south of the tank farm.
- Car wash is located to the southern part of the PFS with associated plant room in the northwest of the site.
- A forecourt interceptor is present in the north-eastern part of the PFS and a car wash interceptor is located in the southern part of the PFS.

4.2 Petroleum Officer Records

A questionnaire was sent to Hertfordshire County Council for completion by the Petroleum Officer (PO). The response dated 29th October 2024 presented at Appendix F records two operational USTs (each split into two tanks) present at the Site.

There are no records of historical tanks present on site provide in the 2024 PO report information.. Information on historical tanks have been reviewed from the previous PO response supplied in the URS 2011 Phase 1 Investigation Report. It is understood that the Site was redeveloped in 2013 and as part of the construction programme five active tanks (comprising seven compartments) and one solid filled decommissioned tank were reported as being removed from the Site.

Details of the operational and historical tanks, as presented in the PO report unless indicated otherwise, are presented in the following table:

Tank No.	Contents (Fuel Type)	Capacity (Litres)	Approximate Date Installed	Construction Type
Operational Tanks				
A (T1)	Petrol	43,650	2013	Double skin steel
A (T2)	Petrol	19,400	2013	Double skin steel
B (T3)	Diesel	38,800	2013	Double skin steel
B (T4)	Diesel	24,250	2013	Double skin steel
Historical Tanks* – Removed in 2013				
1	V-Power UL	13,190	1970	Single walled - Dual Chamber
2	V-Power Diesel	13,190	1970	Single walled - Dual Chamber
3	Unleaded	26,190	1970	Single walled
4	Diesel	26,190	1970	Single walled

Tank No.	Contents (Fuel Type)	Capacity (Litres)	Approximate Date Installed	Construction Type
5	Unleaded	12,363	1970	Single walled - Dual Chamber
6	Unleaded	26,190	1970	Single walled
7	V-Power UL	12,121	1970	Single walled - Dual Chamber

* Information presented in the URS Phase 1 Investigation Report, report ref: R46370079-001, 22 September 2011).

The 2024 PO report stated that there are no records of any historical leaks or incidents on-site. However, a review of the previous PO response included in the URS 2011 Phase 1 Investigation Report noted two incidents: a leak detected near pumps 8/9, which was immediately repaired in January 1991, and a 10-liter petrol spill on the garage forecourt in May 2001, reportedly cleaned up using two small spill kits.

The 2024 Petroleum Officer Report is provided in Appendix H.

4.3 Fuel Distribution and Management Systems

Item	Details
Number of standard (car) pump islands and dispensers	Three pump islands and six dispensers.
Fill points and venting	Above ground offset fill and vent stacks
Wetstock management system	Fairbanks Environmental Limited. Real time data collected at 15-minute intervals and monitored 24/7.

The wetstock management system has confirmed that there are no current or on-going concerns over the performance of the operational tanks at Site. The site performance letter provided by Fairbanks Environmental Limited is included in Appendix G.

4.4 Historical Incidents or Spillages

During the site walkover undertaken on 11th October 2024, no records of accidental spillage of fuel or other substances were identified, and the Site manager was not aware of any incidents or spills.

4.5 Site Drainage

Information on the site drainage has been taken from the site plan titled 'Drainage and Services Drawing, (ref: 10019011-D&S_2013, dated 21st January 2013).

Foul water from the plant room and sales building exits the rear of the building and extends in an easterly direction near the northern boundary of the Site. Surface water from the forecourt is shown to enter the interceptor located in the north-eastern part of the PFS. The surface water is combined with foul water from the car wash entering a three-stage interceptor located in the south of the Site, before exiting at the eastern boundary.

4.6 Groundwater Monitoring Wells

No monitoring wells were identified during the site walkover. Historical groundwater monitoring wells were decommissioned by AECOM in October 2016. (AECOM Well Decommissioning Report, report ref: GB-10019011-20161025-OTH, October 2016).

5 DEVELOPMENT OF THE CONCEPTUAL SITE MODEL

Following completion of the desk study and site walkover, a preliminary CSM has been prepared based on the future development of the Site as CPU. The preliminary CSM is summarised below:

5.1 Potential Areas of Concern (Sources)

Potential Areas of Concern (PAOC) associated with the Site which have been identified during the desk study and Site walkover are listed below.

5.1.1 On-Site

Location	PAOC
Current Usage	Operational USTs and fuel distribution pipework.
	Accidental releases to ground from dispensing pumps, offset fill points, forecourt interceptor and drainage
	Car wash and associated interceptor
	Imported Made Ground associated with development of the Site
Historical Usage	Historical use of the Site as a PFS, although potential secondary source soils from around the former tank installations were removed as part of redevelopment works, with validation soil samples collected.

5.1.2 Off Site

Location	PAOC
Current Usage	Kwik Fit Plus Car Garage located adjacent north of the Site and Boshh Vehicle Servicing (Car Service / Tuning) located adjacent west of the Site
Historical Usage	Historical Hospital located 100m to the east of the site.
	Tanks and Electricity Substation located approximately 80m southwest of the Site, anticipated to be related to Historical Hospital.
	Tank associated with a warehouse is shown approximately 50m north of the site boundary and Garage (later shown as depot) approximately 5m north of the site boundary

The remaining potential off-site sources identified in Section 3 are not considered further due to their significant distance from the Site.

5.2 Constituents of Potential Concern

Constituents of Potential Concern (COPC) for the Site have been selected based on the current and historical on- and off-Site PAOC and with reference to the relevant Department of Environment (DoE) Industry Profiles¹.

PAOC	COPC
On-Site	

¹ Department of Environment, "DoE Industry Profiles" [Online]. Available: <https://www.claire.co.uk/useful-government-legislation-and-guidance-by-country/198-doe-industry-profiles>

PAOC	COPC
Fuel storage and distribution network	- Petroleum hydrocarbons - Benzene, toluene, ethylbenzene, xylenes (BTEX) - Fuel additives (Methyl <i>tertiary</i>-butyl ether (MTBE), ethyl <i>tertiary</i>-butyl ether (ETBE), <i>tertiary</i>-amyl methyl ether (TAME), di-isopropyl ether (DIPE), <i>tertiary</i>-butyl alcohol (TBA) and ethanol) - Polycyclic Aromatic Hydrocarbons (PAH)
Interceptor	
Surface spillages	
Historical use of the site as a garage / PFS	- Heavy metals - Petroleum hydrocarbons - BTEX - PAH - Fuel additives (MTBE, ETBE, TAME, DIPE, TBA and ethanol) - Ground gases (including methane and carbon dioxide) - Leaded additives
Imported Made Ground	- Heavy metals - PAH - Asbestos - Ground gases (including methane and carbon dioxide)
Off-Site	
Imported Made Ground	- Heavy metals - PAH - Asbestos - Ground gases (including methane and carbon dioxide)
Historical Hospital	- Petroleum hydrocarbons - PAH - Volatile Organic Compounds – chlorinated and other solvents - Heavy metals
Electrical substation	- Hydrocarbons - PCBs are not considered as COPC due to their low mobility in the environment
Garage / Vehicle Servicing and tank	- Heavy metals - Petroleum hydrocarbons - BTEX - PAH - Fuel additives (MTBE, ETBE, TAME, DIPE, TBA and ethanol an leaded additives) - Volatile Organic Compounds – chlorinated and other solvents - Ground gases (including methane and carbon dioxide)

5.3 Receptors

The following potential receptors have been identified based on CPU of the Site.

Type of Receptor	Potential Receptors
Human Health*	On-site commercial workers
	Site visitors e.g. general public
	Neighbouring residents (located approximately 20m west, approximately 25m north and approximately 30m south of the Site)

Type of Receptor	Potential Receptors
	Neighbouring commercial workers (located on the north, south and western boundary)
Controlled Waters	Groundwater within superficial deposits - Lowestoft Formation - Diamicton (Secondary Undifferentiated Aquifer) and Zig Zag Chalk Formation - Chalk (Principal Aquifer).

Due to significant distance to the River Hiz and Bearton Pond and anticipated groundwater flow direction to the east, no viable pathways to surface water receptors have been identified.

* Future on-site construction workers are not considered as a potential receptor in this assessment. The potential risks to future on-site construction workers may be managed through appropriate use of Personal Protective Equipment (PPE), good working practices, risk assessments and method statements.

5.4 Potentially Active Pathways

Based on the information presented in this report, the primary potential sources are considered to be associated with the current and historical use of the Site as a PFS, with the following pathways considered potentially active:

Human Health:

- Partitioning of COPC from contaminated soil or groundwater into soil vapour, prior to vertical and lateral migration and subsequent inhalation of vapours in indoor and outdoor air by future on-site commercial workers and visitors e.g. general public and visiting staff
- Lateral migration of vapours or ground gases via preferential pathways (e.g. utility channels), followed by inhalation of vapours in indoor and outdoor air by neighbouring residents and commercial workers.
- Direct contact (ingestion, inhalation, dermal) with impacted soil particulates by future on-Site construction workers and associated visitors, during construction/ redevelopment works

Based on the proposed future development of the Site as a PFS, it is anticipated that the majority of the Site will be covered by buildings or hardstanding, therefore direct contact pathways are not considered to be potentially active.

Controlled Waters:

- Leaching and vertical migration of COPC into groundwater within the Groundwater within superficial deposits - Lowestoft Formation - Diamicton (Secondary Undifferentiated Aquifer) and Zig Zag Chalk Formation - Chalk (Principal Aquifer) beneath the Site and subsequent on- and off-site migration within the aquifer.

The preliminary CSM detailing the potentially active contaminant linkages is presented schematically on Figure 4.

6 Preliminary Risk Assessment

Following development of the preliminary CSM, the plausible Source-Pathway-Receptor contaminant linkages and evaluation of the preliminary level of risk posed to the identified receptors are summarised below. The definitions and classifications of risk are presented in Appendix H (Risk Assessment Methodology).

Source	Pathway	Receptor	Severity	Likelihood	Risk	Justification
Human Health						
Potentially impacted soil/ groundwater	Partitioning of COPC from soil and groundwater into soil vapour, lateral and vertical vapour migration and subsequent inhalation.	On-site commercial workers and visitors	Medium	Low	Moderate / Low	Wetstock monitoring reports from Fairbanks have not raised significant concerns about historical substantial fuel releases or leaks, except for minor leaks in the pumping unit, which were addressed at the time.
		Neighbouring commercial and residents	Medium	Low	Moderate / Low	As part of the Environmental Verification Report (2013), Stage 2 screening values protective of Human Health and Stage 3 Controlled Waters SSAC derived in the URS DQRA was conducted. A risk assessment was undertaken on validation samples collected from soil left in-situ underlying the site and post construction groundwater monitoring data. No potentially significant risks to human health (protective of on-site workers and off-site residents) were identified. Vapour analytical data collected from the Site in October 2011 were compared with URS GAC protective of human health for a HDR end-use (adopted based on the assumption that there will be no direct contact). No COPC were reported above the relevant human health GAC suggesting the theoretical risk from soil and groundwater is not significant.
	Direct contact (ingestion, inhalation, dermal) with impacted soil particulates	Future on-Site construction workers and associated visitors, during construction/ redevelopment works.	Medium	Low	Moderate / Low	Contact with contaminative substances during redevelopment is likely should contaminated ground be exposed. The risk to contactors can be reduced to 'Low' through appropriate use of PPE and good working practices.

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Source	Pathway	Receptor	Severity	Likelihood	Risk	Justification
Controlled Waters						
Potentially impacted soil/ groundwater	Leaching of COPC from soil into groundwater and subsequent migration of impacted groundwater.	Groundwater within superficial deposits - Lowestoft Formation - Diamicton (Secondary Undifferentiated Aquifer), although Glaciofluvial deposits (A secondary A aquifer, maybe present beneath the Site based on URS investigation information and Zig Zag Chalk Formation - Chalk (Principal Aquifer).	Medium	Low	Moderate / Low	Based on Arcadis review of the geology, the site is underlain by the Lowestoft Formation, and Glaciofluvial deposits are to the west of the site, however, based on the URS report, Glaciofluvial deposits were recorded on site in Boreholes BH101 to BH103. Therefore the Site overlies sensitive controlled water receptors – Secondary Secondary A Aquifer where there are glaciofluvial deposits and the Chalk Principal Aquifer. All known historical tanks have been removed from the site and replaced with new double skinned tanks fitted with interstitial alarms reducing the likelihood of accidental spills / leaks. Shell has also established a Third-Party wet stock monitoring system, via Fairbanks Environmental Ltd. As part of the Environmental Verification Report (2013), Stage 2 screening values protective of Human Health and Stage 3 Controlled Waters SSAC derived in the URS DQRA was conducted. A risk assessment was undertaken on validation samples collected from soil left in-situ underlying the site and post construction groundwater monitoring data. No potentially significant risks were identified to groundwater quality within the Drift Deposits or within the underlying Chalk formation. According to the site walkover visual inspections hardstanding surface is present across the site. Surface water drainage system discharge via an interceptor to manage surface water contamination if present.

7 Potential Impact of Climate Change on Land Contamination CSM

It is stated in the LC:RM framework that land contamination assessments must have “information on the importance of taking climate change into account”. While LC:RM provides examples of what should be included, no consistent framework or tool has been provided to aid this process, including within a PRA. As such, Arcadis has developed a screening impact analysis methodology, Climate: CLEAR, with reference to the Society for Brownfield Risk Assessment (SoBRA) 2022 guidance “Guidance on Assessing Risk to Controlled Waters from UK Land Contamination Under Conditions of Future Climate Change”, and other sources such as the guidelines of the United Nations Framework Convention on Climate Change (UNFCCC) and the European Commission.

Climate: CLEAR applies a scoring system approach and has been developed based on a pre-selected set of potential climatic changes and how these could impact the land contamination Conceptual Site Model (CSM). Further information about the methodology used in Climate: CLEAR is presented in Appendix I. Output from the Climate: CLEAR scoring system is presented as Appendix J.

The results of the Climate: CLEAR assessment has determined the following associated climatic changes that have the potential for a medium/moderate impact (amber) on the land contamination CSM as follows:

A Reasonable Worst Case associated with:

- Increased ground (clay) shrinkage affecting soil and groundwater pathways.
- Mean temperature affecting vapour exposure pathways
- Mean temperature rise affecting soil to groundwater pathways and microbial activity.
- Increase in extreme heat events affecting vapour/dust exposure pathways

A Reasonable and Reasonable Worst Case associated with:

- Increased ground (clay) shrinkage affecting vapour pathways
- Net annual increase in precipitation affecting soil to groundwater pathways.

An increase in mean temperatures will result in an increase in near surface ground temperatures, which may increase the volatilisation of selected CoC, where present, in shallow soils/ groundwater and the underlying geology (clays) have a possible/probable risk of shrinkage/swelling, which has the potential to affect future on-Site commercial workers. However, based on the concentrations of volatile CoC measured in soil, groundwater by previous assessments and the validation sampling in excavations related to the removal of the underground storage tanks and groundwater monitoring results it is considered that the potential changes in ground temperature are likely to be significant enough to result in potential risk to future Site users. **In conclusion, the moderate/medium (amber) impact ratings associated with an increase in mean temperature rise and extreme heat events have been moderated down to low (green) based on site specific knowledge.**

Although the Site has been identified in an area of predicted increase in net annual precipitation events affecting soil to groundwater pathways, the Site is located in a Flood Zone 1 with most of the Site identified at a low risk of surface water flooding, and limited potential for groundwater flooding. **In conclusion, the moderate/medium (amber) impact rating associated with net annual increase events has been moderated to low (green) based on site specific knowledge.**

It should be noted, some of the adopted data sets are based on predictions of a rise in temperature or change and extreme rainfall events to the end of the 21st century and consequently the data assessed may be considered beyond the lifetime of the Site for its proposed development use.

8 CONCLUSIONS

The Site comprises an active PFS, located in a primarily residential and commercial area. Bedford Road is located adjacent to the eastern Site boundary. The PRA has been undertaken on the basis of CPU.

Conceptual Site Model

The CSM has been developed based on information gathered during the desktop study and site walkover.

The current and historical use of the site as a PFS have been identified as potential on-site sources of contaminants and car garage located adjacent north and vehicle servicing garage located adjacent west of the Site have been identified as potential off-site sources of contamination.

According to geological map information the Site overlies Lowestoft Formation - Diamicton (designated as Secondary Undifferentiated Aquifer), although the URS site investigation recorded deposits referred to a Glaciofluvial (designated a Secondary A aquifer) The superficial deposits overlies Zig Zag Chalk Formation - Chalk (designated as Principal Aquifer). The nearest surface water features are Bearton Pond, located approximately 170 m north of the site and River Hiz is located approximately 770m east of the Site, although given the distance and likely groundwater flow direction, these are not considered to be potential receptors.

Groundwater wells were dipped prior to decommissioning in September 2016 and groundwater was recorded within the superficial II deposits in all five (5) monitoring wells at depths ranging from 4.585m bgl (MW102) to 6.213m bgl (MW105A). (AECOM, Well Decommissioning Report, Report ref: GB-10019011-20161025-OTH, October 2016). Groundwater is inferred to flow in an easterly direction towards the River Purwell. (AECOM, Comprehensive Groundwater Monitoring Event, Report ref: GB-10019011-20160610-MON, June 2016).

The nearest non potable abstraction is located approximately 846m southeast of the Site. The nearest potable abstraction is located approximately 1.4km southeast of the Site operated by operated by Pilkington Farms and used for Household Water Supply: Drinking; Cooking; Sanitary; Washing; (Small Garden). The nearest surface water feature is Bearton Pond, ~170 m north and River Hiz ~770m east of the Site.

Intrusive investigations at the Site in 2012 and 2013, included drilling five monitoring wells into superficial deposits and three vapor wells in December, followed by additional drilling and well installation in February into the Zig Zag Chalk Formation and superficial deposits. The findings and results of these works supported a DQRA using soil, groundwater, and vapor data from multiple monitoring events. The investigations and DQRA concluded that while some theoretical risks exist to controlled waters under specific conditions, these are unlikely to pose significant risks to human health or the environment under site-specific conditions.

Site redevelopment works were completed in 2013, where five active tanks (consisting of seven compartments) and one decommissioned, solid-filled tank were replaced by two new double-walled, 65KL split-compartment tanks. In addition to fuel infrastructure removal, URS undertook validation sampling in excavations related to the removal of the underground storage tanks (USTs), dismantling of the fuel infrastructure, and the excavation for the new tank farm. The investigation reported no visual or olfactory signs of hydrocarbon impact in monitoring wells. No significant risks to human health or groundwater quality in the Superficial Deposits or Chalk formation was identified, and therefore the site is considered suitable for continued petroleum use.

Preliminary Risk Assessment

The identified source-pathway-receptor contaminant linkages have subsequently been assessed to evaluate the potential level of risk, summarised below:

Human Health

- Partitioning of COPC from contaminated soil or groundwater into soil vapour, prior to vertical and lateral migration and subsequent inhalation of vapours in indoor and outdoor air by future on-site commercial workers and visitors e.g. general public and visiting staff - **moderate / low risk**
- Partitioning of COPC from contaminated soil or groundwater into soil vapour, prior to vertical and lateral migration and subsequent inhalation of vapours in indoor and outdoor air by offsite neighbouring commercial and residents **moderate / low risk**

Controlled Waters

- Leaching and vertical migration of COPC into groundwater within the Groundwater within superficial deposits - Lowestoft Formation - Diamicton (Secondary Undifferentiated Aquifer) and Zig Zag Chalk Formation - Chalk (Principal Aquifer) beneath the Site and subsequent on- and off-site migration within the aquifer- **moderate / low risk**.

Potential Impact of Climate Change on CSM

The results of the Climate:CLEAR Site-specific assessment has determined potential climatic changes that have the potential for a medium/moderate impact on the land contamination CSM. For a reasonable case prediction, this includes mean temperature rise affecting soil to groundwater pathways and microbial activity. For a reasonable and reasonable worst case this includes, net annual increase in precipitation affecting soil to groundwater pathways. However, based on site-specific knowledge these impacts are moderated down to low, considering factors such as predicted flooding risks and the significance of temperature changes on potential risks to future site users.

FIGURES

Figure 1 – Site Location Plan

Figure 2 – Site Boundary Plan

Figure 3 – PFS Layout Plan

Figure 4 – Preliminary Conceptual Site Model