10 Geology, hydrogeology and contamination

Introduction

10.1 This chapter assesses the impact of the proposed development on geological and hydrogeological conditions. In particular, it considers the potential impacts of contamination on sensitive users during the demolition, remediation, construction and post-construction stages of the development. The chapter has been prepared by WSP Environmental and includes summaries of the geoenvironmental factual and interpretive reports contained in technical appendix G.

Legislation and policy

Legislative framework

10.2 The applicable legislative framework is summarised as follows:

- Part IIA of the Environmental Protection Act 1990 (ref. 10.1) - Part IIA of the Environmental Protection Act 1990 describes a regulatory role for local authorities in dealing with contaminated land. Contaminated land is defined as "land which appears to the local authority to be in such a condition, by reason of the presence in, on or under the land, of polluting substances"
- Environment Act 1995 (ref. 10.2) - The Environment Act 1995 creates a system whereby local authorities must identify and, if necessary, arrange for the remediation of contaminated sites
- The Groundwater (England and Wales) Regulations 2009 (ref. 10.3)
- Construction (Design & Management) Regulations 2007 (ref. 10.4) - these regulations are to make explicit duties that exist under the Health and Safety at Work Act 1974 and the Management of Health and Safety at Work Regulations 1999. This requires clients to use their influence to ensure that the arrangements other duty holders have made are sufficient to ensure the health and safety of those working or those affected by that work
- Control of Asbestos Regulations 2006 (ref. 10.5) - the Regulations prohibit the importation, supply and use of all forms of asbestos. If existing asbestos containing materials are in good condition, they may be left in place; their condition monitored and managed to ensure they are not disturbed. The Asbestos Regulations also include the 'duty to manage asbestos' in non-domestic premises

Planning policy

10.3 Planning policy at the national, regional, county and local level, including the scheme's compliance with policy requirements, is discussed in the Planning Supporting Statement.

National planning policy

10.4 National planning policy relating to this chapter includes:

Planning Policy Statement 23: Planning and Pollution Control (2004) (PPS23; ref. 10.6)

- PPS23 seeks to provide comprehensive advice on the relationship between planning and pollution control. It also includes advice on issues such as the redevelopment of contaminated land and the liaison between local planning authorities and the environmental protection agencies. Chapters 8, 9, 11 and 10 assess the potential effects of the development on air quality, noise, drainage, ground conditions and contamination, respectively, in accordance with this guidance

PPS23, Annex 2: Development on Land Affected by Contamination, 2004

- Annex 2 of PPS23 gives detailed guidance on the development of land that may have been affected by contamination and also provides local authorities with the opportunity to require that land contamination is assessed and, if necessary, remediated as a condition of the planning system. The onus is put on the developer to show that risks from contamination are acceptable and that the site will be deemed "fit for purpose".

Draft National Planning Policy Framework, 2011

10.5 Paragraph 171 of the draft National Planning Policy Framework sets out emerging policy on contamination and states that local policies and decisions should ensure that "the site is suitable for its new use, taking account of ground conditions, pollution arising from previous uses and any proposals for land remediation".

Regional and local planning policy

10.6 The Localism Bill was enacted in November 2011, thereafter becoming the Localism Act. Different parts of the Act will, however, come into effect at different times over the coming months. The Act enables Regional Spatial Strategies, including the East of England Plan, to be abolished, but this will be undertaken by statutory order by the government in due course (it is currently understood that this will be around March / April 2012), subject to consultation. Whilst the East of England Plan remains part of the development plan until it is formally abolished, the government has advised that the proposed abolition of Regional Spatial Strategies should be regarded as a material consideration by local planning authorities when deciding planning applications. It should therefore be afforded limited weight in the determination of this planning application.

10.7 Local planning policy relating to this chapter includes the following:

- The Local Development Framework (LDF) for South Cambridgeshire – Core Strategy, adopted January 2007: policy ST/3: Re-Using Previously Developed Land and Buildings
- LDF Development Control Policies, adopted July 2007: policy DP/1: Sustainable Development 1) – ensure no unacceptable adverse impact on land, air and water, and policy DP/3: Development Criteria – planning permission will not be granted where the proposed development would have an unacceptable adverse impact: r) on quality of ground or surface water

10.8 This assessment will take due regard of the South Cambridgeshire District Council Contaminated Land Strategy published in July 2001.

Guidance

10.9 The assessment has taken account of a number of best practice documents including (see table 10.1 for full reference details):

- Health and Safety Executive (HSE), Guidance Note HS (G) 66, *Protection of Workers and the General Public during the Development of Contaminated Land* (ref. 10.7)
- BS10175, *Investigation of Potentially Contaminated Sites – Code of Practice* (ref. 10.8)
- Environment Agency, *Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination: Guidance on Pollution Prevention* (ref. 10.9)
- Environment Agency, PPG1 *General Guide to the Prevention of Water Pollution* (ref. 10.10)
- Environment Agency, PPG2 *Above Ground Oil Storage Tanks* (ref. 10.11)
- Environment Agency, PPG6 *Working at Construction and Demolition Sites* (ref. 10.12)
- Environment Agency, PPG8 *Safe storage and disposal of used oils* (ref. 10.13)
- Environment Agency, PPG21 *Pollution Incident Response Planning* (ref. 10.14)
- CIRIA C665, *Assessing risks posed by hazardous ground gases to buildings* (ref. 10.15)
- CIRIA 681 (2009), *Unexploded Ordnance (UXO): A guide for the construction industry* (ref. 10.16)

Methodology

Scope of the assessment

10.10 As discussed in chapter 3, a Scoping Report was issued to SCDC in July 2011. This document identified the effects that the development will potentially have on ground conditions, hydrogeology and contamination during the site preparation, earthworks and construction and post-construction stages.

10.11 These included the following potentially significant effects:

- Potential for health effects due to contact with contaminants during construction (including asbestos-containing materials in existing buildings)
- Mobilisation of contaminants into the water environment during and post-construction
- Potential for health effects due to contact with contaminants post-construction arising from the use of gardens, landscaped areas and public open space
- Potential for the presence of ground gas or landfill gas to pose a risk to future site users and new structures (explosive and asphyxiant)
- Potential presence of buried munitions and / or ordnance or munitions on the surface posing a risk to human health and new structures
- Effects on surface water and groundwater quality from pollution due to spills during construction and from contaminated runoff post-construction

Extent of the study area

10.12 In terms of contaminated land and risk to controlled waters, the following study areas have been considered:

- Desk study: up to 1 km from the application boundary
- Ground investigation and associated reports: all land within the application boundary

Method of baseline data collection

Previous studies and information

10.13 A number of previous studies have been undertaken that are pertinent to this chapter and these are referenced below. In addition, several different information sources have been used to compile baseline information for this chapter (see table 10.1 for full reference details). Additional references are detailed at the end of this section.

- WSP Environmental, Preliminary Ground Investigation Report (ref. 10.17)
- WSP Environmental, Phase 1 Environmental Audit (ref. 10.18)
- ARP (Paul Francis), RAF Oakington: An Operational History & Gazetteer of Surviving Structures (ref. 10.19)
- Entec UK Ltd, Oakington Barracks APCs, Land Quality Assessment: Phase 2A Site Investigation (ref. 10.20)
- Oxford Archaeotechnics, Cambridge Golf Course and Land North of Rampton Road, Longstanton. Magnetometer (Gradiometer) Survey (ref. 10.21)
- Oxford Archaeotechnics, Land North of Rampton Road, Longstanton. Magnetometer (Gradiometer) Survey (ref. 10.22)

- Bactec International Limited, Explosive Ordnance Threat Assessment, RAF Oakington (ref. 10.23)
- Bactec International Limited, Report on Explosive Ordnance Disposal (EOD) Support to Site Investigation Works (ref. 10.24)
- WSP Risk Management Services, Asbestos Survey Report (Type 2) (ref. 10.25)

10.14 Desk study information has also been obtained for the ES from the following sources:

- Review of historical Ordnance Survey maps and any other available plans to assess the historical usage of the site (former contaminative uses)
- Review of information pertaining to the geology, hydrogeology and hydrology of the site and surrounding area to assess ground conditions and presence of sensitive environmental targets (ref. 10.26 to 10.28)
- Liaison with relevant authorities, including the Environment Agency and local authority
- Landmark Envirocheck report (ref. 10.29)

10.15 Intrusive ground investigations have been undertaken by WSP on and off the site and began in 2005. As part of these investigations, a number of interim Factual Reports were produced for the 2007 planning application for the wider Northstowe site. The relevant information from these reports relating to the new application site has been condensed into a site specific Factual Report (ref. 10.30) and separate Interpretive Report (ref. 10.31) for this planning application. These documents are included in technical appendix G.

10.16 Ground investigations undertaken since 2005 have comprised the drilling of cable percussion boreholes; the excavation of trial pits; the advancement of window sample holes; and Cone Penetration Testing (CPT). Monitoring for ground gas and groundwater elevation from boreholes installed with dedicated monitoring wells has also been undertaken on a monthly basis during 2007, following bi-monthly monitoring during 2006. In addition, water samples have been tested from surface water features on and around the site.

10.17 Data from the ground investigation works outlined above are used within this chapter to detail baseline conditions. However, supplementary ground investigation is required across the golf course and these data will not be available for inclusion within the ES due to access restrictions. As the land uses on the site have not changed since the ground investigations were completed, and supplementary work will be undertaken prior to development in order to characterise the current groundwater and surface water conditions, it is considered that the use of the existing baseline data is sufficient to allow a robust assessment to be completed for the planning application.

10.18 The references set out in table 10.1 (refs. 10.1 to 10.31) have been used in the production of this chapter.

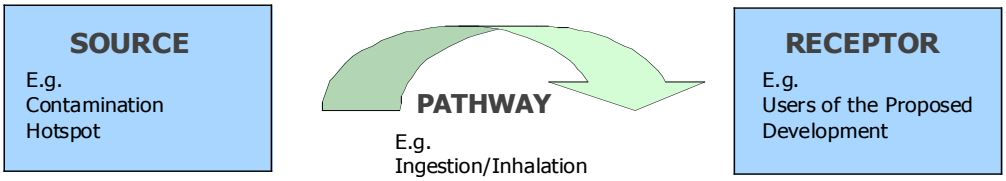
Table 10.1: References

No.	Reference
10.1	HMSO (1990). Environmental Protection Act: Part 2A, Contaminated Land (including Defra Circular 01/2006).
10.2	HMSO (1995). Environment Act 1995.
10.3	HMSO (2009). The Groundwater (England and Wales) Regulations 2009.
10.4	HMSO (2007). Construction (Design & Management) Regulations 2007.
10.5	HMSO (2006). The Control of Asbestos Regulations.
10.6	ODPM (2004). Planning Policy Statement 23: Planning and Pollution Control.
10.7	Health and Safety Executive (HSE) (1991). Guidance Note HS (G) 66, Protection of Workers and the General Public during the Development of Contaminated Land.
10.8	British Standards Institute (BSI) (2011), BS10175:2011 Investigation of Potentially Contaminated Sites – Code of Practice.
10.9	Environment Agency (EA) (2001). Piling and Penetrative Ground Improvement methods on Land Affect by Contamination: Guidance on Pollution Prevention (NC/99/73).
10.10	EA (2001). PPG1 General Guide to the Prevention of Water Pollution.
10.11	EA (2011). PPG2 Above Ground Oil Storage Tanks.
10.12	EA. PPG6 (2006) Working at Construction and Demolition Sites.
10.13	EA (2004). PPG8 Safe Storage and Disposal of Used Oils.
10.14	EA (2004). PPG21 Pollution Incident Response Planning.
10.15	Wilson, S; Oliver, S; Mallet, H; Hutchings, H; Card, G (2006). CIRIA C665 – Assessing Risks Posed by Hazardous Ground Gases to Buildings.
10.16	CIRIA 681 (2009). Unexploded Ordnance (UXO): A guide for the construction industry.
10.17	WSP Environmental, Preliminary Ground Investigation Report, Longstanton/Oakington Barracks, Gallagher Estates, Report Reference 12040122, July 2002.
10.18	WSP Environmental, Phase 1 Environmental Audit, Oakington Barracks, Gallagher Estates, Report Reference 12020566, August 2002.
10.19	ARP (Paul Francis), RAF Oakington: An Operational History & Gazetteer of Surviving Structures, WSP Environmental, January 2005.
10.20	Entec UK Ltd, Oakington Barracks APCs, Land Quality Assessment: Phase 2A Site Investigation, September 2007, Report Reference 12924.
10.21	Oxford Archaeotechnics, Cambridge Golf Course and Land North of Rampton Road, Longstanton, Magnetometer (Gradiometer) Survey, Report 3090406/OAC/JJG, 2006.
10.22	Oxford Archaeotechnics Land North of Rampton Road, Longstanton, Magnetometer (Gradiometer) Survey, Report Reference 309A0406/OAC/JJG, October 2006.
10.23	Bactec International Limited, Explosive Ordnance Threat Assessment, RAF Oakington, Cambridgeshire, Report Reference 8863TA, Preliminary August 2005 and Final January 2006.
10.24	Bactec International Limited, Report on Explosive Ordnance Disposal (EOD) Support to Site Investigation Works (2005), RAF Oakington, Cambridgeshire. Bactec International Limited, Report Reference 8863 SI, January 2006.
10.25	WSP Risk Management Services, Asbestos Survey Report (Type 2), Former Oakington Barracks, Longstanton, Cambridgeshire. Revision 1, November 2007.
10.26	British Geological Survey (2001). 1:50,000 scale, Sheet 187 (Drift) Huntingdon, published 1975; and Sheet 188 (Solid and Drift) Cambridge, published 1981.
10.27	British Geological Survey (2011). Online geology viewer Available at: http://www.bgs.ac.uk/opengeoscience. (Date accessed October 2011).
10.28	Environment Agency (2011) Aquifer Classification and Source Protection Zone Status Available at: www.environment-agency.gov.uk (Date accessed October 2011).
10.29	Landmark Envirocheck Reports May 2002 updated November 2011.
10.30	WSP Environmental, Geoenvironmental Assessment - Factual Report, Northstowe Phase 1, 22881-R01, November 2011.

Table 10.1: References	
No.	**Reference**
10.31	WSP Environmental, Geoenvironmental Assessment - Interpretive Report, Northstowe Phase 1, 22881-R02, November 2011.

Assessment modelling

10.19 Current guidance on the assessment of contamination risk (as set out in the Environmental Protection Act: Part 2A, Contaminated Land (including Defra Circular 01/2006) (ref. 10.1) and BS10175:2011 (ref. 10.8)) advocates the use of a conceptual risk assessment model in an attempt to establish the links between a hazardous source and a sensitive receptor via an exposure pathway. The concept behind this approach is that, without each of the three fundamental elements (source, pathway and receptor) being present there can be no contamination risk. Thus, the mere presence of a contamination source at a particular site does not necessarily imply the existence of an associated risk. The conceptual source-pathway-receptor model has been used qualitatively. However, should a potential pollution linkage be identified then a quantitative risk assessment may be required and would be developed at the time of site investigation works. The philosophy behind the conceptual model is illustrated below:



Significance criteria

10.20 The assessment of potential effects as a result of the proposed development has taken into account the site preparation, construction and post-construction stages. The significance level attributed to each effect has been assessed based on the magnitude of change due to the development proposals, and the sensitivity of the affected receptor / receiving environment to change, as well as a number of other factors that are outlined in more detail in chapter 3. The sensitivity of the affected receptor / receiving environment and the magnitude of change are assessed on a scale of high, medium, low and negligible; and large, medium, small and negligible respectively (as shown in figures 10.1 and 10.2).

10.21 Effect significance has been determined by combining the receptor sensitivity with the impact magnitude to derive the degree of the effect, using the matrix in figure 10.3. Effects that are moderate or above are considered to be significant.

Baseline

Site history

10.22 The history of the site has been interpreted from site walkovers, review of historical mapping and aerial photographs.

10.23 The primary development site has historically supported open agricultural land prior to the development of Cambridge Golf Course on the central and northern areas. The site is located immediately north of the former Oakington Airfield and Barracks. The Hatton's Road attenuation ponds area has supported arable farmland to the present day. Detailed information on the site history is provided within the Factual Report (technical appendix G).

General setting

10.24 A registered waste management and waste transfer station is located approximately 150 m to the north of the primary development site. This is a small facility that is licensed to transfer <10,000 tonnes per annum of waste ferrous and non-ferrous metal.

10.25 A second waste transfer station is located approximately 250 m to the north of the primary development site. Waste licensed to be handled within this facility includes tyres and scrap tubing.

10.26 Waste transfer stations are licensed to sort wastes of similar types, which can then be transferred into larger containers and sent to other waste facilities for further treatment, recovery or disposal. Wastes can be bulked up for disposal or recovery elsewhere and can be manually sorted or separated for recovery, but their licence does not allow any waste treatment activities such as screening and crushing.

10.27 There are no recorded landfills within 1 km of the site.

Hydrological setting

10.28 Notable surface water features within 1 km of the primary development site have been identified as Longstanton Brook (west), Beck Brook (east), Nethergrove Lake (south) and Reynolds Drain (adjacent, east), as well as unnamed drains, as detailed in the Factual Report (technical appendix G). The main surface water bodies generally flow south to north, with drainage generally west to east, linking with the primary surface water bodies. There are several ponds on the golf course; the main pond is to be retained as part of the proposed development.

10.29 Three discharge consents to surface water relate to the sewage treatment plant and oil trap outfall on the airfield to the south east of the site. The discharge is to Reynolds Ditch. A further consent relates to the Lurmark Plc site immediately north of the site. The discharge is stated to be "sewage discharges – final / treated effluent".

10.30 A surface water abstraction for "construction: dust suppression" is located immediately north of the site. It relates to the Edmund Nuthall Ltd Cambridgeshire Guided Busway site and, given that the busway is now complete, is unlikely to be utilised.

10.31 Longstanton Brook flows through the Hatton's Road attenuation ponds area from south to north. Other notable surface water features in the vicinity are limited to unnamed drains. Further information on the surface water environment can be found in chapter 11: water, flooding and drainage and in the flood risk assessment in technical appendix H.

Geological setting

Published geology

10.32 British Geological Survey mapping at 1:50,000 scale, Sheet 187 (Drift) Huntingdon, published 1975 and Sheet 188 (Solid and Drift) Cambridge, published 1981indicate that the geological sequence set out in table 10.2 underlies the site.

Table 10.2: Site geology

Geological unit	Thickness	Are of site	Aquifer status
River Terrace Deposits	Approx. 5 m	Primary development site	Secondary A
Ampthill Clay	Up to 50 m	Both	Unproductive strata
Kimmeridge Clay	Up to 30 m	Hatton's Road attenuation ponds area	Unproductive strata

10.33 The primary development site's geology is shown to comprise superficial drift geology second and third River Terrace Deposits (sands and gravels). The Upper Jurassic Ampthill Clay Formation outcrops in the eastern portion of the site and underlies the site as a whole to depth.

10.34 The Hatton's Road attenuation ponds area is shown to be underlain by the Upper Jurassic Kimmeridge Clay Formation and the Ampthill Clay Formation.

Geology encountered beneath the primary development site

10.35 Exploratory holes have been located on the primary development site by WSP during a groundwater level monitoring investigation (2003); and by WSP during the main ground investigations undertaken from 2005 to 2008. Detail on the scope of the ground investigations and exploratory hole location plans are provided in figures 10.4 and 10.5.

10.36 The geological conditions recorded beneath the site are summarised in table 10.3.

Table 10.3: Geology encountered beneath the primary development site		
Made Ground	**River Terrace Deposits**	**Ampthill Clay**
Grass over dark brown slightly sandy gravelly CLAY (gravel comprising flint, granite and brick). Reworked slightly clayey slightly gravelly sandy TOPSOIL or soft grey sandy organic clay with rare fine gravel.	Predominantly medium dense to dense orange brown sandy flint and chalk GRAVEL, SAND AND GRAVEL or gravelly SAND with variable amounts of clay.	Generally fissured firm to hard grey or blue grey occasionally mottled brown or orange brown CLAY with rare bands of siltstone. Locally slightly sandy with selenite crystals and pyrite.
Depth to base of strata (m)		
0.3 – 1.4	0.4 – 8.0	Unproven

10.37 Made Ground was identified in four locations on the western area of the site (WSA1, BHA30, TPA3 and PTM1) and was found to comprise dark brown, reworked, slightly clayey, slightly sandy topsoil; grass over brown, slightly gravelly, sandy topsoil; dark brown, slightly sandy, gravelly clay with brick, granite and flint gravel; and black / brown, slightly clayey, very gravelly sand with roadstone and clinker gravel.

10.38 However, Made Ground comprising soft, sandy organic clay with rare fine gravel and a single metal rod was identified in TPA3, in the northern and eastern faces of the trial pit, between 0.8 m and 1.4 m below ground level (bgl). TPA3A was excavated adjacent to TPA3 to confirm the lateral extent of Made Ground in this area, and no Made Ground was encountered. It is possible that the observed organic material in TPA3 resulted from a backfilled pond or pit.

10.39 Topsoil was encountered within all exploratory holes where Made Ground was absent (except BHA13, 16, 17 and 22) between ground level and 1.2 m bgl (generally 0.3 - 0.7 m bgl). The deepest deposits were recorded on the golf course and it is considered likely that a proportion of the deeper deposits are reworked across this area, resulting from the re-grading of shallow soils to form the fairways. Topsoil was generally sandy towards the west and clayey towards the east.

10.40 The natural strata underlying the site were found to be consistent with the geological map information, comprising River Terrace Deposits underlain by Ampthill Clay. The superficial deposits were encountered in the western part of the primary development site and predominantly comprise medium dense to dense orange brown sands and gravels, with some silt bands, recorded to a maximum depth of 8.0 m bgl (BHA22, although depth was not proven at several other borehole locations). Some areas of the central and southern portion of the primary development site exhibited River Terrace Deposits channelised into the underlying solid geology.

10.41 The Ampthill Clay was encountered beneath the superficial deposits in the western part of the site (deepest in BHA022 from 8.0 m bgl) beneath the predominantly granular River Terrace Deposits; and at shallower depths to the

east, generally beneath cohesive River Terrace deposits. The lithology comprised firm to hard grey or blue grey clay, occasionally mottled brown. The clay was found to be slightly sandy and fissured in several locations, with a band of siltstone in WSA5 at 2.6 m to 3.0 m bgl. Siltstone bands are more common on the former airfield to the south of the site.

Geology encountered beneath the Hatton's Road attenuation ponds area

10.42 Exploratory holes have been located on the Hatton's Road attenuation ponds area by WSP during the main ground investigations undertaken from 2005 to 2006. Detail on the scope of the ground investigations and an exploratory hole location plan is provided within the Factual Report (technical appendix G).

10.43 The geological conditions recorded beneath the site are summarised in table 10.4.

Table 10.4: Geology encountered beneath the Hatton's Road attenuation ponds area

River Terrace Deposits	Ampthill Clay	Kimmeridge Clay
Firm yellow brown slightly gravelly sandy to very sandy CLAY locally with grey mottling. Loose to medium dense brown slightly gravelly very clayey SAND. Firm to stiff grey mottled orange brown slightly gravelly slightly sandy SILT (one location).	Generally fissured firm to hard grey or blue grey occasionally mottled brown or orange brown CLAY with rare bands of siltstone. Locally slightly sandy with selenite crystals and pyrite.	Generally fissured firm to hard grey or blue grey occasionally mottled brown or orange brown CLAY with rare bands of siltstone. Locally slightly sandy with selenite crystals and pyrite.
Depth to base of strata (m)		
GL – 2.6	Unproven	Unproven

10.44 Made Ground was not encountered within the Hatton's Road attenuation ponds area. Clayey Topsoil was encountered within all exploratory holes (except BHD3, and TPD32), between ground level and 0.5 m bgl (generally circa 0.3 m bgl). This generally correlates with the plough depth across the site.

10.45 The natural strata underlying the site were found to be consistent with the geological map information, comprising River Terrace Deposits underlain by Ampthill Clay or Kimmeridge Clay. Generally thin superficial River Terrace Deposits were encountered above the solid strata. They predominantly comprised sandy clay, with irregular granular deposits often channelised into the underlying solid strata.

10.46 The Ampthill Clay was encountered beneath the superficial deposits in the northern part of the site, and Kimmeridge Clay in southern parts of the site. The lithologies of the two clays were generally similar, comprising firm to hard grey or blue clay, occasionally mottled brown or orange brown. The clay was found to be slightly sandy and fissured in several locations, with

occasional bands of siltstone. The siltstone bands were not encountered fully as one unit, but were generally recorded on the eastern half of the site. There did appear to be a general dip in the bands between exploratory holes towards the north west.

Hydrogeological setting

Primary development site

10.47 Groundwater was predominantly encountered in exploratory holes across the western part of the site. The majority of groundwater strikes were recorded between one and two metres below ground level within the River Terrace Deposits (secondary A aquifer). Groundwater level monitoring has confirmed that the groundwater flow direction is to the north and north east of the site within the River Terrace Deposits, in line with the flow of local surface water features and drainage (see section 5.4 of Factual Report). Some groundwater flow to the east and north east is likely within the Ampthill Clay, in line with the general topography of the eastern half of the site.

10.48 One groundwater abstraction is located on the primary development site (Cambridge Golf Club) and is licensed to abstract 3,410 m^3 of groundwater per year. One groundwater abstraction is located 315 m to the north of the site for 'general farming and domestic' use. Two further groundwater abstractions are located just to the south of the site (up hydraulic gradient); one relating to water supply to a nursery (irrigation) and a second for lake top-up water. A further five revoked abstractions are located within 1 km of the site (north), although they may remain in use but no longer be regulated as they are reported to abstract less than 20 m^3 per year.

10.49 It is considered that surface water features on the site, such as ponds and lakes, are in hydraulic continuity with the groundwater. The principal groundwater receptor is considered to be the River Terrace Deposits beneath the western part of the site.

10.50 Permeability testing was undertaken at several borehole locations across the site. The data are presented within the Factual Report (technical appendix G). The testing indicated hydraulic conductivities between 0.09 m/day and 16.15 m/day within the clay strata. Permeability testing was undertaken in the granular River Terrace Deposits (BHA33 deep), recording hydraulic conductivities between 7.94 m/day and 12.18 m/day.

Hatton's Road attenuation ponds area

10.51 Groundwater was generally encountered in exploratory holes within the Ampthill / Kimmeridge Clay (Unproductive Strata). Groundwater levels during the monitoring period were between 0.54 m bgl and 2.09 m bgl. The direction of groundwater flow beneath the site is to the north or north west. Groundwater flow across the site appears to be influenced by local surface water features, with flows parallel to the open surface drains and Longstanton Brook, which flows through the site. Other surface water features in the

vicinity of the site include unnamed drains, as detailed in the Factual Report (technical appendix G).

10.52 Several groundwater abstractions have been identified within 1 km of the site, although not all of these may still be in use. All the abstractions are located to the south and east of the site (up hydraulic gradient), and are therefore unlikely to be impacted by the site. Abstractions on and immediately around the primary development site are over 1 km from the Hatton's Road attenuation ponds area and are therefore only likely to be impacted by significant pollution incidents.

10.53 Based on the descriptions from the exploratory hole records, River Terrace Deposits are considered to be of variable permeability. Although River Terrace Deposits are technically classified as a secondary A aquifer, it is considered unlikely that they hold notable volumes of groundwater, due to the variable nature of the strata (alternates between granular and cohesive deposits) and their likely limited vertical and lateral extent across the site. The Kimmeridge and Ampthill Clay are non-aquifers and are considered to be of low permeability, although secondary porosity in the form of fissuring may be present. Permeability testing was not undertaken within exploratory holes on the site.

Regulatory enquiries

10.54 As part of the WSP Phase I Geo-Environmental Audit (ref. 10.18), representatives from the regulatory authorities were contacted for any information relevant to the site.

10.55 The Environmental Health Department of SCDC revealed that they were not aware of any contaminated land on the former airfield to the south of the site, farmland within the site boundary, or on immediately adjacent sites. Furthermore, the site has not to date been fully investigated for contaminated land under Part IIA of the Environmental Protection Act 1990. The officer confirmed that there are three known areas of infill material (content unknown) located within the airfield to the south of the primary development site. WSP has confirmed their locations as part of wider works and they are not considered to represent a risk to the site.

10.56 Owing to the absence of significant development in the area, no specific information was available from the building control officer at SCDC.

10.57 The Environment Agency (EA) was contacted specifically regarding the details of the waste transfer station identified on the northern tip of the primary development site at the time of the enquiry. The relevant officer was able to confirm that the waste transfer station operates a license to sort and segregate <10,000 tonnes of inert waste comprising pipelines, cables, soil and rubble. At the time of the enquiry, the officer stated that there were no significant concerns relating to this waste transfer station.

Contamination - soils

Entec ground investigation

10.58 Entec completed a ground investigation predominantly on the north eastern portion of the airfield to the south of the primary development site in 2007 (ref. 10.20). Two trial pits were excavated on the south eastern corner of the primary development site to investigate an area suspected as being used for the storage of ordnance and chemical weapons.

10.59 Analysis was undertaken for a range of contaminants, including chemical warfare agents, associated breakdown products and explosives, all of which were found to be below the laboratory detection limits. No evidence for the burial and disposal of ordnance was identified within these two trial pits. The results from the general contaminant suites were also found to be below the adopted WSP screening criteria or below detection limits.

WSP ground investigations

10.60 The ground investigations undertaken by WSP are detailed within the Factual and Interpretive Reports included as technical appendix G. A brief summary of the pertinent information is provided below.

10.61 No visual or olfactory evidence of significant contamination was recorded during the WSP ground investigations.

10.62 Elevated concentrations of arsenic were recorded at three locations, two on the primary development site and one on the Hatton's Road attenuation ponds area and all within the River Terrace Deposits. The recorded concentrations were between 40 and 61 mg/kg (the adopted screening value is 32 mg/kg).

10.63 Elevated concentrations of petroleum hydrocarbons have been recorded in Made Ground in borehole PTM1 (golf course car park); and natural deposits in TPA12 and TPA19 (farmer's field on the south eastern portion of the primary development site). The testing undertaken was not full speciation (in line with the carbon banding speciation set out by the Total Petroleum Hydrocarbons Criteria Working Group). Additional testing will be required to confirm the actual risks to human health, as current risk assessment methodology requires the carbon banding provided by full speciation.

10.64 Elevated concentrations of selected polycyclic aromatic hydrocarbons (PAHs) were recorded at two locations on the primary development site. Concentrations of benzo(a)pyrene, benzo(a)anthracene and dibenzo(a,h)anthracene were recorded in Made Ground from borehole PTM1 on the golf course car park. These results are considered to be linked to an elevated concentration of petroleum hydrocarbons recorded in the same sample. An elevated concentration of benzo(a)pyrene was recorded in River Terrace Deposits in TPA3 located on the northern portion of the site.

10.65 The elevated concentrations of arsenic are likely to be naturally occurring and not anthropogenic, as they were predominantly associated with natural strata and no potential sources have been identified. Shallow Made Ground in PTM1 did not contain elevated concentrations of arsenic that could account for the result obtained from deeper soil deposits. The elevated concentrations at the remaining two locations were all recorded in natural soils from depth (>1.2 m bgl) that were not overlain by Made Ground or end uses that could have resulted in arsenic contamination. Notwithstanding the above, the elevated concentrations recorded will need to be re-evaluated in line with the proposed earthworks cut and fill, and supplementary ground investigation to be undertaken on the golf course, to ensure contaminated soils are not present at formation level beneath residential and landscaped areas. Further testing to determine the bioavailability of the arsenic present may enable these materials to re-used on site within the cut and fill, if they can be proven not to be a risk to human health.

10.66 Significant sources of petroleum hydrocarbon contamination have not been identified across the site. The concentrations encountered within PTM1, which is located in the golf course car park, are most likely attributable to localised spillages of fuels / oils from cars and are therefore considered to be localised. Further detailed chemical analysis on samples from the vicinity of TPA3, A12, TPA19 and PTM1 is required to confirm potential risks to human health and controlled waters from petroleum hydrocarbons.

10.67 Once the detailed uses of individual development parcels are finalised at the reserved matters stage, a reassessment of the results in accordance with the proposed end uses would be required to confirm if the residential screening values adopted are considered too conservative. Subject to confirmation of detailed uses, and potentially further chemical analysis, the impacted materials may be considered suitable for re-use within the development (e.g. beneath landscaping, structures, roads and sports pitches).

Contamination - water

Soil leachates

10.68 Eight soil samples from the primary development site and two from the Hatton's Road attenuation ponds area were submitted for soil leachate analysis for a range of metals and semi-metals.

10.69 The concentration of chromium (8.19 µg/l) in TPD22 (0.6 m) on the Hatton's Road attenuation ponds area was slightly above the Environmental Quality Standard (EQS) for freshwaters of 3.4 µg/l. Total chromium concentration in the same sample was not elevated and the result recorded is not considered to represent a significant risk to controlled waters.

Groundwater

10.70 Groundwater samples were obtained from the monitoring wells installed as part of the investigation in March and November 2006, March, August,

September and December 2007 and February 2008 as the investigations progressed. The samples were analysed for a range of metals, inorganics and other water quality indicators. Supplementary groundwater sampling will be undertaken across the site as part of further ground investigations required on the golf course. However, the data previously obtained are considered sufficient to form a baseline for the site and undertake an assessment for the planning application, as land uses and working practices have not changed.

10.71 On the primary development site, copper was identified above the EQS of 10 µg/l in only four samples (of 56 tested) at concentrations between 24 µg/l and 47 µg/l. Boron was found to be elevated above the EQS of 2,000 µg/l in approximately 20% of the samples.

10.72 Concentrations of petroleum hydrocarbons above detection limits were recorded in monitoring wells BHA3 (165 µg/l), BHA23 (deep) (310 µg/l), BHA24 (99 µg/l) and WSA4 (243 µg/l). It is noted that boreholes BHA23, BHA24 and WSA4 are located in the centre of the golf course, down hydraulic gradient of the abstraction borehole located within the nursery off Rampton Road. None of the concentrations recorded are considered to be representative of widespread gross petroleum hydrocarbon contamination, but may be indicative of limited localised contamination sources.

10.73 On the Hatton's Road attenuation ponds area, copper was identified above the EQS of 10 µg/l in only two samples in 2006, at concentrations between 22 µg/l and 26 µg/l. Concentrations in both boreholes had dropped well below the EQS by the time monitoring was undertaken in 2007 (both 2 µg/l).

10.74 Concentrations of petroleum hydrocarbons above detection limits were recorded in two monitoring wells (BHD1 and BHD2). It is noted that BHD1 is located just off site to the north (but is considered relevant to this assessment), and boreholes BHD1 and BHD2 are located within arable farmland close to Hatton's Road. The maximum total concentrations recorded in BHD1 and BHD2 were 100 µg/l (split equally between fractions C12-C16 and C16-C21, C21-C35) and 259 µg/l (predominantly C24-C40). One sample was tested from BHD1 in 2006, with two samples tested from BHD2 in 2006 and 2007. The higher concentration in BHD2 was recorded in 2006, with concentrations dropping below the adopted screening concentration by 2007. Further details of the findings are set out in technical appendix G.

10.75 None of the concentrations recorded are considered to be representative of widespread gross petroleum hydrocarbon contamination, but may be indicative of limited localised contamination sources. This may be associated with the adjacent road or farming activities on the site. Given that the proposed development on this area of the site is to comprise a flood attenuation area that, based on the current development plans, will not intersect groundwater, it is not considered that any minor contamination will impact on the proposed end use and further assessment is not considered necessary unless development plans change.

10.76 As part of further ground investigation required on the golf course prior to development taking place, it is recommended that additional trial pits are undertaken within the central area of the golf course to ensure that localised petroleum hydrocarbon sources are not present. Additional groundwater sampling and analysis will also be required to confirm current conditions.

Surface water

10.77 Surface waters in the vicinity of the site were sampled during August and December 2007. A summary of the results is presented in the Interpretive Report (technical appendix G). Supplementary surface water sampling will be undertaken across the site as part of further ground investigations required on the golf course. However, the data previously obtained are considered sufficient to form a baseline for the site and undertake an assessment for the planning application, as land uses and working practices have not changed.

10.78 Although concentrations of a number of determinants were above the adopted screening values (e.g. nitrite, nitrate and ammoniacal nitrogen), no discernible impact was recorded downstream of the site when compared to the results from the upstream samples. As such, it is considered that the site is not impacting surface water quality.

Ground gas

10.79 Gas monitoring has been undertaken on 15 separate occasions between February 2006 and February 2008 inclusive, in boreholes installed across the site. However, not all locations were accessible on all monitoring visits. Some supplementary ground gas monitoring will be undertaken as part of further ground investigations required on the golf course. As the use of historical data is permissible within ground gas assessments (particularly results from the long term monitoring undertaken at the site), and no new sources of ground gas have been identified as part of this assessment, it is considered that the existing information is sufficient to inform this assessment.

10.80 The ground gas assessment in the Interpretive Report (technical appendix G) is primarily focused on the primary development site, as this is the location of the proposed residential development; however, a brief summary assessment is included regarding gas monitoring on the Hatton's Road attenuation ponds area. Although no residential development is proposed within the area, cut materials will be used as shallow fill across the primary development site.

10.81 Recorded concentrations of methane were at or below 0.1% by volume throughout the monitoring period in all of the boreholes. Concentrations of carbon dioxide were found to be variable throughout the monitoring period, but were generally recorded below 5% by volume. Ground gas flow rates were generally low (some locally higher flows were considered to result from the piston effect observed as gas is compressed within the sealed section of pipe at the head of the well as groundwater levels rose).

10.82 The maximum Gas Screening Value (GSV) (gas concentration as a fraction x maximum recorded flow) calculated for carbon dioxide is 0.040 l/hr. The maximum GSV for carbon dioxide places the site in 'Green' in accordance with the NHBC System and 'Characteristic Situation 1' in accordance with CIRIA guidance (both of which are set out in CIRIA C665, 2006, *Assessing Risks Posed by Hazardous Ground Gases to Buildings*; ref. 10.15), and no gas protection measures are considered necessary.

10.83 During the proposed earthworks on phase 1, several ponds and drainage ditches will be backfilled. Before this can take place, all organic material must be removed to prevent the creation of a source of ground gas. It is considered likely that this material may be used at surface in external areas or blended with topsoil to be placed in external areas.

10.84 Fill materials at the site will partially be generated from the Hatton's Road attenuation ponds. Twelve ground gas monitoring visits were undertaken on the site between November 2006 and November 2007. Methane was not recorded during the monitoring period. Slightly elevated concentrations of carbon dioxide were recorded in BHD2 on three occasions, between 2.8% and 5.9% by volume. One gas flow over 1 l/hr was recorded in BHD5 in February 2007 (1.2 l/hr).

10.85 Using the highest readings, the maximum GSV calculated for carbon dioxide is 0.07 l/hr, and places the site in 'Green' in accordance with the NHBC Traffic Light System, and 'Characteristic Situation 1' in accordance with the CIRIA C665 guidance. As such, the use of the underlying material as earthworks fill is considered unlikely to represent a risk to new build development with respect to ground gas. However, post-earthworks there is the potential for the imported Ampthill and Kimmeridge Clays to present a short term risk of carbon dioxide generation due to oxidation following excavation, although the oxidation process is likely to stabilise relatively quickly following placement.

Asbestos

Asbestos in soils

10.86 One sample of Made Ground from PTM1 at 0.2 m was analysed for asbestos and no asbestos was recorded. Given the limited number of former buildings across the site, the current land use and the limited extent of identified Made Ground, the presence for asbestos-containing materials within site soils is considered to be low.

Asbestos in structures

10.87 Given the likely age of current site buildings, the presence of asbestos-containing materials within the building fabrics is considered likely. A Type II asbestos survey has been undertaken, which identified corrugated cement sheet roofs on two outbuildings on the golf course (considered to be very low

risk). However, several buildings, including the clubhouse on the golf course, were not accessible at the time of the survey.

10.88 Further information on the presence of asbestos containing materials within current site buildings is presented within the asbestos survey report (ref. 10.25).

10.89 Full 'Type 3' (demolition) surveys will be required prior to the demolition of existing buildings on the primary development site (no structures are present on the Hatton's Road attenuation ponds area).

Ordnance (primary development site only)

10.90 Bactec International Ltd have assessed potential ordnance risks associated with the former use of the site during World War II (ref. 10.23), and the possibility of dropped ordnance on the site; as well as appropriate mitigation measures to facilitate development of the site.

10.91 This unexploded ordnance (UXO) survey work has been carried out in stages since 2005 as part of the ground investigation works (ref. 10.24) and has continued as part of the master planning process. The surveys followed the discovery of buried ordnance during archaeology and ground investigations on the airfield. The ordnance discovered was considered to have been buried by British servicemen and not dropped ordnance from bombing raids during WWII. The results of the surveys are yet to be published, but will be considered as part of the on-going detailed design process.

Future baseline

10.92 With no development, it is considered that the future baseline conditions in relation to contaminated land would remain relatively unchanged, although localised effects may occur from ad hoc diesel or lubricating oil spillages. Potential asbestos-containing material release is likely to be limited as long as the existing building fabric is not allowed to significantly deteriorate.

Conceptual site model

10.93 Potential sources of contamination at the site are summarised in table 10.5.

Table 10.5: Sources of contamination	
	Potential contamination issue and justification
On-site contamination sources	The site has remained largely undeveloped throughout its documented history; therefore, significant contamination is unlikely to have occurred due to on-site sources. Localised areas of contamination may exist associated with agricultural use and the operation of the golf course. The very eastern tip of the site was historically used as part of the former MOD land to the south. Although no Made Ground has been recorded in this area, some contamination has been recorded as part of the WSP ground investigation, thought to be localised and associated with on-going agricultural use. Ground investigation work has only indicated the presence of localised petroleum hydrocarbon contamination within the shallow soils in the golf course car park; the eastern extent of the primary development site within an agricultural field (formerly part of the former MOD land to the south), and in one trial pit in the north western corner of the primary development site containing organic matter thought to be an infilled pond. One slightly elevated concentration of arsenic has been recorded in natural soils on the Hatton's Road attenuation ponds area, but is considered to be naturally occurring. If used as earthworks fill on the primary development site, this material will be unsuitable for use in residential gardens. The single elevated arsenic concentration recorded in BHA27 is not considered to present a significant risk as it is located at a depth of 1.2 m bgl and will be covered by circa 1.8 m of fill. Groundwater impact is restricted to elevated concentrations of petroleum hydrocarbons in three wells in the centre of the golf course. The samples were tested in 2007 and it is not known if current conditions remain the same. Similar impact observed in a borehole on the northern boundary of the site in 2006 was not recorded during the monitoring in 2007. High concentrations of sulphate have been recorded in natural Ampthill Clay and Kimmeridge Clay deposits on both parts of the site.
Off-site contamination sources	Off-site contamination is restricted to the airfield and barracks to the south of the site. No impact in site soils or groundwater has been observed as part of this assessment that could be attributed to the former MOD land, and the risk of cross boundary contaminant migration from land to the south is considered to be low.

10.94 Potential exposure pathways are set out in table 10.6.

Table 10.6: Exposure pathways	
Exposure pathway	**Receptor summary**
Ingestion and inhalation of dusts; dermal contact and inhalation of vapours from on-site sources.	Human health
Leaching of contaminants from soils; surface runoff; migration under gravity to groundwater or via subsurface flow into drainage ditches, and subsequent migration to surface water features.	Controlled waters
Ground gas may migrate into structures; contaminant permeation of water supply pipes could occur and aggressive ground conditions (sulphate) could impact buried concrete.	Buildings and structures
Contaminant migration via leaching and / or drainage.	Third party land
Uptake of contaminants by plants / vegetation in landscaped areas.	Ecology

10.95 Based on the identified sources and exposure pathway assessment, potential receptors for consideration in the risk assessment are set out in table 10.7.

Table 10.7: Summary of receptors	
Receptor group	**Comments**
Human health	Construction workers, future site users, future maintenance workers and neighbouring site users.
Controlled waters	On site surface water features (including the drainage ditch running through the site and the pond that is to be retained), Reynolds Drain / Beck Brook, Longstanton Brook and the secondary A aquifer that underlies the western extent of the site.
Buildings and structures	Future structures forming the proposed development.
Third party land	Surrounding residential properties and agricultural land.
Ecology	Adjacent sites are feeding grounds for a number of bird species and the area supports a substantial reptile habitat. Ecological corridors will be present on the site post-development, mainly along the lines of existing drainage ditches.

Human health

10.96 The following pollutant linkages have been identified at the site that represent potential risks to human health:

- Direct contact of construction workers and future site users on site with contaminated shallow soils, ingestion / inhalation of contaminated dust and inhalation of vapours in the area of the petroleum hydrocarbon hotspots (PTM1, TPA3, TPA19 and BHA12), and naturally occurring arsenic levels in natural soils (BHA27 and BHD6), as well as areas of potential localised residual impact associated with use of the site for agricultural purposes and as a golf course
- Ingestion of produce grown in contaminated soil on site in the area of the identified petroleum hydrocarbon contamination and elevated arsenic concentrations
- Inhalation of contaminated dust off site by adjacent site users

10.97 The risk from buried ordnance is being dealt with as part of separate works and will be considered as part of the detailed earthworks design. However, as the risks cannot be fully assessed at this stage, ordnance has been considered as a potential risk within this assessment.

Controlled waters

10.98 The following pollutant linkages have been identified at the site that represent potential risks to controlled waters:

- Leaching of contaminants from soil and migration of contamination vertically through the unsaturated zone into the underlying secondary A aquifer from the identified hydrocarbon contaminated soils (PTM1, TPA3, TPA19 and BHA12)
- Migration of contaminated groundwater within the main groundwater body off site towards the groundwater abstractions (considered a low risk) and surface waters within the on site ponds and ditches, and Longstanton and Beck Brooks

Built environment

10.99 The potential for harm to the built environment has also been considered. Potential risks are considered to be:

- Risk to concrete from sulphate attack – can be mitigated by the adoption of an appropriate classification of concrete
- Risk to water supply pipes from localised petroleum hydrocarbon impact in shallow soils (only one potential location identified (BHA12) but this is not located in an area where supply pipes will be located)

Ecology

10.100 The relatively low concentrations and localised nature of the contamination recorded on the site is not considered to present a risk to ecological features on the site or off site.

Effects during construction

Potential for health effects due to contact with contaminants during construction (including asbestos-containing materials in existing buildings)

10.101 To date, only limited localised contamination has been encountered in site soils. An additional phase of ground investigation is required to fully characterise the golf course and to delineate the contamination identified; however, given the current and historical use of the site, the presence of significant widespread contamination is not expected.

10.102 During earthworks, the localised contamination identified could be exposed and transported around site. Such actions will result in earthworks and construction workers being exposed to the contamination. This could take the form of inhalation of dusts / vapours, direct contact and ingestion of impacted materials.

10.103 This will be a change of small to medium magnitude on a receptor of high sensitivity without mitigation, leading to a slight to moderate, significant adverse effect.

Mobilisation of contaminants into the water environment during construction

10.104 As set out in paragraph 10.101, only limited localised contamination has been encountered in site soils and the presence of significant widespread contamination is not expected.

10.105 During earthworks, the localised contamination identified could be disturbed, exposed and transported around site. Such actions could result in mobilisation or re-mobilisation of contaminants that could then migrate and impact controlled waters. However, as the contaminants identified are localised and,

in the case of the petroleum hydrocarbons, generally of low mobility, the risks to controlled waters are likely to be minimal.

10.106 This will be a change of small magnitude on a receptor of medium sensitivity, leading to a slight adverse effect that will not be significant.

Potential presence of buried munitions and / or ordnance or munitions on the surface posing a risk to human health and new structures

10.107 Surveys to identify potential buried ordnance have been undertaken across the airfield and farmland to the south of the golf course. The surveys followed the discovery of buried ordnance during archaeology and ground investigations on the airfield. The ordnance discovered was considered to have been buried by British servicemen and not dropped ordnance from bombing raids during WWII.

10.108 The Explosive Ordnance Threat Assessment (ref. 10.23) classified the golf course and northern extents of the primary development site, and the Hatton's Road attenuation ponds area, as low risk in terms of ordnance threat. Part of the southern boundary of the primary development site abuts the airfield boundary, and land in this area (e.g. Brookfield Farm (located off site) and the field forming the south eastern corner of the primary development site) formed part of the airfield historically. As such, a very small area within the primary development site where it abuts Brookfield Farm was considered as a higher risk within the Explosive Ordnance Threat Assessment (ref. 10.23). Independent ordnance surveys are being undertaken within this part of the application site boundary. The results of these surveys and any mitigation measures considered necessary will be considered as part of the detailed earthworks design.

10.109 This will be a change of uncertain magnitude on a receptor of high sensitivity, leading to an unknown adverse effect at this stage that has the potential to be significant.

Effects on surface water and groundwater quality from pollution due to spills during construction

10.110 The presence of machinery and plant associated with demolition and construction activities (including the development of a site construction compound and haul roads) gives rise to further risk to soils, groundwater and surface water bodies from contaminants through accidental fuel / oil spills and leaks. There is also a risk to surface water bodies and drains from sediment build up resulting from ground disturbance.

10.111 Within the Hatton's Road attenuation ponds area there is a risk of hydrocarbon / fuel spillage entering the ponds, which will be located around Longstanton Brook.

10.112 During the earthworks and limited demolition required on the primary development site, there will be a greater risk of contaminated runoff, including

petroleum hydrocarbon contamination and high-suspended solid loads associated with the operation of vehicles providing pathways for contamination across the site.

10.113 This will be a change of medium magnitude on a receptor of medium sensitivity, leading to a moderate, significant adverse effect.

Effects post-construction

Mobilisation of contaminants into the water environment post-construction

10.114 As set out in paragraph 10.101, only limited localised contamination has been encountered in site soils and the presence of significant widespread contamination is not expected.

10.115 The presence of roads and other hard standing across a proportion of the site will reduce direct infiltration of surface water and therefore decrease risks associated with contaminant leaching.

10.116 Any potentially contaminative end uses located near open surface water features may increase the risk of contamination unless appropriate mitigation measures are considered as part of their design. However, due to the requirements of the UK planning process and, if required, permitting applications, it is considered unlikely that appropriate mitigation would be omitted from any new development, and risks to controlled waters are therefore likely to be limited. This will include the household waste recycling centre and any B2 (general industrial) employment land.

10.117 This will be a change of small magnitude on a receptor of medium sensitivity, leading to a slight adverse effect that will not be significant.

Potential for health effects due to contact with contaminants post-construction arising from the use of gardens, landscaped areas and public open space

10.118 The presence of roads and other hard standing across a proportion of the site will reduce direct contact, ingestion and inhalation risks. However, any contamination remaining in site soils may be present in residential gardens, landscaping and public open space where all three exposure pathways could be active.

10.119 This will be a change of small to medium magnitude on a receptor of high sensitivity, leading to a moderate, significant adverse effect.

Potential for the presence of ground gas or landfill gas to pose a risk to future site users and new structures (explosive and asphyxiant)

10.120 In accordance with the CIRIA and NHBC ground gas assessments undertaken, the site is considered to be classified as 'Green' or 'Characteristic Situation 1' and no gas protection measures are considered necessary.

10.121 Post-earthworks, there is the potential for the imported Ampthill and Kimmeridge Clays to present a risk of carbon dioxide generation due to oxidation following excavation. This is only likely to apply to areas where more than 0.5-1.0m of fill is proposed (approximately half of the area of fill). It should be noted that the risk of carbon dioxide build up in new buildings on the site will be limited, as there is unlikely to be a significant gas flow rate associated with such gas generation. In addition, the oxidation process is likely to stabilise relatively quickly following placement.

10.122 It is proposed to backfill a number of ponds on the golf course as part of the earthworks. Any organic material within the base of the ponds will represent a potential ground gas source if buried.

10.123 This will be a change of small to medium magnitude on a receptor of high sensitivity, leading to a slight to moderate, significant adverse effect.

Potential presence of buried munitions and / or ordnance or munitions on the surface posing a risk to human health and new structures

10.124 As set out in paragraph 10.108, the golf course and northern extent of the primary development site, and the Hatton's Road attenuation ponds area, are classified as 'low risk' in terms of ordnance threat. However, ordnance assessment work is ongoing in the south eastern corner of the site.

10.125 This will be a change of uncertain magnitude on a receptor of high sensitivity, leading to an unknown adverse effect at this stage that has the potential to be significant.

Effects on surface water and groundwater quality from pollution due to contaminated runoff post-construction

10.126 Without appropriate design of open surface water features (and the immediate surrounding land) and site drainage, there is a risk of particulate matter entering surface water features from surface water runoff.

10.127 Post-development, land uses are considered unlikely to present a significant chemical contamination risk. Any contaminated shallow soils left exposed at surface may present a risk of contaminated sediment runoff that could impact surface waters.

10.128 This will be a change of small to medium magnitude on a receptor of medium sensitivity, leading to a slight to moderate, significant adverse effect.

Mitigation

Potential for health effects due to contact with contaminants during construction (including asbestos-containing materials in existing buildings)

10.129 Supplementary ground investigation works are required to complete coverage across the golf course and to delineate known contamination hotspots. The results of the investigation will be used to complete an appropriate risk assessment to determine the significance of any soil and groundwater contamination encountered. Should the risk assessment indicate that any significant contamination is present on the site, a Remediation Strategy will be required to set out the methodology for dealing with the contamination.

10.130 Demolition asbestos surveys (Type 3 surveys) will be required prior to the demolition of all buildings on the site. Appropriate measures to remove asbestos-containing materials will need to be incorporated into the demolition process. Asbestos removal works will be undertaken by a specialist.

10.131 The potential impacts on construction workers from any residual contamination not identified as part of the ground investigation works can be readily managed through the effective use of personal protective equipment (PPE), including wearing gloves and protective overalls etc.

10.132 These PPE measures will be combined with general site best practice, including the provision of on site washing facilities to allow hand, face and forearm washing prior to eating, smoking etc., and enforcing the no eating or smoking rules on site unless in specifically designated areas. These measures are outlined in detail in the Construction Management Strategy submitted in support of the application.

10.133 This will reduce the impact magnitude to negligible and the degree of effect to negligible. The effect will no longer be significant.

Potential presence of buried munitions and / or ordnance or munitions on the surface posing a risk to human health and new structures (during and post construction)

10.134 Ordnance surveys and related risk assessments will be completed to inform the earthworks proposed at the site. Any potential ordnance targets will be excavated by a specialist contractor to determine their presence and significance. Any ordnance will be removed or mitigated as appropriate prior to construction.

10.135 This will reduce the impact magnitude to negligible and the degree of effect to negligible. The effect will no longer be significant.

Effects on surface water and groundwater quality from pollution due to spills during construction

10.136 During construction work all fuels, oils and chemicals will be stored in appropriate containers within a bunded compound, in accordance with the Environment Agency's Pollution Prevention Guidance note 6 *Working at Construction and Demolition Sites* (ref. 10.12). This will mitigate the potential for accidental spills. This will involve on site practices such as:

- Adequate bunding and containment of fuels and oil
- Washing of vehicles and equipment before they leave site
- Adequate protection of on site drains and water courses through the use of temporary covers or bunds

10.137 Construction vehicles will be regularly maintained to reduce the risk of hydrocarbon contamination and will only be active when required.

10.138 Mitigation measures will also be used as part of construction of the balancing ponds, such as appropriate liners and petrol interceptors to contain any potential hydrocarbon spillage.

10.139 General details of the proposed site wide mitigation measures are included within the Construction Management Strategy. A more detailed site wide Construction Environmental Management Plan will be developed prior to construction that will describe any mitigation measures in more detail.

10.140 This will reduce the impact magnitude to negligible and the degree of effect to negligible. The effect will no longer be significant.

Potential for health effects due to contact with contaminants post-construction arising from the use of gardens, landscaped areas and public open space

10.141 As set out in paragraph 10.129, the results of supplementary investigation works will be used to inform an appropriate risk assessment, and associated Remediation Strategy if required.

10.142 This will reduce the impact magnitude to negligible and the degree of effect to negligible. The effect will no longer be significant.

Potential for the presence of ground gas or landfill gas to pose a risk to future site users and new structures (explosive and asphyxiant)

10.143 The only identified risks are from earthworks fill and organic material in backfilled ponds.

10.144 A post-earthworks ground gas assessment, limited to parts of the site where fill depths are over 1 m and comprise Ampthill or Kimmeridge Clays beneath 0.5 m bgl, will determine any residual risks from ground gas, if considered necessary.

10.145 During earthworks, organic material from within any ponds to be backfilled must be excavated for use elsewhere on the development site. This should not be beneath or in the immediate vicinity of buildings.

10.146 This will reduce the impact magnitude to negligible and the degree of effect to negligible. The effect will no longer be significant.

Effects on surface water and groundwater quality from pollution due to contaminated runoff post-construction

10.147 The balancing ponds will be designed with liners (site won clay or man-made) and / or petrol interceptors to prevent any downward migration of contamination into the aquifer and to contain any hydrocarbons should any spillage occur on the Hatton's Road attenuation ponds area.

10.148 Site surface water drainage (essentially roads and pavements) will be designed in accordance with best practice to prevent pollution from surface water runoff.

10.149 This will reduce the impact magnitude to negligible and the degree of effect to negligible. The effect will no longer be significant.

Residual effects

10.150 Provided the mitigation measures outlined above are adopted, no significant residual effects have been identified.