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THAMES QUARTER, KING'S MEADOW ROAD, READING PRELIMINARY RISK ASSESSMENT

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EXECUTIVE SUMMARY

Environment and Health UK Limited (Ramboll) was instructed by Watkin Jones & Son Limited to undertake a Preliminary Risk Assessment of the Thames Quarter development at King's Meadow, Reading, RG1 8BN. The report is required in connection with the proposed development of the site by the Client for residential apartment end use.

The subject site is currently occupied by a multi-storey carpark and current activities have a low potential to have caused ground contamination.

Historically, the site was occupied by railway tracks and of note 'tanks' were associated with the railway activities in the east of the site. The site was then developed for vehicle maintenance in the 1970s and as a motor dealership by the 1980s. In 2013 oil was released into the ground on-site that has caused ground contamination and residual oil remains present on-site that will require further remediation to develop the site. Previous site investigations have also identified ground contamination in other areas of the site notably at WS9 in the east of the site near to where the railway land tanks were present and potentially at WS2/WS3 on the southern boundary.

Historically, the site surrounds were also of a railway land nature. The available ground condition data has not identified evidence of ground contamination migrating onto the site from off-site land to date.

The site is considered to be located in a high sensitivity setting with regard to groundwater resources due to the underlying Alluvium (Secondary A aquifer), River Terrace Gravels (Secondary A aquifer) and the Principal Chalk Aquifer. However, at present there is no evidence that the Chalk aquifer has been impacted on-site and where residual oil contamination is present in the shallow aquifers this does not appear to be migrating across the site towards the site boundary.

The site is considered to be located in a moderate sensitivity setting in regard to surface water resources as the River Thames is located approximately 140 m to the north of the site.

A Conceptual Site Model has been developed taking into account the proposed development scheme and further site investigation is considered necessary to investigate potential source-pathway-receptor relationships. The further investigation is recommended to target the areas subject to limited investigation to date including beneath the multi-storey car park, beneath the showroom/workshop building footprints and around RPS borehole WS9 close to the railway land tanks.

As there is residual oil in the ground further remediation of soils and groundwater will be required to redevelop the site. At this time the remedial strategy for the site is expected to focus on the removal of residual gross contamination associated with the former oil leak and, if identified, the removal of significant contamination from historic activities. A development led approach to mitigation of remaining ground contamination risks for the residential development of the site would then follow such as through the introduction of a clean capping system and breaking direct contact pathways with the presence of the building and hardstanding.

1. INTRODUCTION

1.1 Instruction

Ramboll Environment and Health UK Limited (Ramboll) was instructed by Watkin Jones & Son Limited to undertake a Preliminary Risk Assessment of the Thames Quarter development at King's Meadow, Reading, RG1 8BN. The report is required in connection with the proposed development of the site by the Client for residential apartment end use.

1.2 Objectives

The objective of the review was to assess the potential for soil or groundwater contamination to exist, both at and in the vicinity of the site, and if present, to assess its significance in the context of the redevelopment of the site and potential source-pathway-receptor relationships.

1.3 Scope and Limitation

The scope of the Preliminary Risk Assessment has included the following:

- review of previous site investigation and remediation reports relating to the site;
- examination of historic, recent and current Ordnance Survey plans to identify activities which might have led to contamination of soil or groundwater (for example, from manufacturing processes, from storage activities or waste disposal practices) both on the subject site and on adjacent sites;
- examination of published records and plans on the shallow and deep geology and hydrogeology of the site to assess the vulnerability and sensitivity of groundwater and surface water resources to contamination, if present, and the possible direction of movement off site, if mobile;
- search of a proprietary database of environmental permits, records and incidents at the site and surrounding area;
- enquiries of the Local Authority Planning and Environmental Health Departments to obtain information on environmental conditions, incidents and known contamination risks and on the Local Authority's Contaminated Land Strategy; and
- enquiries of the Petroleum Officer to determine if records exist of above ground or below ground licensed (petrol) storage facilities.

No sampling or analysis of soils, waters or other materials has been carried out as part of the Preliminary Risk Assessment. The PRA is intended to provide the first stage of ground contamination risk assessment in line with current guidance including the Environment Agency's CLR11 Model Procedures for the Management of Land Contamination.

The conclusions presented in this report represent Ramboll Environ's best professional judgment based upon the information available and conditions existing as of the date of this report. In performing its assignment, Ramboll Environ must rely upon publicly available information, information provided by the Client and information provided by third parties. Accordingly, the conclusions in this report are valid only to the extent that the information provided to Ramboll Environ was accurate and complete. This review is not intended as legal advice, nor is it an exhaustive review of site conditions or facility compliance. Ramboll Environ makes no representations or warranties, expressed or implied, about the conditions of the site.

2. SITE DESCRIPTION

2.1 Site Setting

The site is located on the southern side of the King's Meadow Road, approximately 140 metres (m) south of the River Thames, at National Grid Reference 471830, 173870. Access to the site is via the King's Meadow Road. The site location and boundary is shown in Figures 1 and 2, Appendix 1.

The surrounding land uses are detailed in Table 2.1 below.

Table 2.1: Adjacent and Surrounding Land Uses			
Direction	Activity / Occupant	Activities	Notes
North	Environment Agency office and associated car parking	Local Authority	Limited potential for contamination at present.
South	A raised section of railway lines associated with Reading Rail Station	Railway lines and platforms	Limited potential for contamination at present given the raised nature of the railway lines.
East	QA Ltd. Reading	Training Centre	Limited potential for contamination at present.
West	Roads and then Reading Rail Station Multi-storey carpark MSCP	Car parking	Limited potential for contamination at present.

2.2 Site Layout and Activities

Ramboll (and predecessors Ramboll Environ and ENVIRON) have been involved with the site since 2013. The site is currently in use as a pay and display car park. The south-eastern area of the site is a three-level multi-storey car park and the remainder of the site provides outdoor ground level car parking. The site is generally flat lying, as is the surrounding area, and extends to an area of approximately 0.59 hectares (ha).

Prior to its current use the site was a BMW car dealership and was vacant between July 2015 and April 2016. This included a showroom and workshop building in the west of the site that was demolished in May 2016, leaving the multi-storey car park in the south-east of the site. A pollution incident is known to have been caused by the former BMW activities at the site when an underground oil storage tank in the centre-east of the site leaked into the ground. There have been several phases of site investigation and remediation associated with this leak that are discussed in Section 5 of this report.

At present there is no bulk fuel or chemical storage on-site in aboveground or underground storage tanks. The current site activities are considered to have a low potential to cause significant ground contamination.

2.3 Proposed Development

The site is being developed under Reading Borough Council Planning Permission Number 162166, which was permitted on the 6th December 2016.

The Planning Permissions covers the: *"Erection of a part 12 storey, part 23 storey building comprising 315 apartments in a mix of studio, one-bedroom, two-bedroom and 3-bedroom units; residents' lounges, tech-hub, dining room, and cinema room, various rooftop outdoor amenity spaces, concierge/reception with coffee meeting area, residents' storage facilities, postroom,*

ancillary back-of-house facilities, 315 secure cycle parking spaces, 49 car parking spaces, landscaping, and associated works. Demolition of existing multi-storey car park.”

Of particular note in relation to ground contamination assessment there are strips of soft landscaping proposed in the north of the site and two landscaped islands proposed in the west of the site. The remainder of the site will be covered by buildings and hardstanding cover. Also of note there are no residential apartments located at ground floor level and the ground floor will be occupied by an entrance hall, cycle store, plant rooms, post room, a concierge space, and car parking area.

The Planning Permission includes conditions that require ground contamination characterisation, a remediation strategy and then remediation with associated validation. There are also mirror conditions for the assessment and management of ground gas risks. This report is intended to provide a preliminary assessment of potential ground contamination risks and to define the sources, pathways, and receptors that will require further investigation to support the redevelopment.

3. HISTORICAL & REGULATORY INFORMATION

3.1 Map History

Ramboll Environ has undertaken a review of historical mapping and aerial imagery (where available) obtained from a proprietary environmental database to identify potential sources of ground contamination at the site. This is summarised below and selected historical maps are presented in Appendix 2

3.1.1 The Site

The first map edition of 1879 showed east-west orientated railway tracks occupying the centre of the site with the edge of an embankment encroaching onto the southern site edge. The map dated 1931 showed a crane in the centre of the site.

By 1957 three small unmarked buildings were encroaching into the north-west corner of the site, a further elongated building was present on the southern boundary and there were buildings situated on the mid-eastern boundary of the site (that included 'tanks' associated with the buildings by 1971). Overall there was less than 10% building coverage on the site.

By 1979 the site had largely been cleared of features apart from a building in the east of the site (finally removed in 1986). A single building had been developed and occupied the majority of the south-west of the site that by 1986 had been identified as a depot (planning records in Section 3.3.2 suggest this was a vehicle workshop). The depot had been extended by 1988 to the layout of the showroom/workshop that has recently been present on-site (and which is known to have been demolished in 2016). No other changes to the site layout occurred in subsequent map editions.

3.1.2 The Surrounding Area

The earliest map edition dated 1879 showed the surrounds to be largely undeveloped land with the River Thames located approximately 140 m to the north of the site. King's Meadow was situated approximately 200 m east of the site and by 1961 was developed into a recreational ground where it remained unchanged to the final map edition. The River Kennet was situated approximately 425 m to the south of the site.

In the immediate surrounds, there were roads situated along the northern and western edge of the site and east-west orientated railway tracks were present to the immediate south, east and west. To the south the railway lines appear to have been raised on embankments. There was an engine shed present from 55 m to the south of the site and three Goods Yards 60 m east, 100 m south-east and 180 m south-east of the site.

By 1900 the railway tracks south of the site had been expanded and a goods shed was located immediately east of the site. There was an electric works 300 m north-west adjacent to the River Thames, which remained labelled until the historical map dated 1938. Two bathing places were marked from 45m to the north of the site from the early 1900s, one of which remains to the present day and the other appears to have been infilled in the 1970s. A tank associated with a Goods Yard was present from 125m to the south-east.

By 1912 a foundry was present 40m north of the site, this expanded and was labelled as a works by the 1950s and then was no longer present by 1972. Also by 1912 an iron works had been developed 170 m north-west of the site and by 1931 a timber yard and a paint works had been developed 180 m and 190 m north-west of the site, respectively. By 1956 the paint works and timber yard had been replaced by a garage, which was later replaced by a depot and a works by 1993. Five small buildings were present immediately to the north-west of the site and a weighbridge feature was located to the immediate west.

By 1971 a car park, situated approximately 100 m south of the site, had been developed. The car park was later redeveloped into Queens House as a large office use.

By the historical map dated 1979 the goods shed east of the site had been removed and replaced by a depot that was then redeveloped to offices in the 1980s. By the 1980s most of the railway lines had been removed in the immediate surrounds and only the main railway lines remained to the immediate south of the site. The railway lines and industrial uses were replaced with office buildings and car parks during this time.

No further significant changes occurred in the surrounds to the most recent historical map dated 2017.

3.2 Environmental Database Records

The information presented in Table 3.1 has been obtained from a review of a proprietary environmental database procured by Ramboll Environ relating to the site and surrounding land.

Table 3.1: Summary of Key Environmental Database Information					
Data Type	On site	Within 250m	Within 500m	Within 1km	Details of nearest relevant record within 250m of the site
Contaminated Land Register entries	0	0	0	0	None within 250m
Prosecutions or enforcement actions	0	0	0	0	None within 250m
Pollution incidents	0	52	32	88	Eight Category 3 minor incidents relating to oil spills from 70 to 100m distance from the site in the 1990s. No significant incidents within 100m of the site. It should be noted the previous oil leak on-site from 2013 was not classed as a reportable pollution incident due to the rapid response to clean-up.
Former landfill sites	0	0	0	2	None within 250m
Current landfill sites	0	0	0	0	None within 250m
Registered Waste Sites	0	0	0	0	None within 250m
Part A(1) Environmental Permits	0	0	0	0	None within 250m
Part A(2) Environmental Permits	0	0	0	0	None within 250m
Part B Environmental Permits	0	0	1	10	None within 250m
Control of Major Accident Hazards Sites (COMAH)	0	0	0	1	None within 250m

Table 3.1: Summary of Key Environmental Database Information					
Data Type	On site	Within 250m	Within 500m	Within 1km	Details of nearest relevant record within 250m of the site
Fuel Stations	0	0	0	6	None within 250m
Contemporary trade directory entries	0	16	41	279	Three active trade entries within 250m: - Logoplaste 126m SW – Plastic Products: Manufacturers. - Sofology 270m SE – Furniture Manufacturers: Home and Office - Railair Reading 237m W: Bus & Coach Operators & Stations
Registered Radioactive Substances	0	0	0	0	Information on certain radioactive substance authorisations is not publicly accessible.
EA discharge consents	0	7	9	24	Two active discharge consents within 250m: - Sir Robert McAlpine Ltd. 113m NW. Discharge into ditch. - Environment Agency. 200m NE. Sewage discharge – final/treated effluent – not water company into freshwater stream/river.
Radon affected area	N	N	N	N	None within 250m

The LinesearchbeforeUdig database lists pipelines distributing crude oil and refined hydrocarbon products owned and/or operated by a number of UK pipeline operators, including BPA, BP, ConocoPhillips, Esso, Government Pipelines and Storage System, Sabic, Shell and Total. According to the database, there are no records of underground oil or refined hydrocarbon product pipelines on the site or within 250m. There are records of underground electricity cables containing fibre optic cables, which are approximately 55 m east of the site. Such cables are not expected to represent a ground contamination source.

3.3 Regulatory Authority Enquiries

3.3.1 Local Authority Environmental Health Department

An enquiry has been made to the team at Reading Borough Council to obtain specific information about the site that the Council may hold. The Environmental Health Officer at Reading Borough Council has confirmed that:

- the site has been identified for inspection under the Council's Contaminated Land Strategy due to its former use as a warehouse and car dealership;
- in its current commercial land use the site is considered to be low risk. There is no schedule set for the investigation;

- a pollution incident involving the release of oil from an underground storage tank is known to have impacted the soil and groundwater in the vicinity of the site. There have been a large number of site investigation carried out by Ramboll at the site following the pollution incident (full list of available reports shown in Appendix 3);
- there are no current or former landfills located within a 250m radius of the site;
- the Council does not hold any records of current or former nuisance issues associated with the site or the adjoining properties; and
- there are no Environmental Permits issued to the site or the adjoining properties.

3.3.2 Local Authority Planning Department

Ramboll has reviewed planning records available online relating to the site and submitted an enquiry to the planning team at Reading Borough Council. A summary of relevant applications is provided in Table 3.2 below.

Table 3.2: Summary of Relevant Planning Applications at the Site			
Applicant	Application ref.	Details of Application	Status
No applicant detailed.	0000020333	Use as Car Park	Unconditional consent, 7 th August 1972
No applicant detailed.	0000021347	Vehicle Maintenance Workshop	Conditional consent granted, 13 th April 1973. Decision notice not available.
No applicant detailed.	76/00925/00	Erection of a workshop and vehicle washdown apron (full) excepted	Unconditional consent on, 17 th December 1976
No applicant detailed.	77/00378/00	Erection of office in existing warehouse expected	Unconditional consent, 3 rd June 1977
No applicant detailed.	77/00682/000	Car Park (renewal temp. consent)	Conditional consent, 19 th August 1977
No applicant detailed.	86/TP/0574	Redevelopment for light industrial (high tech) parking, servicing and landscaping (full)	Conditional consent, 3 rd October 1986. Decision notice not available.
No applicant detailed.	87/TP/0686	Change of use from light industrial for high tech purposes to business use, Class B1	Conditional consent, 10 th September 1987. Decision notice not available.
BMW Cooper	88/TP/0419	BMW car showroom, workshop and parts store with a mezzanine floor; multi-storey car park with ground level and two upper decks	Conditional consent, 6 th June 1988. Decision notice not available.
BMW Cooper	88/AD/1380	3 BMW Pylons – one at ground level and one at roof level of car park, six fascia signs to showroom	Approved 13 th January 1989. Decision notice not available.
BMW Cooper	01/01242/ADV	Free standing pylon	Approved 9 th November 2001.

Table 3.2: Summary of Relevant Planning Applications at the Site			
Applicant	Application ref.	Details of Application	Status
			Decision notice not available.
Lochailort Reading Ltd.	160236/FUL	Change of use to public car park for temporary three-year period.	Application permitted 24 th May 2016.
Lochailort Reading Ltd.	160012	Application for prior notification of proposed demolition.	Prior approval not required – 6 th January 2016.
Lochailort Reading Ltd.	161121	Temporary 7m x 2m pvc banner sign for the advertising of temporary public car park.	Application permitted 21 st June 2016.
Lochailort Reading Ltd.	162166	Erection of a part 12 storey building comprising 315 apartments in a mix of studio, one bedroom, two bedroom and three bedroom units, residents lounges, tech-hub, dining room and cinema, various rooftop outdoor amenity spaces, concierge/reception with coffee meeting area, residents storage facilities, postroom, ancillary back of house facilities, 325 secure cycle parking spaces, 49 car parking spaces, landscaping and associated works. Demolition of existing multi-storey car park.	Application permitted 23 rd November 2017.

The Client has provided the draft planning conditions for the development. The conditions require ground contamination characterisation, the development of a remediation scheme, its implementation and management of unexpected contamination if encountered during the development. There are mirror conditions for the characterisation, remediation scheme development and implementation for ground gas risks as well.

3.3.3 Petroleum Licensing Authority

Information from the Petroleum Licensing Authority (PLA) at the Reading Borough Council stated the following:

- There is no record of petroleum storage at the former Cooper Reading site from 1995 until the site was closed.
- There are no records of disused or decommissioned tanks on-site or at any adjacent or nearby premise.

The PLA has stated that they do not retain any record of storage of fuels or other potentially hazardous material at sites that are operated or owned by rail companies. Furthermore the records relate to petroleum spirit storage only and not the storage of diesel fuel or oils.

3.4 Historical Potential for Ground Contamination

3.4.1 The Site

Historically, from the late 1800s the site was occupied by railway land and from the 1970s potential tank features were marked in the east of the site. The site was then redeveloped as a

depot that expanded to become a car showroom and workshop with an associated multi-storey car park.

In general terms potential contaminants associated with the historic activities would include petroleum hydrocarbons, degreasing solvents, and potentially asbestos from building demolitions. Ramboll is aware from previous reports (reviewed in Section 5) that a release of oil occurred into the ground on-site in 2013 associated with the motor workshop activities. This is discussed in more detail in Section 5.

3.4.2 The Surrounding Area

The surrounding area has a similar potential for ground contamination as the subject site due to its historic use as railway land and associated activities.

The potential for ground contamination to migrate onto or away from the subject site is discussed in Section 4 below.

4. ENVIRONMENTAL SETTING

Desk-based research of the local geology, hydrogeology and hydrology was carried out to establish the potential for migration of contamination onto or away from the site, and to assess the sensitivity and vulnerability of the site's setting with respect to surface water, groundwater and ecological resources.

Information was obtained from sources including:

- available site investigation reports;
- examination of published geological maps produced by the British Geological Survey (BGS) and associated sheet memoirs (where available);
- a proprietary third party environmental database procured by Ramboll Environ; and
- Regulatory Authority websites including the Environment Agency (EA).

4.1 Geology and Hydrogeology

According to the BGS 1:50,000 mapping of the area (Sheet 268) and the online BGS Geology Map Viewer, the majority of the site is sequentially underlain by the Langley Silt Member (clayey and sandy silt), Alluvium, River Terrace Deposits (sand and gravel), and the Seaford Chalk and Newhaven Chalk formation. Boreholes drilled on-site have identified 1-2m of Made Ground overlying the natural strata of Alluvium, River Terrace Gravels and then the Chalk. The Langley Silt has not been identified on-site.

A summary of the identified geology on-site is provided in Table 4.1 below.

Table 4.1: Summary of Geology and Hydrogeology				
Formation	Description	Thickness	EA Aquifer Designation	Hydrogeological Significance
Langley Silt Member	Clay and silt.	Not identified on-site.	Unproductive Strata	Low permeability formations with negligible significance for water supply.
Alluvium	Grey / blue sandy clay with some fine to medium flint gravel.	1.0m to 1.5m thick	Secondary A	Permeable formations with potential to support localised abstractions.
River Terrace Gravels	Very sandy light brown fine to medium flint gravel. Gravelly sand in places.	Up to 4.6 m thick	Secondary A	Permeable formations with potential to support localised abstractions.
Seaford Chalk Formation and Newhaven Chalk Formation	Identified as a white structureless chalk	Up to 200m thick	Principal	Highly permeable, with significant water storage. Able to support large abstractions.

The EA groundwater vulnerability map shows the site is situated on Secondary A and Principal Aquifers, relating to the underlying Alluvium (Secondary A), River Terrace Gravels (Secondary A), and Chalk (Principal). Previous site investigation reports have identified groundwater to be present in the Alluvium, River Terrace Gravels and Chalk as three separate groundwater bodies.

The EA currently classifies groundwater at the site as being part of the Berkshire Downs Chalk and is of 'poor' chemical quality and of 'poor' quantitative status under the Water Framework Directive classification scheme.

According to EA information presented in the third party environmental database, there are 21 licensed groundwater abstractions are located within a 2km radius of the site, some with multiple licenses, as detailed in Table 4.2 below.

Table 4.2: Licensed Groundwater Abstractions within 2km of the Site			
Licence Holder	Distance from Site	Abstraction source	Purpose of Abstraction
Berendsen UK Ltd.	509m N	Not specified	Industrial; commercial and public service: laundry use
Primark Stores Ltd.	674m SW	Not specified	Retail: drinking, cooking, sanitary, washing.
M J Gleeson Group Plc	853m E	Not specified	Environmental: pump and treat: pollution remediation
Manrose Manufacturing Ltd.	900m W	Not specified	Commercial/Industrial/Public Services: Drinking; cooking; sanitary; washing (small garden).
Royal Berkshire Hospital	1159m SE	Not specified	Hospitals: drinking; cooking; sanitary; washing (small garden).
Hillier Group of Companies	1179m W	Not specified	Metal: process water.
British Road Services Ltd	1216m W	Not specified	Vehicle washing
Reading Borough Council	1364m NE	Not specified	Agriculture (general)
Hillier Group of Companies	1391m W	Not specified	Metal: process water
Birse Construction Ltd	1525m S	Not specified	Industrial processing
University of Reading	1615m E	Not specified	Schools and Colleges: General Use
Wokingham Waterside Centre Ltd.	1676m E	Not specified	Sports grounds/facilities: drinking; cooling; sanitary; washing (small gardens)
Mr D A Drayton	1725m W	Not specified	General farming and domestic
West Berkshire Health Authority	1974m W	Not specified	Hospitals: Drinking; cooking; sanitary; washing (small garden)

The site is located within an EA defined groundwater Source Protection Zone (SPZ) III. This is the area around a water resource within which all groundwater recharge is presumed to supply the resource. The water resource is understood to relate to a borehole located at Reading University approximately 2 km south-east of the site.

Reading Borough Council has stated there is one private groundwater abstraction borehole within 2km radius of the site. Whilst Reading Borough Council is not able to confirm the location it is understood that the borehole is located close to 2km from the site.

4.2 Hydrology

The nearest identified main surface water body is the River Thames, an inland river located 140 m north of the site. The Vastern Ditch, a surface water body that runs along the southern bank and ultimately drains into the River Thames, is located from 130m to the north of the site. The River Thames is located within the Thames Wallingford to Caversham surface water catchment. The EA currently classifies the River Thames as being of 'moderate' ecological quality and 'good' chemical quality under the Water Framework Directive classification scheme.

A Thames Water surface water drainage culvert runs from north to south through the site and discharges into the Vastern Ditch and the River Thames.

According to an independent, third party environmental database, there are four licensed surface water abstractions within a 2km radius of the site, as detailed in Table 4.3 below.

Table 4.3: Licensed Surface Water Abstractions within 2km of the Site

Licence Holder	Distance from Site	Abstraction source	Purpose of Abstraction
The Reading Sustainability Centre Cic	352m NE	River Thames at Caversham Weir	Other Environmental Improvements: Transfer between sources
Reading Borough Council	654m NW	River Thames – Christchurch Meadows	Environmental: Non-remedial River/Wetland Support: Transfer between sources
Reading Borough Council	654m NW	Thames at Christchurch Meadow	Environmental: Non-remedial River/Wetland Support: lake & pond
Oracle Shopping Centre Ltd	723m S	St. Giles Stream	Amenity: Lake and pond throughflow

4.3 Ecology

No sensitive ecological sites or ancient monuments have been identified in the immediate surrounds of the site.

4.4 Environmental Sensitivity and Vulnerability

The site is located in a position of high groundwater sensitivity due to the underlying aquifers. The shallow Secondary A aquifers are considered to have a high vulnerability. However, the chalk, whilst highly sensitive, is less vulnerable to shallow ground contamination due to the presence of the overlying hydraulically separate shallow aquifers that would be expected to intercept shallow mobile contamination and therefore limit the downwards migration of contamination at the site. However, the underlying aquifers, particularly the more vulnerable shallow aquifers, may also provide a pathway for contaminants to migrate onto or away from the site.

The site is considered to be in a moderately sensitive setting in relation to surface water resources as the Vastern Ditch and River Thames are located from approximately 130 - 140 m north of the site. A culvert crosses the site and discharges into these surface watercourses.

The available ground contamination documentation for the site is discussed in Section 5.

5. PREVIOUS REPORTS

An overview of the available documentation accompanied Planning Permission 162166 that has been granted. The overview report is titled:

- **Ramboll Environ UK Ltd, September 2017:** Overview of Site Contamination Status (Ref UK11-22808). (Summary of the above Ramboll Environ (formerly ENVIRON UK Ltd) reports)

This summarises a substantial volume of reports that has been produced in relation to the site from 2008 to 2017. A site investigation was completed by RPS in 2008 to inform the future development of the site and Ramboll has undertaken a number of site investigation and remediation activities on-site relating to a release of oil that occurred on part of the site in 2013. The available reports were summarised in the overview report and a brief summary is provided in this section.

5.1 2008 Phase I Desk Study and a Phase II Site Investigation

5.1.1 RPS Desk Study

This report summarises the findings of a Phase I desk study and a Phase II site investigation completed at the site by RPS for Lochailort Investments Ltd and Inchcape Estates Ltd. The report relates to the proposed sale of the site to Lochailort and future redevelopment of the site to residential use. The desk study identified the historic uses to be as reported in this report.

5.1.2 RPS Site Investigation

The RPS site investigation involved:

- the drilling of eleven window sample boreholes to provide coverage across the site to a maximum depth of 4m below ground level (bgl) (of which eight were installed) and the installation two deep cable percussion boreholes into the chalk aquifer to 20m bgl. The shallow boreholes were installed in the Made Ground, Alluvium and Gravel. The deeper boreholes were installed in the Chalk;
- observations of hydrocarbon odours were reported in soils and groundwater at three locations:
 - at WS9 in the east of the site; and
 - Adjacent locations of WS2 & WS3, on the southern boundary of the site.
- RPS completed two rounds of ground gas monitoring on the 21st December 2007 and January 2008. No methane or positive flow was detected during either monitoring round. A carbon dioxide concentration of 1.6% was recorded in WS9. These gas levels are typical for an urban site. RPS stated that further monitoring of ground gas should take place.

5.1.3 Chemical Analysis

A summary of the chemical analysis from the investigation is provided below:

- Inorganic contaminants were not reported at significantly elevated concentrations. Within groundwater, two determinants were reported with concentrations marginally elevated over UK Drinking Water Standard limit values (boron in WS11 @ 1.3 mg/l and nickel in BH2 @ 0.064 mg/l). Soil inorganic parameters were screened against RPS Generic Assessment Criteria for residential use without plant uptake; no exceedances were reported.
- Soil concentrations of hydrocarbons and PAHs were described as elevated by RPS (although on review of the data these do not appear to be significantly elevated in Ramboll's opinion). The maximum total petroleum hydrocarbon (TPH) concentration detected was at WS6 (1.6-

1.9m bgl), where 730mg/kg was reported. At WS9 (2.8-3.2m bgl) 160mg/kg of gasoline range organics (GRO) was detected. A maximum polycyclic aromatic hydrocarbon (PAH) concentration of 120mg/kg was detected at WS10 (0.6-0.9) m bgl. RPS analysed two soil samples for VOCs and SVOCs. When compared with Ramboll Environ GAC for residential land use with no plant uptake, two determinants were identified to exceed the GAC - (Dibenzofuran (0.41 mg/kg) in WS3 (0.3m-0.6m BGL), and Naphthalene (2.3 mg/kg) in WS9 (2.8m-3.2m BGL)).

- During groundwater monitoring, a strong hydrocarbon odour was described at WS9 and a moderate hydrocarbon odour at BH2 and BH3 (no BH3 was drilled so it is not clear which borehole RPS are actually referring to as BH3, it may be that they are referring to WS2 and WS3). Selected groundwater samples were analysed for TPH, PAHs, Phenols, VOCs and SVOCs. Maximum groundwater concentrations of TPH (190mg/l) and GRO (180mg/l) were detected at WS9 (in the east of the site). The next highest concentration was 1.5mg/l of TPH in BH2 (possibly WS2). A total of five polycyclic aromatic hydrocarbons (PAHs) were reported in exceedance of environmental quality standards (EQS). Maximum concentrations of organic parameters in groundwater were all reported in WS9.

In summary, the RPS investigation encountered hydrocarbon and fuel contamination at the site, within the soil and groundwater, prior to the recent pollution incident. RPS concluded that the contamination was either the result of fuel storage activities associated with the showroom or linked to the use of heavier grade fuels and lubricants associated with historical railway and goods yard uses.

RPS' investigation was focussed on particular areas of the site and RPS was not aware of, and did not target specifically, the Underground Storage Tank (UST).

5.2 Overview of Contamination Status (Ramboll)

In October 2013, a pollution incident occurred at the site involving the release of oil from an underground waste oil tank (UST). Oil, resulting from a tank overfill, had entered the River Thames via the site's drainage system, off-site culverts and ditches. Oil was detected on the surface of the water and in soil and groundwater in the immediate vicinity of the waste oil tank (now decommissioned and removed from the site). The tank was located broadly in the centre-east of the site and oil contamination was generally found within 5m of the tank.

Three phases of remediation and monitoring work were undertaken by Ramboll Environ between 2013-2015 and are summarised below.

5.2.1 Pollution Incident Response and Mitigation (late 2013)

This involved:

- Pollution investigation and response, cleaning of the drainage infrastructure, investigation of ground conditions and installation of a bentonite 'stank wall'.
- The bentonite stank wall was installed at the junction of the site drainage and the on-site storm water culvert to prevent further oil from entering the culvert.
- The waste oil UST was decommissioned, cleaned and emptied.
- A pollution incident site investigation was undertaken in December 2013 which installed nine new monitoring wells and oil (herein 'free phase product') removal sumps.

The results of the pollution incident site investigation found that:

- Free phase product and heavily impacted soils were present generally within 5m of the UST;
- Free phase product was found adjacent to the site drainage outfall point into the culvert; and

- Free phase product was not encountered in soil and groundwater beneath the building footprint or in the wider area.

5.2.2 Source Removal Remediation (Summer 2014)

This involved removal of the waste oil UST and excavation of surrounding hydrocarbon impacted soils. Ramboll Environ arranged for a remediation contractor to attend site on a fortnightly basis to remove free phase product from the wells and sumps.

The remediation approach was undertaken in June and July 2014 and involved:

- the removal of the UST and the surrounding contaminated soils;
- 'chasing out' and excavation of contaminated soils within the alluvial clay;
- soil validation sampling of the walls and base of the remediation excavation;
- installation of five sumps into the underlying aquifer; and
- post-remediation groundwater monitoring.

Following completion of source removal remediation works, free phase product was believed to remain; pooling adjacent to the west of the culvert and floating upon groundwater in the gravel aquifer. Ramboll Environ undertook further site investigation works to delineate the lateral extent of the free and dissolved phase hydrocarbon contamination and to provide monitoring wells for further groundwater monitoring.

In October 2014 Ramboll Environ completed four rounds of post-'Source Removal' groundwater monitoring prior to the second phase of remediation works. This involved the installation of five boreholes, four of which were installed adjacent to the culvert (to the north and east of the source removal remediation area) and one was installed further west, to the north of the location of the UST.

The results of the post-'Source Removal' groundwater sampling found that:

- a hydrocarbon sheen of dissolved phase TPH was observed in Sumps C, D and E which were installed into the gravel aquifer. Free phase product was also detected in the gravel aquifer adjacent to the west of the culvert;
- TPH was not detected in the gravel aquifer monitoring wells that were down-gradient of the pollution incident; and
- no persistent TPH was detected in the Chalk monitoring wells (RPS wells BH1 and BH2).

Free phase product was encountered during the source removal remediation works that was not practical to remove and as such a further phase of remediation was commissioned, the "Mid-Term Works".

5.2.3 Mid-Term Works (June-December 2015)

Ramboll Environ undertook a second phase of remediation which involved remediation activities in areas outside of the building footprint, including: excavation of impacted soils in the vicinity of the culvert; delineation investigations; and groundwater remediation (pumping of free phase product and in-situ treatment). This involved:

- excavation, removal and disposal of contaminated soil surrounding the storm water culvert and to the north of the main car park building;
- investigative trial pits over the culvert;
- commencing groundwater remediation through frequent pumping of free phase product and hydrocarbon impacted groundwater;
- treatment of contaminated groundwater via an on-site waste water treatment plant prior to discharge to a sewer; and

- injection of a treatment compound into the groundwater to encourage breakdown of hydrocarbons.

The results of the Mid-Term works were as follows:

- the soil that was visually impacted (with black oil contamination) was excavated and removed;
- free phase product was also encountered within the underlying gravel strata. Gravel sump 1E was excavated further to the north of the central manhole and an area of approximately 29 sqm was excavated to target deeper contamination within the gravel, and excavation faces were validated;
- approximately 1,450 litres of black oily product was recovered during the waste water treatment phase which occurred during 10 separate visits to the site over a three month period;
- bentonite was utilised extensively during excavation works and reinstatement to prevent recontamination of remediation excavations.

The soil validation results showed that:

- 70% of soil samples were reported with a total TPH concentration of <1,000 mg/kg;
- two soil samples were reported with a concentration >9,000 mg/kg;
- TPH was predominantly present in heavier Aliphatic and Aromatic fractions (typically bands C16-C35).
- out of twenty soil samples collected from trial pits, no TPH was detected at concentrations above the remediation target values (RTVs) and no Free Phase Product was encountered during trial pit investigations; and
- delineation and remediation of soil contamination beneath the building footprint was expected to be completed during later works at the time of redevelopment.

5.2.4 Groundwater Monitoring and Showroom Demolition Works

Between the completion of the Source Removal Works in September 2014 and the start of the Mid Term Works in June 2015, 266 litres of free phase product had been removed by pumping and hand bailing. Whilst a large volume of free phase product and contaminated groundwater was removed from the site, contamination in groundwater is still present.

Following completion of the Mid Term works four further rounds of groundwater monitoring for up to 12 selected wells were undertaken between March 2016 and July 2017.

The results were as follows:

- a measurable thickness (of up to 10mm and 30mm) of free phase product (oil floating on water) has been detected in up to two monitoring wells in the remediation area (Sumps 1B and 1C respectively);
- a slight hydrocarbon sheen was observed in sumps 1A and 1D, which were installed into the gravel aquifer in the footprint of the 'Source Removal' and 'Mid-Term Works' remediation excavation; and
- up to 12 groundwater samples were collected where no sheen or product was observed.

Ramboll Environ was then instructed to consider the potential for groundwater contaminant mobilisation during the showroom demolition. It was noted that:

- the showroom building was not in the area of the site expected to be impacted by the 2013 pollution incident;
- should the showroom involve the removal of the ground floor slab it would be replaced with a low permeability surfacing to prevent an increased infiltration in previously surfaced parts of the site; and

- a watching brief was undertaken for unexpected soil or groundwater contamination during the ground excavation works that did not identify contamination that warranted remediation.

5.2.5 Remaining Work

Due to the presence of buildings and infrastructure across the site, it was not practical to complete the remediation and Ramboll considered that the proposed development of the site would provide an opportunity to complete the remediation in areas that were not accessible. The following areas were identified as requiring additional investigation and potentially remediation:

- A. Southern Face of Source Removal Excavation.
- B. Western Face of Source Removal.
- C. Contamination along culvert to south beneath building.
- D. Free Phase in Aquifer - Sump 1B and 1C

5.3 Ramboll Environ Comments

Ramboll considers there to be residual contamination present at the site relating to the pollution incident and evidence of potentially significant contamination from historic activities close to RPS location WS9 where tanks were marked historically. Further site investigation is recommended to delineate this contamination and inform the remediation works that will be required to facilitate redevelopment of the site.

6. PRELIMINARY RISK ASSESSMENT

6.1 CSM

In the UK ground contamination is assessed by identifying whether a pollutant linkage is present (or potentially present) between a source, a pathway and a receptor in the form of a Conceptual Site Model (CSM).

A preliminary Conceptual Site Model (CSM) has been developed to inform further site investigation works that will take place. This is a simplified representation of the possible environmental conditions at and in the vicinity of the site, and is used to initially identify potentially sensitive receptors and pollutant linkages.

The CSM has been developed considering the proposed residential apartment scheme that will involve the development of apartment blocks above ground floor level. No apartments will be located at the ground floor level, which will be occupied by the entrance hall, refuse storage rooms, cycle storage and other amenity rooms. Landscaped areas will be present along the northern and western perimeters of the site. No private gardens are proposed.

The preliminary Sources, Pathways and Receptors are summarised in separate sections below.

1.1. Potential Sources of Contamination

On-Site:

- Historic sources of contamination are the use of the site as railway sidings and the presence of tanks in the east of the site from at least the 1950s to 1970s. The site was then occupied by a vehicle showroom, which also represents a source of contamination where fuel storage took place and a leak into the ground is known to have occurred.
- Residual oil contamination is known to exist at the site. The underground storage tanks and a large proportion of gross contamination associated with the former leak has been removed. However, there is known to be residual oil contamination near to the culvert and further delineation investigation is required in certain areas.
- There is a potential for Made Ground throughout the site to represent a potential ground gas source and contaminant source e.g. from asbestos from previous building demolitions. Degraded hydrocarbon contamination may also represent a ground gas source,
- There are no current significant potential sources of ground contamination on-site.

Off-Site

- The historic surrounding railway land represents a potential off-site source of contamination.

1.2. Potential Pathways for Contamination

The potential pathways for contamination to travel from Source to Receptor have been assessed, based on the environmental setting (geology, hydrogeology, and hydrology) of the site and its surroundings. The potential pathways are summarised below and in Table 3.3:

Residential development:

- Direct Physical Contact – Dermal contact, ingestion, inhalation.
- Contaminant volatilisation into indoor and outdoor airspaces from the ground.
- Lateral migration in groundwater to affect off-site commercial uses.
- Ground gas ingress to buildings.
- Leaching of contaminants into water supply pipes.
- Piling creating preferential pathways for migration of shallow contaminants into deeper soils and groundwater.

Controlled waters:

- Leaching from shallow soils to shallow or deep groundwater.
- Lateral migration within shallow or deep groundwater to the wider aquifers or surface water receptors.

1.3. Potential Receptors to Contamination

Potential human and environmental receptors that could be at risk from the potential contamination sources are assessed in the table below.

Table 6.1: Potential Receptors to Contamination (if Present)			Receptor Present
Humans	On-Site	The site is proposed to be developed as a residential apartment scheme. No apartments will be present on the ground floor and there will be limited landscaping present around the perimeter of the site.	Yes
	Off-Site	The site is located within a commercial setting with railway lines and offices in the immediate surrounds.	Yes
Water Environment	On-Site	Three groundwater aquifers are present on-site, two shallow secondary A aquifers are present in the Alluvium and River Terrace Gravels and a deeper Principal aquifer is present in the Chalk.	Yes
	Off-Site	Shallow and deeper groundwater beneath the site is likely to be in continuity with the wider aquifers although this would be expected to be relatively restricted for the alluvium to the immediate vicinity of the site. The Chalk is designated as being a Source Protection Zone III relating to an abstraction at Reading University 2km distant. Surface Water: the river terrace gravels are expected to be in continuity with the Vastern Drain and River Thames.	Yes
Ecological Receptors	On-Site	There are no designated ecological sites present on-site.	No
	Off-Site	There are no statutory designated conservation sites or monuments of importance immediately near the site.	Yes
Built Environment	On-Site	The site is scheduled for development as a residential scheme.	Yes

1.4. Preliminary Conceptual Site Model

The CSM takes into account the known information from the site, surroundings and the environmental setting. The CSM will be refined taking into account the specific ground conditions and measured concentrations of contaminants identified during future site investigation. The potential pollutant linkages are detailed in the CSM in Table 6.2 below.

Table 6.2: Potential Pollutant Linkages			Pollutant Linkage
Humans	On-site	Dermal contact, inhalation and ingestion of contaminated soils by residents in landscaped areas.	PL1
	On-site	Contaminant volatilisation into indoor and outdoor airspaces.	PL2

Table 6.2: Potential Pollutant Linkages			Pollutant Linkage
	Off-site	Lateral migration and volatilisation of contaminants from groundwater to off-site commercial receptors.	PL3
Water Environment	On-site	Migration of soil contaminants to groundwater via leaching.	PL4
	On-Site / Off-site	Lateral migration of contaminants in groundwater to the wider aquifers, off-site surface waters, potable water abstractions.	PL5
Built Environment	On-site	Migration of ground gases into buildings and structures.	PL6
		Leaching of contaminants into water supply pipes.	PL7
		Piled foundations creating preferential pathways for contaminant migration.	PL8

The potential pollutant linkages noted in Table 6.2 will be discussed in light of the findings of the future intrusive investigation, from which an assessment of the potential risk posed by the identified contamination (if present) to either human health or controlled waters receptors will be determined.

6.2 Proposed Scope of Works

The proposed scope of works for future site investigation is as follows:

- thirteen window sample boreholes across the site to provide a broad coverage of the ground conditions on-site including in the footprint of the proposed building and targeting the main residual contaminant source areas on-site, namely the former remediation area, beneath the current multi-storey car park and beneath the former showroom / workshop building. These boreholes will be installed as gas monitoring wells targeting the Made Ground soils and upper alluvial deposits;
- six boreholes to be drilled into the river terrace gravels beneath the alluvium to provide additional data on groundwater conditions in the gravels to supplement the existing groundwater data on-site (these are largely for controlled waters purposes although shallow soils will be taken from the Made Ground for human health assessment purposes);
- laboratory analysis of twenty soil samples for a range of contaminants including asbestos screening, metals, petroleum hydrocarbons and chlorinated solvents; and
- one round of twenty groundwater samples to be collected from the new and existing wells installed in the alluvial and terrace gravel groundwater bodies.

A separate interpretive report will be prepared to provide the findings of the further site investigation.

6.3 Borehole Rationale

The rationale for the proposed boreholes is provided in Table 6.4 below.

Table 6.3: Borehole Rationale	
Borehole	Feature Targeted
BH404, WS408, WS412, WS413	Targeted around WS9 where petroleum hydrocarbon contamination was identified in the alluvial soil and river terrace gravel groundwater previously. This is close to the 'tanks' marked on historic maps in the east of the site.
BH495, BH406, WS408, WS411	Targeted beneath the multi-storey car park building to establish if ground contamination is present in these areas.
WS406, WS407, BH403	Targeted at the waste oil tanks and underground storage tank fill point located in the workshop.
WS401, WS402, WS403, WS404, WS405, BH401, BH402	Targeted at the footprint of the workshop / showroom area where limited previous site investigation has taken place.

The borehole positions are shown on Figure 2, Appendix 1.

In addition to the above a geotechnical site investigation will be separately completed by a third party. This will involve the drilling of three boreholes into the chalk aquifer on-site that will be installed as groundwater monitoring wells for sampling from the chalk.

The scope of the site investigation and borehole locations have been agreed with the Environmental Health Officer of Reading Brough Council and Environment Agency officer with the confirmatory email correspondence provided in Appendix 4 of this report.

The overall conclusions of the report are discussed below.

7. CONCLUSIONS AND RECOMMENDATIONS

The subject site is currently occupied by a multi-storey carpark and current activities have a low potential to have caused ground contamination.

Historically, the site was occupied by railway tracks and of note tanks were associated with the railway activities in the east of the site. The site was then developed for vehicle maintenance use in the 1970s and was used as a motor dealership from the 1980s up to 2016. In 2013 oil was released into the ground on-site that has caused ground contamination and residual oil remains present on-site that will require further remediation to develop the site. Previous site investigations have also identified ground contamination in other areas of the site notably at WS9 in the east of the site near to where the railway land tanks were present and potentially at WS2/WS3 on the southern boundary.

Historically, the site surrounds were also of a railway land nature. The available ground condition data has not identified evidence of ground contamination migrating onto the site from off-site land to date.

The site is considered to be located in a high sensitivity setting with regard to groundwater resources due to the underlying Alluvium (Secondary A aquifer), River Terrace Gravels (Secondary A aquifer) and the Principal Chalk Aquifer. However, at present there is no evidence that the Chalk aquifer has been impacted on-site and where residual oil contamination is present in the shallow aquifers this does not appear to be migrating across the site towards the site boundary.

The site is considered to be located in a moderate sensitivity setting in regard to surface water resources as the River Thames is located approximately 140 m north of the site.

A Conceptual Site Model has been developed taking into account the proposed development scheme and further site investigation is considered necessary to investigate potential source-pathway-receptor relationships. The further investigation is recommended to target the areas subject to limited investigation to date including beneath the multi-storey car park, beneath the showroom/workshop building footprints and around RPS borehole WS9 close to the railway land tanks.

As there is residual oil in the ground further remediation of soils and groundwater will be required to redevelop the site. At this time the remedial strategy for the site is expected to focus on the removal of residual gross contamination associated with the former oil leak and, if identified, the removal of significant contamination from historic activities. A development led approach to mitigation of remaining ground contamination risks for the residential development of the site would then follow such as through the introduction of a clean capping system and breaking direct contact pathways with the presence of the building and hardstanding.