

11 GROUND CONDITIONS AND GEOLOGY

11.1 INTRODUCTION

11.1.1 This Chapter assesses the likely significant effects of the Proposed Development with respect to the likely ground conditions and contamination at the Site.

11.2 LEGISLATIVE AND POLICY FRAMEWORK

National Planning Policy

11.2.1 Planning Policy Statement 23: 'Planning and Pollution Control' 2004 (PPS23) is designed to protect the environment from potential harm caused by development and operations. Consequently, opportunities should be taken wherever possible, to assist and encourage the remediation of contaminated land that will be redeveloped.

Table 11.1: National Planning Policy

Planning Policy	Description
The National Planning Policy Framework (NPPF) March 2012	<p>The National Planning Policy Framework requires that development plans should minimise pollution and other adverse effects on the local and natural environment. Specifically:</p> <p><i>"The planning system should contribute to and enhance the natural and local environment by preventing both new and existing development from contributing to or being put at unacceptable risk from, or being adversely affected by unacceptable levels of soil, air, water or noise pollution or land instability..."</i> (Paragraph 109)</p> <p>Pollution is defined as 'anything that affects the quality of land, water or soils'.</p> <p>In relation to ground conditions the National Planning Policy Framework states that:</p> <p><i>"Planning policies and decisions should also ensure that the site is suitable for its new use taking account of ground conditions and land instability, including from natural hazards or former activities such as mining, pollution arising from previous uses and any proposals for mitigation including land remediation or impacts on the natural environment arising from that remediation..."</i> (Paragraph 121)</p>
Planning Practice Guidance (PPG)	<p>PPG on Land affected by contamination notes that failure to deal adequately with contamination could cause harm to human health, property and the wider environment. It could also undermine compliance with European Directives such as the Water Framework Directive.</p> <p>PPG on Water Supply, wastewater, and water quality advocates the need to protect surface water and groundwater, with a requirement to steer potentially polluting development away from the vicinity of potable water supplies.</p>
Environmental Protection Act 1990: Part 2A April 2012	<p>Part 2A of the Environmental Protection Act 1990, as inserted by Section 57 of the Environment Act 1995 (Ref 13.19), was brought into force on 1 April 2000.</p> <p>The legal definition of contaminated land (as of April 2012 from Section 78A(2) of Part 2A of the Environmental Protection Act 1990) (Ref 13.4) is:</p> <p>'...any land which appears to the local authority in whose area it is situated to be in such a condition, by reason of substances in, on or under the land, that - (a) significant harm is being caused or there is the significant possibility of such harm being caused; or (b) significant pollution of controlled waters is being caused, or there is a significant possibility of such pollution being caused.</p>

Planning Policy	Description
	<p>Controlled waters include all surface watercourses or bodies, including those which are man-made, and also groundwater.</p> <p>Development of land will have to take into account Part 2A as to alter the use of the land may bring the development inside the statutory definition of contaminated land.</p>
<p>The Environment Agency Groundwater Protection March 2017</p>	<p>This document replaces the Environment Agency Groundwater protection: principles and practice GP3.</p> <p>There are several documents as guidance to protect and prevent groundwater pollution, technical guidance and position statements which provide information about the EA's approach to managing and protecting groundwater.</p>
<p>The Water Resources Act 1991, as amended by the Water Act 2003 and 2014</p>	<p>Water resources in England and Wales are protected by law under the Water Resources Act 1991 and the Environmental Protection Act 1990 (as amended by the Environment Act 1995).</p> <p>The Water Act 2003 amends the Water Resources Act 1991 to improve long term water resource management, specifically with regard to the regulation of water abstraction and impoundment. The Water Act 2014 contains further amendments relating to water resources and environmental regulation.</p>
<p>Water Framework Directive (2000/60/EC and daughter directive 2006/118/EC as amended by 2013/39/EU)</p>	<p>The purpose of the Water Framework Directive is to establish a framework for the protection of inland surface waters, estuaries, coastal waters and groundwater. The framework for delivering the Directive is through River Basin Management Planning. The UK has been split into several River Basin Districts (RBDs). Each River Basin District has been characterised into smaller management units known as Water Bodies. The surface Water Bodies may be rivers, lakes, estuary or coastal. To achieve the purpose of the Directive of protecting all Water Bodies, Environmental Objectives have been set. These Environmental Objectives are reported for each water body in the River Basin Management Plan (RBMP).</p> <p>It follows that developments within individual RBDs must be such that the Environmental Objectives are not compromised.</p>
<p>Waste Framework Directive (2006/12/EC and daughter directive 2006/118/EC as amended by 2013/39/EU)</p>	<p>Collectively, these Directives set the basic concepts and definitions related to waste management in the EU, such as definitions of waste, recycling, and recovery. The Directive lays down some basic waste management principles: it requires that waste be managed without endangering human health and harming the environment, and in particular without risk to water, air, soil, plants or animals, without causing a nuisance through noise or odours, and without adversely affecting the countryside or places of special interest. These principles have been implemented through applicable UK legislation that must be complied with.</p> <p>Of particular relevance to the proposed works is compliance with Environmental Permitting (England and Wales) Regulations 2016, Schedule 10 (should any remediation works be required) and compliance with the Definition of Waste Code of Practice should re-use of materials on site be required.</p>
<p>The Water Supply (Water Quality) Regulations 2016</p>	<p>This legislation sets out the physical and chemical requirements for a public water supply organisation intended for human consumption.</p> <p>The ES will assess whether there are any implications of the proposed works with regards to public water supplies.</p>
<p>Environmental Permitting (England and Wales) Regulations 2016</p>	<p>For England and Wales, the principal water pollution offences are contained in the Environmental Permitting (England and Wales) Regulations 2016: regulations 38(1) and 12(1). The offences are similar to ones that used to be set out in section 85 of the Water Resources Act 1991.</p> <p>Under regulation 12(1) and 38(1) it is an offence to, except if authorised</p>

Planning Policy	Description
	<p>by an environmental permit, "cause or knowingly permit a water discharge activity or groundwater activity".</p> <p>The Environmental Permitting Regulations (2016) requires those that carry out activities that involve the release of emissions to land, air and water, or that involve waste, to undertake these activities under an environmental permit.</p> <p>With respect to the release of substances to groundwater, under schedule 22 (Regulation 35(1)), the regulator must take all necessary measures to "(a) to prevent the input of any hazardous substance to groundwater, and (b) to limit the input of non-hazardous pollutants to groundwater so as to ensure that such inputs do not cause pollution of groundwater".</p>
<p>The Private Water Supplies (England) Regulations 2016</p>	<p>This legislation sets out the physical and chemical requirements for private supplies of water intended for human consumption.</p> <p>The ES will assess whether there are any implications of the proposed works with regards to private water supplies.</p>

Local Planning Policy

11.2.2 The adopted 'Cherwell Local Plan', 1996 updated and included in the 'Non Statutory Cherwell Local Plan 2011', contains policies relating to contaminated land and water quality.

- Policy EN12 'Contaminated Land' stipulates that where land is known, or is suspected to be contaminated, adequate measures should be taken to remove the risk of contamination to future site users. Development would only be permitted where it is not likely to result in the contamination of surface or underground water resources.
- Policy EN12 'Contaminated Land' is supported by Policy EN7 'Water Quality' which states that developments which would adversely affect the quality of surface waters and groundwater would not be permitted.

11.2.3 In addition, the 'Non Statutory Cherwell Local Plan 2011' contains policies specific to developing the Site.

- Policy UH2 (iii) stipulates proposals for the onsite treatment of contaminated liquids and materials including soil where that would accord with the good environmental practice and have no detrimental environmental impacts arising.

11.3 ASSESSMENT METHODOLOGY

Study Area

11.3.1 The study area for this assessment comprises the Application Site but extends up to 1km where necessary, for example where the Proposed Development may impact the hydrogeology outside the Application Site.

Surveys

11.3.2 This Chapter draws on the assessment undertaken in the Ground Conditions Desk Study (see **Appendix 11.1**) and the following information sources were reviewed as part of this:

- Vertase F.L.I. Limited. February 2012. 'Contract Completion Report – POL System – Clean and Make Safe'.
- Waterman Energy, Environment & Design Ltd. March 2012. 'Hydrogeological Characterisation and Groundwater Quality Assessment'.

- Waterman. May 2012. 'Preliminary Ground Investigation, New Settlement Area, Heyford Park'.
- Waterman Energy, Environment & Design Ltd. September 2012. 'Controlled Water Detailed Quantitative Risk Assessment'.
- Waterman Energy, Environment and Design Ltd. September 2012. 'Remediation Strategy at New Settlement Area, Upper Heyford'.
- Hydrock. February 2017. 'Heyford Park – Western Development, Phase 9, 10, 16 and 16A, Desk Study and Ground Investigation Report'.
- Hydrock. April 2017. 'Heyford Park – Western Development, Phase 9, 10, 16 and 16A, Remediation Method Statement'.
- Groundsure Insights, Enviro Insight, Geo Insight and Historical Mapping dated September 2017.

Method of Assessment

11.3.3 The assessment of ground contamination was undertaken in general accordance with current UK guidance on the assessment of contaminated land, including DEFRA Contaminated Land Reports (CLR) 11 'Model Procedures for the Management of Contaminated Land' (DEFRA & Environment Agency, 2004).

11.3.4 Current guidance on the assessment of contamination risk advocates the use of a conceptual risk assessment model to establish the links between a contamination source and a sensitive receptor via an exposure pathway. In order to evaluate the potential environmental and health risks associated with any potential contamination, sensitive receptors and potential pathways relevant to the Site and the Development were identified through the baseline research. This was followed by an appraisal of the means (i.e. the pathways) by which sources might affect receptors.

Significance Criteria

11.3.5 The significance of a potential effect is based on a combination of the sensitivity and magnitude of that effect, and assessed as a beneficial, neutral or adverse type of effect, and on a minor, moderate or major scale, as outlined in **Tables 11.2** and **11.3** below, with those effects deemed 'significant' shaded.

Table 11.2: Significance Matrix

Magnitude of Change	Sensitivity of Receptor				
		High	Medium	Low	Negligible
High		Major	Major	Moderate	Negligible
Medium		Major	Moderate	Minor to Moderate	Negligible
Low		Moderate	Minor to Moderate	Minor	Negligible
Negligible		Negligible	Negligible	Negligible	Negligible

Table 11.3: Significance Criteria

Significance Criteria	Description of Criteria
Major Beneficial	Major reduction in risks to human, animal or plant health. Significant regional scale improvement to the quality of potable groundwater or surface water resources.
Moderate Beneficial	Significant local improvement to the quality of potable groundwater or surface water resources. Significant improvement to the quality of

Significance Criteria	Description of Criteria
	groundwater or surface water resources used for public water supply.
Minor Beneficial	Risks to human, animal or plant health are reduced to acceptable levels. Local scale improvement to the quality of groundwater or surface water resources used for commercial or industrial abstraction.
Neutral	No appreciable impact on human, animal or plant health, groundwater or surface water resources.
Minor Adverse	Potential pollutant linkages with human health and / or animal / plant populations identified. Reversible, localised reduction in the quality of groundwater or surface water resources used for commercial or industrial abstractions, Secondary Aquifer etc.
Moderate Adverse	Proven (or likely significant) pollutant linkages with human health and/or animal/plant populations, with harm from long-term exposure. Impact on a potable groundwater or surface water resource at a local level e.g. impact on an outer groundwater source protection zone. Temporary alteration to the regional hydrological or hydrogeological regime or permanent alteration to the local regime.
Major Adverse	Acute or severe chronic impacts on human health and/or animal/plant populations predicted. Impact on a potable groundwater or surface water resource of regional importance e.g. Principal Aquifer, public water reservoir or inner protection zone of a public supply borehole.

Assumptions and Limitations

11.3.6 The assessment process is designed to enable good decision-making based on the best possible information about the environmental implications of a proposed development. However, there will always be some uncertainty as to the exact scale and nature of the environmental effects identified. Where this is the case, this has been highlighted in the assessment of effects. This arises through the detail of information available at the time of the assessment and the limitations of the prediction process itself.

11.4 BASELINE CONDITIONS

11.4.1 Below is a summary of the baseline conditions. For more detailed information please refer to the Ground Conditions Desk Study in **Appendix 11.1**.

Site Description

11.4.2 The site is the former RAF Upper Heyford and can be split into several different development parcels as indicated on **Figure 4.2: Composite Parameter Plan**. These parcels are numbered 10 through to 13 and 15 through to 38. Areas between these parcels are not numbered and are not being developed.

11.4.3 The parcels are described below and start from the southernmost parcels and continue north. In the south, Parcels 18, 34 and 18 and 17 are generally arable fields. Parcel 36 comprises the sewage treatment works to the south of Parcel 17. Parcel 32 West is a sports field with a football pitch and tennis/netball courts.

11.4.4 In the southwest of the site, Parcel 10 is currently open ground and includes three large above ground fuel tanks, known as POL 21. Parcel 20 comprises three

buildings. Parcel 32 East comprises the Heyford Park Free School. Parcel 38 lies just south of Camp Road and is currently an open space used for construction storage. Parcel 35 is in two areas; the western area is hardstanding used for storage and the eastern area is a small building and hardstanding. Parcel 19 is currently a warehouse with external hardstanding and landscaping.

11.4.5 Parcel 13 is a thin area of open, grassed land and hardstanding. Parcel 15 is a grassed area on the central east of the site. Parcel 33 is Chilgrove Drive running up the east of the site.

11.4.6 Parcel 11 currently houses four thin, long buildings. The rest of the parcel is concrete hardstanding and landscaped areas.

11.4.7 In the centre of the site, Parcels 12, 21, 22 and 23 are currently used for car storage. Parcel 22 houses six former RAF aircraft shelters and several former RAF buildings. Parcel 24 comprises many former RAF bunkers. Parcels 25, 31, 37 and 29 comprise car storage and several former RAF warehouses. Parcels 30, 28 and the Parcel 27 East are part of the former Flying Field. Parcel 27 West currently houses nine former RAF aircraft shelters. Parcel 26 is eight former RAF aircraft shelters across the north of the site. The rest of the site is the former airfield, with various former RAF buildings, aircraft shelters and storage.

Surrounding Land Uses

Surrounding Land Use

11.4.8 The site area is generally bound by agricultural fields. The current Heyford Park development, of residential and commercial use, are along the southern boundary of the site area and to the east of Parcels 16 and 32, and to the north and west of Parcel 17.

Surrounding Land Designation

11.4.9 There are two Sites of Special Scientific Interest in the vicinity of the site, Ardley Cutting and Quarry, the cutting running southeast to northwest 120m northeast of the site and the quarry 230m northeast of the site, and Ardley Trackways approximately 1km southeast of the site.

11.4.10 An Environmentally Sensitive Area is from 350m west of the site and comprises the River Cherwell, part of the Upper Thames Tributaries and the area around it.

Site History

11.4.11 Historical maps are presented in the Groundsure Insights report presented in **Appendix 11.1**. A summary of the history of the site is presented below. Due to the military use of the site, limited information is given in the historical maps.

11.4.12 The Upper Heyford airbase was constructed in 1915 for the Royal Air Force. Following World War II, the United States Air Force leased the site until 1994 when the site was returned to the Military of Defence and closed. The airbase comprised the Flying Field and was surrounded by aircraft shelters, bunkers and tanks for storage of fuel.

11.4.13 A sewage works was constructed to the south of Parcel 17 in the 1970s.

Geology

11.4.14 The British Geological map (1:50,000) of Chipping Norton (Sheet 218) shows that there is superficial geology in the far eastern corner of the site, of Head Deposits and comprises sand and gravel with lenses of clay and silt. The underlying bedrock comprises the White Limestone Formation, part of the Great Oolite Group, which comprises limestone with rare sandy limestone, marl and mudstone or clay. The Horsehay Sand Formation is mapped at the western edge of the site, which comprises medium to fine grained sand locally cemented into sandstone with thin mudstone and siltstone beds in placed.

Mining or Mineral Extraction

11.4.15 Several limestone quarries/pits are noted on the historical mapping on site or on the boundaries of the site. However, these appear to be small in nature and are likely to have been backfilled.

Hydrogeology

11.4.16 The White Limestone Formation is classified by the Environment Agency as a Principal Aquifer. Hydraulic conductivity and water storage is high in limestone aquifers, due to the fractured and fissured nature of the rock. The hydraulic conductivity in any marls, mudstones or clays in the strata will be lower due to the lower porosity of these beds. However, the thickness of these beds is not so great to affect the overall conductivity of the aquifer in this area.

11.4.17 The groundwater beneath the site has been proven in previous investigations to comprise a layered system, with shallow and deep groundwater bodies. Vertical migration of contaminants is expected between these groundwater bodies.

11.4.18 The groundwater bodies beneath the site are in the Tackley Jurassic (across most of the site) and Banbury Jurassic (along the western edge). Tackley Jurassic is classified by the Environment Agency as having good chemical and quantitative quality and the Banbury Jurassic has good quantitative quality but poor chemical quality. There is an objective for the Banbury Jurassic groundwater body to have good chemical quality by 2027.

11.4.19 The site is not within a groundwater Source Protection Zone (SPZ). However, one licensed groundwater abstraction is present within 1km of the site, at Manor Farm, Middleton Stoney and abstracts from the Thames groundwater 650m southeast of the site.

11.4.20 The site is within a Drinking Water Protected Area and Nitrates Directive area.

Hydrology

11.4.21 A number of small streams issue close to the site boundaries and flow away from the site. These are detailed further in **Chapter 10**.

11.4.22 The closest watercourse, of note, is the River Cherwell approximately 600m to the west of the site. This discharges to the River Thames in Oxford, south of the site.

11.4.23 There are no surface water abstractions within 1km of the site.

11.4.24 The proposed development is in Flood Zone 1 (with low probability of flooding). Further information can be found in **Chapter 10**.

Waste Management and Hazardous Substances

11.4.25 A historical landfill is present 180m northeast of the site at Ardley Wood, Cherwell and was licensed between 1977 and 1985 for inert, industrial, commercial and household waste.

11.4.26 Radioactive materials were stored on the Application Site by Oxford Bio-innovation between 2006 and 2015.

11.4.27 The Southern Bomb Store between Parcels 11 and 35 is a current Upper Tier Control of Major Accidents Hazards (COMAH) Regulations 2015 site. COMAH sites are subject to Regulations because certain dangerous substances are present at these sites and all activities must be managed to reduce the risk from to workers and the public. The Southern Bomb Store is used for general manufacture and/or storage and/or distribution of energetic materials that could potentially cause fire/explosion. It is assumed that the Southern Bomb Store operates all activities to the Regulations.

Previous Investigations and Reports

11.4.28 Further information on the previous investigations and reports can be found in the Ground Condition Desk Study in **Appendix 11.1**.

Vertase F.L.I. Limited. February 2012. Contract Completion Report – POL System – Clean and Make Safe. Report ref. 1246DOR.

11.4.29 This report details and confirms the decommissioning of the Petroleum Oil and Lubrication (POL) system at the former RAF airbase at Upper Heyford.

11.4.30 All waters from tanks were pumped directly to mobile waste water treatment plants. Monitoring and validation of groundwater and soils in the vicinity of the works confirmed the works did not impact on residual site conditions.

Waterman Energy, Environment & Design Ltd. March 2012. Hydrogeological Characterisation and Groundwater Quality Assessment. Report ref. EED10658-109 R 9.3.1 FA.

11.4.31 This report details and confirms the decommissioning of the POL system at the former RAF airbase at Upper Heyford and covers the Flying Field at Heyford Park. The works comprised 42 rotary cored boreholes, 5 rotary open hole boreholes and the installation of 46 monitoring wells.

11.4.32 The shallow groundwater has been marginally impacted from historical site use. Total Petroleum Hydrocarbon (TPH) concentrations were more elevated in the south of the Flying Field. Works including tanks and pipes being emptied and cleaned were being undertaken at the time of the investigation. Following these it was recommended a groundwater monitoring programme of sampling every quarter and testing for speciated TPH and a further review to determine if supplementary works in the most contaminated area of the site would be required.

Waterman Energy, Environment & Design Ltd. May 2012. Preliminary Generic Quantitative Environmental Risk Assessment. Report ref. EED10658-13.2.2 FA.

11.4.33 This report covers the 'New Settlement Area' of Heyford Park, of which the Retained Commercial Area (RCA) covers an area around Parcels 20, 19 and 11 of the site. Overall the works undertaken comprised 41 boreholes and 96 trial pits.

11.4.34 The RCA area is considered suitable for continued commercial use with regards to soil contamination.

11.4.35 Ground gas levels indicate the RCA area can be classified as Characteristic Situation 2 for Situation A development.

11.4.36 Barrier pipe is recommending for water supply pipes due to elevated organic contamination, based on guidance provided in 'Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites', and should be confirmed with Thames Water.

11.4.37 Tank removal and hydrocarbon contamination associated with the tank was recommended to improve the groundwater quality.

11.4.38 A Detailed Quantitative Risk Assessment (DQRA) was proposed to generate threshold values for the soils.

Waterman Energy, Environment & Design Ltd. September 2012. Controlled Water Detailed Quantitative Risk Assessment. Report ref. EED10658-14.1.7 FA.

11.4.39 A Controlled Waters DQRA was undertaken for the 'New Settlement Area' of Heyford Park.

11.4.40 Site Specific Remediation targets were derived using the Environment Agency's Remedial Targets Methodology model. Two sets of target values were derived for a compliance point at the site boundary, depending on the distance of the tank clusters to the site boundary.

11.4.41 Residual environmental liabilities are anticipated to be of low risk after implementation of the remediation strategy (below) using the target values.

Waterman Energy, Environment & Design Ltd. September 2012. Remediation Strategy. Report ref. EED10658-109 S 12.2.2 FA.

11.4.42 This report covers the 'New Settlement Area' of Heyford Park.

11.4.43 The remediation activities include tank and impacted soil removal, backfill excavations with appropriate material and treatment and disposal of groundwater in excavations

Hydrock. Desk Study and Ground Investigation Report. February 2017. Report ref. HPW-HYD-MS-ZZ-RP-G-0001.

11.4.44 This report covers Parcels 10, 16 and 18.

11.4.45 Pervasive elevated concentrations of TPH, Poly-aromatic hydrocarbons (PAH), and Volatile Organic Compounds (VOCs) were detected in the Made Ground in Parcel 10, when compared to residential end use Generic Assessment Criteria (GAC).

11.4.46 No risk identified to Controlled Waters (subject to regulatory approval).

11.4.47 Elevated concentrations of methane were identified in Parcel 10. Using guidance provided in BS 8485:2015 and CIRIA 665, Parcel 10 can be classified as Characteristic Situation 2 for Situation A (all forms of development) and Amber 1 for Situation B (low-rise housing with sub-floor void development) with regards to ground gases. Ground gas mitigation measures will be required.

11.4.48 Strip/trench fill foundations can give an allowable net bearing pressure of 100kN/m² on natural soils, and at least 250kN/m² on natural rock quality strata.

11.4.49 Ground bearing floor slabs are recommended.

11.4.50 Soakaways may be possible. Further infiltration rate testing is required.

11.4.51 Based on guidelines provided in BRE Special Digest 1 the soils at the site can be classified as Design Class 1 for a 50-year design life for concrete construction.

Hydrock. Remediation Method Statement. April 2017. Report ref. HPW-HYD-MS-ZZ-RP-G-3000.

11.4.52 This report covers Parcels 10, 16 and 18.

11.4.53 The following remediation strategy was proposed:

- Asbestos survey of former buildings.
- Asbestos removal.
- Controlled decommissioning, decontamination and demolition of site buildings and ancillary structures.
- Removal of slabs, tanks, existing drainage system and pipework.
- Excavation of hotspots around tanks etc.
- *Ex situ* remediation of hydrocarbon impacted soils.
- Installation of barrier pipe for potable water supply.
- Installation of ground gas protection measures in Parcel 10.
- Installation of engineered cover system in Parcel 10.
- Validation and verification of above.

Evaluation

11.4.54 Site investigation and remediation has been undertaken for several parcels of the site to date. From these works it can be concluded that the groundwater has been marginally impacted by petroleum hydrocarbons from the historical site use as a RAF/USAF airbase in the vicinity of former underground storage tanks. Site specific remedial targets were calculated and a strategy of betterment by removal of tanks and pipework and hydrocarbon impacted soils was recommended for the Flying Field and the central area of the site. Groundwater to the south of Camp Road, away from underground storage tanks, had not been impacted. However, soils in the developed areas of the site may pose a risk to human health, depending on the proposed end use.

PRELIMINARY CONCEPTUAL SITE MODEL

11.4.55 The following potential sources, receptors and pathways have been determined from the baseline conditions of the site, including current and historical land use, geology, hydrogeology, hydrology and waste management/hazardous substances and information presented in previous reports. For further information on the Preliminary Conceptual Site Model refer to the Ground Conditions Desk Study in **Appendix 11.1**.

Potential Sources

11.4.56 The following on and off site current and historical sources of contamination have been identified as, but not limited to, the below:

- Made Ground possibly including metals, metalloids, asbestos, PAH and petroleum hydrocarbons.

- Hydrocarbon fuels associated with the former land use as an airfield and underground storage tanks.
- VOCs and Semi-Volatile Organic Compounds (SVOCs) associated with former land use as an airfield and storage of substances.
- Polychlorinated biphenyls (PCBs) associated with former transformers for electricity substations.
- Ground gases (gases carbon dioxide and methane) from organic materials present in the Made Ground.
- Ground gases (radon) from natural strata.
- Quarry backfill adjacent to the southern boundary of Parcel 18 possibly including metals, metalloids, asbestos, PAH and petroleum hydrocarbons.
- Ground gas (carbon dioxide and methane) from nearby landfills.

Potential Receptors

11.4.57 The following potential receptors have been identified including those required by Part 2A of the Environmental Protection Act 1990 are below:

- Humans (future site users and neighbours, construction and maintenance workers and visitors).
- Development end use (buildings, utilities and landscaping).
- Controlled Waters (Principal Aquifer status of the White Limestone Formation, unnamed streams and Gallos Brook, River Cherwell and River Thames).

Potential Pathways

11.4.58 The following pathways have been identified as those which could be present on site or be established following the proposed development:

- Humans: ingestion, skin contact, inhalation of dust and outdoor air.
- Buildings: methane ingress via permeable soils and/or construction gaps.
- Plant life: root uptake and methane ingress to the root zone.
- Underlying groundwater: migration of contaminant via leachate dispersion through the unsaturated zone in the White Limestone Formation and migration of contaminant into the White Limestone Formation aquifer.
- Surface water: overland flow and base flow from groundwater.

Table 11.4: Summary of Receptor Sensitivity:

Receptor	Receptor Sensitivity			
	High	Medium	Low	Neutral / Not Significant
Human health – site end users	X			
Human health - neighbours		X		
Plant life			X	
Groundwater – Principal aquifer of White Limestone Formation		X		
Surface water – Gallos Brook and other unnamed streams		X		
Aquatic ecosystems		X		

11.5 PREDICTED LIKELY EFFECTS**LIKELY SIGNIFICANT EFFECTS****Effects During Demolition and Construction***Human Health*

11.5.1 Construction workers may be exposed to contaminated soils and perched or shallow groundwater during earthworks and excavation activities, through dermal contact, ingestion or inhalation of dust.

11.5.2 Construction workers may be exposed to ground gases if working in enclosed spaces such as trenches or deep excavations through the inhalation of gas or vapours.

11.5.3 Dust could be generated from stockpiled soils and excavated materials. The general public in the vicinity of the site and neighbours living near the site may be exposed to this fugitive dust.

11.5.4 Asbestos Containing Materials (ACM) may be present in the current buildings that are proposed to be demolished. Demolition activities may release airborne asbestos fibres that construction workers, visitors and the general public/neighbours in the vicinity of the site may inhale.

11.5.5 In the absence of appropriate mitigation measures, these impacts are considered to be of moderate adverse significance to human health. The impacts from inhalation of asbestos fibres is considered to be of major adverse significance to human health.

Controlled Waters

11.5.6 The White Limestone Formation is classified by the Environment Agency as a Principal Aquifer and is abstracted for local water supply.

11.5.7 During demolition and construction activities, spillages and uncontrolled leakages could occur, introducing new sources of contamination.

11.5.8 Construction and earthworks activities could provide potential new migration pathways for free phase hydrocarbons present in the soils or groundwater. These could include underground service routes, building foundations, attenuation features and cut-fill exercises.

11.5.9 Disturbance of contaminated soils and Made Ground has the potential to release or remobilise contamination currently stable in soils or groundwater.

11.5.10 Spills or runoff from dewatering activities, contaminated water, spillages or leakages has the potential to occur into water courses from site activities close to water courses at the edge of the site.

11.5.11 In the absence of mitigation measures, these impacts are considered to be of moderate adverse significance.

Effects During Operation*Human Health*

11.5.12 Future site users and visitors have the potential to be exposed to contamination associated with Made Ground within near surface soils and perched or shallow groundwater in landscaped and garden areas of the site, through dermal contact, ingestion or inhalation of dust. Previous ground investigations have identified PAH, petroleum hydrocarbons and VOC contamination in shallow soils, exceeding the GAC for residential end use.

11.5.13 Gas and vapours have the potential to be produced from the Made Ground, contaminated soils and petroleum hydrocarbons. Ground gases and vapours have the potential to accumulate in unvented buildings and rooms.

11.5.14 Organic (PAH, TPH, VOC) contaminated soils have the potential to permeate through plastic potable water pipelines and affect drinking water.

11.5.15 In the absence of appropriate mitigation measures, these impacts are considered to be of moderate adverse significance. The impacts from accumulation of methane gas in unvented buildings is of major adverse significance.

Plant Life

11.5.16 The proposed development will include gardens and landscaping. Plant life associated with new soft landscaping will have the potential to come into contact with contamination associated with the Made Ground and near surface soils and perched or shallow groundwater. Previous ground investigations have identified PAH, PHC and VOC contamination in shallow soils at the site.

11.5.17 In the absence of appropriate mitigation measures, this impact is considered to be of minor adverse significance.

Controlled Waters

11.5.18 The proposed development is not likely to introduce additional major contamination sources to the soils or Controlled Waters. Fuel and oil leakages have the potential to occur in car park areas or driveways or in relation to commercial use.

11.5.19 Attenuation features may mobilise contaminants in soils or Made Ground into the groundwater.

11.5.20 Underground service routes and building foundations have the potential to introduce new migration pathways for contamination in the shallow soils, Made Ground and Controlled Waters.

11.5.21 In the absence of mitigation measures, these impacts are considered to be of moderate adverse significance.

Table 11.5: Significance of Effects (before Mitigation)

Environmental Effect	Sensitivity of Receptor	Impact Magnitude	Nature of Impact (Permanent/Temporary)	Significance
Demolition/Construction				
Construction workers exposed to contaminated soils and groundwater.	High	Medium	Temporary/Permanent	Moderate adverse
Construction workers exposed to ground gases.	High	Medium	Temporary	Moderate adverse
General public and neighbours inhale soil dust.	High	Medium	Temporary	Moderate adverse
Asbestos fibres released and inhaled by general public/neighbours and construction workers.	High	High	Permanent	Major adverse
Spillages/leakages into Controlled Waters.	Medium	Medium	Temporary	Moderate adverse
New migration pathways created for hydrocarbons to Controlled Waters.	Medium	Medium	Permanent	Moderate adverse
Release or remobilise contamination into Controlled Waters.	Medium	Medium	Temporary/Permanent	Moderate adverse
Operation				
Site end users and visitors exposed to contamination.	High	Medium	Permanent	Moderate adverse
Gas and vapours accumulate in unvented buildings.	High	High	Permanent	Major adverse
Organic contamination permeates into potable water pipelines.	High	Medium	Permanent	Moderate adverse
Plant life exposed to contamination.	Low	Low	Permanent	Minor adverse
Fuel/oil leakages from cars to Controlled Waters	Medium	Low	Permanent	Minor adverse
Attenuation features mobilise contaminants into Controlled Waters.	Medium	Medium	Permanent	Moderate adverse

Environmental Effect	Sensitivity of Receptor	Impact Magnitude	Nature of Impact (Permanent/Temporary)	Significance
New migration pathways for contamination to Controlled Waters.	Medium	Medium	Permanent	Moderate adverse

11.6 MITIGATION AND ENHANCEMENT

11.6.1 The following mitigation and enhancement methods are to be undertaken to lower the adverse impacts on the site during the demolition and construction phase and for the completed development.

All Phases

11.6.2 There is the potential for contamination to be present in the Made Ground, shallow soils and groundwater at the site. Ground investigation would be undertaken at the site to confirm the ground and groundwater conditions and levels of contamination in the soils and groundwater across the site. Following this, a Generic Quantitative Risk Assessment and if necessary a Detailed Quantitative Risk Assessment would be carried out in accordance with CLR11. If unacceptable risks are identified, a Remediation Strategy should be produced and agreed with statutory bodies, detailing remediation methodologies to mitigate these risks. Validation works and reporting should be undertaken to document that these works have been carried out. This will be subject to consultation and agreement with the NHBC and Cherwell District Council.

Demolition and Construction Phase

Human Health

11.6.3 Construction workers are subject to health and safety requirements under the Construction (Design and Management) Regulations 2015 and the Control of Substances Hazardous to Health (COSHH) Regulations (2002). Construction workers and all site visitors will be required to have appropriate personal protective equipment (PPE) to minimise dermal contact, ingestion and inhalation of dust with contaminated soils and perched or shallow groundwater.

11.6.4 Access into enclosed spaces would be minimised as far as possible. If required, adequate ventilation would be provided and air monitors be utilised during the works. All personnel will be appropriately trained and have the required PPE and equipment.

11.6.5 Dust generated from stockpiles or excavated materials will be mitigated with dust suppression measures during dry and/or windy weather conditions.

11.6.6 Asbestos surveys would be undertaken for all buildings to be demolished. If ACM is identified, mitigation measures in line with CAR 2012 will be undertaken during demolition, including appropriate PPE and dust suppression. All ACM removed will be disposed of to an appropriate waste facility.

11.6.7 With the above mitigation measures in place, the impacts to human health during demolition and construction are considered to be of neutral significance.

Controlled Waters

11.6.8 During all refuelling activities, drip trays will be used to mitigate any spills on to the ground. If spills or leaks of fuel or oils do occur during demolition or construction works, spill kits will be available at all times and all spills and leaks will either be absorbed by the spill kit or the spillages excavated and sent for treatment or offsite disposal.

11.6.9 Any petroleum hydrocarbon free product identified in soils or groundwater will be removed by excavation or pumping and will be treated or disposed of offsite. This will remove the potential for migration through new migration corridors.

11.6.10 With the above mitigation measures in place, the impacts to Controlled Waters during demolition and construction are considered to be of neutral significance.

Completed Development

Human Health

11.6.11 If the ground investigation and subsequent risk assessments identify contamination in the shallow soils is likely to pose a risk to human health, remediation measures will be undertaken during the construction phase to mitigate these risks.

11.6.12 If shallow soils are pervasively contaminated, the remediation strategy will have measures to prevent future site users being exposed to contaminated soils or perched or shallow groundwater through dermal contact, ingestion or inhalation of dust in the form of disposal or an engineered cover system (materials management).

11.6.13 If ground gases are present at the site, ground gas protection measures will be installed in line with CIRIA 665.

11.6.14 Barrier pipe will be recommended if organic contamination is identified in soils or shallow groundwater where water pipelines are installed.

11.6.15 If the ground investigation and subsequent risk assessments identify contamination in the groundwater at the site, remediation will be required. The removal of the sources of contamination will be recommended during the demolition/construction phase.

11.6.16 With the above mitigation measures in place, the impacts to future site users and visitors are considered to be of neutral significance.

Plant Life

11.6.17 If the ground investigation and subsequent risk assessments identify contamination in the shallow soils is likely to pose a risk to plant life, remediation measures will be undertaken during the construction phase to mitigate these risks.

11.6.18 Mitigation measures may include the importation of clean soils for garden areas and landscaping for plant growth.

11.6.19 With the above mitigation measures in place, the impact to future plant life is considered to be of minor beneficial significance due to the potential improvement of plant life for future end users at the site.

Controlled Waters

11.6.20 If the ground investigation and subsequent risk assessments identify contamination in the shallow soils is likely to pose a risk to Controlled Waters, remediation measures will be undertaken during the construction phase to mitigate these risks.

11.6.21 The inclusion of interceptor tanks in the drainage system from roads and car park areas will reduce the impact of fuel leakages on Controlled Waters.

11.6.22 Any attenuation features would be designed to mitigate against the mobilisation of contaminants in the soils into the groundwater and surface waters at the site.

11.6.23 As above, any free product identified in soils or groundwater will be removed by excavation or pumping and will be treated or disposed of offsite. This will remove the potential for migration through new migration corridors.

11.6.24 With the above mitigation measures in place, the impact to Controlled Waters is considered to be of minor beneficial significance due to the potential improvement of groundwater at the site.

Table 11.6: Delivery of Mitigation Measures

Proposed Mitigation	Means of Implementation	How Measure would be Secured
Undertake Generic Quantitative Risk Assessment in accordance with CLR11. If unacceptable risks are identified, a Remediation Strategy produced to mitigate risks.	Carry out a Phase 2 Ground Investigation and Risk Assessment. If risks identified, produce a Remediation Strategy.	Planning condition. Validation/verification of remediation.
Minimise dermal contact, ingestion and inhalation of dust between construction workers and contaminated soils and/or waters	Appropriate Personal Protective Equipment (PPE).	Construction (Design and Management) Regulations 2015 and the Control of Substances Hazardous to Health (COSHH) Regulations (2002)
Minimise access into enclosed spaces by construction workers. If required, mitigate against inhalation of ground gases.	Provide adequate ventilation, air monitors. Provide appropriate training and PPE.	Construction (Design and Management) Regulations 2015
Limit dust from stockpiles to reduce inhalation by construction workers, visitors, site end users and neighbours.	Dust suppression during dry or windy weather conditions.	Demolition/Enablement Specifications
Limit asbestos fibre release during demolition.	Asbestos surveys undertaken for all buildings to be demolished. Mitigation measures in line with CAR 2012. Removal of all asbestos waste to licensed waste facility.	CAR 2012. Demolition/Enablement Specifications
Limit release of fuels or oils during refuelling activities.	Drip trays during refuelling and provision of spill kits if a spill occurs.	Demolition/Enablement Specifications
Remove the potential for	Excavate/pump free product	Remediation Strategy.

Proposed Mitigation	Means of Implementation	How Measure would be Secured
migration of contamination via groundwater.	from soils or groundwater.	Planning Condition.
If shallow soils are contaminated, remove pathway between contaminated soils and site end users and plant life.	Installation of a cover system or Materials Management.	Remediation Strategy. Planning Condition.
If ground gases are present, prevent ground gas migration into unvented buildings.	Installation of ground gas protection measures in the form of sub-floor voids and gas membranes.	Remediation Strategy. Planning Condition.
If organic contamination encountered in soils, remove pathway between soils and potable water pipes.	Install clean soils around potable water pipelines and use Protectaline pipework.	Remediation Strategy. Planning Condition.
Remove pathway between fuel leakages from cars and Controlled Waters.	Installation of interceptor tanks.	Design
Restrict mobilisation of contaminants in attenuation features.	Design attenuation features to mitigate against the mobilisation of contaminants in soils.	Design

11.7 CUMULATIVE AND IN-COMBINATION EFFECTS ASSESSMENT

11.7.1 Cumulative and in-combination effects can result from a combination of impacts, which on their own may not be significant but when combined with others, could generate significant effects.

11.7.2 The assessment with regards to geology, hydrogeology and ground conditions are highly site specific, with assessment limited to the site only. However, potential cumulative effects are listed in **Table 10.5** below.

Table 11.7: Cumulative and In-combination Effects Assessment

Site	Nature of Cumulative Effect	Significance
Village Centre North, Heyford Pye Homes, Upper Heyford Land South west of Camp Road, Heyford	Creation of cumulatively more waste, from which dust has the potential to accumulate and be inhaled by both site users, visitors and construction workers.	Minor adverse significance.
Parcel 15, Heyford Park Masterplan	Creation of new migration pathways between sites.	Minor adverse significance.

11.8 CONCLUSIONS

Introduction

11.8.1 This Chapter assessed the likely significant effects of the proposed development on the environment in respect of the ground conditions, specifically in relation to:

- Site History
- Geology
- Hydrogeology
- Hydrology

Baseline Conditions

11.8.2 The site is a former RAF airbase, constructed in 1915 and closed by 1994.

11.8.3 The geology of the site comprises Head Deposits of sand and gravel with lenses of clay and silt as superficial deposits in the far eastern corner of the site, overlying bedrock of the White Limestone Formation of limestone with far sandy limestone, marl and mudstone or clay. The Horsehay Sand Formation of sand locally cemented into sandstone outcrops at the western edge of the site.

11.8.4 The White Limestone Formation is classified by the Environment Agency as a Principal Aquifer. The groundwater has been proved in previous ground investigations to comprise a layered system of shallow and deep groundwater bodies. One local licensed groundwater abstraction is present 650m southeast of the site.

11.8.5 The closest watercourse of noted is the River Cherwell approximately 600m west of the site.

11.8.6 A historical landfill is 180m northeast of the site. Radioactive materials were stored on the site between 2006 and 2015.

11.8.7 Previous ground investigations at and in the vicinity of the site have identified localised impacted groundwater and contaminated Made Ground.

Likely Significant Effects

11.8.8 During the demolition and construction phase, the ground workers may be exposed to contaminated soils and groundwater from dermal contact, ingestion or inhalation or inhalation of ground gases. Neighbours and visitors may inhale fugitive dust. Asbestos Containing Materials (ACM) may be present in former buildings and airborne fibres will be released upon demolition and inhaled by ground workers, neighbours and visitors. These impacts are considered to be of moderate adverse significance, and major adverse significance in relation to ACM release.

11.8.9 During the demolition and construction phase Controlled Waters may be impacted by spillages or leakages and runoff from dewatering activities, migration pathways could be created during construction of service routes, foundations, attenuation features or cut-fill exercises and contaminants could be released or remobilised during disturbance of contaminated soils. These impacts are considered to be of moderate adverse significance.

11.8.10 Once the development is complete, future site users may be exposed to contamination through dermal contact, ingestion or inhalation of fugitive dust, inhale ground gases through accumulation of unvented buildings and rooms and ingest impacted drinking water through permeation of organic contamination through potable water pipelines. These impacts are considered to be of moderate adverse significance.

11.8.11 New planting for the proposed development may be impacted by contamination from soils or groundwater through root uptake. This impact is considered to be of minor adverse significance.

11.8.12 No additional major contamination sources are likely to be introduced with the proposed development, except for fuel or oil leakages around car park areas of driveways. Attenuation features may also mobilise contaminants in soils or groundwater. As above, service routes and foundations may introduce new migration pathways for contaminants. These impacts are considered to be of moderate adverse significance.

Mitigation and Enhancement

11.8.13 Ground investigation, Generic, and if required, Detailed Quantitative Risk Assessment is proposed for the site to confirm the ground and groundwater conditions and levels of contamination in the soils and groundwater across the site. If unacceptable risks are identified, a Remediation Strategy would be produced to detail the remediation required to mitigate these risks. The remediation will be carried out during the demolition and construction works. Validation works and reporting should then be undertaken to confirm these have been carried out.

11.8.14 During demolition and construction works, the following mitigation measures would be in place and will reduce the impact to neutral significance for human health and Controlled Waters:

- Construction workers are subject to health and safety requirements under the Construction (Design and Management) Regulations 2015 and the Control of Substances Hazardous to Health (COSHH) Regulations (2002). Appropriate PPE would also be worn to minimise contact (dermal, ingestion and inhalation) of contaminated soils and groundwater.
- Ventilation, air monitors and appropriate training and equipment will be utilised if access into enclosed spaces is necessary.
- Dust suppression would be used where stockpiled soils or excavated materials could create dust during dry/windy conditions.
- Asbestos surveys would be undertaken prior to demolition and asbestos removal would be undertaken in accordance with CAR 2012 using appropriate PPE and dust suppression measures. All ACM removed will be disposed of at an appropriate waste facility.
- Drip trays to be used during refuelling. Spill kits available if spills do occur, or if spill kits are unable to absorb the spill, excavation and disposal or treatment of soils/groundwater.
- Free product in soils or groundwater is to be removed by excavation or pumping and treated or disposed of offsite to remove the potential for migration.

11.8.15 The following mitigation measures will be put in place if required in the completed development and will reduce the impact to neutral significance for human health and minor beneficial significance for Controlled Waters and plant life:

- Removal of pathway between contaminated soils/groundwater and site end users and plant life via excavation and disposal or an engineered cover system.
- Ground gas protection measures if ground gases are identified.
- Barrier pipe if organic contamination is in shallow soils or groundwater.
- Source removal of contamination hotspots.
- Interceptor tanks within drainage systems to reduce impact of fuel/oil from vehicles on Controlled Waters.
- Design of attenuation features to mitigate against mobilisation of contaminants.
- Removal of free phase product from soil or groundwater.

Conclusion

11.8.16 With the mitigation measures integrated into the design, construction and operation of the proposed development, it is concluded that the proposed development is acceptable from a ground conditions perspective, with all potential effects assessed as being of either 'negligible' or 'minor beneficial' significance.

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