Chapter 7

7

# GROUND CONDITIONS AND THE WATER ENVIRONMENT

# 7 Ground conditions and the water environment

## Introduction

7.1 Hydrock undertook the assessments of ground conditions and the water environment, including a flood risk assessment (FRA). The findings of the assessments are summarised in this chapter and the full reports are included as technical appendices E1 (ground conditions) and E2 (FRA). The references and data sources used in the assessment are set out in table 7.1.

| |
|---|
| Allen, D.L., Brewerton, L.J., Coleby, L.M., Gibbs, B.R., Lewis, M.A., Macdonald, A.M., Wagstaff, S.J. and Williams, A.T., 1997, The physical properties of major aquifers in England and Wales. British Geological Survey Technical Report WD/97/34. Environment Agency R&D Publication 8 |
| Association of Ground Investigation Specialists, 2006, Good Practice Guidelines for Site Investigations |
| British Geological Survey, 2002, Geological Map Sheet 205, Saffron Walden, 1:50,000 Solid and Drift Edition |
| British Standards Institution, 2015, BS5930:2015 Code of practice for ground investigations |
| British Standards Institution, 2013, BS10175:2011+A1:2013 Code of practice for the investigation of potentially contaminated sites |
| Department for Communities and Local Government, 2016, National Planning Practice Guidance: Flood Risk and Coastal Change |
| Department for Communities and Local Government, 2012, National Planning Policy Framework |
| Environment Agency, 2017, Flood Risk Assessments: Climate Change Allowances |
| Environment Agency, 2013, Water stressed areas – final classification |
| Environment Agency, 2004, CLR 11: Model Procedures for the Management of Land Contamination |
| Environment Agency website: www.gov.uk/government/organisations/environment-agency |
| Groundsure Limited, November 2015, Groundsure EnviroInsight, ref: HYDNOR-2567870 |
| Groundsure Limited, November 2015, Groundsure GeoInsight, ref: HYDNOR-2567871 |
| Groundsure Limited, November 2015, Groundsure Historical Mapping Report, ref: HYDNOR-2567872/3 |
| Jones, H.K., Morris, B.L., Cheney, C.S., Brewerton, L.J., Merrin, P.D., Lewis, M.A., Macdonald, A.M., Coleby, L.M., Talbot, J.C., McKenzie, A.A., Bird, M.J., Cunningham, J. and Robinson, V.K., 2000, The physical properties of minor aquifers in England and Wales. British Geological Survey Technical Report WD/00/04. Environment Agency R&D Publication 68 |
| South Cambridgeshire District Council, 2013, Proposed Submission Local Plan |
| South Cambridgeshire District Council, 2007, Development Control Policies Development Plan Document |
| Wilson, S., Oliver, S., Mallett, H., Hutchings, H. and Card, G., 2007, Assessing risks posed by hazardous ground gases to buildings. CIRIA Report C665 |
| WSP, 2010, Level 1 Strategic Flood Risk Assessment for South Cambridgeshire District Council and Cambridge City Council |

**Table 7.1: References and data sources**

## Legislation and policy

### *Ground conditions*

7.2 Risks associated with contamination are assessed in accordance with the Contaminated Land (England) Regulations 2006 (as amended) and Part IIA of the Environmental Protection Act 1990, which was introduced by the Environment Act 1995. Part IIA defines contaminated land as:

> *"land which appears to the local authority in whose area it is situated to be in such a condition that, by reason of substances in, on or under the land that significant harm is being caused, or there is a significant possibility that such*

*harm could be caused, or pollution of controlled waters is being, or likely to be, caused."*

7.3 Paragraph 121 of the National Planning Policy Framework (NPPF; 2012) states in relation to ground conditions that:

*"Planning policies and decisions should also ensure that the site is suitable for its new use taking account of ground conditions and land instability, including from natural hazards or former activities such as mining, pollution arising from previous uses and any proposals for mitigation including land remediation or impacts on the natural environment arising from that mitigation."*

***Water environment***

7.4 The Water Framework Directive (2000/60/EC) aims to ensure all surface water and groundwater reaches 'good' status in terms of ecological and chemical quality and water quantity, as appropriate, to reduce pollution and contribute to the mitigation of flooding. It also contains provisions for controlling discharges of dangerous substances to water. The directive is implemented in England by the Environment Agency.

7.5 Water resources in England and Wales are protected by law under the Water Resources Act 1991 and the Environmental Protection Act 1990 (as amended by the Environment Act 1995). Under section 85 of the Water Resources Act 1991, it is an offence to *"cause or knowingly permit the discharge or other entry of poisonous, noxious or polluting matters or any solid waste matter into controlled waters (as defined under section 104 of the Act)."* Most waters will meet this definition, including groundwater. Any parties intending to discharge such substances, or those discharging trade or sewage effluent directly into controlled waters, must obtain a consent from the Environment Agency.

7.6 The Water Act 2003 amends the Water Resources Act 1991 to improve long term water resource management, specifically with regard to the regulation of water abstraction and impoundment. The Water Act 2014 contains further amendments relating to water resources and environmental regulation.

7.7 The Groundwater (England and Wales) Regulations 2009 place a duty on the Environment Agency to protect groundwater, in effect by prohibiting discharges of hazardous substances to groundwater and preventing pollution of groundwater by non-hazardous substances.

7.8 Government policy on flood risk is set out in the NPPF and the National Planning Practice Guidance: *Flood Risk and Coastal Change* (updated 2016). The latter contains advice to planning authorities and developers about flood risk and the role played by the Environment Agency in advising on planning applications in possible flood risk areas. It recommends that a risk-based approach should be applied to assess the risk of all forms of flooding to and from development, taking climate change into account. It also contains guidelines for carrying out a FRA.

7.9 South Cambridgeshire District Council's adopted Development Control Policies Development Plan Document (2007) contains the following policies relating to the water environment:

- Policy NE/8 Groundwater: development will not be permitted that poses an unacceptable risk to the quality of the underlying groundwater from the chalk aquifer to the south and east of Cambridge
- Policy NE/9 Water and drainage infrastructure requires adequate water supply, sewerage and land drainage infrastructure to be in place to meet development demands
- Policy NE/10 Foul drainage – alternative drainage systems requires that any alternative foul drainage facilities will not pose an unacceptable risk to groundwater and surface water quality and quantity. Any petrol, chemical or oil tanks must be contained by appropriately sized bund walls. Road drainage must be connected to trapped gullies and interceptors

7.10 Emerging policy is provided by the council's Proposed Submission Local Plan (2013), which includes the following policies relevant to the water environment:

- Policy CC/7 Water Quality requires adequate water supply, sewerage and land drainage infrastructure to be in place to meet development demands. Water quality must not be harmed and appropriate consideration must be given to sources of pollution
- Policy CC/8 Sustainable Drainage Systems requires development proposals to incorporate sustainable surface water drainage systems appropriate to the nature of the site
- Policy CC/9 Managing Flood Risk states that development will only be permitted where the relevant tests established by the NPPF are met, suitable flood protection measures are incorporated as appropriate and there would be no increase to flood risk elsewhere

## Methodology

### *Ground conditions*

*Levels of assessment*

7.11 The principle of risk assessment underlies the determination of whether land is contaminated. The risk assessment includes the development of a conceptual site model, which describes the types and locations of contamination source(s), potential receptor(s) and potential migration / transportation pathway(s) that may link the identified source(s) to the identified receptor(s). The methodology is endorsed in relevant technical guidance. A tiered approach to land assessment is outlined as follows:

- Tier 1 preliminary risk assessment – a qualitative assessment informed by a phase 1 study comprising a desk study and walkover survey
- Tier 2 generic risk assessment – a quantitative assessment of site-specific data by comparison to generic assessment criteria informed by a phase 2 study comprising intrusive investigations and laboratory testing

- Tier 3 detailed quantitative risk assessment – a quantitative risk assessment by comparison to site-specific assessment criteria

7.12 The guidance for the assessment methodology advocates that each tier of assessment should be undertaken in a stepwise approach until the level of risk posed by the site is fully understood and deemed to be acceptable. Therefore, if a tier 1 assessment concludes that the risks associated with the site are acceptable, no further assessment is required. Similarly, where unacceptable risks can be ruled out by a tier 2 assessment, then there is no need for a tier 3 assessment.

*Baseline*

7.13 In order to establish the existing baseline conditions of the site and its surrounds, site visits and a desk study were undertaken. The desk study followed the guidance set out in *CLR 11: Model Procedures for the Management of Land Contamination.* Full details of references and data sources are set out in table 7.1.

7.14 Intrusive site investigations, which were undertaken in accordance with the Association of Ground Investigation Specialists' (2006) *Good Practice Guidelines for Site Investigations*, BS5930:2015 *Code of practice for ground investigations* and BS10175:2011+A1:2013 *Code of practice for the investigation of potentially contaminated sites*, included the following elements:

- Three cable percussive boreholes to a maximum depth of 10.0 m, including in situ testing, sampling and installation of gas / groundwater monitoring standpipes
- 17 dynamic percussive sampling boreholes, ranging from 2.97 to 11.16 m deep, including in situ testing, sampling and installation of gas / groundwater monitoring standpipes in selected boreholes
- 54 machine excavated trial pits, ranging from 1.50 to 2.80 m deep, including sampling. Infiltration tests were conducted in a number of the pits
- Six hand excavated trial pits to a maximum depth of 0.20 m, including shallow topsoil sampling within the area used by NIAB for crop trials
- Dynamic cone penetrometer probing across the site
- Monitoring of ground gas concentrations on four occasions
- Laboratory testing of soil samples to determine geotechnical properties
- Laboratory analysis of soil and groundwater samples to determine geochemical properties

7.15 The sampling locations for the intrusive site investigations are shown on figure 7.1. It should be noted that these were undertaken across a wider survey area than just the application site, and included the fields to the east and north of the main site, the area around the existing commercial buildings to the east of the main site and the fields to the north west of the bus / cycle interchange site. Full details of the methodology and results of the intrusive investigations are provided in technical appendix E1.

*Uncertainties and limitations*

7.16 A number of the originally proposed exploratory holes could not be excavated because of the presence of an easement strip along the route of a high pressure gas main, which crosses the survey area from north east to south west. Access was not granted to the car park / yard of the commercial premises to the east of the main site. Proposed borehole BH06 could not be undertaken because of boggy ground and the identification of an unmarked manhole cover and drain run adjacent to the borehole location.

*Assessment of risk*

7.17 A qualitative risk assessment was undertaken using the following four stages:

- Hazard identification: identifying potential contaminant sources on and off site
- Hazard assessment: analysing the potential for unacceptable risks by identifying what pathways and receptors could be present, and what contaminant linkages could result (forming a preliminary conceptual site model)
- Risk estimation: establishing the magnitude and probability of the possible consequences (what degree of harm might result to defined receptors and the likelihood)
- Risk evaluation: deciding whether the risk is unacceptable

7.18 The ground conditions assessment focused on the identification of contaminant linkages in order to evaluate whether the presence of a source of contamination could potentially lead to harmful consequences. A contaminant linkage consists of the following three elements, all of which must be present for a contaminant linkage to occur:

- A source that has the potential to cause harm or pollution
- A receptor that could be adversely affected by the contaminant
- A pathway by which the contaminant can reach the receptor

7.19 The level of risk to receptors was classified with reference to the criteria set out in figure 7.2. Full details of the assessment methodology are set out in technical appendix E1.

***Water environment***

*Baseline*

7.20 Baseline conditions were identified through a desk study and site walkover and the intrusive investigations discussed above. Consultation was undertaken with the Environment Agency, Cambridgeshire County Council (the lead local flood authority), Anglian Water and Cambridge Water Company, and relevant data and published materials relating to the local and wider hydrological environment were reviewed. Environment Agency Product 4 Detailed Flood Information was used as the basis for understanding the existing levels of flood risk from all sources, the details of which are included in the FRA in technical appendix E2. This review also included establishing the existing quality of local watercourses

and groundwater and the runoff rates on site. No difficulties were encountered in obtaining the necessary information.

*Impact assessment*

7.21 There are no standard significance criteria for assessing effects on the water environment. The significance of effects has been derived from measures of receptor sensitivity and magnitude of change, as shown on figures 7.3 and 7.4 respectively. The sensitivity and magnitude criteria were combined to determine the degree of effect using the matrix shown in figure 7.5, which was then used to determine whether the effect was significant. As discussed in chapter 3, effects that are moderate or above are considered to be significant in EIA terms.

**Baseline**

***Ground conditions***

*Geology*

7.22 The British Geological Survey's 1:50,000 scale geological map of Saffron Walden (sheet 205) shows that the site is underlain by the following geological sequence:

- Alluvium (localised in the west)
- River Terrace Deposits (localised in the west)
- Lowestoft Formation (localised deposits)
- Holywell Nodular Chalk Formation (western and central parts of the site)
- New Pit Chalk Formation (at depth beneath the site, cropping in the east)

7.23 Localised made ground is also anticipated across and in the vicinity of the site in areas of previous and existing development.

7.24 The Alluvium is located in a thin ribbon in the west of the bus / cycle interchange site, adjacent to the River Cam, and generally consists of silty clay, but can contain layers of silt, sand, peat and basal gravel. The River Terrace Deposits cover the rest of the bus / cycle interchange site and comprise sand and gravel, with local lenses of silt, clay or peat. The Lowestoft Formation is expected to be very localised in the north of the bus / cycle interchange site and generally comprises chalky glacial till.

7.25 The Holywell Nodular Chalk Formation is exposed in the west of the main site and underlies the east of the bus / cycle interchange site at depth. It consists of generally hard nodular chalks with thin flaser marls and significant proportions of shell debris in part. The New Pit Chalk Formation underlies the main site at depth and is exposed in eastern, elevated parts of the south east. It is principally blocky, white, firm to moderately hard chalk, with numerous marls or paired marl seams.

7.26 The results of the intrusive site investigations indicate that generally the ground conditions on site conform with the anticipated geology. Topsoil was recorded across the majority of the survey area to typical depths of between 0.20 and 0.50 metres below ground level (mbgl), but was found locally to be 0.80 m thick.

The only exceptions were outside the application site and included an area of rough ground south of the commercial building immediately to the east of the main site, within the former railway cutting and on the embankment to the west of the A11, where made ground was encountered instead. The made ground in the vicinity of the commercial building comprised a gravelly sand with gravel of concrete, brick, asphalt and flint and some metal fragments. The made ground along the former railway embankment and in the cutting comprised a gravelly sandy silt of chalk and flint.

7.27 Alluvium was only encountered underlying the topsoil to the north west of the bus / cycle interchange site to between 1.00 and 1.80 mbgl, largely outside the application site boundary. River Terrace Deposits were encountered underlying the topsoil, and locally the Alluvium, within and to the north west of the bus / cycle interchange site to between 0.75 and over 5.45 mbgl. Glacial deposits of the Lowestoft Formation were encountered locally across the central and eastern parts of the survey area, underlying the topsoil to between 0.35 and 3.80 mbgl. The solid geology of the Holywell Nodular Chalk Formation was encountered underlying the topsoil and superficial deposits in the central and north western parts of the survey area to between 2.00 and 10.00 mbgl, while the Pit Chalk Formation was encountered underlying the topsoil, localised made ground and superficial deposits in the eastern and south eastern parts of the survey area to between at least 2.00 and 5.45 mbgl.

7.28 Details of the site's hydrogeology are set out in the water environment section of this chapter.

*Site history*

7.29 The site history was established by a study of historic Ordnance Survey maps dating back to 1877, as supplied in a Groundsure Historical Mapping Report. The mapping evidence indicates that the main site has primarily comprised open fields since the late 1880s, with Hinxton Grange and its grounds situated to the east. The land to the north and east of Hinxton Grange became partially developed in this period and over the following years, with New Farm, several dwellings, stables and commercial premises. In the late 19$^{th}$ century, land to the east of the main site was changed significantly, with the construction of railway embankments and a cutting. However, the railway is very rapidly shown as disused and was either only in use for a short time or never fully commissioned. A groundwater pumping station was present to the north of the main site by the mid-1990s.

7.30 Pampisford Mill corn mill, to the north west of the bus / cycle interchange site, became disused in the 1950s and was then used as a works until the late 20$^{th}$ century. A track, hardstanding and numerous small structures associated with the mill were present to the north of the bus / cycle interchange site, but were later removed and a large copse was planted in this area.

7.31 Areas to the north and west of the main site were noted to contain several petrol filling stations and works / factory buildings, which would be considered as potentially contaminative former and current uses. Several backfilled former clay and gravel pits were also noted in the vicinity of the main site, which could be a source of hazardous gas emissions. However, the closest observed pit was approximately 180 m from the site, on the opposite side of the River Cam.

*Intrusive investigations*

7.32 The soil samples were analysed for a range of commonly occurring contaminants against tier 2 screening criteria using generic assessment criteria (GAC) for a commercial / industrial land use. No contaminants were recorded at concentrations in excess of the relevant GAC in relation to human health effects.

7.33 No asbestos was recorded on site, although the ploughed topsoil in the field to the south east of the A1301 / A505 'McDonalds' roundabout in the wider survey area (TP01) was found to contain asbestos in a single shallow sample, comprising loose chrysotile fibres. The current land use on this part of the survey area, and absence of historical development, are not conducive to the generation of potentially asbestos-containing materials. It is therefore considered most likely that any loose fibres present close to the main road were deposited as airborne particulates from the adjacent A1301 or service station area.

7.34 Priority phytotoxic chemical concentrations were screened against published values to determine the potential risk to plant growth. No exceedances of the GAC were identified in natural soils, but elevated concentrations of copper and zinc above the relevant GAC were recorded in the made ground adjacent to the existing commercial premises to the east of the main site (table 7.2).

| Chemical | GAC (mg/kg) | No. samples | Minimum (mg/kg) | Maximum (mg/kg) | No. samples exceeding GAC |
|---|---|---|---|---|---|
| Copper | 135 | 2 | 310 | 2,100 | 2 |
| Zinc | 300 | 2 | 130 | 340 | 1 |

**Table 7.2: Exceedances of the GAC for phytotoxic chemicals**

7.35 However, it should be noted that detriment to plant life is difficult to quantify and many of the GAC are based on agricultural crop yields, rather than serious harm or death of a plant species. The vegetation in this part of the survey area did not show any signs of physical distress.

7.36 Four rounds of ground gas monitoring have been undertaken and the ranges of the findings were as follows:

- Methane: <0.1%
- Carbon dioxide: 0.3-5.5%
- Oxygen: 10.8-20.7%
- Flow rate: <0.1 litres/hour

7.37 The typical worst case gas screening values have been calculated as <0.0001 litres/hour for methane and 0.0055 litres/hour for carbon dioxide. In accordance with CIRIA Report C665 *Assessing risks posed by hazardous ground gases to buildings* (2007), the site is classified as Characteristic Situation 1, with a very low hazard potential.

### *Water environment*

*Surface water*

7.38 The River Cam flows northwards through the west of the bus / cycle interchange site. It is designated as a county wildlife site (CWS). An unnamed ordinary watercourse that forms a tributary of the River Cam flows in a northerly direction approximately 75 m west of the Cam, below Station Road East.

7.39 The River Cam is a Water Framework Directive waterbody for which the Environment Agency has responsibility. The Agency uses over 30 measures to classify the quality of waterbodies under the directive. The status of waterbodies against these measures is classified by the Agency as high, good, moderate, poor or bad. 'High' represents 'largely undisturbed conditions', while other classes show increasing deviation from undisturbed conditions.

7.40 Water quality in the River Cam is monitored to the west of Hinxton village, around 580 m south west of the main site. In 2015, the River Cam was classified as being of high quality for ammonia, dissolved oxygen, pH, temperature and invertebrates, good for chemical quality, fish and priority substances, moderate for physico-chemical quality elements and supporting elements (surface water) and poor for ecological quality, biological quality elements, macrophytes and phytobenthos, and phosphate levels. The overall status of the river was classified as poor. The site is within a nitrate vulnerable zone, which is protected under the Water Framework Directive.

7.41 Given the undeveloped nature of the site, no formal below ground surface water drainage systems are expected to be present. There is one surface water abstraction licence on site from the River Cam, which is for spray irrigation. There are two other active licences within 1 km of the site, both of which are also for spray irrigation, the closest of which is approximately 3 m to the west. Five active licensed discharge consents are registered within 500 m of the site, three of which are in Pampisford for treated sewage effluent, one of which is in Whittlesford for treated sewage effluent and one of which is in Hinxton for sewer storm overflow. There have been five Environment Agency recorded pollution incidents within 500 m of the site, all of which were recorded as having either a minor impact or no impact on water quality.

7.42 While the River Cam is currently of poor ecological quality, it is designated as a CWS. It is therefore considered to be a receptor of medium sensitivity with reference to figure 7.3. The unnamed tributary of the River Cam is a receptor of low sensitivity.

*Flood risk*

7.43 The main site and the majority of the bus / cycle interchange site are in fluvial flood zone 1. However, the section of the bus / interchange site either side of the River Cam falls within flood zones 2 and 3. South Cambridgeshire's strategic flood risk assessment (WSP, 2010) shows that the nearest historic fluvial flooding events to the site were in west Hinxton and central Pampisford. The Environment Agency's map of historic fluvial flood events shows flooding from the River Cam extending into the west of the bus / cycle interchange site in 1947 and 2001.

7.44 The Environment Agency's surface water flooding map indicates that the majority of the site is at very low risk of surface water flooding. However, there appear to be several small areas of low and medium risk in the west of the main site, where depressions that are not hydraulically connected to any watercourses are susceptible to localised ponding. There is also a historic record of minor flooding around the A1301 / A505 'McDonalds' roundabout and the south west corner of the main site (the western end of Tichbaulk Road), where local authority jurisdiction to undertake regular maintenance of highways drainage is likely to significantly reduce the risk.

7.45 Given that part of the bus / cycle interchange site is adjacent to a watercourse, groundwater levels in this area are likely to be comparable to fluvial levels and the ground below the site may experience a high water table during high flows. However, as the main site and the east of the bus / cycle interchange site are elevated several metres above the River Cam, overall it is concluded that there is a low risk of groundwater flooding. The nearest historic groundwater flooding event recorded in the strategic flood risk assessment was to the west of Pampisford.

7.46 The strategic flood risk assessment does not contain any mention of sewer flooding risk in Hinxton. The nearest record of historic sewer flooding was in Duxford. The site is therefore considered to be at low risk of sewer flooding. The Environment Agency's flooding from reservoirs map indicates that the site is wholly outside the maximum extent of flooding in the event of a dam failure. It is therefore considered to be at low risk from flooding due to infrastructure failure.

*Hydrogeology*

7.47 The Alluvium and River Terrace Deposits are classified by the Environment Agency as secondary A aquifers, while the Holywell Nodular Chalk Formation and New Pit Chalk Formation are classified as principal aquifers. The alluvium is described by Jones *et al* (2000) as being of moderate to high porosity, because of its unconsolidated nature, but its permeability is likely to be constrained to low or low to moderate because of poor sorting and the clay content.

7.48 The River Terrace Deposits are categorised as a potentially variable stratum, possibly containing permeable layers capable of transmitting groundwater laterally off site and vertically downwards to underlying strata. The two chalk formations are categorised as strata of likely high intergranular and / or fracture permeability, usually providing a high level of water storage, that may support water supply / river base flow on a strategic scale (Allen *et al*, 1997).

*Groundwater*

7.49 Groundwater was recorded in several of the exploratory holes during the intrusive investigations (table 7.3).

| Stratum | Exploratory hole | Depth groundwater encountered (mbgl)* | Depth to groundwater (mbgl)** |
|---|---|---|---|
| Alluvium | BH02 | 2.20 | -- |
| River Terrace Deposits | BH01 | 1.15 | -- |
| | TP55 | 2.00 | -- |
| | TP57 | 1.90 | -- |
| Holywell Nodular Chalk Formation | BH02 | 6.50 | -- |
| | BH04 | 6.50 | 5.44-5.59 |
| | BH05 | 6.50 | 5.07-5.21 |

**Table 7.3: Summary of recorded groundwater levels**
*Fieldwork
**Post-fieldwork monitoring

7.50 The Environment Agency monitors groundwater quality under the Water Framework Directive. It considers both quantitative quality (the degree to which a body of groundwater is currently affected by direct and indirect abstractions) and chemical quality. The groundwater beneath the site, which forms part of the Cam and Ely Ouse Chalk groundwater body, is currently classified as being of poor quality for both indicators.

7.51 There is an active potable water abstraction licence approximately 380 m to the north of the main site, with an associated groundwater source protection zone (SPZ) 1 (inner catchment) surrounding the abstraction point. The remainder of the site falls within SPZ 2 (outer catchment) and SPZ 3 (total catchment). There are two other active groundwater abstraction licences within 500 m of the site, both of which are for general use, 310 m and 445 m to the north of the northernmost extent of the bus / cycle interchange site.

7.52 Groundwater is considered to be a receptor of high sensitivity.

*Wastewater treatment and drinking water supply*

7.53 Given the undeveloped nature of the site, no formal wastewater drainage systems are expected to be present. It should be noted that there may be private drains associated with the nearby existing buildings, but these are likely to be unrecorded.

7.54 Anglian Water is the sewerage undertaker for the area. The nearest public foul sewer to the site is a 150 mm diameter main beneath the High Street in Hinxton, approximately 250 m west of the main site boundary. There is another foul sewer and an existing wastewater pumping station approximately 600 m west of the A1301 / A505 'McDonalds' roundabout. Anglian Water has advised that the existing foul sewer network does not have the capacity to accommodate flows from the proposed development. Sewage from the village is currently treated at the Great Chesterford Water Recycling Centre, approximately 1.7 km to the south of the site. Anglian Water has advised that the centre does not currently have the capacity to treat flows from the proposed development, although capacity is available at the Sawston Water Recycling Centre approximately 3.2 km to the north of the main site.

7.55 Potable water in the area is provided by Cambridge Water Company. A 180 mm water main is present beneath the A1301 Mill Lane to the west of the main site. Connecting to this, a 450 mm water main runs to the north of the main site. Cambridge Water Company has confirmed that there is sufficient capacity

available within the existing 450 mm trunk main to serve the proposed development, although a small booster station may be required to ensure adequate service is received. Environment Agency water mapping shows that the site is in an area under moderate water stress (Environment Agency, 2013).

7.56 The wastewater treatment network and potable water supply network are receptors of high sensitivity.

***Future baseline***

7.57 In the absence of the proposed development, the site will continue in its current use. It is therefore unlikely that there would be any change in the ground conditions. The existing water environment could be subject to change as a result of climate change or changes of land use upstream within the catchment of the River Cam.

**Effects during construction**

***Ground conditions***

*Human health*

7.58 Intrusive investigation and subsequent chemical testing of soil samples has not identified any sources of contaminants of potential concern with respect to human health. The findings of the ground investigation and the fact that much of the site is greenfield indicate that there is a low risk to ground workers and adjacent land users from existing contamination within soils. No significant risks are therefore predicted. The potential for unknown contaminated soils to be present in uninvestigated areas cannot be ruled out, but would be addressed if encountered (see mitigation section).

7.59 Occasional concentrations of carbon dioxide in soil greater than 5.0% were recorded. These exceed the Health and Safety Executive workplace exposure limits for personnel in the working environment (1.5% for short term (15 minutes) exposure and 0.5% for long term exposure). In addition, soil concentrations of oxygen were occasionally recorded as below the Health and Safety Executive's recommendation of 18%. Assuming that all standard precautions and recommended personal protective equipment (PPE) are used by ground workers during the construction process on site, appropriate to the task and work environment, the likely risk to human health from such gases is considered to be low.

*Controlled waters*

7.60 No elevated concentrations of the contaminants of concern in relation to potential effects on controlled waters (principally metals, metalloids, polycyclic aromatic hydrocarbons and petroleum hydrocarbons) were found in either made ground or natural soils. As a result, the risk to controlled waters from mobilisation of existing contamination during construction of the proposed development is considered to be low. No significant risks are therefore predicted to controlled waters.

***Water environment***

*Surface water and flood risk*

7.61 During the construction phase, there is the possibility that rainfall could mobilise materials stored within the site, such as silt and stockpiles of site-won soils, into the surrounding surface water drainage network. Surface water quality could also be impacted by pollution from accidental spillages and leaks of liquids such as oils and fuels. In the absence of mitigation, it is considered that such events could result in a medium change, leading to a slight adverse effect on the unnamed tributary of the River Cam that will not be significant, and a moderate, significant adverse effect on the River Cam.

7.62 Construction activities in or near a watercourse have the potential to cause pollution or affect the watercourse's bed and banks. The widening of the existing Station Road East bridge over the unnamed tributary of the River Cam and the construction of the proposed pedestrian / cycleway / equestrian bridge across the Cam have the potential to lead to a medium magnitude of change to the water's quality and hydrology in the absence of mitigation. This will be a slight adverse effect on the unnamed tributary, which will not be significant, and a moderate, significant adverse effect on the River Cam.

7.63 The increased impermeable area on site during construction has the potential to increase surface water runoff, which could pose a flood risk to site users and affect flood risk to the surrounding area. However, the likelihood of widespread impacts from flooding is considered to be low, given the setting of the site. A medium magnitude of change is predicted, leading to a slight adverse effect that will not be significant.

*Groundwater*

7.64 There is a risk that accidental spillages of potentially harmful fluids such as fuels, oils and lubricants could occur and have an effect on groundwater quality during construction. However, any such events would be uncommon, localised in extent and small in magnitude. Given the high sensitivity of the groundwater beneath the site to changes in quality, this would lead to a moderate, significant adverse effect in the absence of mitigation.

*Wastewater treatment and drinking water supply*

7.65 During the construction phase, wastewater from welfare facilities on site is likely either to be removed from site solely by tanker, rather than being discharged into the existing foul sewer, or managed by a combination of both methods of disposal. As a result, there will be a negligible to small impact on the local wastewater network, leading to a slight adverse effect that will not be significant.

7.66 Clean water for use by construction personnel will be required in relatively low quantities and any water required for construction works is likely to be tankered to the site, combined with a possible connection to the existing water supply on a localised basis. Therefore, a negligible to small impact is predicted on the existing drinking water network, leading to a slight adverse effect that will not be significant.

### Effects post-construction

#### *Ground conditions*

*Human health*

7.67 As discussed in the baseline section, no contaminants were recorded at concentrations above the GAC. While asbestos fibres were found in one sample to the north west of the main site, it is considered most likely that these were deposited as airborne particulates from the adjacent road or service station area. As all other samples were found to be clear of asbestos, no significant risks to human health are predicted post-construction.

*Controlled waters*

7.68 The lack of significant potential sources of contamination and of evidence of actual solid phase contaminants indicate that the risk posed to controlled waters by mobilisation of existing contamination post-construction is low. No significant risks are therefore predicted to controlled waters.

*Plant life*

7.69 No contaminants were recorded at concentrations above the GAC in natural soils on the site. The only exceedances recorded were for copper and zinc in the made ground to the east of the main site. Given that only limited exceedances were recorded, none of which were on site, and that no signs of physical distress were observed in existing vegetation, no significant risks to plant life are predicted post-construction.

#### *Water environment*

*Surface water*

7.70 Post-construction, there is a risk that pollution associated with the new development on site, such as accidental spillages of fuels, oils and chemicals associated with vehicles and building maintenance, could affect the quality of surface waterbodies on and near the site. Similarly, the use of herbicides or pesticides associated with vegetation in landscaping and crops may impact on surface water quality. However, as set out in the groundwater section below, the proposed sustainable drainage system (SuDS) network comprises infiltration to groundwater and includes measures to protect water quality. No significant adverse effects are therefore predicted.

7.71 There is also a risk to surface water quality from the management of the proposed development's wastewater, either from leaks associated with the wastewater pumping station to pump flows to the existing network or from leaks and discharge of treated water from the on site package treatment works to groundwater. However, details are provided in the groundwater section below of measures that will be built into the wastewater drainage system to prevent these effects and no significant adverse effects are predicted.

*Flood risk*

7.72 The area proposed for built development on the main site is within flood zone 1 and is at low risk of flooding from all other sources, as the areas of medium surface water flood risk will be used for public open space. The proposed commercial development will therefore not be at risk of flooding or give rise to a reduction in floodplain storage. The proposed SuDS measures described above will limit runoff to the existing greenfield rates for the 1-in-100 year storm, plus a 20% allowance for climate change, which will ensure there will be no downstream increase in flood risk.

7.73 The western corner of the proposed bus / cycle interchange site lies within flood zone 2. However, this use is classified as 'essential infrastructure', which is considered appropriate in flood zones 1 and 2. Safe access and egress in the event of a flood will be available via the A505, which is in flood zone 1. The proposed bus / cycle interchange will not include any buildings that could displace water and will not give rise to a reduction in floodplain storage. As for the main site, the proposed SuDS measures will limit runoff to the existing greenfield rates for the 1-in-100 year storm, plus a 20% allowance for climate change, so there will be no downstream increase in flood risk.

7.74 Existing localised flooding issues have been identified at the junction of Tichbaulk Road with the A1301 and adjacent to the A1301 / A505 'McDonalds' roundabout. As part of the development proposals, it is intended that new road drainage will be installed to intercept these flows and discharge them to a new soakaway within the site, providing some betterment to the surface water flood risk in this area.

7.75 As discussed in chapter 2, the proposed crossings over the River Cam, the unnamed watercourse in the west of the bus / cycle interchange site and the highway ditch to the west of the A1301 have been designed to ensure the crossings will be free from flooding and will not increase flood risk elsewhere. A suitable maintenance regime will be put in place to ensure that the necessary storage and conveyance capacities of the watercourses are maintained.

*Groundwater*

7.76 Direct infiltration of runoff into the ground has the potential to affect groundwater quality through the introduction of pollutants such as spilled fuels, oils or chemicals associated with the use of the site post-construction. However, the proposed SuDS is designed to prevent any significant reduction in water quality.

7.77 As discussed in chapter 2, SuDS measures proposed at the site include drainage of clean runoff from buildings to infiltration trenches. Runoff from private parking areas will use permeable paved surfaces with a clean stone sub-base, which will act as storage prior to discharge to ground. The main access roads will either discharge to roadside swales or use a collector drain to convey runoff to a soakaway located in a suitable area of open space. Permeable surfacing will be used at the bus / cycle interchange to allow runoff to infiltrate to the ground.

7.78 No infiltration drainage is proposed in the area of the site within SPZ1. The use of permeable paving in the SuDS network will minimise the potential for pollution

of groundwater in SPZs 2 and 3, as the stone medium under the permeable paving will naturally capture any hydrocarbon contamination. The infiltration trenches will include granular material and geotextile membranes to prevent infiltration of contaminants. Oil / silt / debris traps will be incorporated into the access road drainage system as necessary to intercept contamination or silt prior to infiltration. Together, these measures will ensure that runoff will receive adequate treatment prior to infiltration and no significant effects are predicted on groundwater quality.

7.79 As discussed in chapter 2, three options are proposed to treat the wastewater arising from the proposed development. If the option of connecting to the existing wastewater treatment network is chosen, a wastewater pumping station would be required in the west of the main site in SPZ3. The failure of the pump or a blockage could lead to foul water flooding, which could affect groundwater quality. There is also the potential for leaks from the pumping station to affect groundwater. However, the pumping station would include 81 $m^3$ of emergency storage, in accordance with Anglian Water guidelines. This would be provided in three underground tanks contained within the pumping station compound. The pumping station would be designed in accordance with regulatory requirements and Anglian Water's design standards and would be monitored remotely.

7.80 If either of the on site package treatment options are used, approximately four package treatment plants and a number of pumping stations would be located within the development parcels. Both the package treatment plants and the pumping stations would be designed in accordance with relevant regulatory requirements and guidelines to prevent pollution of groundwater. The plants would treat wastewater to a standard to be agreed with the Environment Agency. The treated water from the plants would be discharged into a constructed wetland infiltration area to the north of the avenue, which would provide tertiary treatment of the water as it infiltrates into the ground. This would ensure that there would be no significant adverse effects on groundwater quality from the treated water.

*Wastewater treatment and drinking water supply*

7.81 As discussed above, three options are proposed to treat the wastewater arising from the proposed development. If either of the on site package treatment options are used, there would be no increase in wastewater flows as a result of the proposed development and no significant effects on the capacity of the area's wastewater treatment network.

7.82 If the option of connecting to the existing public foul sewer network is used, upgrades to the network would be required, although Sawston Water Recycling Centre has the capacity to treat flows from the proposed development. A pumping station would be provided on site, together with a new length of off site rising main to connect to the existing sewer network. These provisions would ensure that there would be no significant effects on the capacity of the wastewater treatment network.

7.83 Cambridge Water Company has confirmed that there is sufficient capacity available within the existing 450 mm trunk main to serve the proposed development. As set out in the water conservation statement submitted in

support of the planning application, the achievement of a BREEAM Excellent rating will require a 40% reduction in water consumption within the proposed development compared to existing average levels. If the option of using enhanced ecological package treatment plants to manage the proposed development's wastewater is used, there is the potential for capture and recycling of greywater following treatment. This would further reduce the proposed development's water consumption. No significant effects are therefore predicted on water supply.

## Mitigation

### *Ground conditions*

*General construction measures*

7.84 No contaminated soils were found during the initial site-wide intrusive ground investigation. It is likely that further intrusive investigation will be undertaken within individual plots to suit the development types. Further reporting would include (if necessary) a remediation method statement and verification report to deal with any identified contaminated ground. Should any contaminated soils be encountered during the development works, these materials would be handled, stored and possibly removed in accordance with current waste management legislation and guidance.

7.85 Health and safety risks to adjacent site users relating to dust, noise, odour and vibration will be appropriately addressed prior to commencement of specific works in sensitive areas. A construction environmental management plan (CEMP) will be prepared and implemented by the contractors prior to the commencement of each construction phase.

*Construction workers*

7.86 Appropriate health and safety measures will be implemented to mitigate risks to construction workers. Contractors developing each area or development plot will be responsible for ensuring that members of the public and site workers are protected from the potential effects of any identified contamination encountered during works on site.

7.87 The contractors will carry out a health and safety risk assessment, with appropriate precautionary measures planned and recorded in advance by adequately trained and qualified staff. At present, based on the existing site investigation information, contaminated ground and soils are not expected.

7.88 All site personnel will be advised of the significance of land affected by contamination and the associated risks to human health on site prior to commencing work. No land affected by contamination has been identified thus far; however, there is the possibility that such materials may be uncovered in subsequent investigations and during development works. Suitable PPE, including clothing, footwear, gloves, safety helmets and breathing apparatus, will be provided for all site personnel, who will be advised on the specific use of PPE on various areas of the site. Comprehensive welfare facilities will be provided for all site staff to enable workers to wash prior to eating or leaving the site.

7.89 While recorded soil gas concentrations are not necessarily reflected in the air breathed in by workers, all contractors and maintenance workers will be made aware of the possible presence of carbon dioxide and will take all necessary health and safety precautions when working in trenches or confined spaces.

*Controlled waters*

7.90 Protection of the underlying groundwater and nearby surface water from mobilisation of any unknown existing contamination that is revealed during site works and construction activities will be achieved using the following methods that will form part of a specific management strategy as required:

- Prevention of water from entering excavations, where possible
- Use of measures such as cut-off ditches, silt fences or impermeable membranes to prevent uncontrolled release of runoff from excavations or exposed ground
- Use of adequate wheel wash facilities to contain and dispose of potentially polluted runoff
- Regular washing of plant and access roads and dampening to reduce dust, with appropriate collection and disposal

***Water environment***

7.91 The CEMP that will be prepared for each development plot / area and established prior to construction commencing will include the following measures to prevent pollution of the water environment during construction:

- Appropriate storage of potentially polluting materials and chemicals in accordance with relevant regulations and guidance
- Implementation of measures such as cut-off ditches, silt fences or impermeable membranes to prevent the release of silts and sediment into surface waterbodies
- Control of any refuelling facilities, chemical and waste storage and handling areas
- Adequate supervision of all deliveries and refuelling involving potentially polluting substances
- Delivery and refuelling areas to be located away from surface waterbodies and outside SPZ1, with adequate measures in place to contain spillages at these locations
- Leaks or spillages of potentially polluting substances to be contained, collected and removed from site in an appropriate manner, for example through the use of absorbent material or booms. An emergency action plan will be formulated, which all site personnel will have read and understood
- Storage of plant and equipment away from surface waterbodies and outside SPZ1. Drip trays to be placed underneath any parts where oil / fuel may be found
- Regular servicing and inspection of vehicles used on site
- Restriction of vehicle movements in close proximity to surface waterbodies
- Management of any dewatering required for construction of foundations

- Secure access to the site for construction personnel only, to prevent vandalism and minimise the potential for release of polluting fluids

7.92 The potential for effects on the River Cam and its unnamed tributary as a result of the construction of the proposed bridge and widening of the existing bridge will be minimised through compliance with the legal requirements covering works in or near a main river. Necessary consents under the Water Resources Act 1991 will be obtained. The stability of the watercourses' banks will be assessed and the works will be designed and undertaken accordingly. Appropriate materials and construction methods will be used and works will be programmed to avoid periods of higher flood risk.

7.93 While no mitigation measures are required in relation to flood risk at the main site, it is recommended that all building finished floor levels be elevated 150 mm above the immediately surrounding ground. This will ensure that any design exceedance flows, should they occur, are directed away from the buildings.

7.94 As part of the bus / cycle interchange site lies within flood zone 2, travel between Whittlesford Parkway station and the site could be disrupted during an extreme flooding event. The Environment Agency provides a flood warning service for the stretch of the River Cam immediately downstream of the site, which will provide information in the event of a flood.

### Residual effects

#### *Ground conditions*

7.95 No significant residual ground conditions effects are predicted.

#### *Water environment*

7.96 With the above mitigation measures in place, no significant residual effects are envisaged on the water environment.

### Cumulative effects

7.97 As set out in chapter 3, the potential for cumulative effects with a number of consented and proposed developments in the area needs to be assessed.

#### *Ground conditions*

7.98 The overall impact from the proposed development on the ground conditions and potential contamination of soils is considered to be generally confined to the site. The remediation of any previously unidentified contaminated soils on site as works progress would provide a slight cumulative benefit to the general quality of the ground conditions in the area, which would not be significant.

#### *Water environment*

7.99 The other developments in the area have been designed, and will need to be built, in accordance with the requirements of the NPPF to avoid adverse effects on flood risk and water quality. As set out in the FRAs that accompany the applications, the greenfield developments will be required to limit runoff to

greenfield rates, while the brownfield redevelopments will need to at least limit runoff to existing rates. Similarly, the greenfield developments will be required to incorporate SuDS proposals to treat runoff, while the brownfield developments will either use existing strategies or be required to ensure there is no reduction in quality. No significant cumulative effects are therefore predicted on water quality or hydrology.

7.100 The other developments in the area are either approved, within the planning system or part of ongoing larger scale developments. They will therefore already have been taken into account in the analysis of the wastewater and potable water supply networks, so no further cumulative effects are predicted.

Notes:

1. All dimensions are to be checked on site before the commencement of works. Any discrepancies are to be reported to the Architect & Engineer for verification. Figured dimensions only are to be taken from this drawing.
2. This drawing is to be read in conjunction with all relevant Engineers' and Service Engineers' drawings and specifications.
3. Based on unreferenced, undated drawing by Survey Solutions.

SURVEY AREA

TPXX TRIAL PIT

BHXX BOREHOLE

WSXX WINDOW SAMPLER

HPXX HAND DUG PIT



TERENCE O'ROURKE

## **Ground conditions** – the classification of risk

| Probability | Consequence: Severe | Consequence: Medium | Consequence: Mild | Consequence: Minor |
|---|---|---|---|---|
| High likelihood | Very high risk | High risk | Moderate risk | Low risk |
| Likely | High risk | Moderate risk | Moderate / low risk | Low risk |
| Low likelihood | Moderate risk | Moderate / low risk | Low risk | Very low risk |
| Unlikely | Moderate / low risk | Low risk | Very low risk | Very low risk |

## Description of the classified risks

**Very high risk**
There is a high probability that severe harm could arise to a designated receptor from an identified hazard at the site without remediation action OR there is evidence that severe harm to a designated receptor is already occurring. Realisation of that risk is likely to present a substantial liability to the site owner or occupier. Investigation is required as a matter of urgency and remediation works are likely to follow in the short term.

**High risk**
Harm is likely to arise to a designated receptor from an identified hazard at the site without remediation action. Realisation of the risk is likely to present a substantial liability to the site owner or occupier. Investigation is required as a matter of urgency to clarify the risk. Remediation works may be necessary in the short term and are likely over the longer term.

**Moderate risk**
It is possible that harm could arise to a designated receptor from an identified hazard. However, it is relatively unlikely that any such harm would be severe and, if any harm were to occur, it is more likely that the harm would be relatively mild. Further investigative work is normally required to clarify the risk and to determine the potential liability to the site owner / occupier. Some remediation works may be required in the longer term.

**Low risk**
It is possible that harm could arise to a designated receptor from an identified hazard, but it is likely, at worst, that this harm if realised would normally be mild. It is unlikely that the site owner / occupier would face substantial liabilities from such a risk. Further investigative work (which is likely to be limited) to clarify the risk may be required. Any subsequent remediation works are likely to be relatively limited.

**Very low risk**
It is a low possibility that harm could arise to a designated receptor, but it is likely, at worst, that this harm if realised would normally be mild or minor.

**No potential risk**
There is no potential risk if no pollution linkage has been established.

From: Environment Agency, NHBC and Chartered Institute of Environmental Health, 2008, Guidance for the Safe Development of Housing on Land Affected by Contamination.

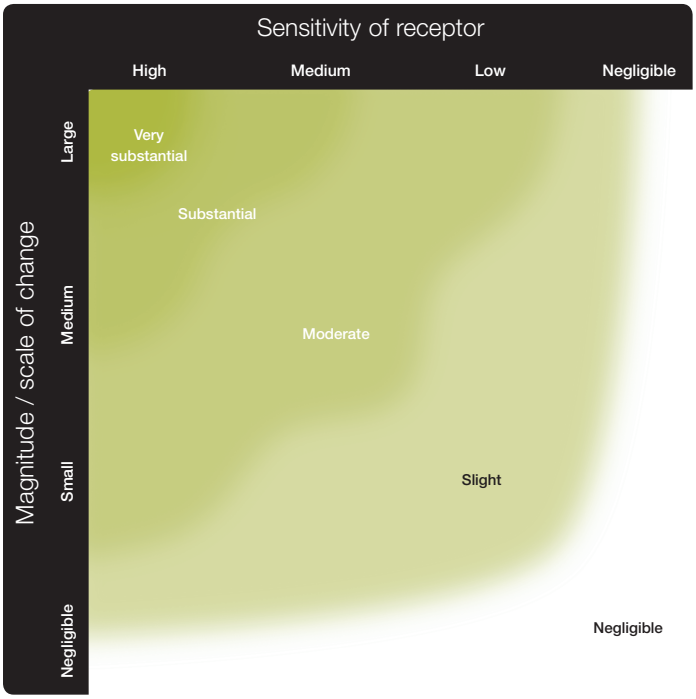
TERENCE O'ROURKE

## **Sensitivity of receptor** – Water

## **Magnitude of change** – Water


TERENCE O'ROURKE

## **Determination of significance matrix** – Water




## Degrees of effect

**Very substantial:**
Wholesale change to watercourse, water chemistry, erosion and sedimentation characteristics within areas protected for their environmental importance or significance as water supply sources.

**Substantial:**
Wholesale or fundamental changes to water bodies, which are not water supply sources, but of good quality. Wholesale and/or moderate changes to associated erosion/sedimentation patterns and water chemistry. Also, moderate changes to watercourse, water chemistry, erosion and sedimentation characteristics within areas protected for their environmental importance or significant as water supply sources.

**Moderate:**
Wholesale and/or fundamental changes to water bodies of average quality, and features of local interest. Also minor changes to important water bodies such as those in areas protected for their environmental significance, water bodies of good quality, and both water supply and non-water supply sources.

**Slight:**
Small changes to water bodies of local interest or of average water quality.

**Not significant:**
No change to water bodies of poor quality and artificial watercourses.

Professional judgement can be used to vary the category of significance where specific circumstances dictate, for example due to the vulnerability or condition of the receptor.

The reason for and nature of any variation will be made clear in the assessment.

TERENCE O'ROURKE