12 GEOLOGY, SOILS AND CONTAMINATION

12.1 INTRODUCTION

12.1.1 This chapter describes the ground conditions in terms of the geology, the soils and contamination issues, at Heyford Park. It considers the potential ground engineering impacts of the proposed development of the site, during the construction phases of the proposed development and any potential cumulative and residual effects of the proposed development. Descriptions of the overall development are provided elsewhere within Chapter 3 and this chapter should be considered within the overall context of this ES.

Technical Assumptions and Limitations

12.1.2 This chapter has been compiled using desk study information and previous ground investigation data prepared by previously appointed consultants on behalf of NOC. Assumptions are based on this previous data however please note that Arup has neither checked nor verified any of that data.

12.1.3 Legislation, best practice, contaminated soil test methods etc. have all changed since the original ground investigation was carried out approximately 10 years ago. It is recommended that, as part of ongoing detailed site specific investigation to inform the detailed proposals and strategies, further ground investigation, sampling and testing, interpretation, analysis and appropriate risk assessments are carried out for final detailed design purposes.

The Proposed Development

12.1.4 This ES has been prepared to accompany the outline planning application. The key aspects of the proposed development relevant to this chapter are considered to be:

- the continued re-use of approximately 70 existing houses;
- the construction of approximately 1,005 new houses;
- the change of use of existing buildings for employment generating purposes;
- the construction of new buildings and re-use of existing buildings to provide shopping, community centre and other commercial facilities;
- the construction of a new primary school;
- the provision of public open space;
- the construction of new roads, footpaths, cycle ways and parking facilities; and
- the planning of structural landscaping.

Background

12.1.5 The presence of ground contamination can give rise to a range of different adverse effects. These principally concern:

- pollution of groundwater;
- pollution of surface waters;
- human toxicology;
- health and safety;
- aggressive attack on construction materials;
- ingress of potentially explosive and/or toxic gases into buildings;

- plant growth restrictions and effects on ecosystems.

12.1.6 The previous uses of the site will determine the potential for ground contamination and consequently a brief history is presented.

Structure of this Chapter

12.1.7 This chapter contains the following sections:

1: Introduction

2: Outlines the applicable policy framework for ground contamination in the UK;

3: Provides details on the methodology for the assessment;

4: Presents the baseline ground conditions at the Site and potential contamination;

5: Presents a conceptual ground model;

6: Presents the risk assessment and mitigation measures.

7: Comments on residual effects.

8: Recommendations for further work in connection with geology, soils and contamination issues.

12.2 POLICY FRAMEWORK

Contamination

12.2.1 **Environmental Protection Act, 1990**: Current UK legislation on contaminated land is principally contained in Part IIA of the Environmental Protection Act, 1990, which was retrospectively inserted by Section 57 of the Environment Act 1995.

12.2.2 The Contaminated Land Regulations came into force on 1st April 2000 when the Government issued its Circular 02/2000, dated 20 March 2000. The circular has subsequently been updated as Circular 01/2006, dated September 2006.

12.2.3 The legislation endorses the principle of a "suitable for use" approach for contaminated land, where remedial action is only required if there are unacceptable risks of health or the environment, taking into account the use of the land and its environmental setting.

12.2.4 The legislation defines "Contaminated Land" as:

"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 significant harm is being caused or there is a significant possibility of significant harm being caused; or pollution of controlled waters is being, or is likely to be, caused."

12.2.5 The definition of "Contaminated Land" embodies the concept of risk assessment. The statutory guidance describes the risk assessment methodology in terms of **"significant pollutants"** and **"significant pollutant linkages"** within a source-pathway-receptor model of the site. The model comprises:

- the principal pollutant hazards associated with site (the sources);
- the principal targets at risk from the identified hazards (the receptors);
- the existence, or absence, of plausible pathways, which may exist between the identified hazards and receptors (the pathways).

12.2.6 For land to be identified as "Contaminated Land" all three elements of a significant pollutant linkage must be present.

12.2.7 The advantages of a risk assessment approach to the assessment of "Contaminated Land" are:

- it is systematic and objective;
- it takes into account the particular end-use characteristics;
- it provides a rational, transparent and defensible basis for discussion about a proposed course of action between all parties.

12.2.8 **Water Resources Act 1991**: Under Section 161 of the Water Resources Act 1991, the Environment Agency can serve a Works Order on a person or persons who cause or knowingly permit pollution of controlled waters, which includes both surface water and groundwater.

12.2.9 **Water Act 2003**: The Water Act modernises water legislation and gives powers to the Environment Agency that enable it to better manage the balance between the needs of society and the environment. The Water Act revises definitions in Section 78A of the Environmental Protection Act, 1990 by defining contaminated land in terms of "significant pollution", rather than simply "pollution". The Act also clarifies the groundwater above the saturated zone is **not** "controlled waters".

12.2.10 **Planning Policy Guidance Note 23 (PPG23) – Planning and Pollution Control Nov 2004**: Whereas the contaminated land regime, set out in the Environmental Protection Act, 1990 and its accompanying regulations, deals with existing conditions of land, remediation of contamination from historic land uses is also managed through the planning regime. At the time of a proposed redevelopment, the Local Authority may require remediation works to be undertaken as part of the redevelopment of the site for the new land use. These works usually encompass site investigation, consultation and remediation works.

12.2.11 Whilst the planning and pollution control systems are separate, they are complementary in that both are designed to protect the environment from potential harm caused by a development, but with different objectives. Historic land contamination is a material planning consideration which must be taken into account at various stages in the planning process, including proposals for the future use and redevelopment of a site.

12.2.12 A planning authority may require remediation works additional to those that would be required under Part IIA of the Environmental Protection Act, 1990 obligations. For example, in situations where the new land use is more "sensitive" in health and safety terms than the existing land use or where the process of ground disturbance due to redevelopment leads to increased environmental risks.

12.2.13 The presence of contamination in land can present risks to human health and the environment, which adversely affect or restrict the beneficial use of land, but development presents an opportunity to deal with these risks successfully.

12.2.14 Contamination is not restricted to land with previous industrial uses, it can occur on greenfield as well as previously developed land and it can arise from natural sources as well as from human activities.

12.2.15 CLEA UK: Ground contamination of the site has been assessed with reference to the Contaminated Land Exposure Assessment Model (CLEA UK) and appropriate Soil Guideline Values (SGV) (DEFRA 2002).

Contaminated Land Waste Management and Disposal

12.2.16 Spoil generated from development will usually require disposal and or recovery in accordance with the **Environmental Protection Act 1990**, the **Landfill (England and Wales) Regulations 2002** (as amended), the **Waste Management Licensing Regulations 1994**, the **Protection (Duty of Care) Regulations 1991** and any other relevant statutory instrument and guidance.

12.2.17 The classification of excavation arisings should be in accordance with the **List of Waste Regulations (LoWR) 2005** and the **Hazardous Waste Regulations (HWR) 2005**. The Hazardous Waste Regulations 2005 and the List of Waste Regulations came into force on 16 July 2005 and implement the provisions of the European Hazardous Waste Directive (91/689/EEC) into England and Wales. The principal, aim of the Hazardous Waste Regulations 2005 is to provide a definition of hazardous waste consistent with other EU member states and to ensure the environmentally sound management and regulation of such wastes.

12.2.18 The first part of the Hazardous Waste Regulations 2005 came into force on 16 April 2005, with the requirement:

> *"… where hazardous waste is produced at, or removed from, any premises other than exempt premises, the premises must be notified to the Environment Agency...".*

12.2.19 This means that any businesses producing hazardous waste (including construction sites) have a legal duty to register with the Environment Agency any premises where hazardous waste is generated. Certain types of premises are exempt from the requirement to register if less than 200kg of hazardous waste are produced at specified premises in any twelve month period.

12.2.20 The removal and disposal of hazardous waste will need to be in accordance with the Hazardous Waste Regulations 2005. Contractors are required to implement a new consignment note system as required by the Hazardous Waste Regulations 2005. Controlled waste transfer notes shall be maintained for the removal of non-hazardous waste.

12.2.21 Contractors are required to provide copies of documentation confirming that the landfill site(s) is/are licensed to accept the excavated contaminated soil (waste) under their landfill permit. In addition, Contractors are required to provide copies of all Certificates of Registration issued to haulage contractors under the Control

of Pollution (Amendment Act) 1989 and the Controlled Waste (Registration of Carrier and Seizure of Vehicles) Regulation 1991.

European Landfill Directive/Landfill Regulations

12.2.22 The **Landfill (England and Wales) Regulations 2002** (the Landfill Regulations) came into force on 16 July 2004, and map out progressive measures to prevent or reduce the negative effects of landfilling waste on the environment and on human health. The Regulations define a framework for:

- the classification of landfill sites (hazardous, non-hazardous and inert);
- a ban on co-disposal of hazardous and non-hazardous wastes from July 2004;
- the requirement to pre-treat hazardous waste by 16 July 2004;
- procedures for waste acceptance to be adopted at landfills from July 2005; and
- waste acceptance criteria (WAC) based on the types of waste for hazardous and inert landfills.

12.2.23 The Landfill Regulations require that before waste is accepted at a landfill site the holder or operator must be able to show that the waste can be accepted according to the permit conditions and the waste acceptance criteria (WAC).

12.2.24 The Waste Acceptance Criteria are maximum limits for both total and leachable characteristics that cannot be exceeded for particular classes of waste when disposing of that particular waste. They are set for hazardous waste, stable non-reactive hazardous waste (SNRHW) placed in engineered cells in non-hazardous sites, and inert wastes. There are currently no Waste Acceptance Criteria for non-hazardous waste. The implication is that if waste exceeds the Waste Acceptance Criteria it has to be treated to meet the Waste Acceptance Criteria before disposal. Since July 2004, all hazardous waste must be pre-treated before disposal.

Waste classifications

12.2.25 The soils arising from any excavation works will require classification before any disposal to a suitably licensed waste disposal facility. There are now three types of landfill (inert, non-hazardous and hazardous) and four principal classifications of waste, as outlined below:

12.2.26 **Inert**: The classification of inert waste is relatively restrictive. The material must match a list of specific materials listed in the Landfill Regulations. Generally inert waste comprises uncontaminated natural soils. If this is the case the material may be disposed of to an inert landfill if it satisfies the inert Waste Acceptance Criteria. Natural soils (excluding topsoil and organic materials) do not require testing for the inert Waste Acceptance Criteria. "Soil and stones" from contaminated sites must satisfy a list of inert Waste Acceptance Criteria. Inert excavation arisings may also be used as a construction material on other sites;

12.2.27 **Non-Hazardous**: If the waste is not inert and not hazardous then by default the waste is non-hazardous. Non-hazardous waste may be sub-classified based on the biodegradable content.

12.2.28 **Hazardous**: Defined by the EWC (European Waste Directive) and the analysis of "total" chemical determinands to assess the hazard properties. It must be treated in accordance with the principles set out by the Landfill Directive (BPEO). Treatment may change the classification to non-hazardous (as defined by the

EWC and the "total" chemical content). Subsequent to treatment, and the classification following treatment, the waste may only be disposed of if it satisfies the leachability Waste Acceptance Criteria for the relevant classification of landfill;

12.2.29 **Stable Non-Reactive Hazardous Waste**: Defined in a similar manner to hazardous waste but satisfying stricter Waste Acceptance Criteria. Subsequent to treatment, it may be disposed of in specifically designed separate cells in non-hazardous landfills (if the operator has obtained a permit to operate these cells).

12.3 METHODOLOGY

12.3.1 An assessment of baseline ground conditions at the site has been made from readily available information on site history, geology, hydro-geology and potential contaminative uses on and adjacent to the site and from previous ground investigations and historical data relating to the site.

Sources of Information

12.3.2 The sources of information included:

- Aspinwall & Company Limited, June 1997, "RAF Upper Heyford Land Quality Assessment, Phase Two: Intrusive Survey Factual Report, Appendices".
- Aspinwall & Company Limited, August 1998, "Upper Heyford New Settlement Environmental Statement – Geological and Hydrological Issues".
- The Barton Willmore Planning Partnering et al, June 1999, "Heyford Park - Environmental Statement".
- The Barton Willmore Planning Partnering et al, June 1999, "Heyford Park - Environmental Statement -Technical Appendices Volume 2".
- Enviros Consulting Limited, December 2005, "Land Quality Assessment for the Acquisition and Development of Heyford Park".
- Roger Evans Associates Ltd, October 2006, "Heyford Park Environmental Statement – List of Terms and Corresponding Maps".
- Landmark Envirocheck report. Distances quoted in the Envirocheck report are measured from grid reference 451450 226560, located approximately at the centre of the site.
- Landmark Envirocheck Historical Maps & Datasheets, Jan 2007, Order Number: 20841665_1_1 for Site at 451000, 226800.

Previous Ground Investigation by Aspinwall

12.3.3 Aspinwall & Company was commissioned by Defence Estate Organisation to undertake ground investigation works, groundwater and spring water sampling, analysis and assessment on site during March 1997. The ground investigation was designed to investigate potential pollutants sources.

12.3.4 Only the appendices of Aspinwall's Intrusive Survey Factual Report dated June 1997 have been made available and reviewed as part of this assessment and included details of groundwater and surface water abstractions, results of the soil vapour survey, trial pit logs, results of chemical testing from trial pits, borehole logs, permeability (Slug) testing, details of purging completed at boreholes 1 to 7, results of chemical testing for boreholes and springs and DERA Radiation Protection Services (DRPS) Radiological Investigation.

Contamination Assessment Criteria

12.3.5 To simplify the assessment of risks, UK statutory guidance allows the use of authoritative and scientifically based guideline values for the initial hazard screening assessment, provided that such guideline values are available and are appropriate to the site circumstances of the pollutant linkages in question. The following screening guidelines have been used for the contamination assessment.

Soil Screening Guidelines

12.3.6 The following guidelines have been used for the assessment of soil contamination. Wherever possible and available UK Contaminated Land Exposure Assessment (CLEA) soil guideline values or Arup Generic Assessment Criteria have been used. Where neither of these screening values is available, screening values from superseded references have been used:

- UK Contaminated Land Exposure Assessment (CLEA) soil guideline values (SGVs) for residential land-use (without plant uptake), where available.
- Arup Generic Assessment Criteria (GAC) derived using CLEA 2002 or RISC 4 software where no SGVs are available.
- Dutch Serious Risk Concentrations (SRC) for human health where no SGVs or Arup Generic Assessment Criteria are available.
- UK ICRCL Guidance Note for asbestos on contaminated sites.
- The Dutch Intervention Values (DIV) for soil for those contaminants where no SGVs have been published and Arup GAC and Dutch SRCs are not available or appropriate.
- BRE Special Digest 1 "Concrete in aggressive ground".

12.3.7 The screening values used for the assessment of risks at the site are shown in Table G.01 below. Screening values represent "intervention values", which, if exceeded, indicate potentially unacceptable risks to site users or other receptors. The Environment Agency state that screening values can be used in support of the application of the statutory regimes addressing land contamination (the "sources" in source-pathway-receptor model). Exceedances of screening values may also indicate that further investigation and/or remedial action may be required to protect human health.

Table G.01: Screening Values for Soils			
Parameters	**Unit**	**Screening Value**	**Ref**
Benzo[a]pyrene	mg/kg	1.34	A
Water Soluble Sulphate	g/l	1.2	BRE
Arsenic	mg/kg	20	C_1
Chromium	mg/kg	130	C_1
Lead	mg/kg	450	C_1
Mercury	mg/kg	8	C_1
Nickel	mg/kg	50	C_1
Selenium	mg/kg	35	C_1
Cadmium	mg/kg	30	C_2
TPH/Min Oil (C10 -C40)	mg/kg	1,000	Ass
Total PAH (Sum of 16 USEPA PAHs)	mg/kg	40	D
Copper	mg/kg	8,600	D_{SRC}
Asbestos	%w/w	0.001/absent	12
Zinc	mg/kg	330	L

Key:

A	Arup Generic Assessment Criteria derived using CLEA 2002 or RISC 4
BRE	BRE Special Digest 1.
C_1	CLEA Soil Guideline Values for residential use with plant uptake.
C_2	CLEA Soil Guideline Values for residential use with no plant uptake.
D	Dutch Intervention Values for Soil
D_{SRC}	Dutch Serious Risk Concentration (human health)
L	LQM CIEM Generic Assessment Criteria for residential with plant uptake
Ass	An Arup assumed value set lower than the Dutch Intervention Values of 5,000mg/kg.

Significance Criteria

12.3.8 Assessing the significance of environmental effects is not straightforward, since there are frequently no standards against which to make a comparison. Where this is the case, this chapter has relied upon reasoned arguments based on the advice and views of appropriate consultees and the specialist expertise of the study team.

12.3.9 In order to aid judgement of the importance of potential environmental effects and to ensure consistency between topics, significance criteria have been defined which follow the generic framework shown in Table G.02 below. These criteria are based on guidance set out in the Environmental Impact Assessment Regulations 1999.

Table G.02: Significance criteria

Degree of Significance	Assessment Criteria
Severe	Severe irreversible detrimental effect to human health or irreversible reduction in the quality of a potable groundwater or surface water resource of local, regional or national importance. Irreversible or severe detrimental effect on animal or plant populations. Irreversible detrimental effect to nationally important geological feature. Irreversible detrimental effect to building structure resulting in collapse or demolition.
Major	Irreversible moderate detrimental effect to human health. Temporary or irreversible reduction in the quality of a potable groundwater or surface water resource of local, regional or national importance. Irreversible or severe temporary detrimental effect on animal or plant populations. Irreversible detrimental effect to nationally important geological feature. Irreversible detrimental effect to building structure resulting in collapse or demolition.
Moderate	Long-term minor or short-term moderate detrimental effect to human health. Slight or moderate, local-scale reduction in the quality of potable groundwater or surface water resources of local, regional or national importance, reversible with time. Reversible widespread reduction in the quality of groundwater or surface water resources used for commercial or industrial abstractions. Medium-term, reversible detrimental effect on animal or plant populations. Medium-term, reversible detrimental effect to nationally important geological feature. Detrimental effect to building structure requiring remedial engineering works.

Table G.02: Significance criteria	
Degree of Significance	**Assessment Criteria**
Minor	Short-term minor detrimental effect to human health. Temporary, slight or moderate detrimental effect in the quality of groundwater or surface water resources that are used for, or have the potential to be used for, commercial or industrial abstractions. Short-term, reversible detrimental effect on animal or plant populations. Short-term, reversible detrimental effect to nationally important geological feature. Detrimental effect to building structures not requiring remedial engineering works.
Negligible	No appreciable impact on human, animal or plant health, potable groundwater or surface water resources or geological feature of importance.

12.4 BASELINE CONDITIONS

Site Description, Location and Topography

12.4.1 Heyford Park is located in North Oxfordshire at National Grid Reference 451450E, 226560N, east of the Cherwell Valley and covers an area of approximately 516 hectares. The Birmingham to Marylebone railway runs close to the site's eastern perimeter while the Birmingham to Oxford railway service operates in the Cherwell Valley to the west. The nearest villages to the airbase are Upper and Lower Heyford. The site lies approximately 8km north-west of Bicester (the nearest major service centre) and some 6km west of Junction 10 of the M40.

12.4.2 The site, a former airbase, contains a wide range of civilian and military buildings and associated areas of hard standing mainly located to the north of Camp Road, the principal access route which bisects the base. To the south of this road, the area includes residential housing, a disused petrol station, supermarket, disused school, gymnasium, disused hospital and recreational facilities.

12.4.3 Throughout the site there is a Petroleum Oil and Lubricant (POL) system, which is an above and below ground system, with extensive infrastructure of pipe work, pumps, valves, storage tanks and aircraft refuelling ancillaries across the airbase. The POL system was originally connected to the national fuel grid and although that connection still exists, it has been decommissioned by the installation of a cut-off valve located off-site. NOC intend to install a second cut-off valve within the boundary of the site. The Barton Willmore Planning Partnering et al (1999) environmental assessment reports that the tanks were cleaned and were filled with alkaline water or water. The environmental assessment also states that the only tanks not drained, cleaned and filled were those at POL 19 which were used by QEK for the storage and supply of diesel and petrol at

the time the report was prepared. No documentation to confirm either a specification of the cleaning and filling or certificates of completion has been located to date.

12.4.4 The Petroleum Oil and Lubricant (POL) distribution system comprises an estimated 13,000m of below ground pipework. The majority of this pipework is 150mm diameter although there is also 100mm diameter pipework in some areas.

12.4.5 There are three basic types of tank in the POL system; the first are early 1970s large capacity (760m^3 to 4 754m^3) circular, semi-buried, steel lined and number 10 across the site. The second are 12 number sites with smaller capacity tanks (typically 50,000 or 100,000 US gallons) dating from the 1950-60s. They comprise single or twin steel tanks enclosed in a concrete pit. The third type are four sites where petrol or diesel was stored and these tanks number either 6 or 12 underground tanks, each with a volume of 14,500 US gallons.

Geology

12.4.6 Information on the geology is based partly on the solid and drift 1: 63,360 geological map (Sheet 218 Chipping Norton – 1968 publication). Reference is also made to the British Regional Geology Memoir for London and the Thames Valley (4th edition 1996), for modern nomenclature of the middle Jurassic strata present. The shallow ground conditions are taken from the Aspinwall's report dated June 1997, "RAF Upper Heyford Land Quality Assessment, Phase Two: Intrusive Survey Factual Report, Appendices".

12.4.7 **Made Ground**: Aspinwall report that their ground investigation generally encountered a layer or layers of silt or clay, often sandy, and comprising a significant proportions of gravel to cobble sized pieces of limestone. This unconsolidated material was underlain by weathered limestone bedrock. The average depth to bedrock is reported to be 1.5m with a range of 0.8m to 3.0m.

12.4.8 Aspinwall report that in 60 of the trial pits Made Ground was encountered and that in many instances the overlying material appeared to be natural, suggesting that at a number of locations the natural material may have been excavated and then replaced following completion of whatever work has been carried out.

12.4.9 **Solid Geology**: The Solid Geology of the site comprises the Middle Jurassic **Great Oolite Limestone** – White Limestone Formation (part of the Great Oolite Group) which consists predominantly of fine grained limestones up to 20m thick. Beneath the White Limestone Formation, the Lower part of the Great Oolite Group comprises a series of thin interbedded limestones, sandstones and mudstones. The overall thickness of Great Oolite Group is about 25m.

12.4.10 The underlying **Inferior Oolite Group** is thin (<10m) and includes sand, sandstones and thin mudstone of the Lower Estuarine Series, and sandy limestone, shelly limestones and sandstones of the Northampton Sand.

12.4.11 The strata beneath the site dip gently in a south-easterly direction. To the north-west (just beyond the western site boundary) the Great Oolite Limestone forms a strong scarp feature. The geological map shows a series of east-north-east trending faults to the north of the site. No faults are recorded beneath the site, with the nearest being 4km to the north-west.

12.4.12 Groundwater: Aspinwall report that groundwater was present within a number of horizons depending upon the lithology present. Their data on groundwater levels records groundwater levels, over the monitoring period, in BH1 at an average level of 81m AOD, approximately 35m below ground level at that borehole, and in BHs 2 to 7 at an average levels of between 115m AOD and 125m AOD, corresponding to approximately 1m to 21m below ground level at the respective boreholes.

Hydrogeology and Hydrology

12.4.13 The Landmark Envirocheck report indicates a Minor Aquifer beneath the site, surrounded by a Major Aquifer. The outline of the Minor Aquifer coincides remarkably well with the site boundary. There appears to be no geological reasons for the presence of the Minor Aquifer. Therefore, it is considered that groundwater beneath and surrounding the site should be considered as a **Major Aquifer**, until otherwise determined.

12.4.14 The limestone bands form a layered aquifer that can allow rapid groundwater movement. As the site is close to the scarp edge, to the west, groundwater beneath the western part of the site may flow north-westwards towards the Cherwell Valley. Most of the groundwater flow is likely to be south-eastwards down the dip slope. Groundwater sampling indicates that water quality is generally good.

12.4.15 Groundwater is discharged at a number of good quality springs around the former airbase. Some of these coincide with storm water outfall points. These discharge to the headwaters of two river systems. The receiving watercourses are generally of good quality.

Chapter 11 of the Environmental Statement covers the Surface Water Drainage, Hydrology and Hydrogeology aspects in greater detail.

Previous Site and Surrounding Area Uses

12.4.16 The previous site use and history has been ascertained from the Landmark Envirocheck report historical editions of Ordnance Survey maps. Due to the considerable size of the site, the Envirocheck report and drawings have been split into 4 areas or zones which Envirocheck refer to as Slices(Slice A, Slice B, Slice C, and Slice D). Each slice represents an area of 2.7km by 2.7km. These slices are shown on Drawing CG_G.2. The historical editions of the Ordnance Survey maps date back to 1875. Information on the previous site uses, and the surrounding area, is summarised in Tables G.03, G.04, G.05, and G.06 respectively as below:

Table G.03: Previous site and surrounding area uses for Envirocheck Slice A

Year	Site Use	Surrounding Area (off site)
1875 to 1881	The site is mainly an undeveloped area. Some structures in Field Barn area are found. A tower and two pumps are	Houses and farm field in Upper Heyford Village lie to the south-west of the site. Some structures in Lower Heyford Village,

Table G.03: Previous site and surrounding area uses for Envirocheck Slice A		
Year	**Site Use**	**Surrounding Area (off site)**
	indicated in the map. Two main roads (named Camp Road and Roman Road in future) are found.	located further to the south-west of the site, are seen. A farm village called Caulcott, including houses, a school and a well, are found to the south.
1900	A well is shown next to the tower.	A pump appears in Caulcott Village. At least two new wells are built in Lower Heyford Village.
1922	One of the pumps and the well are removed.	The pump and the well in Caulcott Village are removed. Two wells are removed from Lower Heyford.
1976	More than a 100 houses, plus buildings, shops, hospital, school, recreation park, car parks, and local roads are built in the south. Hardened aircraft shelters, bunkers, runways and lighting are built in the north. The pump and the tower since 1875 are removed. The structures in Farm Barn are modified.	More structures are built in the villages. Services include water works and sewage works are also found in Upper Heyford and Lower Heyford Village.
1994	No significant changes are apparent.	
1995	About 30 structures are now built, removed or modified. They include some of the public facilities, e.g. hospital, library, etc.	A playground close to Upper Heyford Village is moved to the north. Some structures are modified in Upper Heyford Village.
1999	Buildings in Upper Heyford American High School are modified. A few more buildings are built near the taxiways.	No significant changes are apparent.
2001-2003	No significant changes are apparent.	

Table G.04: Previous site and surrounding area uses for Envirocheck Slice B		
Year	**Site Use**	**Surrounding Area (off site)**
1881	The site is mainly an undeveloped area. Two farms can be found on the site. They are North Leys Farm and Leys Farm. A few woodlands are found. A well to the north of North Leys Farm is indicated. Some roads are built to connect the farms.	A few farms are found in the surrounding area. They are Ashgrove Farm, Ardley Fields Farm, Middleton Grounds Farm and Park Farm. Some structures and wells can be found in or near the farms.
1900	Two pumps are built in North Leys Farm and Leys Farm. One for each farm. No significant changes are apparent.	No significant changes are apparent.
1922	One structure is removed in North Leys Farm. Some road layouts are changed. The pump in Leys Farm is removed.	No significant changes are apparent.
1976	Ballard's Copse Woodland is removed. Dozens of houses, sewage works (incl. tanks) and airfield runways are built. North Leys Farm is now called Letchmere Farm. 3 more structures are built in North Leys Farm (Letchmere Farm); the pump which was indicated since 1900 is not shown.	More new buildings are shown in Ashgrove Farm. No significant changes are apparent in other farms.
1994 – 1995	Two large buildings are removed. One of the tanks structure is removed.	
1999	About 20 new buildings appear.	Some buildings are now built or modified.
2003	No significant changes are apparent.	

Table G.05: Previous site and surrounding area uses for Envirocheck Slice C		
Year	**Site Use**	**Surrounding Area (off site)**
1875 – 1881	The site is mainly an undeveloped area.	Somerton is located at the north-west of the area. Some houses (known as Village Farm in future) and a pump are found to the north-west of the area. A well is also found about 100m away. A few small village farms can be found in the surrounding area.
1900	Two pumps are found.	No significant changes are apparent.
1922	No significant changes are apparent.	
1976	About 10 airfield structures and taxiways are found. The pumps are removed.	No significant changes are apparent.
1994 – 1995	No significant changes are apparent.	
1999	About 90% of the existing buildings in the area are built in this period.	Some buildings are now built or modified.
2003	No significant changes are apparent.	

Table G.06: Previous site and surrounding area uses for Envirocheck Slice D		
Year	**Site Use**	**Surrounding Area (off site)**
1875 – 1881	The site is mainly an undeveloped area. Some woodlands, one named Kennel Copse and a house called Hall's Barn are found. Some road networks are built to connect the surrounding towns.	A few towns and farm houses are found. Fritwell, located to the north, is a relatively large town. It includes more than 50 houses. Other towns/farm houses include Fewcot and Troy Farm.
1900	No significant changes are apparent.	
1922	No significant changes are apparent.	
1976	About 6 airfield structures and some taxiways are found. Part of Kennel Copse Woodland is occupied by the airfield. About 300m long road from Troy Farm to the site is removed	Fritwell and Fewcott Towns expand.

Table G.06: Previous site and surrounding area uses for Envirocheck Slice D		
Year	**Site Use**	**Surrounding Area (off site)**
1994 – 1995	No significant changes are apparent.	Sewage works are built to the south of Fritwell Town.
1999	More than 10 new buildings and local roads can be found.	A few new buildings can be found in surrounding towns.
2003	No significant changes are apparent.	

Potential on Site Contamination

Former Land Use

12.4.17 A number of former land uses, which could be potential contamination sources, have been identified at the site. The following paragraphs describe the current potential for contamination at these locations prior to any mitigation measures being put in place.

Petrol, Oil and Lubrication (POL) Fuel Storage and Pipeline System

12.4.18 Throughout the site there is a Petroleum Oil and Lubricant (POL) system, which is an above and below ground system, with extensive infrastructure of pipe work, pumps, valves, storage tanks and aircraft refuelling ancillaries across the airbase as discussed earlier in the chapter under Baseline Conditions.

12.4.19 Although the POL system is reported to have been emptied of petrol, oil and lubrication products, cleaned and subsequently filled with water, some residue of the former contents may remain. The hydrocarbon fraction could vary from light (e.g. motor spirit) to very heavy (e.g. residual oil or lubricating oil). Contamination may be found in connection with existing infrastructure, such as underground storage tanks and pipelines. Asbestos may be associated with the pipework system.

Filling Station at Car Garages

12.4.20 The filling facility at the car garages may have leaked petrol and diesel consisting of a mixture of hydrocarbons and chemical additives. Additives include oxygenates (e.g. alcohols and ethers), anti-knock components (normally organo-lead compounds), anti-oxidants, metal deactivators, detergents, corrosion inhibitors, etc. Other materials may also be present in petrol as impurities from crude petroleum, for example sulphur.

12.4.21 Engine and transmission lubricating oils, both new and used, are stored on site in metal containers and storage tanks. The contaminants in used oils are mainly heavy metals and products of combustion, e.g. lead from fuel, copper from engine bearings, a range of metals from other parts of the engine, unburnt fuel, products of combustion, etc. Other contaminants include anti-freeze, brake fluids, solvents and paints.

Former Fire Practice Area

12.4.22 Located just to the west of the centre of the site and shown on Drawing CG_G.1. Contaminants may include hydrocarbons (petroleum based fuels) and residues from fire fighting foams that may be toxic or harmful.

Boilers, Incinerators

12.4.23 About 13 boilers and incinerators can be found on the site. If waste water were used to quench the hot ash, residues of unburnt organic material and particulates from the incinerator would have been produced which would be acidic. Waste may also be generated from any flue gas scrubbing operations. Boilers and incinerators may have caused pollution from organic compounds such as polychlorinated biphenyls (PCBs).

Airfield Facilities, Buildings and Houses

12.4.24 The former airbase contains a number of features which include 56 hardened aircraft shelters, four nose docking sheds and a specialist military building, all located to the north of Camp Road. Asbestos may be found in most kinds of buildings association with refinery equipment, sewage pipework and building materials, such as cladding and roofing. The possible buildings that asbestos would be found in are electrical substations, boilers/incinerators, sewage works, Petrol, Oil and Lubrication (POL) fuel tanks and facilities, and workshops. The site, or parts of the site, may have contamination associated with Made Ground and construction fills. De-icing chemicals, which include glycol, urea and acetate-based formulations, are applied to the runways and aircrafts.

Electrical Substations

12.4.25 More than 50 electrical substations can be found on the site. Electrical transformers built since the 1940s may have caused pollution from polychlorinated biphenyls (PCBs) as a dielectric fluid.

Former Launderette

12.4.26 Located to the south of the site. Dry cleaners may have caused pollution from solvents, PCBs and hydrocarbon fuels. The site might have been used for uncontrolled disposal of dry-cleaning wastes.

Fireworks and Weapon Storage Areas

12.4.27 The fireworks and weapon storage areas occupy approximately 26.3 hectares. They are located at the north (i.e. Northern Bomb Store) and south (i.e. Southern Conventional Arms Store and Southern Bomb Store) of the site. Contamination may be present in or near fireworks and weapon storage areas arising from accidents, spillages or leaks from drains, sumps and tanks. Any contaminated soil may contain the following explosive compounds: NC, NG, PETN (pentaerythritol tetranitrate), nitroaromatics such as TNT, propellants and nitramines such as RDX. The quantities of explosives may build up in sub-surface soil. In many cases, they can pose a toxicity hazard as well as an explosive risk.

Car Storage Areas and Car Wash Facility

12.4.28 These are reported to have covered more than 160 hectares of the site area. Garage and car repairing area may have caused pollution from products of combustion and other chemicals. Car wash detergents essentially comprise a surfactant and other chemicals to increase the effectiveness of the surfactants.

Workshops

12.4.29 There are at least 29 buildings registered as workshops on the site. The kinds of workshops possibly include servicing and maintenance, electrical, and manufacturing. Workshops may have caused pollution from a wide range of heavy metal and chemical contaminants which include waste of maintenance element (normally metals and plastic), organic solvents for engines and machines, solvent-based cleaning agents, etc.

Sewage Works

12.4.30 At least 9 sewage works can be found on the site. The chemical composition of incoming industrial effluents varies widely in terms of heavy metals and organic chemicals, and could include, for example, solvents and pesticides. Some chemicals, including aluminium, iron and chloride compounds, polyelectrolytes and other may be added to assist biological breakdown. Other contaminants could include methane, carbon dioxide and, where sulphur compounds exist, hydrogen sulphide.

Landfill Sites and Waste Disposal Pits

12.4.31 Leachate and landfill gases are produced as a result of the decomposition of waste materials within a landfill site. Landfill leachates contain simple organic compounds and ammonia. They may contain iron and other metals and inorganic compounds which have been dissolved from the residual wastes. They may continue to be produced for years after the closure of a site. The main constituents of landfill gas are methane and carbon dioxide. Trace components may include hydrogen, hydrogen sulphide, organosulphur compounds, aliphatic

hydrocarbons and halogenated hydrocarbons. Landfills may contain waste including asbestos which may be present throughout the landfill.

12.4.32 At least 13 waste disposal pits and bunkers can be found on the site. They are understood to have accepted domestic, industrial and commercial waste.

Former Hospital

12.4.33 The former hospital is located to the south of the site, surrounded by recreational areas, former school buildings and houses. Spillages at or waste from the former hospital may consist of a variety of materials including liquid and solid clinical waste (infectious or chemical), ancillary process chemicals and other substances, e.g. hydraulic oil, fuel.

Data from the Envirocheck Report

Table G.07: Summary of possible contamination sources on site and within 500m surrounding areas stated in Envirocheck Report

Data Type	On site	0 to 250m	251 to 500m (*up to 1,000m)
BGS Recorded Landfill Sites		2	
BGS Recorded Mineral Sites			1
Contemporary Trade Directory Entries	23		1
Control of Major Accident Hazards Site (COMAH)	2		
Discharge Consents	14	3	2
Explosive Sites	2		
Local Authority Pollution Prevention and Controls	2		
Local Authority Recorded Landfill Sites		3	
Pollution Incidents to Controlled Waters	6	1	1
Registered Landfill Sites			1
Registered Radioactive Substances	2		

Table G.07: Summary of possible contamination sources on site and within 500m surrounding areas stated in Envirocheck Report			
Data Type	**On site**	**0 to 250m**	**251 to 500m (*up to 1,000m)**
Water Abstractions			5 from 251 to 500m7 up to 1,000m *

12.4.34 The 2 BGS Recorded Landfill Sites and the 3 Local Authority Recorded Landfill Sites are all located in the same general area at Ardley Wood, just outside the north eastern corner of the site. It appears that these landfill sites may now be closed. The closest boundaries of these landfill sites are between 90 metres and 170 metres from the north eastern corner of the site. However, they are still within 250m from the site boundary, a commonly used consideration distance with respect to the migration of landfill gases, and therefore possible effects of landfill gas migration from these old closed landfill sites cannot be entirely ignored.

Table G.08: Descriptions of possible contamination sources and their possible receptors and incident severity on site and in the surrounding areas stated in Envirocheck Report		
Type	**Description**	**Receptor/Incident Severity**
BGS Recorded Landfill Sites	Both are in Ardley Wood operated by BGS	Boundary Accuracy: moderate and derived
BGS Recorded Mineral Sites	A limestone mineral site located in Ardley Woods operated by Associated Portland Cement Manufacturers Ltd.	
Contemporary Trade Directory Entries	Plant & machinery repairs, manufacturers (plastic products, printing equipment, laundry equipment, electronic equipment, medical equipment, scientific apparatus & instruments. fireworks), crane hire, commercial cleaning services, garage services, photocopiers, road haulage services	
Control of Major Accident Hazards Site (COMAH)	Two fireworks sites.	

Table G.08: Descriptions of possible contamination sources and their possible receptors and incident severity on site and in the surrounding areas stated in Envirocheck Report

Type	Description	Receptor/Incident Severity
Discharge consents	Trade effluent (discharge-site drainage), sewage discharges, discharge of other matter-surface water	Leys Farm Ditch, Tributary of the Upper Heyford, groundwater by a soakaway, Gallows Brook, Tributary Padbury Brook, Padbury Brook River Great Ouse.
Explosive Sites	Two fireworks sites.	
Local Authority Pollution Prevention and Controls	Respraying of road vehicles	
Local Authority Recorded Landfill Sites	All 3 of the landfill sites are located in Ardley Wood.	Boundary Quality: good and moderate
Pollution Incidents to Controlled Waters	Unknown oil, unknown sewage, unknown chemical	Minor (one is significant)
Registered Landfill Sites	Receive local authority collected waste; located in Ardley Wood	
Registered Radioactive Substances	Both are operated by Oxford-Bio-Innovation – keeping and use of Radioactive materials	
Water Abstractions	General farming and domestic, household private water undertaking, public water supply (Thames Water Authority)	

12.4.35 Locations of the possible contaminative sources identified within the Heyford Park are shown on Drawing CG_G.2.

Evidence from Previous Ground Investigation

Soil Vapour Survey

12.4.36 A soil vapour survey was carried out by Aspinwall, June 1997, in a number of areas in order to assess the potential for contamination by hydrocarbons. Such soil vapour surveys are intended as an initial screening survey, not as a definitive assessment of the magnitude of hydrocarbon contamination, to assist in identifying possible areas of hydrocarbon contamination. The soil vapour was measured using a portable Flame Ionisation Detector (FID), which can measure hydrocarbon vapours to parts per million (ppm). There are no definitive screening values or 'intervention values', which, if exceeded, indicate potentially unacceptable risks to receptors, but, typically readings less than 100ppm can be regarded as low and of no significance. Readings of 1,000ppm and above can be regarded as high and as an indication of hydrocarbon or flammable gas contamination. There were a total of 355 soil vapour survey holes on site. The areas investigated included:

- The Petrol, Oil and Lubrication (POL) ring main, with particular emphasis on areas with a significant number of pipe junctions;
- The Petrol, Oil and Lubrication (POL) storage locations 17, 19, 20, 23, with POLs 3, 10, 21, 22 also investigated as part of the POL pipe junction assessment outlined above;
- The fire practise area;
- Selected underground and above ground storage tanks which could either not be accessed for, or fully investigated by, excavation of trial pits.

12.4.37 Location of the soil vapour survey points, trial pits and boreholes is shown on Drawing CG_G.1.

Table G.09: Summary of Soil Vapour Survey results in the concerned areas

Location	No. of Holes	Hydrocarbon Vapour Concentration parts per million (ppm)
POL 17	8	All <10
POL 19	5	All <1.0
POL 20	8	All <1.0
POL 23	13	All <1.0
Fire Practise Area	8	All <1.0 (except three >10,000)

Table G.09: Summary of Soil Vapour Survey results in the concerned areas		
Location	**No. of Holes**	**Hydrocarbon Vapour Concentration parts per million (ppm)**
Miscellaneous areas include: De-icing Fluid Storage Tanks, and at the locations of abandoned trial pits.	17	All <=1.0
POL Supply Ring Main		
Area A	30	All <=1 (except one > 10,000)
Area B	23	<10
Area C	12	All <1 (except one = 20)
Area D	9	All < 1 (except two, =1000 & 6000)
Area E	3	All < 1
POL Supply Ring Main Junctions		
Area A1	50	All <= 10
Area A2	39	All <= 10
Area C1	58	All <1.0 (except one = 7.0)
Area D1	20	All < 1.0
Area D2	32	All < 1.0
Area D3	20	All < 1.0

POL = Petrol, Oil and Lubrication

Table G.10: Range of gas concentration obtained in Soil Vapour Survey	
Range of Gas Concentration (ppm)	**No. of Soil Vapour Survey Points**
<1.0	336
1.0 to 10	13
>10 to 1,000	1
>1,000 to 10,000	1
>10,000	4 (3 of which were within the former fire practise area)

12.4.38 In summary, of the 355 soil vapour survey points only 6 recorded elevated flammable gas concentrations. Three of these were all greater than 10,000 ppm and were within the former fire practice area where fuel had been deposited and ignited as part of exercises during the operational life of the site. The remaining 3 locations, which had flammable gas concentrations of 1,000 ppm, 6,000 ppm and greater than 10,000 ppm respectively, where along the POL ring main. It suggests that the ground in these areas could be contaminated with hydrocarbons and remediation may be required.

12.4.39 In conclusion, it is considered that the impact/s of soil vapour contamination and associated hydrocarbon contamination, where it occurs, from the proposed development are **major to moderate**, but could be reduced to **negligible** provided further investigation is undertaken for detailed design purposes and with the implementation of appropriate measures are taken in accordance with current best practice.

Chemical Testing from Trial Pits & Boreholes

12.4.40 A total of 149 trial pits were installed at selected locations for the purposes of visual and olfactory examination of sub-surface strata, and for collection of disturbed samples for chemical analysis. Trial pits were positioned to target those areas identified as high risk which were considered more susceptible to potential contamination as a result of historical activities.

12.4.41 A total of 7 boreholes were drilled at the site. Six of these were around the site perimeter, and the seventh in the centre of the site.

12.4.42 The results of chemical analyses can be found in the Aspinwall report dated June 1997, "RAF Upper Heyford Land Quality Assessment, Phase Two: Intrusive Survey Factual Report, Appendices".

12.4.43 A total of 314 soil samples were analysed for a selected range of parameters. Contaminants present at levels above the screening values given in Table G.01 are summarised in Table G.11 below. The locations of soil exceedances are shown in Drawing CG_G.2.

Table G.11: Summary of Soil Screening Value Exceedances

Determinand	Units	No of samples tested	Range Measured	Mean	Screening Values	Number of Exceedances
Arsenic	mg/kg	301	<1 to 76	16.7	20[2]	110
Chromium	mg/kg	301	<1 to 187	17.9	130[2]	1
Lead	mg/kg	301	<1 to 767	20.5	450[2]	3
Zinc	mg/kg	301	2 to 4,563	64.6	330[4]	2
TPH	mg/kg	41	17 to 8,482	717.9	1,000[5] (5,000[3])	7 (2)
Water soluble sulphate 2:1	g/l	301	0.003 to 3.206	0.048	1.2[1]	3
Total PAHs	mg/kg	8	1 to 415.5	58.6	40[4]	2

Key:

1 – BRE Special Digest 1.

2 – CLEA Soil Guideline Values for residential use with plant uptake.

3 – Dutch Intervention Values for Soil.

4 – LQM CIEM Generic Assessment Criteria for residential with plant uptake.

5 – See Section 12.4.46 for details.

12.4.44 Heavy Metals: Elevated concentrations of heavy metals, above the screening values, were limited to arsenic, chromium, lead and zinc. The concentration of arsenic is exceeded in 110 samples of 301 tests (36%) and those are spread all over the site. On the other hand, less than 1% of samples were detected to be over the screening values for chromium, lead and zinc.

12.4.45 Total petroleum hydrocarbon: The Aspinwall 1997 investigations did not test for, nor separate out, the total petrol hydrocarbons into discrete carbon bands, from light hydrocarbons to heavier hydrocarbons. Therefore, it is not possible to properly assess the significance or magnitude of contamination from total petroleum hydrocarbons. Chemical testing for total petroleum hydrocarbon (TPH) was slightly elevated, by comparison with the screening value of 1,000mg/kg, in only 7 of 41 samples (17%). The mean concentration of TPH is only 717.9 mg/kg. The samples which contained more than 1,000mg/kg of TPH were obtained at TP127 (next to a tank that could have been used to store fuels), at TP93 (POL 20), at TP124 (Northern Bomb Store), at TP53 (Settlement Area), at both TP149 & at TP142 (Fire Practice Area) and at TP93 (POL 20). A

comparison has also been made with the now superseded Dutch intervention values for mineral oils of 5,000 mg/kg. There are only two exceedances above 5,000mg/kg. For initial screening purposes it is considered that a screening value of 1,000mg/kg is more appropriate than the former Dutch value of 5,000mg/kg.

12.4.46 Water soluble sulphate: Only 3 in 301 samples, less than 1% of samples, show the concentration of water soluble sulphate 2:1 is over the screening values.

12.4.47 Total polyaromatic hydrocarbons: Concentrations of total polyaromatic hydrocarbons (PAHs) were elevated in 2 of the 8 samples (25%). The 2 samples were obtained at TP8 (approximately 200m from POL 24) and TP100 (POL 25A & 25B and the liquid fuels pipes).

12.4.48 In conclusion, it is considered that the impact/s of soil contamination, where it exists, from the proposed development are **moderate to minor**, but could be reduced to **negligible** provided further investigation is undertaken for detailed design purposes and with the implementation of appropriate measures are taken in accordance with current best practice.

Asbestos

12.4.49 No asbestos analysis was carried out on soil samples during the Aspinwall 1997 investigations. However, an extract has been obtained which appears to be a supplementary investigation, dated 10/08/06, there are no other document references, and asbestos was detected in many of the houses and properties.

12.4.50 In conclusion, it is considered that the impact/s of hazardous asbestos containing materials, where they occur, from the proposed development are **severe**, especially if present in the existing houses or buildings that are to be re-used, but could be reduced to **negligible** provided further investigation is undertaken for detailed design purposes and appropriate measures are taken in accordance with current best practice.

Radiological Investigation

12.4.51 DERA Radiation Protection Services" (DRPS) report, "RAF Upper Heyford - Land Quality Assessment - Radioactive Contamination Issues", Report No 40/97, dated 20 June 1997, is included in Appendix 10 of Aspinwall's "Appendix" report dated June 1997. DRPS state in their report:

> *"With the exception of caesium-137, no radioactive contamination due to the presence of man-made radionuclides or significantly enhanced levels of naturally occurring radioactive materials were detected during this radiological survey. The discovery of caesium-137 is expected as this material is present throughout the UK as a result of the Chernobyl accident and atmospheric nuclear weapons testing. These results are in agreement with the findings of an earlier DRPS survey which was carried out in support of site closure operations in January and February 1995."*

12.4.52 However, DRPS also state in their report:

> *"… it would be prudent to survey tips or areas where ash from incinerators has been dumped for the presence of radium-226. This naturally occurring radioactive material could have been present in luminised instruments which might have been buried or burnt at the site in the distant past."*

12.4.53 Although the report was completed over 10 years ago there is no reason to assume that radioactive contamination at the site has become any worse with time.

12.4.54 In conclusion, it is considered that the impact/s of radioactive contamination from the proposed development, where it occurs, are **moderate to minor** , but could be reduced to **negligible** provided further investigation is undertaken for detailed design purposes and appropriate measures are taken in accordance with current best practice.

Potential off Site Contamination

12.4.55 Based on the Envirocheck report, the key off site potential contamination sources are considered to be associated with the **2 BGS Recorded Landfill Sites**, and the **3 Local Authority Recorded Landfill Sites.** They are all located in the same general area at Ardley Wood, just outside the north eastern corner of the site. It appears that these landfill sites may now be closed. The closest boundaries of these landfill sites are between 90 metres and 170 metres from the north eastern corner of the site. However, they are still within 250m from the site boundary, a commonly used consideration distance with respect to the migration of landfill gases, and therefore possible effects of landfill gas migration from these old closed landfill sites cannot be entirely ignored.

12.4.56 In conclusion, it is considered that the impact/s of these landfill sites on the proposed development are **minor**.

12.5 CONCEPTUAL GROUND MODEL

Framework for The Assessment Of Contamination – UK Approach

12.5.1 Current UK legislation on contaminated land is principally contained in Part IIA of the Environmental Protection Act, 1990, which was retrospectively inserted by Section 57 of the Environment Act 1995.

12.5.2 The legislation endorses the principle of a "suitable for use" approach to "Contaminated Land", where remedial action is only required if there are unacceptable risks to health or the environment, taking into account the use of the land and its environmental setting.

12.5.3 The legislation places a responsibility on the Local Authority to determine whether the land in its area is contaminated by consideration of whether:

- significant harm is being caused; or
- there is a significant possibility of significant harm being caused; or
- significant pollution of controlled waters is being, or is likely to be, caused.

12.5.4 The statutory guidance describes a risk assessment methodology in terms of "significant pollutants" and "significant pollutant linkages" within a **source-pathway-receptor** model of the site. The model comprises:

- The principal pollutant hazards associated with the site (the **source**);
- The principal **receptor** at risk from the identified hazards; and
- The existence, or absence, of plausible **pathways** which may exist between the identified hazards and receptor.

12.5.5 For land to be determined as "Contaminated Land" in a regulatory sense, and thereby require remediation or a change to less sensitive use, all three elements (source-pathway-receptor) of a significant pollutant linkage must be present.

On Site Potential Contaminative Sources

12.5.6 The key potential on site sources of contamination are described in the previous section and are listed below:

- Petrol, Oil and Lubrication (POL) Fuel Storage and Pipeline System
- Filling Station at Car Garages
- Former Fire Practise Area
- Boilers, Incinerators
- Airfield Facilities, Buildings and Houses
- Electrical Sub-stations
- Former Launderette
- Fireworks and Weapon Storage Areas
- Car Storage Areas and Car Wash Facility
- Workshops
- Sewage Works
- Landfill Sites and Waste Disposal Pits
- Former Hospital

Off Site Potential Contaminative Sources

12.5.7 The key potential off site sources of contamination are described in the previous section and are listed below:

- 2 BGS Recorded Landfill Sites, and
- 3 Local Authority Recorded Landfill Sites all located in the same general area at Ardley Wood, just outside the north east corner of the site.

Current Contaminant Pathways

12.5.8 To assess whether baseline ground conditions may represent a risk to human health, the eco system or controlled waters, the potential pathways are identified and described in this chapter. Each pathway is evaluated according to their potential to be present, i.e. a "**high**", "**medium**" or "**low**" potential of being present, and providing a link between contaminant sources and potential receptors.

Contaminated Soils Leaching To Groundwater

12.5.9 The Landmark Envirocheck report indicates a Minor Aquifer beneath the site, surrounded by a Major Aquifer. The outline of the Minor Aquifer coincides remarkably well with the site boundary. There appears to be no geological reasons for the presence of the Minor Aquifer. Therefore, based on currently available information, it is considered that groundwater beneath and surrounding the site should be considered as a **Major Aquifer**, until otherwise determined.

12.5.10 It is understood that this Major Aquifer is used locally for water supply and that it is drained by a series of springs which support baseflow in good quality watercourses in the area.

12.5.11 In conclusion, it is considered that, where present, contaminated soils leaching to groundwater has a **high** potential of providing a link between contaminant sources and potential receptors where present, but could be reduced to a **low** potential if appropriate measures are taken in accordance with current best practice.

Transport Along Existing Buried Services

12.5.12 High permeability gravel used as bedding for sub-surface water, gas and other utilities may introduce preferential contamination paths capable of transferring contaminants or contaminated groundwater at higher rates. At the site, existing buried services may provide a potential preferential pathway for sub-surface transportation of contamination.

12.5.13 In conclusion, it is considered that transport along existing buried services has a **high to medium** potential of providing a link between contaminant sources and potential receptors, but could be reduced to a **low** potential if appropriate measures are taken in accordance with current best practice.

Mixing With Surface Water

12.5.14 Approximately 50% of the total former airbase area is paved. The majority of these paved areas drain by positively drained piped networks to various watercourses to the south, east and north of the site. Prior to discharging to the watercourses run-off generally drains through one of a number of oil interceptors on the site. However, the main potentially, high risk, contaminative activities are no longer present at the site in its current use.

12.5.15 In conclusion, it is considered that mixing with surface water has a **medium to low** potential of providing a link between contaminant sources and potential receptors, but could be reduced to a **low** potential if appropriate measures are taken in accordance with current best practice.

Direct Transportation Of Contamination

12.5.16 Direct transportation of contaminated land may be possible in the area as a result of construction activities. However, with proper regulation and design and by adopting current best practices, direct transportation of contamination should be minimal.

12.5.17 In conclusion, it is considered that direct transportation of contamination has a **medium** potential of providing a link between contaminant sources and potential receptors, but could be reduced to a **low** potential if appropriate measures are taken in accordance with current best practice.

Airborne Pathways

12.5.18 Asbestos particles are suited to airborne transmission. As discussed in Chapter 12.4.49 there are a number of buildings containing asbestos on the site, thus airborne transmission of contaminants can be considered as one of the pathways during the construction phases of the proposed development.

12.5.19 In conclusion, it is considered that that airborne pathways have a **high** potential of providing a link between contaminant sources and potential receptors, but could be reduced to a **low** potential if appropriate measures are taken in accordance with current best practice.

Consumption Of Contaminated Soil, Dust Or Water

12.5.20 Consumption of contaminated food, both by direct soil ingestion or indirectly by other food items is a possibility.

12.5.21 In conclusion, it is considered that that consumption of contaminated soil, dust or water has a **medium** potential of providing a link between contaminant sources and potential receptors, but could be reduced to a **low** potential if appropriate measures are taken in accordance with current best practice.

Dermal Contact With Contaminated Soil, Dust Or Water

12.5.22 Dermal contact with contaminants in soil, dust or water is minimal due to most of the site currently being beneath sealed made ground or landscaped amenities. There will be greater potential risk during the construction phases of the proposed development.

12.5.23 In conclusion, it is considered that that dermal contact with contaminated soil, dust or water has a **medium** potential of providing a link between contaminant sources and potential receptors, but could be reduced to a **low** potential if appropriate measures are taken in accordance with current best practice.

Contaminant Receptors

12.5.24 The receptors of possible contamination at the site have been identified. Each of these is assessed according to its likelihood to be influenced by the pollutant-receptor-pathway linkage, i.e. as "**high**", "**medium**" or "**low**".

Construction Workers

12.5.25 Construction workers could be affected by potentially contaminated land. This could be through dermal contact or accidental soil ingestion.

12.5.26 In conclusion, it is considered that construction workers have a **high** likelihood of being influenced by the pollutant-receptor-pathway linkage, but could be reduced to a **low** potential if appropriate measures are taken in accordance with current best practice.

Structures And Services

12.5.27 The development at the former airbase will result in up to 1,075 houses with associated facilities, services and infrastructure.

12.5.28 In conclusion, it is considered that structures and services have a **medium** likelihood of being influenced by the pollutant-receptor-pathway linkage, but could be reduced to a **low** potential if appropriate measures are taken in accordance with current best practice.

Controlled Waters

12.5.29 The Landmark Envirocheck report indicates a Minor Aquifer beneath the site, surrounded by a Major Aquifer. The outline of the Minor Aquifer coincides remarkably well with the site boundary. There appears to be no geological reasons for the presence of the Minor Aquifer. It is therefore considered that groundwater beneath and surrounding the site should be considered as a **Major Aquifer**.

12.5.30 Aspinwall's 1998 Environmental Statement indicates that approximately 50% of the total former airbase area, including the airfield, is currently paved. (See Table 4.2 of that report for details.) The majority of these paved areas drain by positively drained piped networks to various watercourses to the south, east and north of the site. Prior to discharging to the watercourses, run off generally drains through one of a number of oil interceptors on the site. However, the main potentially, high risk, contaminative activities are no longer present at the site in its current use.

12.5.31 In conclusion, it is considered that this controlled waters have a **high** likelihood of being influenced by the pollutant-receptor-pathway linkage, but could be reduced to a **low** potential if appropriate measures are taken in accordance with current best practice.

Summary of Conceptual Ground Model

12.5.32 The preliminary conceptual model indicates various potential contamination sources arising from past and current uses of the site.

12.5.33 The main potential contamination sources are considered to be the storage tanks and associated pipework at the site as well as other former airbase facilities and workshops. Hydrocarbons and arsenic in the soil and asbestos in the existing houses and buildings are considered to be the main contaminants of concern arising from these sources.

Table G.12: Conceptual Ground Model Summary

Potential Contamination	Target/Receptor	Pathway
Hydrocarbons, organic, inorganic compounds, explosives, wastes, asbestos, PCBs and other chemical compounds / solvents due to	Future site users	Direct transportation of contamination. Airborne pathways, inhalation. Consumption, ingestion. Dermal contact.

Table G.12: Conceptual Ground Model Summary		
Potential Contamination	**Target/Receptor**	**Pathway**
compounds / solvents due to spillages from storage tanks, sewage works, etc and associated with the electrical substation and dry cleaners.	Construction workers	Direct transportation of contamination. Airborne pathways, inhalation. Consumption, ingestion. Dermal contact.
	Groundwater	Leaching to groundwater. Transport along existing buried services.
	Controlled surface waters	Transport along existing buried services. Mixing with surface water.
	Eco system	Mixing with surface water. Airborne pathways, inhalation. Consumption, ingestion. Dermal contact.
	Structures and services	Transport along existing buried services. Contact.
Off site contamination sources including pollution incidents, landfill sites and mineral sites.	Groundwater	Leaching to groundwater.
Possible redevelopment activities resulting in mixing demolition waste with ground material and reuse of land	Construction workers	Direct transportation of contamination. Airborne pathways, inhalation. Consumption, ingestion. Dermal contact.
	Future site users	Direct transportation of contamination. Airborne pathways, inhalation. Consumption, ingestion. Dermal contact.

Table G.12: Conceptual Ground Model Summary		
Potential Contamination	**Target/Receptor**	**Pathway**
	Groundwater	Leaching to groundwater. Transport along existing buried services.
	Controlled surface waters	Mixing with surface water Transport along existing buried services.
	Eco system	Mixing with surface water. Airborne pathways, inhalation. Consumption, ingestion. Dermal contact.

12.6 RISK ASSESSMENT AND MITIGATION MEASURES

Construction Impacts

12.6.1 The potential adverse environmental impacts and corresponding mitigations measures are presented within the following Table G.13.

Table G.13: Potential Adverse Environmental Impacts and Corresponding Mitigations Measures			
Impact (Source / pathway / Receptor)	**Degree of significance if not mitigated**	**Mitigation**	**Mitigated degree of significance**
Source: Asbestos. **Pathway**: Airborne pathways, inhalation. **Receptor**: Construction workers, future site users. Asbestos particles are suited to airborne transmission. Work with asbestos can release small fibres	Severe	▪ The Development of a Code of Construction Practice (CoCP) will include the following measures: ▪ Any asbestos containing materials on the site will have been identified before work starts with information on the location and condition of these materials. Existence of asbestos will be tested by a specialist laboratory. ▪ Demolition of asbestos structures will be carried out by a specialist asbestos removal	Negligible

Table G.13: Potential Adverse Environmental Impacts and Corresponding Mitigations Measures

Impact (Source / pathway / Receptor)	Degree of significance if not mitigated	Mitigation	Mitigated degree of significance
into the air. Breathing in these fibres can eventually lead to a number of fatal diseases. It is especially dangerous to construction workers without appropriate protection measures.		contractor. ▪ Prevent construction workers exposure to asbestos or reduce it to the lowest level possible by using suitable controls. ▪ Abandon the use of power tools, dampen the material, enclose the work and using dust extraction equipment where required. ▪ Provide the construction workers with information, instruction and training about the risks of working in asbestos environment and the precautions they will take. Make sure they are properly trained to use relevant equipment (e.g. respirator, clean protective clothing etc.). ▪ Consult the health and safety representative, if there is one, about the control measures to be taken.	
Source: hydrocarbons, heavy metals and sewage and waste. **Pathway**: leaching to groundwater, consumption, ingestion, dermal contact. **Receptor**: future site users on site and in neighbouring areas and construction workers. Hydrocarbon, organic and inorganic compounds / solvent, heavy metals, etc. may leak from the sources resulting in local contamination. Construction workers and future	Moderate	The Development of a Code of Construction Practice (CoCP) that will include the following measures: ▪ Procedures and protocols to prevent construction workers, visitors, occupiers and neighbouring areas, from being exposed to contaminated materials in appropriate areas. Construction workers and site visitors will wear adequate Personal Protective Equipment (PPE) where required. Ensure that ingestion of contaminated soil is avoided (e.g. by washing hands prior to eating, smoking and drinking). ▪ Handling and storage of	Negligible

Table G.13: Potential Adverse Environmental Impacts and Corresponding Mitigations Measures

Impact (Source / pathway / Receptor)	Degree of significance if not mitigated	Mitigation	Mitigated degree of significance
Construction workers and future site users may be at risk through direct/indirect contact with contaminated soil or water, through the inhalation of gases and dust or ingestion of contaminated dust.		potentially contaminated materials. ▪ Systems to record and monitor the movement and deposition of waste material leaving or being transported to other part of the site. ▪ Sampling, testing and monitoring of the excavation works to identify suspect ground.	
Source: hydrocarbons, heavy metals and sewage and waste. **Pathway**: leaching to groundwater. **Receptor**: groundwater Groundwater quality beneath the site may be affected by contamination entering the groundwater or the leakage / spillage of fuels, chemicals, waste landfill, etc.	Moderate	The Development of a Code of Construction Practice (CoCP) will include the following measures: ▪ Developing an outline method statement for investigation, testing and remediating contamination encountered on the site. ▪ Outline emergency procedures to deal with the discovery of unknown contaminated materials, and spills during the works in accordance with established guidelines. ▪ Storage of all potentially polluting substances will be located on impermeable surfaces with controlled drainage, away from permeable areas of ground, storm water sewers, grids, channels and watercourses. ▪ A programme of environmental monitoring of groundwater and comparison of results with the baseline conditions will identify potential impacts on water bodies as a result of the construction process and allow further mitigating measures to be adopted, such as water treatment/settlement.	Negligible

Table G.13: Potential Adverse Environmental Impacts and Corresponding Mitigations Measures

Impact (Source / pathway / Receptor)	Degree of significance if not mitigated	Mitigation	Mitigated degree of significance
Source: hydrocarbons, heavy metals and sewage and waste. **Pathway**: earthwork activities, direct transportation of contamination. **Receptor:** groundwater. Piling and other earthwork activities could create a new pathway for the contaminants / leachates to enter the aquifers.	Moderate	The Development of a Code of Construction Practice (CoCP) will include the following measures: ▪ A risk assessment will be undertaken to identify the piling method and other deep foundation best able to avoid creation of pathways for contaminated leachate to impact on groundwater and to assess the likelihood that the piling works will allow the transport of contaminants.	Negligible
Source: hydrocarbons, heavy metals and sewage and waste. **Pathway**: loss of contaminated water, mixing with surface water. **Receptors**: surface water, river. Potential impacts upon the water environment may occur due to mobilisation of contaminants, loss of contaminated water from the Petrol, Oil and Lubrication (POL) system or leaks/spillages from machinery and storage tanks on the site.	Moderate	The Development of a Code of Construction Practice (CoCP) will present a set of procedures based upon a full environmental risk assessment. It will include details of the following measures: ▪ Control of surface water run off. All water run off from possible contamination sources will be channelled to a treatment system prior to an authorised discharge route. ▪ Outline emergency procedures to deal with the discovery of unknown contaminated materials, and spills during the works in accordance with established guidelines. ▪ All fuel, chemicals and oils will be stored within a bunded area and	Negligible

Table G.13: Potential Adverse Environmental Impacts and Corresponding Mitigations Measures

Impact (Source / pathway / Receptor)	Degree of significance if not mitigated	Mitigation	Mitigated degree of significance
Contaminants from tanks, sewage and waste enter water by the storm drainage network. Other impacts include changes to flow volume and water levels.		clearly labelled.	
Source: Waste produced by possible construction activities. **Pathway**: Leaching to groundwater, transport along existing buried services, mixing with surface water. **Receptors**: Surface water / groundwater. The redevelopment activities are likely to include demolition, concrete operations, earthwork etc. They will produce waste water which would possibility mix and contaminate the surface water and groundwater.	Moderate	The Development of a Code of Construction Practice (CoCP) will include the following measures: ▪ Provisions for construction site drainage will be achieved by the development and implementation of an appropriate site drainage plan to ensure that surface water run off is contained and managed appropriately. ▪ Waste water from construction site will be either recycled or fully contained and treated prior to disposal. Measures will be taken to ensure that run off from earthworks, concrete operations and wash out does not enter drains or watercourses. ▪ Where the site is potentially or actually contaminated, or the groundwater that has gathered in the base of the excavation appears contaminated, samples need to be taken of the soil and water and laboratory testing undertaken before the water is pumped out. The degree of contamination and for in situ soils their susceptibility to leaching will be determined to select the appropriate method of disposal	Negligible

Table G.13: Potential Adverse Environmental Impacts and Corresponding Mitigations Measures

Impact (Source / pathway / Receptor)	Degree of significance if not mitigated	Mitigation	Mitigated degree of significance
Source: hydrocarbons, heavy metals and sewage and waste. **Pathway**: Mixing with surface water, airborne pathways, inhalation, consumption, ingestion, dermal contact. **Receptor**: Eco system. Planting is at risk from heavy metals contaminants. The pathway for contaminants is usually by uptake through plant root systems in contact with contaminated groundwater. Hydrocarbons can adversely affect plant growth. Animals may intake contaminants.	Moderate	The Development of a Code of Construction Practice (CoCP) will include the following measures: ▪ Developing an outline method statement for investigation, testing or excavating contamination encountered on the site. ▪ Outline emergency procedures to deal with the discovery of unknown contaminated materials and abnormal performance of plant and animals, and spills during the works in accordance with established guidelines.	Negligible

Table G.13: Potential Adverse Environmental Impacts and Corresponding Mitigations Measures

Impact (Source / pathway / Receptor)	Degree of significance if not mitigated	Mitigation	Mitigated degree of significance
Sources: hydrocarbon, acidic compounds, high soluble sulphate in soil. **Pathway**: Leaching to groundwater, transport along existing buried services, direct transportation of contamination, direct contact. **Receptor**: structures and services. Services such as water mains, foul sewer, surface water sewer, gas, electricity, and telecoms can be adversely affected. Elevated concentrations of hydrocarbons can have an adverse affect on concrete, plastic pipework and rubber seals. High soluble sulphate levels may also have deleterious effects on concrete, services, and foundations.	Moderate	The Development of a Code of Construction Practice (CoCP) will include the following measures: ▪ Developing an outline method statement for investigation, testing or excavating contamination encountered on the site. ▪ Outline emergency procedures to deal with the discovery of unknown contaminated materials, and spills during the works in accordance with established guidelines. ▪ A programme of environmental monitoring of underground soil and comparison of results with the baseline conditions will identify potential impacts on the soil as a result of the construction process and allow further mitigating measures to be adopted, such as soil treatment, where required.	Negligible

Table G.13: Potential Adverse Environmental Impacts and Corresponding Mitigations Measures

Impact (Source / pathway / Receptor)	Degree of significance if not mitigated	Mitigation	Mitigated degree of significance
Source: explosives from fireworks and weapon storage area. **Pathway**: Airborne pathways, inhalation, consumption, ingestion, contact. **Receptor**: construction workers, future site users. Residues of materials present in fireworks and weapon storage area may be released into the environment during redevelopment, demolition and clearance work and could be spread across the site	Minor	The Development of a Code of Construction Practice (CoCP) will include the following measures: ▪ Developing an outline method statement for investigation, testing or excavating explosive materials. ▪ Outline emergency procedures to deal with the discovery of explosive materials, and spills during the works in accordance with established guidelines. ▪ Monitoring of gas levels. ▪ Use of appropriate precautions and PPE.	Negligible

Table G.13: Potential Adverse Environmental Impacts and Corresponding Mitigations Measures			
Impact (Source / pathway / Receptor)	**Degree of significance if not mitigated**	**Mitigation**	**Mitigated degree of significance**
Source: ground gases, vapours, explosive gases. **Pathway**: Airborne pathways, inhalation. **Receptor**: construction workers. Made ground, topsoil, hydrocarbon contamination or natural organic materials could generate gases such as methane and carbon dioxide. Confined areas and underground structure (e.g. tunnel, basement) may be at risk of ground gases accumulating to harmful concentrations.	Moderate	Generally work in confined spaces will be avoided. However where access is unavoidable the following mitigation methods will be included in the Development of a Code of Construction Practice (CoCP): ▪ Appropriate supervision and Confined Space Entry (CSE) training for site personnel. ▪ Monitoring of gas levels. ▪ Use of appropriate precautions and PPE.	Negligible

Table G.13: Potential Adverse Environmental Impacts and Corresponding Mitigations Measures

Impact (Source / pathway / Receptor)	Degree of significance if not mitigated	Mitigation	Mitigated degree of significance
Source: Radiation. **Pathway**: Airborne pathways, inhalation. **Receptor**: Construction workers, future site users. The DERA Radiation report, 20 June 1997, states: "With the exception of caesium-137, no radioactive contamination due to the presence of man-made radionuclides or significantly enhanced levels of naturally occurring radioactive materials were detected during this radiological survey."	Moderate	The Development of a Code of Construction Practice (CoCP) will include the following measures: ▪ Any radiation on the site will have been identified before work starts with information on the location and condition of these materials. Existence of radiation will be tested by a specialist laboratory. ▪ Prevent construction workers exposure to radiation or reduce it to the lowest level possible by using suitable controls. ▪ Provide the construction workers with information, instruction and training about the risks of working in a radiation environment and the precautions they will take. Make sure they are properly trained to use relevant equipment. ▪ Consult the health and safety representative, if there is one, about the control measures to be taken.	Negligible

12.7 RESIDUAL EFFECTS

12.7.1 Provided all the appropriate and necessary mitigation measures are successfully implemented the proposed development of the Site will result in no significant risk to the health and safety of users and neighbours of the proposed development from contaminated ground remaining on the site.

12.7.2 Within the area proposed for development all known ground contamination will be remediated in addition to any unknown area encountered during demolition and construction works. There will therefore be no residual impacts from the redeveloped area associated with contaminated soils.

12.7.3 The residual impacts following development of the site are associated with the changes in the proportion of hard standing across the area proposed for development. In very broad terms the overall change in the proportion of hard standing is understood to be of the order of just under an 8 hectare decrease. The change will result in a small net increase in recharge to groundwater. This is a positive aspect of the proposed development, however, the change is not deemed to be significant in terms of the total recharge over the whole base area.

12.7.4 In addition to the change in hard standing cover it is proposed to change the routing of some of the storm water discharge. This may include routing to soakaways to improve recharge to groundwater. The volume and location of the changes associated with this will be determined at the detailed design stage and could result in a significant positive improvement to groundwater recharge and a reduction in stormwater run off to drain and thence surface water courses.

12.7.5 The slight increase in recharge and change of routing will serve to reduce peaks in the rate of discharge to stream during periods of rainfall; and increase groundwater recharge which will help to improve stream base flow. Both of these improvements may be noticed beyond the local area, but are unlikely to remain apparent for a significant distance.