15 Ground Conditions and Contamination

15.1 Introduction

15.1.1 This chapter of the ES was prepared by Hydrock Consultants Ltd (Hydrock) and presents an assessment of the likely significant effects of the Proposed Development on Ground Conditions and Contamination. Mitigation measures are identified, where appropriate, to avoid, reduce or offset any significant adverse effects identified and/or enhance likely beneficial effects. The nature and significance of the likely residual effects are reported.

15.1.2 The chapter is supported by the following appendix:

- Appendix 15.1: Begbroke Innovation District, Oxfordshire. Desk Study Review and Ground Investigation. June 2023[1]; and
- Appendix 15.2: Begbroke Innovation District, Oxfordshire. Remediation Strategy and Verification Plan. June 2023[2].

15.1.3 This chapter considers groundwater and surface water in so much as they interact with land contamination. Related aspects of groundwater, hydrogeology and water quality are assessed in Chapter 16: Water Resources and Flood Risk of this ES.

Competence

15.1.4 This assessment has been completed by Claire Daly. Claire has over 17 years of experience in the contaminated land industry, and has worked on projects across the UK, Australia and Asia. She has a degree in Applied Geology BSc (Hons) (Staffordshire University) and is a Fellow of the Geological Society of London. Claire is also a Chartered Geologist, European Geologist, Chartered Scientist and Accredited SoBRA Risk Assessor (Human Health and Vapour Intrusion) as a member of the Society of Brownfield Risk Assessment (SoBRA).

15.1.5 This assessment has been overseen and approved by Allan Bell. Allan has 30 years of experience in the mining, geotechnical and contaminated land industries, and has worked on projects across Australia and the UK. He has a degree in Geology BSc (University of Queensland), a Masters of Economic Geology (James Cook University) and is a Fellow of the Geological Society of London. Allan is also a Chartered Geologist, European Geologist, Register of Ground Engineering Professionals (RoGEP), and a Specialist in Land Condition (SiLC).

15.2 Legislation, Planning Policy and Guidance

Legislation Context

15.2.1 The following legislation is relevant to the Proposed Development:

- The Asbestos (Licensing) (Amendment) Regulations 1998[3];
- The Building Regulations 2010[4];
- The Construction (Design and Management) Regulations 2015[5];

- The Contaminated Land (England) (Amendment) Regulations 2012[6];
- The Contaminated Land (England) Regulations 2006[7];
- The Control of Asbestos Regulations 2012[8];
- Drinking Water Regulations, including:
  - The Private Water Supplies (England) Regulations 2016[9]; and
  - The Water Supply (Water Quality) Regulations 2016[10];
- Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives[11];
- Environment Act 1995[12];
- Environment Act 2021[13];
- The Environmental Damage (Prevention and Remediation) (England) Regulations 2015[14];
- The Environmental Permitting (England and Wales) Regulations 2016[15];
- Health and Safety at Work etc. Act 1974[16];
- Part 2A of the Environmental Protection Act 1990[17];
- Planning Act 2008[18];
- Pollution Prevention and Control Act 1999[19];
- Town and Country Planning Act 1990[20];
- The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017[21];
- Water Resources Act 1991[22], as amended by the Water Act 2003[23], and 2014[24], taking into account the provisions of the following Directives:
  - Directive 2000/60/EC[25]; and
  - Directive 2006/118/EC[26] as amended by 2013/39/EU[27].

Planning Policy Context

15.2.2 The following national, regional, and local planning policy is relevant to the Proposed Development:

National

- National Planning Policy Framework (2021)[28];

Regional

- Oxfordshire County Council (OCC) (2017). Oxfordshire Minerals and Waste Local Plan[29]; and
- OCC (2021). Local Standards and Guidance for Surface Water Drainage on Major Development in Oxfordshire[30].

Local

- Cherwell District Council (2015). Cherwell Local Plan[31];
- CDC (2020). Cherwell LPPR [32]; and

- CDC (2013). Development of Potentially Contaminated Land and Sensitive End Uses. An Essential Guide for Developers[33].

Guidance

15.2.3 The following guidance is relevant to the assessment:

- Association of Ground Investigation Specialists (AGS) (2006). Guidelines for Good Practice in Site Investigation. Issue 2[34];
- Building Research Establishment (BRE) (2005). Concrete in aggressive ground. BRE Special Digest 1, Third Edition[35];
- BRE (2023). BR 211 Radon: Guidance on protective measures for new buildings[36];
- British Plastic Federation (BPF) Pipes Group (2018). Designing Drains and Sewers for Brownfield Sites: Guidance Notes[37];
- British Standards Institution (BSI) (2010). BS EN 1997-2:2007 Eurocode 7: Geotechnical design. Part 2: Ground investigation and testing (incorporating corrigendum June 2010)[38];
- BSI, (2010) BS 6031:2009 Code of practice for earthworks (incorporating corrigendum No.1)[39];
- BSI (2013). BS EN 1997-1:2004+A1:2013 Eurocode 7: Geotechnical design. Part 1 General rules (incorporating corrigendum February 2009)[40];
- BSI (2017). BS 10175:2011+A2:2017 Investigation of potentially contaminated sites - code of practice[41];
- BSI (2019). BS 8485:2015+A1:2019. Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings[42];
- BSI (2020). BS 8004:2015+A1:2020 Code of practice for foundations[43];
- BSI (2020). BS 5930:2015+A1:2020 Code of practice for ground investigations[44];
- BSI (2020) BS EN ISO 21365:2020 Soil quality – Conceptual site models for potentially contaminated sites[45].
- CIRIA (2001). C552 Contaminated land risk assessment – a guide to good practice[46];
- CIRIA (2007). C665 Assessing risks posed by hazardous ground gases to buildings[47];
- CIRIA (2009). C681 Unexploded ordnance (UXO), A guide for the construction industry[48];
- Contaminated Land: Applications in Real Environments (CL:AIRE) (2011). The Definition of Waste: Development Industry Code of Practice, Version 2[49];
- CL:AIRE (2017). Research Bulletin 17, A Pragmatic Approach to Ground Gas Risk Assessment[50];
- CL:AIRE (2020). Professional Guidance: Comparing Soil Contamination Data with a Critical Concentration[51];
- Department for Environment, Food and Rural Affairs (DEFRA) (2012). Environmental Protection Act 1990: Part 2A, Contaminated Land Statutory Guidance[52];

- DEFRA (2014). SP1010: Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination – Policy Companion Document[53].
- Department for Levelling Up, Housing and Communities (DLUHC) and Ministry of Housing, Communities & Local Government (MHCLG) (2020). Environmental Impact Assessment Guidance[54];
- DLUHC and MHCLG (2021). Land affected by contamination guidance[55];
- DLUHC and MHCLG (2021). Planning practice guidance[56];
- Environment Agency (EA) (2001). National Groundwater & Contaminated Land Centre report NC/99/73. Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination: Guidance on Pollution Prevention[57];
- EA (2006). Guidance on the design and installation of groundwater quality monitoring points[58];
- EA and National House Building Council (NHBC) (2008). R&D Publication 66. Guidance for the safe development of housing on land affected by contamination[59].
- EA (2014). Land Contamination: remedial targets methodology[60];
- EA (2015). Contaminated land exposure assessment (CLEA) tool[61];
- EA (2021). Land contamination risk management (LCRM)[62];
- Highways England (2019) Design Manual for Roads and Bridges. LA 109 – Geology and soils[63];
- Highways England (2020). Design Manual for Roads and Bridges. CD 622 - Managing Geotechnical Risk[64];
- Highways England (2020). Design Manual for Roads and Bridges. CS 641 - Managing the maintenance of highway geotechnical assets[65]; and
- UK Health Security Agency (UKHSA) and British Geological Survey (BGS), (2022). Indicative Atlas of Radon in the United Kingdom[66].

15.3 Assessment Methodology

Consultation

EIA Scoping Opinion

15.3.1 A request for a Scoping Opinion was submitted by the Applicant to CDC on 9th December 2022. An EIA Scoping Report (the 'Scoping Report') accompanied the request (Appendix 3.2). A Scoping Opinion was issued by the CDC on 27th January 2023 (Appendix 3.3) which included comments from statutory consultees. Table 15.1 summarises key comments raised by consultees of relevance to this assessment by the EIA Scoping Opinion and how the assessment has responded to them.

Table 15.1: EIA Scoping Opinion Response

Consultee and Comment	Response
Cherwell District Council, North Oxfordshire (27 January 2023)	
The presence of a foul water pipe and sewer crossing the site is noted however the exact trajectory is not shown. The presence of	Not considered relevant to Ground Conditions and Contamination. See standalone Utilities Assessment.

Consultee and Comment	Response
underground pipes is not permitted on school sites and should be shown in relation to the proposed education sites. Further guidance can be found in the Design Criteria for Primary and Secondary Schools.	
The applicant is asked to consider the need for the canal corridor, users of the canal towpath and occupants of moored boats to be included as a sensitive receptor for pollution including the management and remediation of contamination in particular during the construction phase.	Users of the canal towpath and occupants of moored boats have been included as a sensitive receptor in the assessment.
Contamination related to the creation of the Central Park concept should be clearly set out in ensuring that the area is fit for use.	An assessment of contamination at the Site (including the historical landfill site and the Central Park design) has been undertaken in this chapter and within Appendix 15.1 (Section 7) with any required mitigation measures also identified in order for the area to be suitable for the proposed end use. Baseline conditions related to the historical landfill site are set out in this chapter together with the proposed outline Remediation Strategy as set in Section 15.5.
In respect of Para 9.10. [of the Scoping Report] the issue of remediation of the previously contaminated land and whether there would be any airborne contaminants released as part of bringing this into meaningful use would need to be accounted for in the ES.	The potential for release of airborne contaminants as part of remediation works and during construction is assessed within this chapter and Appendix 15.1 (see Section 7.8) and appropriate mitigation measures are detailed within the Framework CEMP (Appendix 6.1).
Cherwell District Council – Environmental Protection and Enforcement: Email follow up to Scoping Opinion (17 March 2023)	
The assessment methodology under Section 12: Ground Conditions and Contamination in the EIA Scoping Report was satisfactory so I had no comments.	No response required.

Other Pre-Application Consultation

15.3.2 Table 15.2 summarises key comments raised by consultees of relevance to this assessment during other meetings and/or communication exchanges and how the assessment has responded to them.

Table 15.2: Consultation Response Summary

Consultee and Comment	Response
Natural England (11 May 2018)	
"*..as recommended by the* [Rushy Meadows SSSI – Hydrological & Hydrogeological] *desk top study[67] (Appendix B of Appendix 15.1) we advise further, more detailed assessment, would be needed to support a planning application. In particular, such an assessment should include a site investigation to:* ▪ *Collect borehole data across the PR8 site and SSSI to determine geology and groundwater levels to confirm whether there is any hydrogeological continuity between the two areas, particularly through the alluvium or sands and gravel.* ▪ *Assess any likely effects of the development on water quality within the SSSI via the Rowel Brook (when in flood).* *This information should be used to inform avoidance and mitigation measures including use of SUDs and design and layout of open spaces, to be incorporated into a planning application."*	As part of the ground investigation works completed by Jubb[68] and Hydrock[1] at the Site for the purposes of the EIA, borehole data has been collected across the Site to inform the Ground Model, which is presented in Appendix 15.1 (see Section 2.6) and summarised in paragraphs 15.4.7 through to 15.4.8. No data has been collected within Rushy Meadows SSSI due to this being outside of the land ownership and due to the sensitivity of the SSSI site restricting access for intrusive investigation. An assessment of groundwater levels and hydraulic continuity between the PR8 site and the SSSI is presented in Appendix 15.1 (see Section 2.8). The effects of the Proposed Development on water quality within the SSSI (via Rowel Brook) are assessed within Appendix 15.1 (see Section 2.8). The data from the site investigation has been used to inform the site-wide drainage strategy, including infiltration drainage and surface water attenuation ponds. Further details are provided in Chapter 16 and Appendix 16.1.

Summary of Assessment Scope

15.3.3 The scope of the assessment is outlined within the EIA Scoping Report (Appendix 3.2). The approach was agreed with CDC via the EIA Scoping Opinion (Appendix 3.3) and direct consultation with the CDC Environmental Protection and Enforcement team, who had reviewed but not directly commented on the EIA Scoping Opinion. The scope of this ES chapter is limited to the following assessment of effects:

Construction

15.3.4 The potential environmental effects during the construction phase considered in this assessment include:

- Potential effects on human health (on-site and off-site) from exposure to contamination and/or ground gas associated with historical and current land use from construction phase works;
- Potential for increased mobilisation of chemical contaminants into surface water and/or groundwater from construction phase works;

- Potential for mobilisation of contaminants from compaction works to historical landfill site; and
- Temporary alteration of groundwater flow regime in relation to the baseflow to surface water features.

Completed Development

15.3.5 The potential environmental effects during the operational phase considered in this assessment include:

- Potential effects on human health (on-site and off-site) from exposure to contamination and/or ground gas associated with historical and current land use;
- Potential for increased mobilisation of chemical contaminants into surface water and/or groundwater;
- Alteration of groundwater flow regime in relation to the baseflow to surface water features;
- Potential degradation of plastic pipes from contaminants;
- Potential permeation of water supply pipes from contaminants;
- Potential effects to new buildings (primarily foundations), from any aggressive ground conditions; and
- Potential effects to proposed new landscaped areas, including new Local Nature Reserve (LNR), nature conservation area, and parks from the release of any potential contamination.

Non-Significant Effects

15.3.6 All other Ground Conditions and Contamination effects were scoped out of further assessment within this ES.

15.3.7 The potential for cumulative effects of the Proposed Development in combination with other cumulative schemes are not significant in relation to Ground Conditions and Contamination as any effect is likely to be localised to the site and there are unlikely to be any cumulative effects across all sites as contaminated land is assessed to a common standard. As such, an assessment of cumulative effects has been scoped out of this ES Chapter. Further details and justification are provided in Section 12 of the EIA Scoping Report (Appendix 3.2).

Study Area

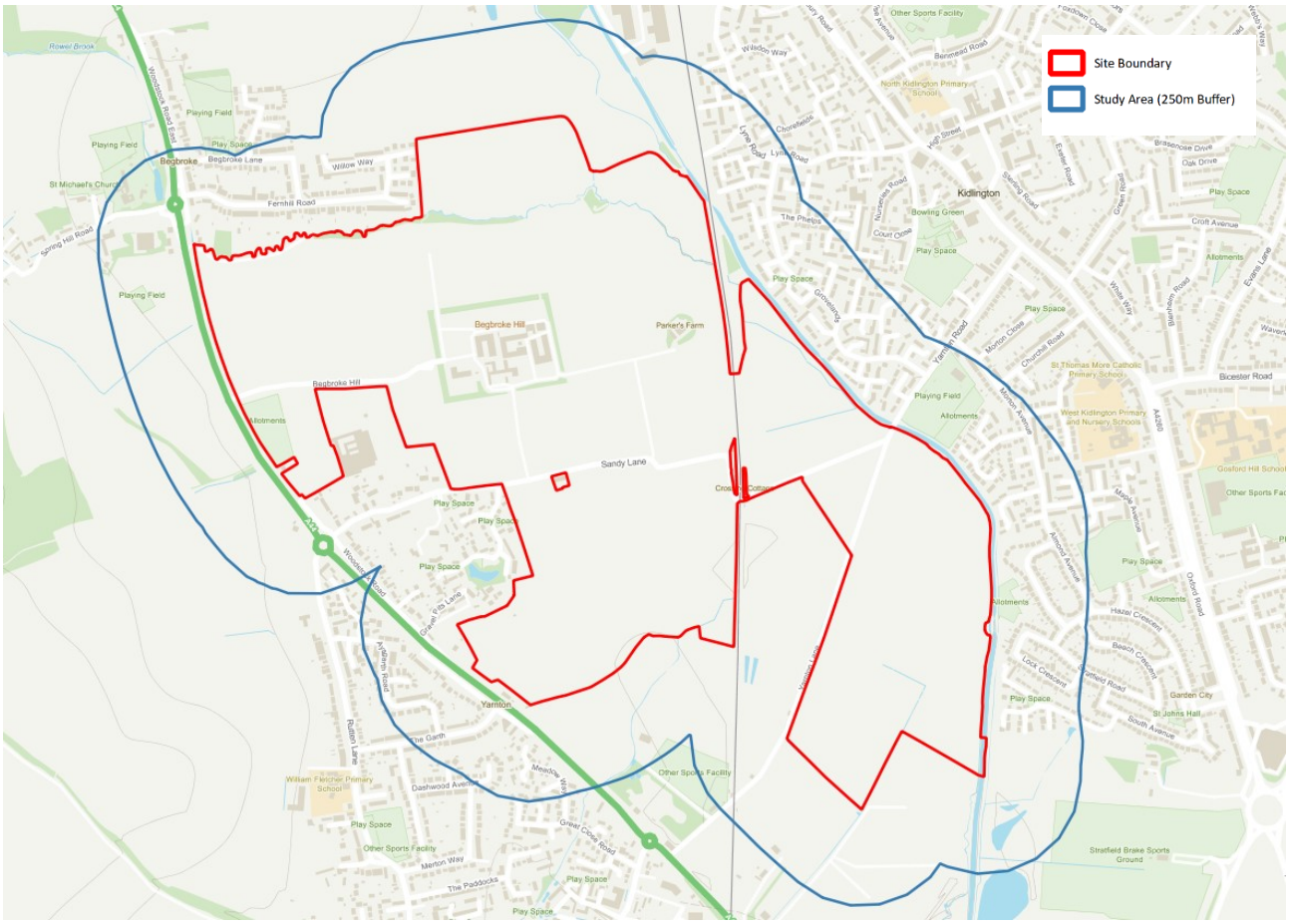
15.3.8 The extent of the Ground Conditions and Contamination study area is the Site itself and the immediate surrounding area.

15.3.9 The study area is defined for the purposes of this chapter as land within close proximity to, or bordering the relevant part of the Site (i.e. less than 250m from the Site) and which has the potential to be a contaminant source or receptor and there is a potential pathway for contaminant migration, which may affect the site or be affected by the Site.

15.3.10 The inclusion of a 250m buffer is based on the 'Guidance for the Safe Development of Housing on Land Affected by Contamination' (EA, 2008[59]). This buffer is reasonable in the context of the scheme taking into account the distance over which contamination can

migrate, and the relatively low density of existing development in the vicinity of the Proposed Development.

Figure 15.1: Study Area



Establishing Baseline Conditions

15.3.11 Baseline conditions have been established through the following:

- **Phase 1 Desk Study** – including a site walkover survey, review of publicly available data, historical desk study and site investigation reports including: *Phase 1 Desk Top Study Report. Land at Begbroke, Oxfordshire* (Jubb, 2018[69]) and *Ground Conditions Assessment Report. Begbroke Tripartite, Oxfordshire* (Jubb, 2019[68]). Information related to Rushy Meadows SSSI is sourced from *Rushy Meadows SSSI: Hydrogeological and Hydrogeological Desk Top Study* (White Young Green, February 2018) which is included as Appendix B of Appendix 15.1. The Phase 1 Desk Study is provided in Appendix 15.1.
- **Phase 2 Ground Investigation** – Intrusive site investigations were conducted by Hydrock at the Site in August 2021 (landfill investigation), September to October 2021 (soil infiltration rate testing), August to September 2022 (wider site preliminary investigation) and January to February 2023 (Sandy Lane Railway bridge and canal bridge investigation and groundwater levels investigation) and are all reported in Hydrock, 2023[1] (Appendix 15.1). The site investigations included trial pitting, hand pits, soakaways, windowless sampling, rotary cored boreholes, cable percussive boring and geotechnical and chemical laboratory analysis. Gas monitoring and groundwater sampling and level gauging was also undertaken on the landfill area six times between August and October 2021 and across the wider site 13 times

between September 2022 and submission in July 2023, with ongoing monitoring (three further visits) being undertaken until September 2023.

15.3.12 Based on guidance in LCRM[62], a tiered approach is taken with regards to the risk assessment process. Appendix 15.1 includes a preliminary Ground Model representing expected below ground conditions at the Site and an initial Conceptual Site Model (ICSM), which identifies potential contaminant linkages.

15.3.13 The preliminary Ground Model is prepared based on review of published geological and hydrogeological information and historical ground investigation data, where available, and considers naturally occurring geological conditions and any man-made deposits. The hydrogeological regime, comprising the groundwater in any permeable deposits beneath the Site, and the hydrological regime (surface water), are described in so much as they interact with land contamination, with any information relating to water quality being presented where available.

15.3.14 In order to develop the ICSM, a review of current and historical land use in the study area is undertaken to identify potential sources of contamination. The end use of the Site and the preliminary Ground Model are then reviewed to identify potential receptors and pathways linking the sources to those receptors, known as the Source-Pathway-Receptor approach. A potential contaminant linkage is identified where the source, pathway and receptor are all present.

15.3.15 A qualitative assessment is then undertaken of any geo-environmental risks identified and plausible geotechnical hazards are identified.

15.3.16 The Phase 2 Ground Investigation was undertaken based on the findings of the Phase 1 Desk Study, with the objective of refining and updating the preliminary Ground Model and the ICSM based on site-specific data to produce a Ground Model and the Conceptual Site Model (CSM). A CSM is defined in BSI (2020)[45] as *the synthesis of all information about a potentially contaminated site relevant to the task in hand with interpretation as necessary and recognition of uncertainties*. The CSM comprises all relevant information, including:

- past and present uses;
- intended future uses;
- the geological, geomorphological, hydrogeological and hydrological settings, soil, sediments, and air (indoor air and the atmosphere) of the site and surrounding area;
- the properties of the potential contaminants (e.g. volatility solubility, toxicity) and their sources, including distribution of contamination (i.e. depth and area), potential migration pathways (natural and anthropogenic features such as sewer lines) and transport mechanisms;
- potential receptors of the contamination;
- possibilities of new exposure pathways and new receptors associated with the construction and completion of a new development; and
- foreseeable events (e.g. potentials for flooding (rivers, sea, groundwater), rising groundwater levels, extreme weather conditions, change of use, etc.).

15.3.17 The CSM is presented in Section 3 and Section 7.1 of Appendix 15.1 and forms the basis for Generic Quantitative Risk Assessment (GQRA), which is undertaken in accordance with current guidelines (see Sections 7.3 to 7.8 of Appendix 15.1).

15.3.18 Where remediation or mitigation measures are required, these are summarised in Section 8 of Appendix 15.1, along with an Outline Remediation Strategy. Full details of the remedial/mitigation measures and how they will be validated are presented in the Remediation Strategy and Verification Plan (RSVP)[2] (Appendix 15.2).

Assessing Likely Significant Effects

Construction Phase

15.3.19 The assessment approach undertaken to identify likely significant effects for Ground Conditions and Contamination during the construction phase is based on guidance within LCRM[62], 'Guidance for the Safe Development of Housing on Land Affected by Contamination' (EA, 2008[59]), EIA Guidance[54] and CIRIA C552[46]. The assessment is made in-line with the sustainable development objective of the NPPF[28], which, amongst other factors includes using natural resources prudently and the minimisation of waste and pollution.

15.3.20 The first stage of the assessment is risk estimation, which is undertaking the Source-Pathway-Receptor approach to identify potentially complete contaminant linkages. As discussed in paragraph 15.3.14, a source, pathway and receptor must all be present in order for a contamination linkage to be complete. Where one or more of the elements are absent, i.e. there is no pathway linking the source to the receptor, or no source of contamination has been identified where a pathway and receptor are present, there is no complete contaminant linkage.

15.3.21 The second stage of the assessment is risk evaluation, which is a qualitative method of interpreting the output from the risk estimation stage and involves the classification of the following to attribute a risk factor for each complete contaminant linkage:

- Magnitude of the probability (likelihood) of the risk occurring (Table 15.3); and
- Magnitude of the potential consequence (severity) of risk occurring (Table 15.4).

15.3.22 As stated in CIRIA C552[46], it is important that this classification is only applied where there is a possibility of a contaminant linkage existing.

15.3.23 The risk evaluation, based on the above guidance, is presented in the form of a consequence and probability matrix to establish the level of risk (Table 15.5). For the purpose of this assessment, risk levels of moderate, high and very high are considered significant, whereas low and very low risks are considered insignificant.

Table 15.3: Classification of Probability

Classification	Definition of the probability of harm/pollution occurring
High likelihood	There is a contaminant linkage and an event that either appears very likely in the short team and almost inevitable over the long term, or there is evidence at the receptor of harm or pollution.
Likely	There is a contaminant linkage and all the elements are present and in the right place, which means that it is probable that an event will occur. Circumstances are such that and event is not inevitable, but possible in the short team and likely over the long term.

Classification	Definition of the probability of harm/pollution occurring
Low likelihood	There is a contaminant linkage and circumstances are possible under which an event could occur. However, it is by no means certain that even over a longer period such event would take place, and is less likely in the shorter term.
Unlikely	There is a contaminant linkage but circumstances are such that it is improbable that an event would occur even in the very long term.

Table 15.4: Classification of Consequence

Classification	Definition of consequence
Human health impacts from chemicals in the ground	
Severe	Short-term (acute) effects likely to result in significant harm e.g. high concentration of cyanide on the surface of an informal recreational area.
Medium	Long-term (chronic) effects likely to result in significant harm e.g. high concentration of contaminants close to the surface of a development site.
Mild	Harm but probably not significant harm unless particularly sensitive individual within the receptor group. May be aesthetic/olfactory impacts.
Minor	No measurable effects.
Site workers impacts from chemicals in the ground	
Severe	Risk assessment required to determine required personal protective equipment (PPE) and this may involve high level of protection similar to United States Environmental Protection Agency (USEPA) Level A, B or C.
Medium	Risk assessment required to determine required personal protective equipment (PPE) and this may involve high level of protection similar to USEPA Level B, C or D.
Mild	Risk assessment required to determine required personal protective equipment (PPE) and this may involve moderate level of protection similar to USEPA Level C or D.
Minor	No measurable effects, but simple personal protective equipment (PPE) required (similar to USEPA Level D protection, i.e. overalls, boots, goggles, hard hat).
Human health impact from ground gases such as radon and landfill gas where exceedance of a risk-based trigger indicates the potential for harm	
Severe	Pollution linkage identified over a large area.
Medium	Pollution linkage identified in limited areas.
Mild	Pollution linkage uncertain.
Minor	Plausible pollution linkage not established.
Controlled Waters impacts from chemicals in the ground	
Severe	Pollution of highly sensitive water resources (Principal aquifer within a groundwater Source Protection Zone, potable water supply or rivers). Discharge of a List I or List II substance to Controlled Waters or major spillage.

Classification	Definition of consequence
	Substances leaching from contaminated soil causing receiving waters to exceed surface water and groundwater quality indicators (EQS/DWS) over a large area or resulting in a change in water quality grade for the river reach.
Medium	Pollution of sensitive water resources (Principal aquifer outside of a groundwater Source Protection Zone (inner and outer), Secondary A aquifer, industrial groundwater abstraction, irrigation supply or rivers/streams). Substances leaching from contaminated soil cause receiving waters to exceed surface water and groundwater quality indicators (EQS/DWS) in limited areas, insufficient to result in a change in the water quality grade of the river reach.
Mild	Pollution of non-sensitive water bodies (Secondary A or Secondary B aquifer) or non-classified groundwater or minor ditches. Substances leaching from contaminated soil cause receiving waters to slightly exceed surface water and groundwater quality indicators (EQS/DWS), insufficient to result in a change in the water quality grade of the river reach or pollution of a surface water course without a quality classification.
Minor	No measurable effects. Substances leaching from contaminated soil do not cause receiving waters to exceed surface water and groundwater quality indicators (EQS/DWS).
Ecosystems impacts from chemicals in the ground	
Severe	Short-term risk to a particular ecosystem or organism forming part of that ecosystem in a designated protected area, e.g. by contamination spillage. Irreversible damage to a protected area of international significance (e.g. Ramsar site).
Medium	Death of species in a particular ecosystem in a designated protected area, e.g. by contamination spillage. Substantial damage to a protected area of national significance (e.g. Site of Special Scientific Interest).
Mild	Minor change in a particular ecosystem in a designated protected area, but not significant harm. Damage to a locally important area.
Minor	No measurable effects. Limited harm to ecosystems of low sensitivity such as sites of local importance.
New planting impacts from chemicals in the ground.	
Severe	Complete and rapid die-back of landscaped areas.
Medium	Stressed or dead plants in landscaped areas.
Mild	Damage to plants in landscaped areas, e.g. stunted growth, discoloration.
Minor	No measurable effects.
Damage to building products form chemicals in the ground (e.g. sulphate attack of concrete, organic solvent decay of plastics)	
Severe	Maximum soil concentration exceeds industry accepted trigger value over a large area.

Classification	Definition of consequence
Medium	Maximum soil concentration exceeds industry accepted trigger value in limited areas.
Mild	Maximum soil concentration slightly exceeds industry accepted trigger value in limited areas.
Minor	Maximum soil concentration less than industry accepted trigger value.
Damage to buildings from flammable ground gas	
Severe	Catastrophic damage, e.g. gas explosion causing collapse.
Medium	Damage renders unsafe to occupy.
Mild	Damage to sensitive buildings etc.
Minor	No measurable effects.
Impacts to people, property or infrastructure cause by excessive ground movements	
Severe	Major damage involving destruction of buildings or infrastructure, blocking of river courses and major flooding or loss of life.
Medium	Significant damage to property or infrastructure, minor damage to river channels, injury to people.
Mild	Minor damage to property or infrastructure, minor blocking of river channels.
Minor	Minor ground movements but no significant damage to property, infrastructure, river channels or human health.

Table 15.5: Risk Level Estimation

	Consequence			
Probability	Severe	Medium	Mild	Minor
High likelihood	Very High	High	Moderate	Low
Likely	High	Moderate	Low	Low
Low likelihood	Moderate	Low	Low	Very Low
Unlikely	Low	Low	Very Low	Very Low

15.3.24 The temporal scope used in the assessment of the construction phase is eight years, based on a commencement of construction activities during 2025, running until 2033, with the peak construction works expected during 2028.

Completed Development

15.3.25 The assessment approach undertaken for Ground Conditions and Contamination during the Completed Development is the same as the approach for the construction phase but will be based on receptors present during the Completed Development.

15.3.26 The temporal scope used in the assessment of the operational Proposed Development is the lifetime of the Proposed Development, following operational commencement in 2033.

Determining Effect Significance

Sensitivity of Receptor

15.3.27 The sensitivity of the receptors is a matter of professional judgement. In this chapter, the sensitivity is taken to be the likelihood that one of the sensitive receptors is impacted (see Table 15.6).

Table 15.6: Receptor Sensitivity Descriptors

Value (Sensitivity)	Descriptor
High	The receptor has low ability to absorb change without fundamentally altering its present character/health, is of high environmental value, or is of national importance, e.g. human health, highly sensitive water resources (Principal aquifer within a groundwater Source Protection Zone, potable water supply or rivers), protected area of international or national significance (e.g. SSSI).
Medium	The receptor has capacity to absorb change without significantly altering its present character/health, has some environmental value, or is of regional importance, e.g. sensitive water resources (Principal aquifer outside of a groundwater Source Protection Zone (inner and outer), Secondary A aquifer, industrial groundwater abstraction, irrigation supply or rivers/streams), protected areas of locally importance.
Low	The receptor is tolerant of change without detriment to its character/health, is low environmental value, or local importance, e.g. non-sensitive water bodies (secondary aquifer) or non-classified groundwater or minor ditches, planting and landscaping.
Negligible	The receptor is resistant to change and is of little environmental value e.g. buildings and infrastructure.

Magnitude of Impact

15.3.28 The magnitude of impacts is judged on the consequences of the impact. In terms of contamination, for example, this would be the degree of exceedance of the assessment criteria and whether this takes place locally or across large areas of the Site. Professional judgement is used to estimate the likely degree of exceedance based on experience from other, similar sites (see Table 15.7).

Table 15.7: Magnitude of Impact Descriptors

Impact Magnitude	Descriptor
High	Total loss of major alterations to one of more of the key elements, features or characteristics of the baseline. The post-development situation will be fundamentally different. Acute or genotoxic risks to human health, catastrophic damage to buildings, major pollution to highly sensitive controlled waters (e.g. significant spill).
Medium	Partial loss or alteration to one of more of the key elements or characteristics of the baseline. The post-development situation will be partially changed.

Impact Magnitude	Descriptor
	Chronic risks to human health, pollution of sensitive controlled waters, significant effects on sensitive ecosystems or species, rapid die-back of landscaped areas, significant damage to buildings or infrastructure rendering them unsafe for use.
Low	Minor loss or alteration to one or more of the key elements, features or characteristics of the baseline. Post-development, the change will be discernible but the underlying situation will remain similar to the baseline. Nuisance from odours, pollution of non-sensitive waters, minor damage to landscaping (stressed plants, stunted growth), buildings or infrastructure (not sufficient to render unsafe).
Negligible	Very minor loss or alteration to one of more of the key elements, features or characteristics of the baseline, such that post-development, the change will be barely discernible, approximating to the “no change” situation. No reversible effect to human health, limited harm to non-sensitive ecosystems or species, aesthetic changes (discoloration of plant life or concrete).

Assessing Significance

15.3.29 The significance of a potential impact is based on the combination of the magnitude and sensitivity of that impact as given in the matrix in Appendix 3.5. Note that the degree of ‘significance’ is not the same as the legal definition of ‘significant harm’ as defined by the Environmental Protection Act 1990.

Assumptions and Limitations

15.3.30 Third party data used to inform any desk-based research, such as that provided by the Environment Agency and British Geological Survey, is assumed to be complete, accurate and up to date. Reports referenced, but authored by others, have been used in good faith and taken at face value.

15.3.31 The ground conditions at the Site are understood with a high level of confidence based on the investigations undertaken to date and are considered to be suitable for understanding the baseline conditions. Although every reasonable effort has been made to gather all relevant information, not all potential environmental constraints or liabilities associated with the Site may have been revealed.

15.3.32 Hydrock has used reasonable skill, care and diligence in the design of the investigations of the Site and in its interpretation of the information obtained. However, as with any ground investigation, the inherent variation of ground conditions allows only definition of the actual conditions at the locations and depths of trial pits and boreholes at the time of the investigation. At intermediate locations, conditions can only be inferred.

15.3.33 Groundwater data are only representative of the dates on which they were obtained and both levels and quality may vary.

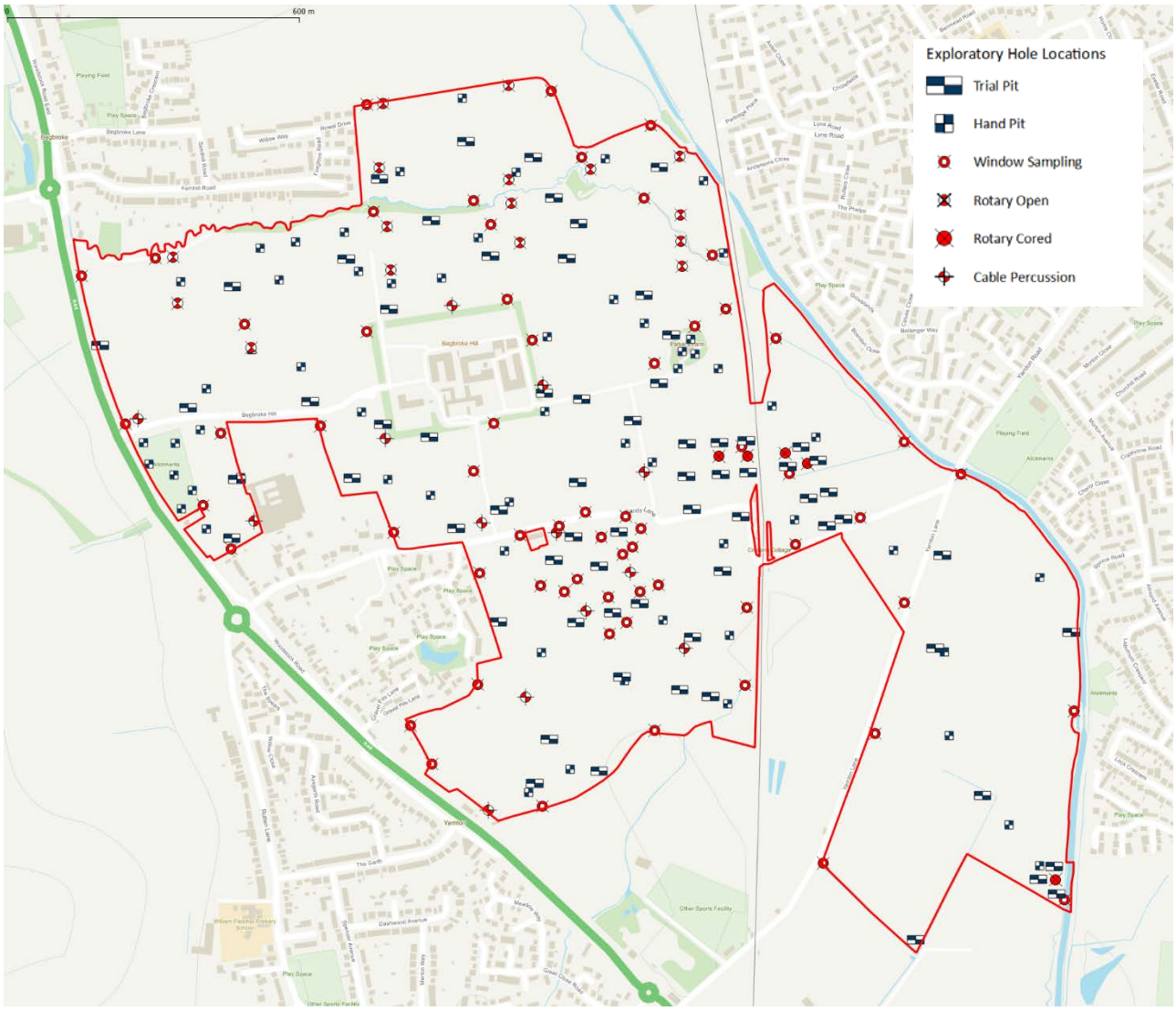
15.3.34 It is assumed that the findings of the investigations, remediation strategies and earthworks proposals will be incorporated into a Construction Environmental Management Plan(s)

(CEMP(s)) and foundation designs to ensure that an appropriate level of mitigation is provided.

15.4 Baseline Conditions

15.4.1 The baseline conditions at the Site have been informed by publicly available data, a site walkover survey, historical desk study (Jubb, 2018[69]) and site investigation reports (Jubb, 2019) and Appendix 15.1 as detailed in paragraphs 15.3.11 through 15.3.17. The coverage of the ground investigations is presented in Figure 15.2.

Figure 15.2: Ground Investigation Coverage



Site Description

15.4.2 The majority of the Site is in agricultural use, with farm storage barns located in the central area of the Site, and allotments located in the central west of the Site. A section of the agricultural land in the south east of the Site is currently in use as a poultry and deer farm. A historical landfill (approximately 5.2 ha) (filled with inert/industrial waste) is present in the central-south of the Site. A foul water pipe runs beneath the Site on a north west to south east alignment. A medium pressure gas pipe runs around Begbroke Science Park and in a southwest direction from Begbroke Science Park towards Sandy Lane. An abandoned

sewer is located beneath the south east of the Site, to the north west of the Cherwell Valley Railway Line.

15.4.3 Begbroke Science Park has a number of tenancies that necessitate the storage of chemical and hazardous waste. There are a number of backfilled gravel pits within the Site and a fuel station is present adjacent to the south west corner of the Site. An underground sewer crosses the Site in a north to south direction, to the west of Begbroke Science Park (joining a pumping station in the north) and either side of the landfill area.

15.4.4 The nearest surface water features are Rowel Brook, which forms the northern boundary of the Site flowing west to east towards the Oxford Canal. A small watercourse, Thrupp Ditch, runs through Rushy Meadows SSSI to the north of the Site converging with Rowel Brook on the central-northern edge of the Site and a small stream/ditch is located in the south of the Site. One abstraction consent is located 960m to the north east of the Site. Further details of watercourses are provided in Chapter 16: Water Resources and Flood Risk.

Site History

15.4.5 Historical mapping indicates that much of the Site has not been previously developed and has been utilised for agricultural use from the earliest available mapping to the present day.

15.4.6 A number of former gravel pits are located within the central-southern part of the Site to the south of Sandy Lane, known as Sandy Lane Pits. Following completion of the gravel extraction operations, these pits were used as landfill and were backfilled by the early 1980s. The easternmost Sandy Lane Pit was shown as a refuse pit until 1978 and remains undeveloped and backfilled slightly above the surrounding ground level.

Geology

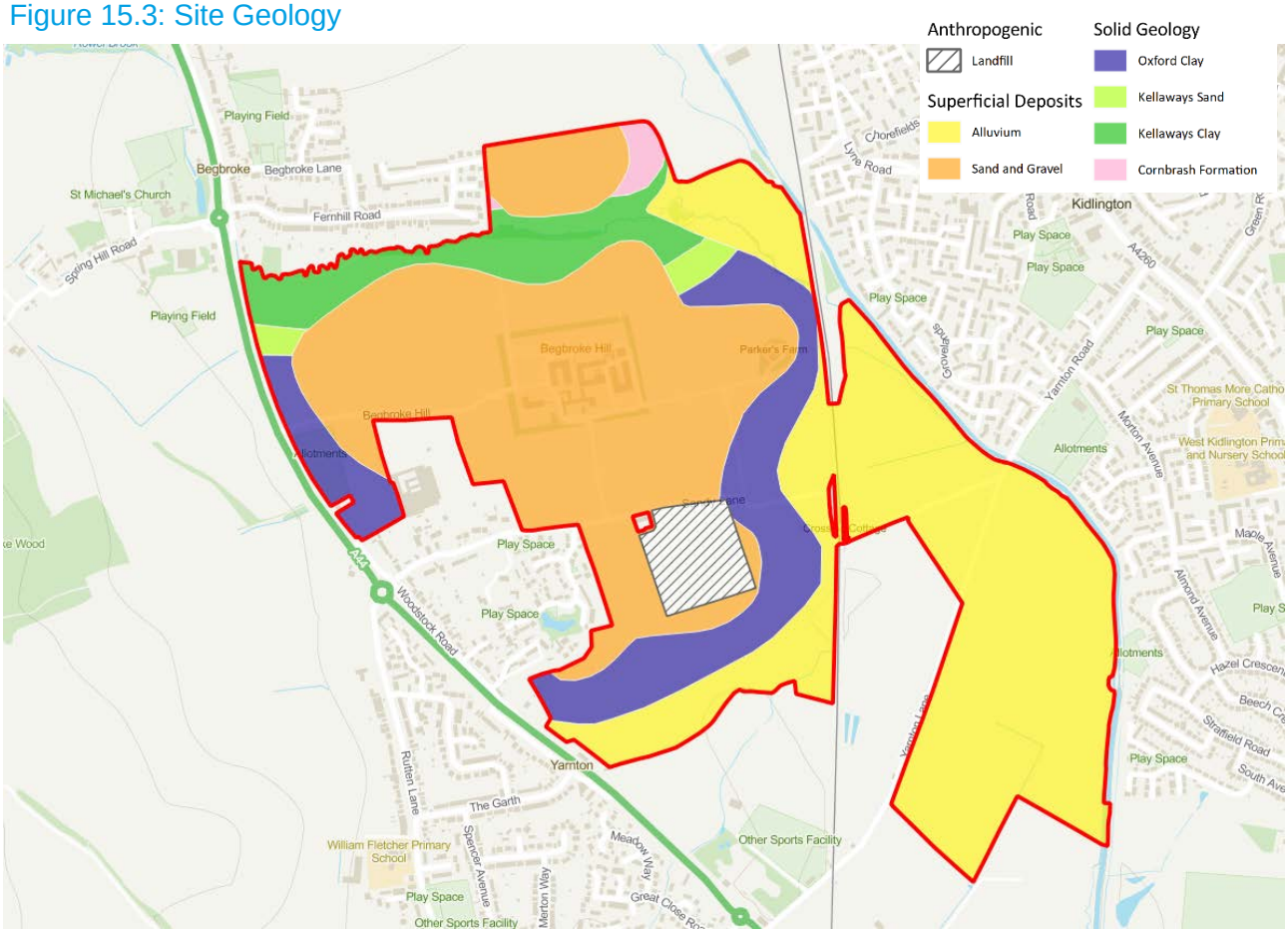
15.4.7 The British Geological Survey (BGS) and site investigation undertaken by Hydrock between 2021 and 2023 has shown the geology underling the Site to comprise the following, with further details in Appendix 15.1:

- A surface covering comprising:
  - Agricultural topsoil, comprising a brown slightly gravelly clayey sand or dark brown slightly gravelly sandy clay; and
  - Made Ground – in the former Sandy Lane landfill, comprising brown gravelly sand (predominantly ash) with abundant man-made putrescible waste and fragments of concrete, slag, brick, glass and plastic bottles, plastic wrapping, scrap metal, batteries, animal bones and newspaper. Also in localised areas across the Site, comprising clayey soils with gravel, flint, and brick.
- over, Superficial deposits, comprising:
  - Alluvium; encountered close to the streams in the north and south of the Site and across the east of the Site between the railway line and Oxford Canal;
  - Head Deposits; identified locally over the River Terrace Deposits; and
  - River Terrace Deposits encountered in the higher areas of the Site (west, centre and north).
- Over solid geology, comprising:

- Oxford Clay Formation in the centre and south of the Site (at topographic highs) and in the south east of the Site;
- Kellaways Sand Member sub-cropping at the surface in the north of the Site, south of the Site and underlying the Oxford Clay Formation;
- Kellaways Clay Member sub-cropping at the surface in the north of the Site;
- Cornbrash Limestone Formation sub cropping in the north of the Site and below the Kellaway's Clay Formation (where penetrated), and considered to extend at depth under the entire Site;
- Forest Marble Formation outcropping in the north east of the Site and underlying the Cornbrash Limestone Formation (where penetrated); and
- White Limestone Formation encountered underlying the Forest Marble Formation (at depth where fully penetrated).

15.4.8 The geology of the Site is shown in Figure 15.3.

Figure 15.3: Site Geology



15.4.9 The EA classifies the River Terrace Deposits, Alluvium, Cornbrash Limestone Formation and Kellaways Sand Member, as Secondary A Aquifers. The Kellaways Clay Member and the Oxford Clay Formation are classified as unproductive strata. The Site is not located in a groundwater Source Protection Zone.

Landfill Site

15.4.10 The historical Sandy Lane East landfill, which backfilled the former Sandy Lane Gravel Pit, accepted inert and industrial waste from unrecorded sources over an unspecified

timeframe, but generally in the late 1960s and 1970s. It is unknown whether the landfill was licenced.

15.4.11 The landfill is currently undeveloped open land, approximately 0.50m to 1.00m above the surrounding ground levels.

15.4.12 Historical ground investigation was undertaken by Jubb[68] in 2019 and further investigation was undertaken by Hydrock[1] (detailed in Appendix 15.1) on and in the vicinity of the historical landfill site. This identified Topsoil Made Ground, in all locations within the landfill, to a maximum depth of 0.80m (with an average of 0.24m). However, it should be noted that in some areas, the topsoil cover was minimal, with the surface cover comprising grass surfacing straight onto landfill.

15.4.13 The Topsoil Made Ground generally consisted of dark brown to orangish brown silty gravelly sand with high root content. Gravels consist of angular to sub-rounded, fine to coarse, of flint and sandstone with gravel sized fragments of angular fine to coarse brick and concrete and occasional glass, metal and fabric.

15.4.14 No obvious capping of the landfill was identified, although locally in two locations, to depths of up to 0.60m bgl, a firm yellowish greyish brown slightly sandy occasionally slightly gravelly clay was encountered (General Made Ground), which appeared different to the underlying Landfill Made Ground. No plastic, metal, etc. objects were identified in this material. Whilst the locations where General Made Ground was encountered were within the apparent landfill boundary, the absence of obvious and significant man-made material suggests potential differences in material deposited and therefore, it has been interpretated that the materials in the areas of these observations are separate from the main landfill deposits.

15.4.15 Landfill Made Ground was encountered across the area of the former landfill site to depths of up to 3.90m bgl. The depth and level to the base of the landfill are shown on Hydrock Drawings 19114-HYD-XX-ZZ-SK-GE-01003 and 19114-HYD-XX-ZZ-SK-GE-01004, provided in Appendix 15.1.

15.4.16 The Landfill Made Ground was highly variable. However, it generally consisted of a mixture of greyish, orangish brown, gravelly sand (predominantly ash) with abundant man-made putrescible waste and gravel sized fragments of fine to coarse, angular to sub-rounded concrete, slag and brick, glass bottles (containing unknown liquid), plastic bottles, plastic wrapping, scrap metal, wires, batteries, bike frames, animal bones and newspaper (dated 1960's). Locally cobbles and boulders of concrete were encountered. Towards the base of the landfill the colour notably changed to dark grey and black.

15.4.17 During the investigation it was noted that the Landfill Made Ground had a putrid odour in all locations that increased with depth and in one location a strong hydrocarbon odour was noted between 1.40m and 3.20m bgl.

15.4.18 No low permeability lining was encountered at the base of the landfill.

15.4.19 The lateral extents of the landfill were unable to be determined due to the presence of badger setts. However, investigation in the fields beyond identified natural strata in all locations and as such the lateral extents of the landfill are interpreted as the hedgerows around the site.

15.4.20 The landfill material overlies River Terrace Gravels from between 2.10m bgl and 3.90m bgl. In the three locations where the thickness of the River Terrace Deposits were proven beneath the landfill material, the Oxford Clay Formation was encountered between 4.00m and 4.90m bgl, which in turn overlay the Kellaways Sand.

Unexploded Ordnance

15.4.21 An Unexploded Ordnance ('UXO') screening exercise has been undertaken which indicates a low risk and no further assessment is required with regard to UXO.

Radon

15.4.22 A full Radon report was obtained by Hydrock in March 2023 (Appendix 15.1), which indicates that the far northern part of the Site (Radon Report ID BGS_331991/43780), north of Rowel Brook, is in a Radon affected area of between 3-5% and 10-30% where either basic or full protection measures will be required in any buildings constructed in this area of the Site.

15.4.23 The remainder of the Site (Radon Report ID: BGS_331991/43779) is not considered to be in a Radon affected area (<3%) and no radon protection measures are required.

Groundwater

15.4.24 Groundwater was present in monitoring wells at between 2.70m bgl and 6.40m bgl. Slightly elevated levels of heavy metals were identified in localised groundwater samples, with concentrations of arsenic and rare naphthalene in soil samples from the River Terrace Gravels.

15.4.25 The Hydrock site investigation encountered groundwater at depths between 0.10m below ground level (bgl) and 4.00m bgl during the investigation. Groundwater levels recorded post-fieldwork ranged between 0.03m bgl and 5.83m bgl (57.52m OD to 67.28m OD). Monitoring is ongoing. The variation in groundwater levels across the Site is due to the geological control on hydrogeology, where the main control on groundwater levels is the interfaces between permeable and impermeable strata, with these levels changing significantly across the site.

15.4.26 The shallow groundwater flow within the superficial deposits is from the west of the Site to the east and south-east, although in the north of the Site groundwater flow is locally towards Rowel Brook. In the far east of the Site, groundwater flows are to the south.

15.4.27 Within the bedrock geology in the north of the Site, groundwater flow is shown from west to east although this is likely due to a complicated bedrock outcropping and superficial deposits and temporal limits of the investigation. Groundwater flow is likely to be towards the south following the dip of the strata.

15.4.28 Based on the data to date, groundwater flow in the far north of the Site (adjacent to Rushy Meadows SSSI) is to the south towards Rowel Brook. Consequently, it is unlikely that any impact from the Proposed Development will extend to the north, past Rowel Brook and be transmitted upgradient to the SSSI.

Human Health Risk Assessment

15.4.29 Appendix 15.1 presents an assessment of the contamination status of the Site in relation to Human Health.

15.4.30 With the Site, outside of the historical landfill area, concentrations of arsenic and beryllium elevated above the adopted assessment criteria have been reported in natural soils, including Topsoil. In addition, elevated dibenz(a,h)anthracene has also been reported in Topsoil. In Made Ground, elevated arsenic has been reported. Suspected asbestos cement fragments were also identified in the vicinity of Parkers Farm in the central-east of the Site, as well as asbestos sheet roofing as part of the two barn structures.

15.4.31 The elevated concentrations of arsenic were considered likely to be naturally occurring and, the risk level for human health exposure to elevated arsenic and beryllium across the Site is considered to be low (medium / low likelihood).

15.4.32 For the area of the Site outside the historical landfill, only one sample reported elevated dibenz(a,h)anthracene, which was marginally above the assessment criteria, and was not considered to pose a risk to human health. The risk level for human health exposure to elevated dibenz(a,h)anthracene across the wider Site is considered to be low (medium / unlikely).

15.4.33 Although asbestos fragments were noted on the ground surface and asbestos sheet roofing in use on structures, no asbestos containing materials (ACM) were detected in soils across the wider Site. As it is plausible for these materials to be disturbed during construction, and for ACM to be present within Made Ground in the vicinity of the farm, the risk level for human health exposure to asbestos fibres is considered to be moderate (severe / low likelihood).

15.4.34 In the historical landfill area, the same elevated contaminants as the wider Site have been reported, along with lead, benzo(b)fluoranthene, ACM and low concentrations of asbestos fibres of chrysotile and amosite. The risk levels for these contaminants are the same as those discussed for the wider Site, with lead and benzo(b)fluoranthene being low (medium / unlikely) (insignificant for this assessment) and from asbestos fibres being moderate (severe / low likelihood).

15.4.35 It is assumed that Made Ground in the vicinity of Parkers Farm will be removed (and managed in accordance with a Materials Management Plan (to be produced during detailed design), as detailed in the RSVP (Appendix 15.2)) and therefore no mitigation measures in relation to human health are required across the wider Site. However, within current buildings due for demolition and the landfill area, mitigation measures will be required in relation to elevated contaminants including asbestos. During the construction phase, mitigation measures are that all asbestos removal works should be undertaken under the appropriate licence/permit, with personal protective equipment being available for construction workers and with regards to Made Ground soils, these are handled in accordance with CAR 2012[8]. Mitigation is required in the form of a cover system in the landfill area, to break the exposure pathway between human health receptors during the completed Proposed Development. Further details of this cover system will be presented in the RSVP (Appendix 15.2).

Phytotoxic Risk Assessment

15.4.36 Appendix 15.1 presents an assessment of the contamination status of the Site in relation to phytotoxic risks i.e. adverse effects on plant growth, physiology, or metabolism.

15.4.37 Elevated concentrations of metals (copper, nickel, zinc) and boron have been reported above the assessment criteria in Made Ground soils in the landfill area and one exceedance of the criteria for boron in the natural soils in the landfill area. No elevated concentrations were reported above the assessment criteria across the wider Site.

15.4.38 The risk level for phytotoxic exposure across the landfill area is considered to be low (mild / likely).

Controlled Waters Risk Assessment

15.4.39 Appendix 15.1 presents an assessment of the contamination status of the Site in relation to Controlled Waters i.e. groundwater and surface waters.

15.4.40 Elevated concentrations of metals (cadmium, cobalt, chromium (III), copper, manganese and nickel), ammoniacal nitrogen and sulphate were identified in shallow groundwater within the River Terrace Deposits outside of the historical landfill area, and within shallow perched water within the landfill area.

15.4.41 As concentrations are above the assessment criteria within the groundwater, the risk level for Controlled Waters (groundwater) is considered to be moderate (mild / high likelihood).

Ground Gas Risk Assessment

15.4.42 Elevated gas concentrations and/or flow rates have been identified in the landfill area, which fall into the assessment bracket of Characteristic Situation (CS) 2 conditions (low hazard), whereas limited gas concentrations and flow rates have been reported across the wider Site, indicating CS1 conditions, based on the assessment, in accordance with CIRIA C665[47] and BS 8485:2015+A1:2019[42].

15.4.43 As the monitoring indicates that the wider site is CS1, this reflects that the ground gas from the landfill is not migrating to areas outside of the landfill and therefore presents a low risk to any proposed properties adjacent to and surrounding the landfill.

15.4.44 As no buildings or structures are proposed above the historical landfill, there is no complete contaminant linkage and the risk level for ground gas is very low (minor / unlikely).

15.4.45 Monitoring of gas concentrations and flow will be undertaken in adjacent properties during the compaction works to the landfill, as detailed in the Remediation Strategy.

Construction Materials Risk Assessment

15.4.46 Across the wider Site, no elevated contaminants were reported in relation to pipework for delivering potable water to the Site. In the landfill area, elevated PAHs were identified in excess of the threshold values.

15.4.47 Across the wider Site, in accordance with the British Plastics Federation Guidance [37], the concentrations of PAH, and BTEX are below 100mg/kg and the concentrations of petroleum

hydrocarbons (TPH) are below 200mg/kg. However, in the historical landfill area, localised concentrations of TPH above 200mg/kg have been reported.

15.4.48 As no utilities or pipework are proposed within the historical landfill area, there is no complete contaminant linkage and the risk level is very low (minor / unlikely).

15.4.49 Based on BRE SD1[35], for buried concrete Design Sulphate Class DS-1 and ACEC Class AC-1 apply to most of the natural deposits underlying the Site (Head Deposits, Alluvium, River Terrace Deposits, Kellaways Sand Member, and Cornbrash Limestone Member). This is equivalent to Design Chemical Class DC-1 for a 50-year design life. Design Sulphate Class DS-4 and ACEC Class AC-4 apply to the Oxford Clay. This is equivalent to Design Chemical Class DC-4 for a 50-year design life.

Geotechnical Hazards Risk Assessment

15.4.50 Compressible and unstable soils, shallow groundwater and potential erosion of soils related to the stream have been identified as potential geotechnical hazards with regards to the Proposed Development. The risk level from geotechnical hazards is moderate (medium / likely).

Future Baseline

15.4.51 Based on the available information, it is considered that the existing baseline conditions would not materially change in the absence of the Proposed Development as the land would remain in its current use and conditions will only vary through the change of land use and development.

Summary of Receptors and Sensitivity

15.4.52 The baseline assessment has indicated that the receptors listed in Table 15.8 are present and have been assigned a sensitivity based on the definitions in Table 15.6.

Table 15.8: Summary of Receptor Sensitivity

Receptor	Sensitivity (Value)
Existing	
Human Health – Current site users	High
Human Health – Off site users of surrounding area (including residential properties, users of the canal towpath and occupants of moored boats)	High
Controlled Waters – groundwater within Secondary A aquifers	Medium
Controlled Waters – surface waters (Rowel Brook, Thrupp Ditch)	Medium
Ecosystems – Rushy Meadows SSSI	High
Existing buildings and infrastructure	Negligible
Future	
Human Health – Construction Workers	High
Human Health – Future Site Users	High
Human Health – Off Site Users (including residential properties, users of the canal towpath and occupants of moored boats)	High

Receptor	Sensitivity (Value)
Future landscaping	Low
Ecosystems – Rushy Meadows SSSI	High
Ecosystems – New Local Nature Reserve, Nature Conservation Area	Moderate
Proposed buildings and infrastructure	Negligible

15.5 Embedded Mitigation (Scheme Design and Management)

Construction

15.5.1 Measures will be undertaken during the construction phase in order to minimise disruption and manage the impacts of the Proposed Development. These measures will be secured through the outline planning permission as detailed below:

- **Pre-demolition asbestos survey of building/structures** – this will be undertaken on any buildings to be removed as part of the Proposed Development, which will identify any ACM requiring removal, in accordance with the Health and Safety at Work Act[16] and the Control of Asbestos Regulations[8]. The subsequent removal of identified ACM by specialist licenced contractors (as appropriate) will mitigate the risk to human health from release of asbestos fibres during demolition. The pre-demolition asbestos survey is considered tertiary mitigation as this is a legal requirement through the referenced regulations.
- **Pre-demolition hazardous materials survey** – this will be undertaken prior to demolition in any areas of the site where hazardous materials may be present, in accordance with the Health and Safety at Work Act[16]. The subsequent removal of any hazardous materials by specialist contractors (as appropriate) will mitigate the risk to human health from hazardous substances during demolition. The pre-demolition hazardous materials survey is considered tertiary mitigation as this is a legal requirement through the referenced regulations.
- **Outline CEMP** (Appendix 6.1) – this will include control measures for pollution prevention, spillages (such as oil, fuel, cement, chemicals etc.) and soil erosion or the generation of suspended solids during construction activities (including excavations and plant/wheel washing). This will include pollution prevention measures such as: bunded storage; designated wheel washing areas; settling basins; screening stockpiles of materials; dampening exposed soils and other measures as appropriate. The Outline CEMP also sets out requirements for ongoing liaison with relevant regulators including OCC, the EA and CDC. This will ensure that in the unlikely event of an accidental spillage, surface and groundwater will remain protected. The Outline CEMP is considered tertiary mitigation as this is a commitment by the Applicant, which will be secured through appropriate planning condition(s). Detailed CEMPs would be approved by CDC prior to the commencement of construction.
- **Geotechnical measures** – The presence of compressible and unstable ground, mostly associated with the Alluvium present at the Site, will be identified during the enabling works prior to the commencement of the main construction activities. Remedial measures to address issues with unstable and compressible ground during the construction phase will include temporary works and/or ground improvement (shoring of excavations, the design of haul road, piling mats and crane

platforms etc.) to protect human health during the construction phase, as well as general earthworks and foundation design to remove potential risks during the operational phase. Mitigation for compressible and unstable ground will be designed in accordance with guidance presented in CIRIA C572 [70] BRE FB75 [71] and BS 6031:2009 [72]. The remedial measures for compressible and unstable ground are considered tertiary mitigation as they inherent to the safe design of the Proposed Development.

- **Remediation Strategy** – A RSVP has been prepared and presents the required mitigation and monitoring measures to ensure that the Site is suitable for the end uses of the Proposed Development. The RSVP also includes the Verification Pan which presents how the mitigation measures will be documented and verified. Remediation will be undertaken in accordance with the legislative requirements discussed in Paragraph 15.2.1. The RSVP will be secured through appropriate planning condition(s). The following measures are included in the RSVP (Appendix 15.2) (Hydrock, 2023[2]), based on the findings of the ground investigations and risk assessments and is presented in the GIR (Appendix 15.1) (Hydrock, 2023[1]):
  - Development of method statements and risk assessments for construction works and the provision of personal protective equipment as appropriate to the activities being carried out.
  - Preparation of a Materials Management Plan (MMP) and Site Waste Management Plan (SWMP) based on the findings of the Ground Investigation report[1] (Appendix 15.1), future earthworks specifications, and cut to fill designs as appropriate.
  - Monitoring of gas and groundwater concentrations during compaction works and cover system installation to the landfill area.
  - Installation of an engineered cover system in the historical landfill area and importation and placement of subsoil/topsoil in line with a Qualified Person declared MMP. This will remove the pathways between contaminated soils and human health receptors, as well as reducing phytotoxic risks through the placement of ‘clean’ soils within the root zone.
  - Relocation of badger setts which are present in the landfill area, to selected locations under the control of suitably licensed ecologists. This will reduce the risks to human health from burrowing wildlife bringing potentially contaminated materials to the surface.
  - The landfill area has been identified as a ground gas source and parts of the Site have been identified as radon protection areas. Gas generation followed by migration and accumulation of gas in confined spaces during the construction phase is possible and relevant confined space regulations and guidance will need to be followed where man-entry is required into excavations or other confined spaces within these areas.

Completed Proposed Development

15.5.2 The following embedded design measures represent primary mitigation of relevance to the assessment for the operational phase of the Proposed Development:

- There is the potential for unknown contamination sources to be introduced through operational processes and localised spillages of fuel or chemicals (e.g. antifreeze, oils and lubricants associated with vehicle maintenance), which may be carried to

surface watercourses and underlying groundwater through surface run-off and leaching through the soil profile. Contaminants from operational processes and localised spillages of fuel or chemicals are likely to occur on hardstanding areas such as car parking and/or internally within buildings. Such areas will be subject to a controlled drainage scheme as part of the Proposed Development (see Appendix 16.2). This will minimise the contaminants reaching surface water and limit infiltration and permeation to groundwater.

- The permanent mitigation measures implemented during design and construction such as installation of radon protection measures and the engineered cover system, as detailed in the Remediation Strategy, will be present during operation.

15.6 Assessment of Effects – Construction

Potential effects on human health from exposure to contamination and/or ground gas associated with historical and current land use

15.6.1 No significant sources of contamination were identified across most of the Site during the ground investigations (Appendix 15.1), with the exception of the historical landfill site and some localised contamination noted within Made Ground. Where contaminated soils are exposed through earthworks or groundworks there is the potential for dermal contact (on-site only), incidental ingestion (on-site only) and/or inhalation of contaminated soil derived dust and asbestos fibres. For the purposes of this assessment, inhalation of asbestos fibres is considered separately to inhalation of dust.

15.6.2 Following implementation of embedded mitigation including the CEMP (see Section 15.5), the effect on human health (on-site construction workers and off-site users of the surrounding area (including users of the canal towpath and occupants of moored boats)) from exposure to contamination (excluding asbestos) would be temporary, short term and of negligible adverse significance. This is based on the magnitude of impact being negligible, on the high sensitivity receptor.

15.6.3 The effect on human health (on-site construction workers and off-site users of the surrounding area (including users of the canal towpath and occupants of moored boats)) from exposure to contamination (asbestos) would be permanent, short term and of negligible adverse significance based on the magnitude of impact being negligible, on the high sensitivity receptor.

15.6.4 Outside of the historical landfill, limited ground gas concentrations and flow rates were recorded. Within the landfill area, elevated ground gas concentrations and flow rates were recorded. No buildings are proposed on the landfill. During compaction works on the landfill, and placement of the cover system, monitoring will be undertaken in accordance with the Remediation Strategy.

15.6.5 With appropriate ground gas protection measures (as set out in Section 15.5), the effect on human health to all on and off-site receptors from exposure to ground gas would be temporary, short term and of negligible adverse significance. This is based on the magnitude of impact being negligible, on the high sensitivity receptor.

Potential for increased mobilisation of chemical contaminants into surface water and/or groundwater from site works

15.6.6 A limited number of elevated contaminants have been identified within soils across the Site. With the embedded mitigation measures in place, including the Outline CEMP that will manage the risks to surface waters and groundwater during the construction phase, the potential for increased mobilisation of chemical contaminants into surface waters and groundwater is limited.

15.6.7 No buildings are proposed on the landfill area. Whilst piling may be required in areas outside of the landfill, piling is not considered to pose an unacceptable risk to controlled waters.

15.6.8 The effect on surface water and groundwater from increased mobilisation of chemical contaminants would be temporary, short term and of negligible adverse significance. This is based on the magnitude of impact being negligible, on the medium sensitivity receptor.

Potential for mobilisation of contaminants from compaction works to historical landfill site

15.6.9 Based on the requirement for an engineered cover system above the landfill some compaction of the landfill and the placement of clean site won subsoil and topsoil will be required.

15.6.10 The effect on surface water and groundwater from mobilisation of chemical contaminants due to compaction works to the historical landfill would be temporary, short term and of negligible adverse significance. This is based on the magnitude of impact being negligible, on the medium sensitivity receptor (groundwater and surface water).

Temporary alteration of groundwater flow regime in relation to the baseflow to surface water features

15.6.11 Groundwater is present in the River Terrace Deposits at the Site, towards the base of the stratum. Based on the groundwater monitoring undertaken as part of the ground investigations (Hydrock, 2023 [1]) (Appendix 15.1), groundwater flow within the River Terrace Deposits is from the west of the Site (from the topographic high), to the east and south-east, although in the north of the Site groundwater flow is locally towards Rowel Brook (from the north and the south). In the far east of the Site (in the floodplain), groundwater flows are to the south and at a shallower hydraulic gradient, but potentially influenced by the Oxford Canal which borders the east of the Site.

15.6.12 Based on the data, groundwater flow in the far north of the Site (adjacent to Rushy Meadows SSSI) is to the south towards Rowel Brook. Consequently, it is unlikely that any impact from construction and operation of the Proposed Development will extend to the north, past Rowel Brook and be transmitted upgradient to the SSSI as this is ‘upstream’.

15.6.13 Surface water management and pollution prevention measures will be controlled during the construction phase through adherence to the Outline CEMP. Assuming effective implementation of these measures it is considered unlikely that any changes associated with construction works will significantly change the water levels to the north of Rowel Brook. As such, there would be no impact on Rushy Meadows SSSI. The effect of temporary alteration of groundwater flow regime to surface water features during the construction phase would be temporary, short term and of negligible adverse significance.

Additional Mitigation, Monitoring and Residual Effects

15.6.14 No additional mitigation measures or monitoring are required. Residual effects remain as previously stated.

15.7 Assessment of Effects - Completed Proposed Development

Potential effects on human health (on-site and off-site) from exposure to contamination and/or ground gas associated with historical and current land use

15.7.1 Following the implementation of the engineered cover system on the former landfill site, there will be no pathway between the contaminated soils beneath the Site and human health in this location for the completed Proposed Development.

15.7.2 The effect on human health from exposure to contamination would be permanent, long term and of negligible beneficial significance.

15.7.3 In relation to ground gas (including radon), with the installation of ground gas/radon protection measures as appropriate, there will be limited potential for migration and accumulation of gas within confined spaces. The effect on human health on-site future site users from exposure to ground gas would be permanent, long term and of moderate beneficial significance based on the magnitude of impact being low, on the high sensitivity receptor.

15.7.4 The effect on human health to off-site users of surrounding area (including users of the canal towpath and occupants of moored boats)) from exposure to ground gas would be permanent, long term and of negligible beneficial significance based on the magnitude of impact being negligible, on the high sensitivity receptor.

Potential for increased mobilisation of chemical contaminants into surface water and/or groundwater

15.7.5 The completed Proposed Development is unlikely to increase mobilisation of chemical contaminants into surface water and/or groundwater. It is more likely that chemical mobilisation will decrease due the presence of hardstanding and drainage systems, which will:

- reduce infiltration into the underlying soils over large areas;
- focus infiltration to smaller soakaway systems (installed in clean, natural soils); or
- divert surface water runoff to attenuation basins, prior to discharge to the brook.

15.7.6 Groundwater data obtained during monitoring indicates the landfill is not affecting Controlled Waters.

15.7.7 The effect on surface water and groundwater from increased mobilisation of chemical contaminants would be permanent, long term and of moderate/minor beneficial significance. This is based on the magnitude of impact being low, on the medium sensitivity receptor.

Alteration of groundwater flow regime in relation to the baseflow to surface water features

15.7.8 Given that infiltration will be used where possible and attenuation basins will be installed as part of the surface water management works (which will discharge at greenfield runoff rates), it is unlikely that any changes associated with the completed Proposed Development will significantly change the water levels to the north of Rowel Brook (and as such, will not impact Rushy Meadows SSSI).

15.7.9 The effect of alteration of the groundwater flow regime in relation to the baseflow to surface water would be permanent, long term and of negligible adverse significance based on the magnitude of impact being negligible, on the medium sensitivity receptor.

Potential degradation of plastic pipes from contaminants

15.7.10 As no utilities or pipework are to be installed within the landfill area, no mitigation is required.

15.7.11 The effect of degradation of plastic pipes from contaminants would be permanent, long term and of negligible adverse significance.

Potential permeation of water supply pipes from contaminants

15.7.12 As no utilities or pipework are to be installed within the landfill area, no mitigation is required.

15.7.13 The effect of permeation of water supply pipes from contaminants would be permanent, long term and of negligible adverse significance.

Potential effects to new buildings (primarily foundations), from any aggressive ground conditions

15.7.14 Following the embedded mitigation, namely the use of appropriate concrete design class, there will be limited potential for aggressive ground conditions to affect new buildings.

15.7.15 The effect to new buildings from any aggressive ground conditions would be permanent, long term and of negligible beneficial significance.

Potential effects to proposed new landscaped areas from the release of any potential contamination

15.7.16 Following the embedded mitigation, namely the presence of the engineered cover system over the former landfill site, there will be limited potential for the release of contamination to affect new landscaping areas as the root zone will be within ‘clean’ material.

15.7.17 The effects to proposed new landscaped areas from the release of any potential contamination would therefore be permanent, long term and of negligible beneficial significance.

Mitigation, Monitoring and Residual Effects

15.7.18 No additional mitigation or monitoring measures are required. Residual effects remain as previously stated.

Table 15.9: Summary of Residual Effects

Effect	Receptor (Sensitivity)	Geographic & Temporal Scale	Magnitude of Impact	Significance of Effect	Additional Mitigation and Monitoring	Significance of Residual Effect
Construction						
Exposure to contamination (excluding asbestos) associated with historical and current land use	Human Health – construction workers (High)	Local, temporary	Negligible	Negligible Adverse	No addition mitigation and monitoring required	Negligible Adverse
	Human Health – Off-site users of surrounding area (including users of the canal towpath and occupants of moored boats) (High)	Local, temporary	Negligible	Negligible Adverse	No addition mitigation and monitoring required	Negligible Adverse
Exposure to contamination (asbestos) associated with historical and current land use	Human Health – construction workers (High)	Local, permanent	Negligible	Negligible Adverse	No additional mitigation and monitoring required	Negligible Adverse
	Human Health – Off-site users of surrounding area (including users of the canal towpath and occupants of moored boats) (High)	Local, permanent	Negligible	Negligible Adverse	No addition mitigation and monitoring required	Negligible Adverse
Exposure to ground gas associated with	Human Health – construction workers (High)	Local, temporary	Negligible	Negligible Adverse	No addition mitigation and monitoring required	Negligible Adverse

Effect	Receptor (Sensitivity)	Geographic & Temporal Scale	Magnitude of Impact	Significance of Effect	Additional Mitigation and Monitoring	Significance of Residual Effect
historical and current land use	Human Health – Off-site users of surrounding area (including users of the canal towpath and occupants of moored boats) (High)	Local, temporary	Negligible	Negligible Adverse	No addition mitigation and monitoring required	Negligible Adverse
Increased mobilisation of chemical contaminants into surface water and/or groundwater from site works	Surface water (Medium)	Local, temporary	Negligible	Negligible Adverse	No addition mitigation and monitoring required	Negligible Adverse
	Groundwater (Medium	Local, temporary	Negligible	Negligible Adverse	No addition mitigation and monitoring required	Negligible Adverse
Mobilisation of contaminants from compaction works to historical landfill site	Surface water (Medium)	Local, temporary	Negligible	Negligible Adverse	No addition mitigation and monitoring required	Negligible Adverse
	Groundwater (Medium	Local, temporary	Negligible	Negligible Adverse	No addition mitigation and monitoring required	Negligible Adverse
Temporary alteration of groundwater flow regime in relation to the baseflow to	Rushy Meadows SSSI (High)	Local, temporary	Negligible	Negligible Adverse	No addition mitigation and monitoring required	Negligible Adverse
	Surface water (Medium)	Local, temporary	Negligible	Negligible Adverse	No addition mitigation and monitoring required	Negligible Adverse

Effect	Receptor (Sensitivity)	Geographic & Temporal Scale	Magnitude of Impact	Significance of Effect	Additional Mitigation and Monitoring	Significance of Residual Effect
surface water features						
Completed Proposed Development						
Exposure to contamination associated with historical and current land use	Human Health – on-site future site users (High)	Local, temporary	Negligible	Negligible Beneficial	No addition mitigation and monitoring required	Negligible Beneficial
	Human Health – Off-site users of surrounding area (including users of the canal towpath and occupants of moored boats) (High)	Local, permanent	Negligible	Negligible Beneficial	No addition mitigation and monitoring required	Negligible Beneficial
Exposure to ground gas associated with historical and current land use	Human Health – on-site future site users (High)	Local, permanent	Low	Moderate Beneficial	No addition mitigation and monitoring required	Moderate Beneficial
	Human Health – Off-site users of surrounding area (including users of the canal towpath and occupants of moored boats) (High)	Local, permanent	Negligible	Negligible Beneficial	No addition mitigation and monitoring required	Negligible Beneficial
Increased mobilisation of chemical	Surface water (Medium)	Local, permanent	Low	Moderate/Minor Beneficial	No addition mitigation and monitoring required	Moderate/Minor Beneficial

Effect	Receptor (Sensitivity)	Geographic & Temporal Scale	Magnitude of Impact	Significance of Effect	Additional Mitigation and Monitoring	Significance of Residual Effect
contaminants into surface water and/or groundwater	Groundwater (Medium)	Local, permanent	Low	Moderate/Minor Beneficial	No addition mitigation and monitoring required	Moderate/Minor Beneficial
Alteration of groundwater flow regime in relation to the baseflow to surface water features	Rushy Meadows SSSI (High)	Local, permanent	Negligible	Negligible Adverse	No addition mitigation and monitoring required	Negligible Adverse
	Surface water (Medium)	Local, permanent	Negligible	Negligible Adverse	No addition mitigation and monitoring required	Negligible Adverse
Degradation of plastic pipes from contaminants	Plastic pipes (Negligible)	Local, permanent	Negligible	Negligible Adverse	No addition mitigation and monitoring required	Negligible Adverse
Permeation of water supply pipes from contaminants	Human Health (High)	Local, permanent	Negligible	Negligible Adverse	No addition mitigation and monitoring required	Negligible Adverse
Aggressive ground conditions	Below ground infrastructure (Negligible)	Local, permanent	Negligible	Negligible Beneficial	No addition mitigation and monitoring required	Negligible Beneficial
Effects to proposed new landscaped areas from the release of any potential contamination	New landscaped areas (Low)	Local, permanent	Negligible	Negligible Beneficial	No addition mitigation and monitoring required	Negligible Beneficial

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