

7 Geology, Hydrogeology and Ground Conditions

Introduction

- 7.1 This chapter reports on the assessment of the effects of the project with regards to geology, hydrogeology and ground conditions.
- 7.2 The chapter includes an assessment of the baseline conditions informed through the collation of data from a range of sources, including published data sources and a Phase 1 Preliminary Risk Assessment undertaken by RPS (Appendix 7.1) which includes review of several previous assessments undertaken for the site. Mitigation measures are outlined for the construction phase and for the project once completed and operational. The likely significant effects of the project relative to baseline conditions are then assessed.

Assessment Methodology

Legislation and Planning Policy Context

- 7.3 The relevant national and local policies for this topic are:
- National Planning Policy Framework (MHCLG, 2018): The UK planning approach to the management of land contamination is risk based, implemented by the National Planning Policy Framework (NPPF);
 - Reading Borough Council's Core Strategy (2008, amended in 2015) - Policy CS34: Pollution and Water Resources; and
 - Reading Borough Council's Core Strategy (2008, amended in 2015) -Policy CS36: Biodiversity and Geology.
- 7.4 Reading Borough Council's Core Strategy is due to be replaced by the Draft Reading Borough Local Plan (Reading Borough Council, 2018), which details Reading's development up to 2036. This includes Policy EN16: Pollution and Water Resources.
- 7.5 The key European and national environmental legislation documents which relate to Geology, Hydrogeology and Ground Conditions are summarised as follows:
- European Water Framework Directive (2000/60/EC);
 - The Groundwater Daughter Directive (2006/118/EC);
 - The Environmental Liability Directive (2004/35/EC);
 - The Environment Act 1995;
 - Environmental Permitting (England and Wales) Regulations 2016;
 - Water Resources Act 1991 (as amended 2009); and

- Groundwater (England and Wales) Regulations 2009.

7.6 Appendix 7.2 provides further details on relevant legislation and planning policies.

Relevant Guidance

7.7 The assessment has also had regard to relevant guidance, including:

DEFRA Environmental Protection Act 1990: Part 2A - Contaminated Land Statutory Guidance (DEFRA, 2012)

7.8 This guidance details the responsibilities of the local planning authority in prioritising the inspection of sites under Part 2A of the Environmental Protection Act and sets out a revised framework for assessing risk associated with land contamination. Guidance on remediation is also presented and the document introduces the necessity for cost-benefit analysis when assessing appropriate remedial techniques.

British Standard BS 10175 (BSI, 2011 and amended 2017) Investigation of Potentially Contaminated Sites

7.9 This British Standard forms the basis for assessing the necessary methodology and extent of site investigations on potentially contaminated land.

Contaminated Land Report 11 (Environment Agency, 2004)

7.10 Model procedures for the management of land contamination have been developed by the Environment Agency (EA) and are presented in Contaminated Land Report 11 (CLR 11) (EA, 2004). This provides the technical framework for applying a risk management process when dealing with land affected by contamination. The framework presented in CLR 11 forms the basis of the risk assessment approach adopted in this chapter.

Groundwater Protection Position Statements (Environment Agency, 2017 and amended 2018)

7.11 This document published by the Environment Agency sets out the Agency's approach to managing and protecting groundwater. The document includes details of the tiered, risk-based approach to regulate activities that may impact groundwater resources to prevent and limit pollution.

Study Area

7.12 The site occupies an area of approximately 1.94ha and is situated to the north of Reading train station. It comprises a former Royal Mail sorting centre, a three storey office building and areas of car parking. The site has most recently been used by Network Rail as site offices during the works to Reading train station. The site is currently vacant.

7.13 The site is located in an area of predominantly commercial land use.

7.14 The spatial scope of the assessment includes all areas considered to be in direct hydraulic continuity with the project, even where these lie outside the site boundary.

Baseline Methodology

- 7.15 Information collected as part of the RPS Phase 1 Preliminary Risk Assessment (see Appendix 7.1) has been used to inform the baseline conditions. A review of a number of previous environmental assessments has been provided in the report, including:
- Contaminated Land Preliminary Phase 1 Report, Royal Mail Site, Caversham Road, Reading (for Royal Mail Group), by Arup, ref: 211770 Draft 3, dated March 2010;
 - Final Factual Ground Investigation Report, Royal Mail Site, Caversham Road, Reading (for Royal Mail Group, by Ian Farmer Associates, ref: 20958, dated October 2012; and
 - Interpretative Report on Phase 2 Geo-Environmental Ground Investigation, Former Royal Mail Sorting Office Site, Caversham Road, Reading (for Royal Mail Group), by Arup, ref: REP/10-2012/001/RO, dated 14th November 2012.
- 7.16 As part of a previous planning application for the proposed redevelopment of the site (ref: 11/00276/OUT), a Ground Conditions and Contamination ES Chapter (dated February 2011,) was carried out by Arup. The ES chapter included information on a geo-archaeological ground investigation and groundwater monitoring visit undertaken in December 2010 and January 2011.
- 7.17 The RPS Phase 1 Preliminary Risk Assessment includes information supplied from the following sources (either directly or through a third party data report):
- Environment Agency;
 - British Geological Survey;
 - The Coal Authority;
 - Public Health England;
 - Natural England; and
 - Berkshire Geoconservation Group.
- 7.18 The geo-archaeological ground investigation undertaken in 2010 comprised the drilling of two boreholes to depths of approximately 3.50m below ground level (bgl), located on the eastern side of the former Royal Mail sorting office. Monitoring wells were installed in both boreholes. Three samples of Made Ground and one sample of natural material were submitted for chemical laboratory analysis for metals; speciated total petroleum hydrocarbons (TPH CWG) including benzene, toluene, ethylbenzene and xylenes (BTEX); speciated polycyclic aromatic hydrocarbons (PAHs); and asbestos. Groundwater samples were collected from both monitoring wells and analysed for a similar range of determinands as for the soil samples. Groundwater levels were monitored on one occasion.
- 7.19 The site investigation undertaken by Ian Farmer Associates in 2012 comprised three cable percussion boreholes advanced to a maximum depth of approximately 7.50m bgl and nine window

sample boreholes advanced to a maximum depth of approximately 4.00m bgl. Groundwater monitoring wells were installed in all three cable percussion boreholes and seven of the window sample boreholes. Forty-five soil samples were collected and analysed for a range of determinands including asbestos, metals, TPH CWG including BTEX, speciated PAH, polychlorinated biphenyls (PCBs), volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs). Eight soil samples were also subject to waste acceptance criteria (WAC) testing. Six groundwater samples were collected and analysed for a similar range of determinands as the soil samples. One round of ground gas and groundwater level monitoring was undertaken. The site assessed as part of the 2012 site investigation (ref: REP/10-2012/001/RO) included an area to east, which is not included within the current application boundary. Information obtained from the exploratory holes advanced in this area has been included in the assessment where considered relevant.

Consultation

- 7.20 Consultation with Reading Borough Council (RBC) was undertaken as part of the RPS Phase 1 Preliminary Risk Assessment (Appendix 7.1). The table below provides a summary of the response as well as that provided as part of the RBC Scoping Opinion.

Table 7.1: Consultation Responses Relevant to this Chapter

Date	Consultee and Issues Raised	How/ Where Addressed
29 th March 2018	Reading Borough Council – Scoping Opinion <u>General comment</u> The site is/was known to have its own vehicle depot and filling station for Royal Mail fleet vehicles. Fuel tanks will need to be re-surveyed, if still on site and if still at risk of leaking any residual fuel. <u>EA</u> The EA believes that groundwater quality should be scoped into the Environmental Statement. This site lies on Principal and Secondary Aquifers. This includes a chalk aquifer.	Additional information regarding the fuel tanks was provided as part of the Arup Interpretative Report on Phase 2 Geo-Environmental Ground Investigation (ref: REP/10-2012/001/RO, dated 14th November 2012). It was reported that in December 2009, the two fuel tanks beneath the fuel island were decommissioned, the tanks remained in the ground but were foam filled. It should also be noted that the fuel tanks are not located within the current application red line boundary. During the site walkover undertaken by RPS in November 2018 it was noted that this area had been redeveloped and comprised a new entrance area to Reading train station. Consideration of groundwater quality beneath the site has been included as part of the Assessment of Construction Effects section. Following the submission of the previous ES, a site investigation has been undertaken at the site

Date	Consultee and Issues Raised	How/ Where Addressed
	Elevated concentrations of polycyclic aromatic hydrocarbons and petroleum hydrocarbons have previously been identified in groundwater samples. Our understanding of the site investigation that identified this groundwater contamination was that it was a very limited investigation. The report commented that the investigation was not carried out in the potentially most contaminated part of the site, namely not in the refuelling area and vehicle maintenance and repair workshop. Further site investigation was recommended. Given that this Royal Mail site housed a refuelling area and vehicle maintenance and repair workshop there is potential for contamination to be present in the soils and groundwater and this should be explored. The need for further investigation of the potentially most contaminative parts of the site should be included in the Environmental Statement. We understand that this development will require the use of deep penetrative foundation methods (piling) that will likely embed into the top of the Chalk. We therefore need to ensure that the use of piling will not create preferential pathways for contamination to migrate from the surface and through Langley Silt Member (clay and silt) and into the aquifers below the site, Taplow Gravel Formation – Secondary A Aquifer and The Chalk - Principal Aquifer). To this end we need to know the contaminative status of the soils and groundwater in the refuelling area and under the vehicle maintenance and repair workshop (that may have included inspection pits). Remediation of this site may be required before the use of piling could be considered to be acceptable. <u>RBC Environmental Protection</u> The developer proposes to carry out an air quality assessment, noise & vibration assessments and contaminated land investigations in line with the relevant national guidance documents. These will be adequate to assess any impacts from the proposed development and enable appropriate mitigation to be put in place.	(as discussed in the Arup Interpretative Report on Phase 2 Geo-Environmental Ground Investigation (ref: REP/10-2012/001/RO, dated 14th November 2012). The site investigation included exploratory hole locations in the vicinity of the refuelling area and vehicle maintenance and repair workshop. Although it should be noted that these areas are outside of the current red line boundary. A summary of the findings of the site investigation are given in the Contamination Assessment section below. It should be noted that during the site walkover undertaken by RPS in November 2018 this area had been redeveloped and comprised a new entrance area to Reading train station. Consideration of the potential for piling to create preferential pathways has been discussed in the Assessment of Construction Effects section. As discussed above, site investigation has been undertaken in these areas (although the areas highlighted are outside the current red line boundary). No action required.
November 2018	<u>Contaminated Land Officer at RBC</u> The site has been identified by RBC as being potentially contaminated due to its former use as a works and a coal depot. It has been identified for future	No action required.

Date	Consultee and Issues Raised	How/ Where Addressed
	investigation under the Council's Part 2A inspection strategy. The site is currently classified as a low risk. There is no schedule set for the investigation of the site.	

Assessment Criteria and Assignment of Significance

- 7.21 The methodology for the assessment of baseline ground conditions and contamination at the site follows the phased approach presented in CLR 11 (EA, 2004). The baseline characterisation of the site has enabled the development of a Conceptual Site Model (CSM), which identifies the existing ground conditions using the source-pathway-receptor pollutant linkage approach:
- Source: Referring to the source of contamination (Hazard);
 - Pathway: The mechanism for the contaminant to move/migrate to receptor(s); and
 - Receptor: The identified features that may be affected, based on the sensitivity of the site.
- 7.22 The assessment considers the potential risk to environmental receptors and the pathways by which the receptors may be affected. This includes an evaluation of the probability of harm occurring, taking into account potential sources of contamination and receptors that may be affected by such contamination.
- 7.23 The significance of predicted effects likely to occur during the construction and operational phases of the project has been determined by consideration of the sensitivity of the receptors that may be affected and the magnitude of the predicted effect.
- 7.24 The process and objective of this assessment is to focus on those aspects of the project that are likely to give rise to 'significant' effects on the environment relative to the baseline conditions. With respect to contaminated land, a 'significant' effect is determined in accordance with Part 2A of the Environmental Protection Act 1990, introduced by Section 57 of the Environmental Act 1995, and is based on the presence of a significant 'source-pathway-receptor' pollutant linkage.

Receptor Sensitivity/Value

- 7.25 The sensitivities of receptors have been defined in this assessment as follows:

Table 7.2: Example Definitions of Sensitivity or Value

Sensitivity	Typical Descriptors
Very High	Very high importance and rarity, international scale and very limited potential for substitution (e.g. designated Site of Special Scientific Interest (SSSI), potable groundwater and occupants of residential properties).
High	High importance and rarity, national scale, and limited potential for substitution (e.g. Local Geological Sites (LGS), Principal Aquifer, occupants of commercial/industrial properties, ecologically/chemically important surface watercourses and geological resources).
Medium	High or medium importance and rarity, regional scale, limited potential for substitution (e.g. non-designated geological exposures, Secondary Aquifers).
Low	Low or medium importance and rarity, local scale (e.g. Unproductive Strata).
Negligible	Very low importance and rarity, local scale (e.g. previously disturbed land).

Magnitude of Impact

7.26 The magnitude of the predicted impact has been defined in this assessment as follows:

Table 7.3: Example Definitions of Magnitude

Magnitude	Typical Descriptors
High	Loss of resource and/or quality and integrity of resource; severe damage to key characteristics, features or elements (Adverse).
	Large scale or major improvement of resource quality; extensive restoration or enhancement; major improvement of attribute quality (Beneficial).
Medium	Loss of resource, but not adversely affecting the integrity; partial loss of/damage to key characteristics, features or elements (Adverse).
	Benefit to, or addition of, key characteristics, features or elements; improvement of attribute quality (Beneficial).
Low	Some measurable change in attributes, quality or vulnerability; minor loss of, or alteration to, one (maybe more) key characteristics, features or elements (Adverse).
	Minor benefit to, or addition of, one (maybe more) key characteristics, features or elements; some beneficial impact on attribute or a reduced risk of negative impact occurring (Beneficial).
Negligible	Very minor loss or detrimental alteration to one or more characteristics, features or elements (Adverse).
	Very minor benefit to or positive addition of one or more characteristics, features or elements (Beneficial).
No change	No loss or alteration of characteristics, features or elements; no observable impact in either direction.

Significance of Effects

7.27 The assessment of significance has been based on the following matrix (Table 7.4). Where the matrix offers more than one significance option, professional judgement has been used to decide which option is most appropriate.

Table 7.4: Assessment Matrix

Sensitivity	Magnitude of Impact				
	No Change	Negligible	Low	Medium	High
Negligible	No change	Negligible	Negligible or Minor	Negligible or Minor	Minor
Low	No change	Negligible or Minor	Negligible or Minor	Minor	Minor or Moderate
Medium	No change	Negligible or Minor	Minor	Moderate	Moderate or Major
High	No change	Minor	Minor or Moderate	Moderate or Major	Major or Substantial
Very high	No change	Minor	Moderate or Major	Major or Substantial	Substantial

7.28 Explanations of significance criteria used within the assessment are as follows:

Table 7.5: Significance Terminology

Significance of Effect	Definition
Substantial: These beneficial or adverse effects are considered to represent key factors in the decision-making process.	
Substantial Adverse	The potential for significant harm to human health; or permanent or severe temporary reduction in the quality of a Principal Aquifer, potable groundwater or a surface water resource of local, regional or national importance; the potential for permanent or severe temporary harmful effect upon animal or plant populations.
Substantial Beneficial	Substantial improvement in human health; substantial local or regional scale improvement in the quality of potable groundwater resource of local, regional or national importance; substantial beneficial effects upon animal and plant populations.
Major: These beneficial or adverse effects are considered to be very important considerations and are likely to be material in the decision-making process.	
Major Adverse	The potential to result in major medium-term or moderate/minor chronic harm to human health; severe medium-term or localised permanent reduction in the quality of any classified groundwater; the potential for a major medium term detrimental effect upon animal or plant populations.
Major Beneficial	Major improvement in human health; local or regional scale improvement in the quality of potable groundwater or a surface water resource of local, regional or national importance; major beneficial effects upon animal and plant populations.
Moderate: These beneficial or adverse effects may be important, but are not likely to be key decision-making factors. The cumulative effects of such factors may influence decision-making if they lead to an increase in the overall adverse effect on a particular resource or receptor.	
Moderate Adverse	The potential for moderate temporary or minor chronic harm to human health; severe temporary or localised permanent reduction in the quality of any classified groundwater the potential for a moderate temporary detrimental effect upon animal or plant populations.
Moderate Beneficial	Moderate improvement in human health; local or regional scale improvement in the quality of any classified groundwater; moderate beneficial effects upon animal and plant populations.
Minor: These beneficial or adverse effects may be raised as local factors. They are unlikely to be critical in the decision-making process, but are important in enhancing the subsequent design of the project.	
Minor Adverse	The potential for temporary slight/minor harm to human health; localised reduction in the quality of any classified groundwater which would be fully reversible with time or widespread reversible reduction in the quality of groundwater used only for commercial or industrial abstractions; the potential for a minor, localised and reversible detrimental effect on animal or plant populations.
Minor Beneficial	Slight improvement in human health (or slight reduction in existing human health risk factors); minor local scale improvement in the quality of any classified groundwater and/or a moderate or notable improvement in the quality of groundwater resources used only for commercial or industrial abstraction; minor beneficial effects upon animal and plant populations.
Negligible: No appreciable effect on human health, controlled waters and/or other ecological receptors. Any effects would be imperceptible, localised, temporary and fully reversible.	

- 7.29 For the purposes of this assessment, effects of moderate and above are considered significant in terms of the EIA Regulations.

Limitations of the Assessment

- 7.30 The site investigation undertaken by Ian Farmer Associates in 2012, with the findings reported in the Arup Interpretative Report on Phase 2 Geo-Environmental Ground Investigation (ref: REP/10-2012/001/RO, dated 14th November 2012) was predominantly undertaken to better inform the underlying ground conditions and presence of any significant contamination beneath the site as part of the sale/purchase negotiations. As such, a scope of additional investigation/assessment has been recommended by RPS within the Phase 1 Preliminary Risk Assessment (provided as Appendix 7.1), to include additional Phase 2 Site Investigation. It was recommended that this should include the drilling of boreholes/trial pits across the site, particularly in the centre and southwest of the site; collection of soil and groundwater samples; and ground gas monitoring.
- 7.31 A former vehicle maintenance workshop, vehicle wash and refuelling area (all associated with the Royal Mail sorting office) were located adjacent to the east of the current site boundary. At the time of the RPS visit in November 2018, the former vehicle repair workshop, vehicle wash and the refuelling area were no longer present. The area had been redeveloped to comprise an external seating area, taxi rank, bicycle storage and bus stops associated with the northern entrance to Reading train station. RPS has been advised that the works were completed as part of the Crossrail works at the train station. It has not been possible to obtain documentation regarding these development works to ascertain if any further site investigation and/or remediation was carried out.
- 7.32 However, it is considered that the site investigations undertaken to date have provided sufficient information in order to undertake a robust assessment for EIA purposes.

Baseline Environment

Site History

- 7.33 Historical mapping indicates that from at least 1879 the site comprised part of the Great Western Railway Works, which included a railway foundry, forge and saw pit. By c.1899, railway sidings associated with an off-site coal depot were indicated to be present on site. By c.1956, the site had been redeveloped to comprise a large works building, subsequently labelled as a railway works. By 1988, the site had been redeveloped to comprise the Royal Mail sorting office.
- 7.34 Historical maps indicate that a coal depot was located adjacent to the north of the site from at least 1899 to c.1956. Railway sidings were located adjacent to the north, south and east of the site from 1899 to c.1989. Additional historical land uses in the surrounding area include malthouses, a timber yard, a parcel depot and a number of warehouses and works.
- 7.35 A former vehicle maintenance workshop, vehicle wash and refuelling area (all associated with the Royal Mail sorting office) were previously located adjacent to the east of the current site boundary. Planning permission for the construction of the vehicle maintenance workshop was granted in January 1994. Significant black staining was observed on the floors and walls in the vehicle repair workshop and at the refuelling area during the walkover undertaken by Arup as part of their Contaminated Land Preliminary Phase 1 Report. As discussed in the section above, this area has recently been redeveloped as part of Crossrail works at Reading train station.

Published Geological Mapping

7.36 Reference to the British Geological Survey (BGS) online mapping (1:50,000 scale) records the following strategic stratigraphic sequence beneath the project site:

- Langley Silt Member: Indicated to comprise clay and silt and likely to be up to several metres in thickness beneath the site.
- Kempton Park Gravel Member: Indicated to comprise sand and gravel and likely to be several metres in thickness beneath the site.
- White Chalk Subgroup: Comprises chalk with flints and be of substantial thickness beneath the site.

Identified Ground Conditions

7.37 Ground conditions encountered during the geo-archaeological investigation undertaken in December 2010 and January 2011 (as reported in the 2011 Ground Conditions and Contamination ES Chapter), comprised the following:

- Made Ground: Ranging in thickness from approximately 1.60m to 2.20m. Comprised gravelly sand or gravelly sandy clay with brick, ash, clinker and concrete fragments.
- Langley Silt Member: This stratum was only encountered in one of the two boreholes, at a thickness of approximately 0.90m and comprised silty clay.
- River Terrace Deposits: A maximum unproven thickness of approximately 1.30m was encountered. This stratum comprised sandy gravel.

7.38 Ground conditions encountered during the intrusive investigation in October 2012, as reported as part of the Arup Interpretative Report on Phase 2 Geo-Environmental Ground Investigation (ref: REP/10-2012/001/RO, dated 14th November 2012), comprised the following:

- Made Ground: Ranging in thickness from approximately 0.70m to 2.50m. Generally comprised an upper sandy/gravelly layer underlain with clayey and ashy fill.
- Langley Silt Member: Ranging in thickness from absent to approximately 2.20m, it was not encountered in two boreholes, located in the centre of the site. The stratum generally comprised silt and clay with some peat.
- River Terrace Deposits: The full thickness was only proven at one location at a thickness of approximately 4.90m. This stratum comprised sand and gravel.
- White Chalk Subgroup: The top of this stratum was only proven at one location and comprised structureless chalk.

- 7.39 It is noted that Arup used the River Terrace Deposits terminology and, although the BGS mapping indicates that the Kempton Park Gravel Member is present beneath the site, it is considered that the two names can be used interchangeably in the context of this report.

Hydrogeology

- 7.40 The site is located above an Unproductive Stratum relating to the Langley Silt Member. These formations have a low permeability and have negligible significance for water supply or base flow. The underlying Kempton Park Gravel Member is classified as Secondary A Aquifer; these formations are formed of permeable layers capable of supporting water supplies at a local scale, in some cases forming an important source of base flow to rivers. The White Chalk Subgroup is classified as a Principal Aquifer; these formations provide a high level of water storage and may support water supply and / or river base flow on a strategic scale.
- 7.41 According to EA data, the site is not indicated to be located in a groundwater Source Protection Zone (SPZ).
- 7.42 Under the Water Framework Directive, the EA's local River Basin Management Plan classifies groundwater chemical quality beneath the site as poor quality.
- 7.43 Information provided by the EA indicates that there are records of five active licensed groundwater abstractions within 1km of the site. Further details on these are provided in Section 2.4.2 of the RPS Phase 1 Preliminary Risk Assessment (Appendix 7.1).
- 7.44 As part of the geo-archaeological investigation undertaken in December 2010 and January 2011 (as reported in the 2011 Ground Conditions and Contamination ES Chapter, undertaken by Arup to support planning application ref: 11/00276/OUT), groundwater levels within two monitoring wells, screened across the Kempton Park Gravel Member, were recorded at approximately 1.94m and 1.95m bgl.
- 7.45 As part of the monitoring carried out by Ian Farmer Associates, as reported in the Factual Ground Investigation Report (ref: REP/10-2012/001/RO, dated 14th November 2012), groundwater levels within monitoring wells screened across the Kempton Park Gravel Member ranged from approximately 1.58m to 2.20m bgl. For the wells screened across the Made Ground and Langley Silt Member, groundwater levels ranged from approximately 0.96m to 2.27m bgl.

Hydrology

- 7.46 The nearest surface watercourse is the River Thames, located approximately 210m to the northeast of the site.
- 7.47 Information provided by the EA indicates that there are records of two active licensed surface water abstractions within 1km of the site. Further details on these are provided in Section 2.4.3 of the RPS Phase 1 Preliminary Risk Assessment (Appendix 7.1).

Contamination Analysis

- 7.48 As part of the geo-archaeological investigation, lead was recorded at concentrations in excess of the generic assessment criteria (GAC) for a residential end use in two of the samples of Made Ground, but below those for a commercial end use. Ammoniacal nitrogen, several speciated PAHs

and TPH compounds were recorded at concentrations in excess of their AC within the two groundwater samples collected from monitoring wells located in the centre of the site.

- 7.49 As part of the 2012 investigation, visual and olfactory evidence of contamination was observed within the Made Ground and Langley Silt Member at borehole CP12-01, which is located within the vicinity of the former vehicle refuelling area (outside the current site boundary). Soil analytical results were compared to GAC using the standard UK CLEA model for both commercial and residential (without plant uptake) end use scenarios. No exceedances against commercial criteria were reported. Slight exceedances of concentrations of lead in four samples of Made Ground were recorded against GAC for a residential use (three of the locations are within the current boundary and one outside the boundary to the east) and aliphatic hydrocarbons in the sample of Made Ground collected from borehole CP12-01 (this is not located within the current development area). Asbestos was identified in three of the 27 samples of Made Ground screened. All three samples were reported to comprise chrysotile asbestos fibres. Subsequent quantification testing indicated that all samples had less than 0.001% by mass of asbestos. Groundwater analytical results were compared to EQS or UK DWS. The results indicated that the quality of groundwater beneath the site was good and there was no evidence of any significant contamination. The only exceedances related to ammoniacal nitrogen, which was recorded at elevated concentrations within two of the groundwater samples. Very limited ground gas monitoring was undertaken, which indicated that ground gas protection measures would not be required for the current development area.

Radon

- 7.50 According to the Indicative Atlas of Radon in England and Wales published by the Health Protection Agency (part of Public Health England) and the British Geological Survey, the site is not located in an area at risk from radon gas.

Waste Sites

- 7.51 Data provided by the EA, Local Authority and BGS indicates that there are no recorded licensed or known historical landfill sites located within 250m of the site. There are also no waste treatment or transfer sites located within 250m of the site.

Pollution Incidents

- 7.52 As part of the Arup Contaminated Land Preliminary Phase 1 Report (ref: 211770 Draft 3, dated March 2010), Reading Borough Council (RBC) advised of two pollution incidents at the site occurring in August 1991 (chemicals to Vastern Ditch watercourses) and in September 2011 (fly tipping of green waste).
- 7.53 Environment Agency data indicates that there is one pollutant incident recorded in the northwest of the site. The pollutant was listed as general biodegradable materials and wastes and the incident occurred on 12th September 2001. The impact to land was listed as minor with no impact to water.

Geologically Important Sites

- 7.54 Information provided by the Berkshire Geoconservation Group (as provided on their website) indicates that there are no Local Geological Sites (LGS) within 1km of the site.

Environmental Risk Assessment

Source (Land Use)

On Site

- 7.55 Historical mapping indicates that from at least 1879 the site comprised part of the Great Western Railway Works, which included a railway foundry, forge and saw pit. By c.1899, railway sidings associated with an off-site coal depot were indicated to be present on site. By c.1956, the site had been redeveloped to comprise a large works building, subsequently labelled as a railway works. By 1988, the site had been redeveloped to comprise the Royal Mail sorting office.
- 7.56 Environment Agency data indicates that there is one pollutant incident recorded in the northwest of the site. The pollutant was listed as general biodegradable materials and wastes and the incident occurred on 12th September 2001. As part of the Arup Contaminated Land Preliminary Phase 1 Report (ref: 211770 Draft 3, dated March 2010), RBC advised of two pollution incidents at the site occurring in August 1991 (chemicals to Vastern Ditch watercourse) and in September 2011 (fly tipping of green waste).
- 7.57 An electricity substation is currently located in the northwest of the site. At the time of the walkover (November 2018), a disused generator with some evidence of hydrocarbon staining was located in the northwest of the site.
- 7.58 Made Ground is also considered to be a current potential source of contaminants of concern at the site.
- 7.59 The results of the two previous investigations carried out across the site identified lead at concentrations in samples of Made Ground in exceedance of GAC for a residential end use (but not those for a commercial end use). Asbestos was identified in three of the 27 samples of Made Ground. Ammoniacal nitrogen, several speciated PAHs and TPH compounds were recorded at concentrations in excess of their assessment criteria (AC) within groundwater samples collected from monitoring wells located in the centre of the site. An elevated concentration of ammoniacal nitrogen was also recorded in a groundwater sample collected from a monitoring well in the northwest of the site. Very limited ground gas monitoring was undertaken, which indicated that ground gas protection measures would not be required for the current development area.

Off-Site

- 7.60 Historical maps indicate that a coal depot was located adjacent to the north of the site from at least 1899 to c.1956. Railway sidings were located adjacent to the north, south and east of the site from 1899 to c.1989. Additional historical land uses include malthouses, a timber yard, a parcel depot and a number of warehouses and works.
- 7.61 A former vehicle maintenance workshop, vehicle wash and refuelling area (all associated with the Royal Mail sorting office) were located adjacent to the east of the current site boundary. During the walkover undertaken by Arup as part of their Contaminated Land Preliminary Phase 1 Report (ref: 211770 Draft 3, dated March 2010) significant black staining was observed on the floors and walls in the vehicle repair workshop and at the refuelling area. As part of the 2012 investigation, aliphatic hydrocarbons were recorded at concentrations in excess of their GAC for a residential

use (although not for a commercial use) in a sample of Made Ground collected from borehole CP12-01. This borehole was located in the vicinity of the former refuelling area. An elevated concentration of ammoniacal nitrogen was recorded in the groundwater sample collected from this location. It should be noted that this area has been redeveloped to comprise a new entrance area to Reading train station. RPS has been advised the works were completed as part of the Crossrail works at the train station.

- 7.62 An electricity substation is located adjacent to the north of the site.

Potential Pathways

- 7.63 In areas of the site covered by buildings or hardstanding the risks to future on site human health receptors via the pathways of dermal contact and ingestion will be mitigated. However, in areas of soft landscaping, the pathways of dermal contact and ingestion could still be active. In addition, there would be potential for the airborne migration of soil/dust from these areas.
- 7.64 There is the potential for ground gas and volatile contaminants of concern in soil and/or groundwater beneath the site to impact future site users via the inhalation pathway in indoor areas.
- 7.65 Contaminants of concern in shallow soils and/or groundwater could migrate vertically into the deeper Kempton Park Gravel Member and the underlying White Chalk Subgroup.
- 7.66 The site is indicated to be underlain by the relatively impermeable Langley Silt Member, which will likely limit the lateral off-site migration of contaminants of concern via groundwater. However, this stratum was indicated to be absent in one borehole advanced as part of the 2011 geo-archaeological site investigation and two of the boreholes advanced across the centre of the site as part of the 2012 site investigation. There is therefore potential for the off-site migration of contaminants of concern to be facilitated by a likely continuous groundwater body within the underlying Kempton Park Gravel Member. Contaminants of concern may impact off-site human health receptors via the dermal contact, ingestion and vapour inhalation pathways.

Receptors (Environmental Sensitivity)

- 7.67 The future occupants of the residential dwellings (very high sensitivity) and commercial users (high sensitivity) are considered to be sensitive receptors.
- 7.68 Off-site human health receptors associated with the retail units and Reading train station are also considered to be sensitive receptors (high sensitivity).
- 7.69 Construction workers are considered to be high sensitivity receptors.
- 7.70 The nearest surface water feature is the River Thames, which is located approximately 210m to the northeast of the site. Given the distance to this feature, it is not considered to be at significant risk from any contamination sourced from beneath the site and is therefore not considered to be a potential receptor.
- 7.71 The site is underlain by the Langley Silt Member, which is classified as an Unproductive Stratum and therefore considered to be of low sensitivity.
- 7.72 The underlying Kempton Park Gravel Member Secondary A Aquifer is likely to be of limited resource potential, as under the Water Framework Directive, the EA's local River Basin Management Plan

classifies groundwater chemical quality beneath the site as poor. It is therefore considered to be of low to medium sensitivity.

- 7.73 The White Chalk Subgroup Principal Aquifer is considered to be a high sensitivity receptor.

Overall Risk

- 7.74 The potential pollutant linkages based on the source-pathway-receptor components identified above have been assessed in light of the findings of the intrusive investigation carried out at the site. These are discussed below for each of the individual receptors identified. It should be noted that the RPS Phase 1 Preliminary Risk Assessment (Appendix 7.1) recommended that additional intrusive investigation be undertaken at the site. Details of the required additional information are discussed in the relevant sections below.

Human Health

- 7.75 A number of potentially significant current and historical on and off-site contaminative land uses have been identified. The results of the intrusive investigation carried out across the site identified elevated concentrations of lead in samples of Made Ground (for a residential end use), as well as the presence of asbestos. These contaminants may therefore pose a potential risk to future site users *via* the dermal contact/ingestion pathways in areas not covered by hardstanding or building footprint. However, it should be noted that a basement level is proposed to be constructed across the eastern portion of the site and a small area in the southwest corner. The removal of Made Ground and potentially Langley Silt Member in these areas would remove any potentially contaminated material.
- 7.76 Concentrations of volatile contaminants of concern were not recorded at concentrations considered to pose a potentially significant risk to future site users via the inhalation pathway, however there is potential for these to be present in soil and/or groundwater in areas of the site not previously investigated.
- 7.77 Very limited ground gas monitoring was undertaken, which indicated that ground gas protection measures would not be required for the current development area. However, it is recommended that additional ground gas monitoring is undertaken at a number of locations across the site.

Groundwater

- 7.78 As part of the geo-archaeological investigation in January 2011, ammoniacal nitrogen, several speciated PAHs and TPH compounds were recorded at concentrations in excess of their AC within groundwater samples collected from monitoring wells located in the centre of the site. However, as part of the 2012 investigation the only exceedances related to an elevated concentration of ammoniacal nitrogen in a groundwater sample collected from a monitoring well in the northwest of the site.
- 7.79 Based on the information available to date for the site, it is not considered that there would be significant risks to identified groundwater receptors.
- 7.80 However, given that the previous intrusive investigations were carried out six to eight years ago and the site has remained operational until recently (as site offices and office for Network Rail), it is recommended that an additional Phase 2 Environmental Site Investigation is undertaken to

provide an assessment of the current status of soil and groundwater beneath the site and potential impacts to identified receptors.

Future Baseline Conditions

- 7.81 In relation to geology, hydrogeology and ground conditions, identified existing receptors are not considered to be particularly vulnerable to foreseeable factors, such as climate change.

Mitigation Measures Adopted as Part of the Project

Construction Phase

- 7.82 Standard best practice construction mitigation measures would be adopted during the construction phase, implemented through the Code of Construction Practice (CoCP). These include:
- Ground workers will be provided with appropriate risk assessments, which will address the potential for contaminated soil and/or groundwater to be encountered. Appropriate Personal Protective Equipment (PPE) (e.g. disposable coveralls, gloves and particulate/vapour masks) should be provided to protect ground workers in the event that contaminated soils and/or groundwater are encountered.
 - The implementation of industry standard practice dust suppression measures, e.g. dampening/sheeting of stockpiles and exposed soils.
 - Site personnel to be vigilant for any unusual visual or odorous characteristics of soils and groundwater which could indicate the presence of previously unidentified contamination.
 - Maintenance of a 'clean/dirty area' regime, if contamination identified. Smoking, eating and drinking would not be permitted in the buildings and during demolition works. A high standard of hygiene to be maintained at all times.
 - A secure site with respect to public safety.
 - Appropriate disposal of waste soil generated during construction and demolition. All waste soil arisings from the Site should be disposed of in accordance with the relevant statutes and Duty of Care regulations;
 - If required, imported soils for use would be certified 'clean' and suitable for use for the landscaping areas;
 - Appropriate storage of potentially polluting materials and chemicals in accordance with the Control of Pollution (Oil Storage) Regulations (England) 2001;
 - Any areas for the storage of bulk materials including oils, fuel and chemicals would be designated and managed according to current best practice and in compliance with prevailing legislation and EA guidance.

- Leaks or spillages of potentially polluting substances to be contained, collected then removed from site in an appropriate manner e.g. use of absorbent material, bunding or booms. Spill kits will be placed at designated points across the site. An emergency action plan would be formulated which all site personnel would be required to read and understand.
- 7.83 Based on the findings of the recommended additional Phase 2 Site Investigation, a remediation options appraisal and remediation strategy may be required to address any areas of ground or groundwater contamination assessed as requiring remediation. Any remediation works are likely to be undertaken early in the redevelopment programme. This will limit the potential for exposure of the materials to surface water run-off, leaching or migration as dust or mud, as well as limit the potential for workers to be exposed to contamination during the construction phase.
- 7.84 Should any previously unidentified contamination be detected at the site during the construction phase, then risks would be mitigated through measures that would be designed through an options appraisal process. A formal Remediation Strategy would be submitted to the LPA for agreement prior to any remediation works being done.

Operational Phase

- 7.85 All relevant guidance and legislation for operating practices undertaken as part of the business area at the site would be adhered to; e.g. chemicals would be stored on areas of hardstanding with appropriate containment measures to contain and prevent loss of spillage of any chemicals. In addition, all waste streams would be stored in designated areas at the site.
- 7.86 Surface water drainage systems will be appropriately and regularly maintained. Should any oil/water interceptors be present, these will be emptied and cleaned on a regular basis.
- 7.87 Any fuel storage would be carried out in line with the Oil Storage Regulations for Businesses (EA, 2015, updated 2018). Should any oil/water interceptors be required, these would be installed in line with the EA Pollution Prevention for Businesses Guidance (EA, 2016).
- 7.88 No other specific mitigation measures are considered to be necessary in relation to the operational phase of the project.

Assessment of Construction Effects

- 7.89 The key likely impacts associated with geology, hydrogeology and ground conditions during construction that may affect receptors include:
- Mobilisation of any previously unidentified contamination and dust as a result of general ground disturbance, earthworks, establishment of haul routes and removal of vegetation.
 - Potential mobilisation of contaminants of concern within shallow soils and groundwater into the Kempton Park Gravel Member Secondary A Aquifer and the deeper White Chalk Subgroup Principal Aquifer through piling and/or general earthworks.
 - Contamination from the use, storage or spillage of construction related chemicals, fuels, oils, cement; and vehicle/wheel washing.

7.90 During the construction phase, the following receptors are relevant to these likely impacts:

- Construction workers (high sensitivity).
- Off-site human health receptors (high sensitivity).
- Kempton Park Gravel Member Secondary A Aquifer (low to medium sensitivity).
- White Chalk Subgroup (high sensitivity).

7.91 Given that no potentially significant concentrations of contaminants of concern were detected in soil or groundwater beneath the project site as part of the previous intrusive investigations and that mitigation measures would be adopted during the construction phase, the magnitude of any impacts to construction workers and off-site human health receptors would be negligible, resulting in a minor adverse significance of effect. However, it is recommended that the findings of the previous investigations be confirmed through a contemporary assessment.

7.92 Assuming that the recommended additional intrusive investigation is undertaken, and any recommended mitigation measures are implemented there is considered to be a minor potential for any contamination (arising from the construction phase) to migrate into the Kempton Park Gravel Member (low to medium sensitivity) or the White Chalk Subgroup (high sensitivity). The magnitude of these impacts is considered to be negligible to low, resulting in a negligible to minor adverse significance of effect.

7.93 The potential impacts arising from the construction phase would be expected to be localised and short term. Such effects would not be significant in EIA terms. There may also be a minor beneficial effect if any previously unidentified contamination is identified and remediated as part of the construction works. The removal of Made Ground beneath certain areas of the site, as part of basement construction, will lead to the removal of potential source areas and overall betterment of soil and/or groundwater quality beneath the site. This is considered to be a minor beneficial effect.

Further Mitigation and Monitoring

7.94 No further mitigation is likely to be required.

7.95 A watching brief would be undertaken during the construction phase for previously unidentified contamination and monitoring for leaks or spillages of potentially polluting substances.

Accidents and/or Disasters

7.96 Effective implementation of the CoCP and subsequent Construction Environmental Management Plan (CEMP) (incorporating spillage response plans, appropriate storage of potentially polluting materials and chemical, etc.) would mitigate against accidental spillages or leaks.

Assessment of Operational Effects

- 7.97 During the operational phase, the following receptors are relevant to the assessment:
- Residents (very high sensitivity).
 - Commercial on-site users (high sensitivity).
 - Off-site human health receptors (high sensitivity).
 - Kempton Park Gravel Member Secondary A Aquifer (low to medium sensitivity).
 - White Chalk Subgroup (high sensitivity).
- 7.98 The following operational activities may impact upon the ground conditions/contamination status of the site:
- Landscape maintenance (pesticides, herbicides, etc.).
 - Potential spillages in the retail/commercial area.
 - Potential spillages from vehicles.
- 7.99 The presence of hardstanding in trafficked areas of the site would break physical contact pathways between site users (very high and high sensitivity) and any previously unidentified contaminants of concern (if present) within soils. It will also reduce the potential migration of any contaminants of concern (if present) via airborne soil or dust particles toward off site human health receptors (high sensitivity). Consequently, the magnitude of this impact is considered to be negligible, resulting in a minor adverse significance of effect.
- 7.100 The underlying aquifers (low to high sensitivity) could be impacted by the accidental spillage of hazardous substances in areas of soft landscaping. Given that such contamination would likely be localised, the magnitude of this impact is considered to be negligible to low, resulting in a negligible to minor adverse significance of effect.
- 7.101 It is assumed that good environmental site management procedures would be employed during the operation of the project. Any potential impacts arising from operational activities would be expected to be localised and intermittent.

Further Mitigation and Monitoring

- 7.102 No further mitigation measures or monitoring is likely to be required once the project is operational.

Accidents/Disasters

- 7.103 There are not considered to be any operational accidents/disasters which are relevant to this topic, during the operational phase.

Potential Changes to the Assessment as a Result of Climate Change

- 7.104 Future changes to baseline conditions are not considered likely to change the assessment for the operational phase discussed in the section above.

Assessment of Cumulative Effects

- 7.105 The other proposed developments in the vicinity of the project site have been reviewed. On the basis of the information available, only negligible to minor adverse effects have been identified in relation to ground conditions and contamination associated with the project. The project is therefore not considered to represent a significant risk in terms of contaminated soil and/or groundwater. Therefore, the proposed development is not considered to make a significant contribution to any cumulative adverse effect in relation to ground conditions, contamination and hydrogeology.

Inter-relationships

- 7.106 This chapter should be read in conjunction with other technical chapters relating to the proposed works involving the disturbance of ground.
- 7.107 Further information regarding potential surface water receptors in the vicinity of the site is presented in Chapter 8: *Hydrology and Flood Risk* of this ES. In addition, this chapter also provides information regarding the proposed surface water management measures and drainage strategy.

Summary of Effects

- 7.108 The intrusive investigations carried out across the site in 2010 and 2012 did not identify potentially significant concentrations of contaminants of concern in soil or groundwater samples. However, given the time elapsed since then, it is recommended that an additional intrusive investigation (including soil, groundwater and ground gas monitoring) is carried out at the site.
- 7.109 It is considered that if any risks are identified as part of the additional works these can be appropriately controlled through the completion of any recommended mitigation measures and the implementation of environmental management practices during the construction works.
- 7.110 Mitigation measures would be adopted during the construction phase, therefore the magnitude of any impacts through the disturbance and mobilisation of any previously unidentified ground contamination would be negligible to low. Potential impacts arising from the construction phase would be expected to be localised and short term. Consequently, it is concluded that the likely significance of effects would be negligible to minor adverse during the construction phase. There may also be a minor beneficial effect if any previously unidentified contamination is identified and remediated. In addition, the removal of Made Ground beneath certain areas of the site, as part of basement construction, will lead to the removal of potential source areas and overall betterment of soil and/or groundwater quality beneath the site. Such effects would not be significant in EIA terms.
- 7.111 Potential impacts arising from the operational phase would be expected to be localised and intermittent. Overall, the significance of effects would be negligible to minor adverse for the completed project, which would not be significant in EIA terms.

- 7.112 The project is not considered to make a significant contribution to any cumulative adverse effects on soils or groundwater, as the sources of future contaminants of concern are limited.
- 7.113 A summary of the potential likely environmental effects is presented in Table 16.7. No effects have been identified that would be considered significant in terms of the EIA Regulations.

Table 7.6: Summary of Likely Environmental Effects on Hydrogeology, Geology and Ground Conditions

Receptor	Sensitivity of receptor	Description of impact	Short / medium / long term	Magnitude of impact	Significance of effect	Significant / Not significant	Notes
Construction phase							
Construction workers and off-site human health receptors	High to very high	Effects during construction	Short term	Negligible	Minor adverse	Not significant	Any impacts are likely to be localised. The significance of effect may become minor beneficial if remediation of previously unidentified contamination occurs.
Kempton Park Gravel Member Secondary A Aquifer	Low to medium			Negligible to low	Negligible to minor adverse		The removal of Made Ground beneath certain areas of the site, as part of basement construction, will lead to the removal of potential source areas and overall betterment of soil and/or groundwater quality beneath the site. This is considered to be a minor beneficial effect.
White Chalk Subgroup Principal Aquifer	High			Negligible to low	Negligible to minor adverse		
Operational phase							
Residents, commercial/retail users and off site human health receptors	Very high to high	Effects during operation	Short term, intermittent	Negligible	Minor adverse	Not significant	Any impacts are likely to be localised. It is assumed that good environmental site management procedures would be employed during the operation of the development
Kempton Park Gravel Member Secondary A Aquifer	Low to medium			Negligible to low	Negligible to minor adverse		
White Chalk Subgroup Principal Aquifer	High			Negligible to low	Negligible to minor adverse		

References

All references listed throughout the text should be listed in the final section, following the referencing convention below (not using numbers etc.).

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British Standards Institution (2017) BS 10175 Investigation of Potentially Contaminated Sites (2011+A2:2017).

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Environment Agency (2017a) Groundwater Protection Technical Guidance

Environment Agency (2017b) Protect Groundwater and Prevent Groundwater Pollution

Environment Agency (2017c) Land contamination Groundwater Compliance Points: Quantitative Risk Assessments

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European Commission (2000) European Water Framework Directive

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HM Government (2009) Groundwater (England and Wales) Regulations. SI 2009 No 2902

Ministry of Housing, Communities and Local Government (2018) National Planning Policy Framework

Ministry of Housing, Communities and Local Government (2018) Planning Practice Guidance

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Reading Borough Council's Core Strategy (2008, amended in 2015) Policy CS36: Biodiversity and Geology

Reading Borough Council's Draft Reading Borough Local Plan (2018) Policy EN16: Pollution and Water Resources